Metropolis

Fundació Politècnica de Catalunya: la formació contínua
UNIVERSITAT POLITÈCNICA DE CATALUNYA

URBAN SOLID WASTE MANAGEMENT

Municipal Waste and its Management

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Municipal Waste and its Management

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PRESENTATION

The world's big cities confront the difficult challenge of the environmental management of their urban centers every day. Daily public, commercial and industrial life involves the challenge of properly managing municipal waste to try to promote the reduction of waste production and make better use of recoverable fractions.

Metropolis Commission 3 has tried throughout its working life to promote the sustainable management of resources and to provide member cities with the expertise and instruments that the cities have been developing. The technical assistance programs, seminars and exchanges have favored this exchange.

We have now gathered all the technical issues and concrete experiences into this Waste Management Manual, so it may be used by local politicians and technicians as a good practices guide. The aim was to design a training manual that could contribute to environmental protection, waste management and the quality of life of our citizens.

Jose Cuervo
President, Commission 3 Metropolis
President of the Metropolitan Environment Organization
for the Barcelona Metropolitan Area

Cities and people face the important duty of promoting sustainability in the broad sense of the word. The protection of the environment and resources and the wellbeing of our citizens are all part of this strategy.

Solidarity and international and inter-generational cooperation are values that cities and associations like Metropolis should promote.

Commission 3 has dedicated a great deal of human and economic resources to promoting the exchange of knowledge, technology, experience and training.

Training technicians and politicians with regard to waste management has been a cornerstone of the Commission's work. With the participation and coordination of the Polytechnic University of Catalonia, we have prepared the Municipal Waste Management Manual to be an ongoing instrument that can be used by cities and their waste technicians.

The Manual not only attempts to explain the technical values of the efficient management of municipal waste, but also defend the values of environmental education and public participation in this process, along with respect for clean technologies adapted to the realities and requirements of the different countries, in accordance with their own cultures and languages.

Enric Garriga Elies
Technical Coordinator, Commission 3

INTRODUCTION

This Municipal Waste Management Manual is the result of the concern and activity of many people who work in the sector. Starting with the Metropolis Commission 3 training courses devoted to municipal waste management, we gathered together the material of most interest to the different groups at which it is aimed. The Manual is divided into five basic chapters: The Problem of Municipal Waste and How to Manage It; Waste Recycling, Composting and Methanization; Waste Incineration and Controlled Dumping; Legislation and Human and Financial Resources and Environmental Education, Communication and Public Participation.

With this material we aim to provide a support that will be useful to the countries and cities that have yet to begin or that need to improve management in the vast field of waste. Using original situations that differed in terms of each country as the starting point, our aim was to work toward improved levels of organization and management of municipal solid waste in a comprehensive and sustainable manner. As a good practices guide, the Manual provides information on technologies, processes and methodologies successfully applied in other countries and which directly impact resource use, waste assessment and the preservation of the environment.

Because the Manual was mainly prepared in Barcelona, it devotes most attention to the waste-management program in place in Catalonia. The legislation and regulations set out herein also refer to those currently in force in Catalonia and should thus be complemented with those in force in each country.

With the aim of providing plural visions and realities of other contexts, the Manual introduces practices in municipal solid waste management in a number of Metropolis member cities, such as the states of Mexico and Jalisco and the cities of Barcelona, Buenos Aires, Quito, Cuenca, Montreal, Calcutta, Alexandria and Havana.

Josep Maria Casas Sabata
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URBAN SOLID WASTE MANAGEMENT

1. The Problem of Municipal Waste and How to Manage It

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1. THE PROBLEM OF MUNICIPAL WASTE AND HOW TO MANAGE IT

1.1. Introduction and Definition of Waste

Waste is anything generated as an unwanted consequence of human activity and, in general, of any living thing. In order to survive, human beings must continually transform certain products they have at their disposal into others that they can assimilate, consequently generating a part that is waste.

Natural systems do not generate accumulated waste. The natural cycle of the material is closed and chemical elements make and unmake a whole series of structures without generating any type of waste that cannot be assimilated by nature itself.

It is human intervention that breaks this natural cycle of material, when man wants to obtain goods he needs to progress and improve his quality of life. Man extracts the raw materials and after processing and using them leaves behind a series of remains that cannot be assimilated but which instead accumulate or are dumped in areas and places often without any type of treatment.

The problem of increasing waste production is already a matter of world interest. Reducing waste at the point where it is produced and recycling it are the best ways to halt the increasing wave of the production of waste at all levels.

By 2050, the recycling sector and industries that use clean technologies will have replaced today's polluting industries.

The modern 'throwaway' society squanders so much energy and generates so much CO_2, acid rain, waste pollution and toxic waste that it is wiping itself out.

This is one of the grave aberrations that will have to be paid for in the future.

We must avoid all waste that is not essential. The future hierarchy of the use of materials must eventually meet the following sequence: maximum use and reuse of materials; recycling to make new products; safe incineration, where necessary, to make the best use of energy and, finally, dumping in safe and controlled garbage dumps.

The concept of waste is defined in different ways:

According to the OECD (Organisation for Economic Cooperation and Development), waste is defined as: "*materials generated in production and consumption activities that do not have, in the context in which they are produced, any economic value*".

It defines urban solid waste as: "*Waste generated in private households, businesses, offices and services, as well as waste not classified as hazardous and which by its nature or composition could resemble the waste produced in the those places or activities*".

Urban waste is also considered to include: "*Waste from the cleaning of public roads, green areas, recreation areas and beaches. Dead domestic animals, as well as abandoned furniture, tools and vehicles. Garbage waste from minor construction works and household repair work*".

1.2. Basic Regulations and Classifications

For the implementation of the course, we will use the following basic legislation:

European Community

1. Directive on Toxic and Hazardous Waste
   78/EEC of 31-03-1978
2. Directive on Waste Dumping
   91/190/EEC of 22-07-1991
3. Directive on the European Waste Catalogue
   94/904/EEC and 2000/532/EC

Spain

4. Spanish Waste Act
   10/1998 BOE 96 of 22-04-1998
5. Order on Waste Assessment and Elimination Operations and the European Waste List
   304/2002 BOE 43 of 19-02-2002

Catalonia

6. Catalan Waste Act
   6/1993 DOGC 1776 of 28-07-1993
7. Acts Modifying the Above Act
   15/2003 and 16/2003 DOGC 3915 of 01-07-2003

Act 6/1993 of 15 July 1993 (DOGC 1776, 28-07-1993), regulating waste in Catalonia, ends with the previously mentioned classification of household and industrial waste and the differences according to the type of treatment that each requires, classifying it into three groups:

Special Waste:

Special waste is all waste included in the sphere of application of Directive 91/689/EC of 12 December.

It is basically waste that prior to Act 6/1993 was called industrial waste and which includes organic solvents, ethers, organochlorine compounds, pesticides, industrial oils, creosotes, salt and metal baths, cyanides, heavy metal compounds, PCBs and PCTs, dioxins, etc.

Non-Special Waste:

Non-special waste is waste not classified as special or inert. It includes plastic, rubber, leather, textile packaging, etc.

Inert Waste:

Inert waste is that which, once dumped in a tip, does not undergo any significant physical, chemical or biological transformation and which meets the legally determined leaching criteria. It includes tiling waste, slag, scrap iron, gravel, etc.

1.3. Total Waste Generation and Sources

The total amount of solid waste generated in the European Union, Spain and Catalonia is approximately:

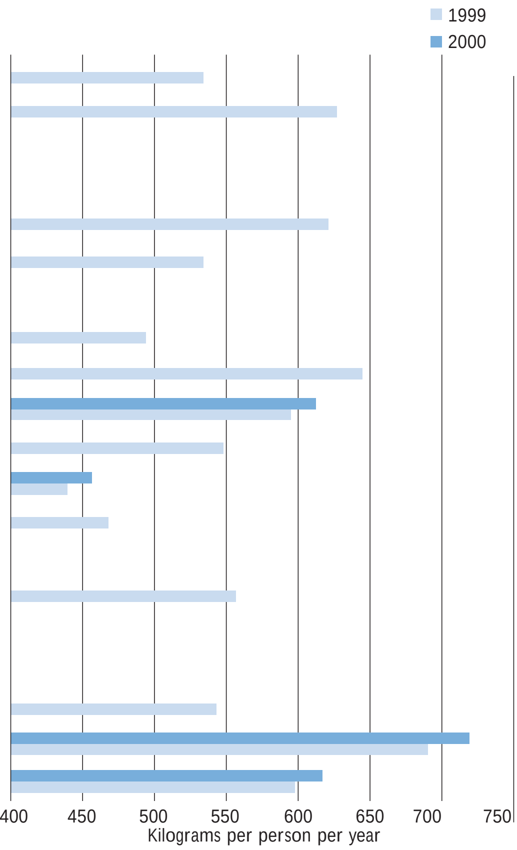
European Union	Spain	Catalonia
2.000 million tons/year	275 million tons/year	40 million tons/year

This waste is approximately distributed according to the type and amounts indicated below (Source: MOPT and Waste Board 2004):

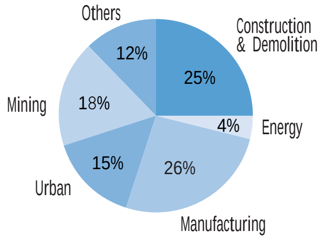
Type of Waste	Spain M ton/year	Catalonia M ton/year	Catalonia Kg/inhabitat day
Cattle	92.0		
Agricultural	35.0	19.0	10.0
Forestry	17.0		
Mining & Quarries	70.0	11.0	5.0
Solid & Urban	45.0	3.0	1.3
Industrial	14.0	5.0	1.7
Building Rubble	—	2.0	1.0
Nuclear	2.500 m³/year	—	—

Tabla 1.3a
Generation of Municipal Waste in European Countries Kg/person/year.

		1999	2000
Belgium	B	534.77	
Denmark	DK	626.51	
Germany	D		
Greece	EL		
Spain	E	621.16	
France	F	539.50	
Ireland	IRL		
Italy	I	492.32	
Luxemburg	L	647.72	
Holland	NL	593.84	610.88
Austria	A	548.82	
Portugal	P	437.30	453.21
Finland	FIN	465.15	
Sweden	S		
United Kingdom	UK	557.77	
	US		
	JAPAN		
	EU15	545.00	
	IS	685.50	713.14
	NO	596.13	615.16



Waste Production by Sector in Europe



1.4. Municipal Household Waste or Urban Solid Waste (USW)

Municipal Household Waste

This is waste generated in private households, businesses, offices and services and also waste not considered special waste and which, by its nature or composition, could resemble the waste produced in the abovementioned places or activities.

Municipal waste is also considered to include:

- Waste from road-cleaning operations
- Waste from green areas
- Waste from recreation areas and beaches
- Dead household animals
- Abandoned furniture, tools and vehicles
- Waste and rubble from minor construction works and household repair work

The amount of urban solid waste (USW) generated depends on many parameters: standard of living, time of the year and populational movements (vacations, festivals, weekends, etc).

The United States produces the most household waste, with 800 kg/inhabitant/year. The country that produces the most waste in Europe is Holland, with more than 500 kg/inhabitant/year. In Spain, Catalonia produces the most waste, with 475 kg/inhabitant/year.

Garbage Bins

It shortly became a requirement to have two bins in the home, or one with two compartments, to separate daily rubbish. One was for organic material (food scraps, meat, fish, vegetables, fruit, peelings, shells, coffee grains, etc.), which could be transformed into compost, and the other was for the most common types of inert materials (inorganic products, pieces of glass, used tins, broken china, cartons, plastic, scraps of metal, etc.), to be taken to the garbage dump or a selection plant.

Selective Collection

Containers appropriate for different types of materials, located in the street and, wherever possible, close to people's homes. There are different containers for paper/cardboard, glass, tin and, hopefully in the near future, plastic and cartons. Other waste, such as batteries, surplus or expired medicine, clothes, etc., can be taken to specific collection sites.

Household Waste Requiring Specific Management

Some waste generated in the domestic sphere has characteristics requiring specific management:

- Glues and pastes
- Paint, varnish and solvents
- Insecticides and pesticides
- Household mineral oils
- Additives and other automotive fluids
- Medicines
- The recipients and containers of the abovementioned materials
- Electrical and electronic waste
- Cleaning products
- Spent batteries and accumulators

Commercial Waste

This is municipal waste generated by commercial activity, e.g., the hotel industry, bars, markets, offices and services.

It also includes waste that originates in industry and which is considered to resemble municipal waste.

The management of commercial waste is the responsibility of the person behind the activity that generates it, who should manage the waste in line with the obligations on waste holders or producers.

An authorized manager should be contacted so the waste can be recovered (wherever possible), released to a clean point or dumped in a controlled tip.

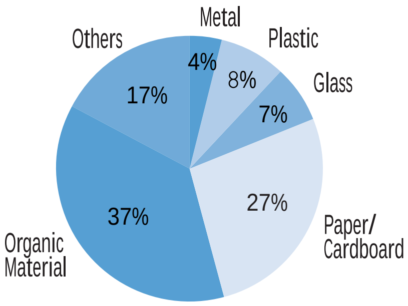
1.4.1. Average Waste Composition

COUNTRY	GENERATION	COMPOSITION						
	Kg/person/year	Paper/Cardboard	Glass	Metal	Plastic	Textile	Organic	Others
Austria	325	21.9%	7.8%	5.2%	9.8%	2.2%	29.8%	23.3%
Belgium	343	30.0%	8.0%	4.0%	4.0%		45.0%	9.0%
Czech Rep	251	9.5%	7.6%	6.4%	5.0%		28.0%	21.0%
Denmark	475	29.0%	4.0%	13.0%	5.0%		28.0%	21.0%
Finland	624	51.0%	6.0%	2.0%	5.0%	2.0%	29.0%	5.0%
France	328	31.0%	12.0%	6.0%	10.0%	4.0%	25.0%	12.0%
Germany	350	17.9%	9.2%	3.2%	5.4%		44.0%	20.3%
Greece	296	22.0%	3.5%	4.2%	10.5%		48.5%	11.3%
Hungary	463	21.5%	5.5%	4.5%	6.0%		31.3%	31.2%
Iceland	314	37.0%	5.0%	6.0%	9.0%		15.0%	28.0%
Ireland	312	34.0%	5.0%	4.0%	15.0%	3.0%	24.0%	15.0%
Italy	348	23.0%	6.0%	3.0%	7.0%		47.0%	14.0%
Luxemburg	445	17.0%	7.0%	3.0%	6.0%		34.0%	33.0%
Netherlands	497	24.7%	5.0%	3.7%	8.1%	2.1%	51.9%	4.5%
Norway	472	31.0%	5.5%	4.5%	6.0%		30.0%	23.0%
Poland	338	10.0%	12.0%	8.0%	10.0%		38.0%	22.0%
Portugal	257	23.0%	3.0%	4.0%	4.0%		60.0%	6.0%
Spain	322	20.0%	8.0%	4.0%	7.0%	1.6%	49.0%	10.4%
Sweden	374	44.0%	8.0%	2.0%	7.0%		30.0%	9.0%
Switzerland	441	31.0%	8.0%	6.0%	15.0%	3.1%	30.0%	6.9%
Turkey	353	37.0%	9.0%	7.0%	10.0%		19.0%	18.0%
UK	348	34.8%	9.1%	7.3%	11.3%	2.2%	19.8%	15.5%
USA	720	35.6%	8.4%	8.9%	7.3%	2.0%	29.0%	8.8%

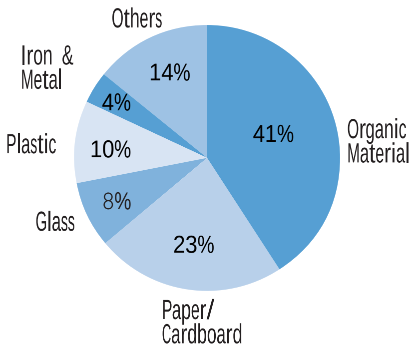
Ref. White et al. (1995) and sources anoted therein.

1.4.2. Waste Bag Characteristic:

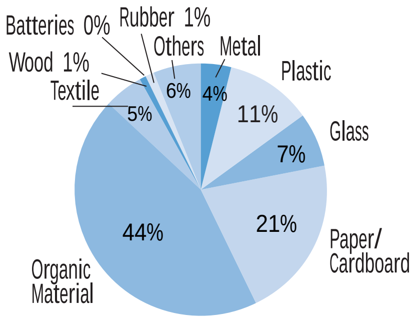
USW Composition in the European Union



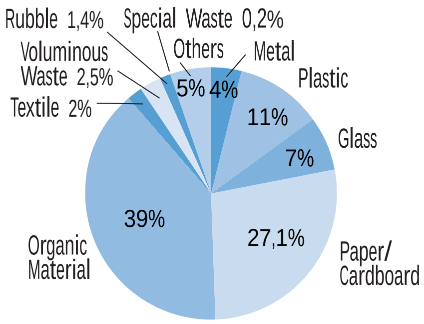
Average Composition of a Waste Bag in Catalonia



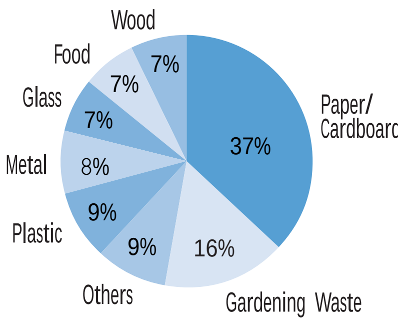
USW Composition in Spain



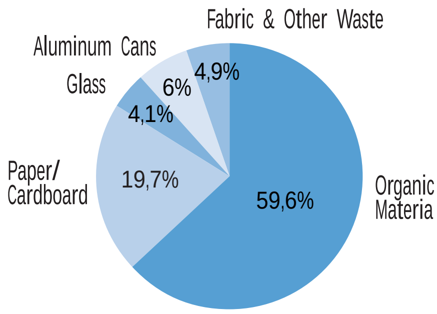
Average Municipal Waste in the Barcelona Metropolitan Area



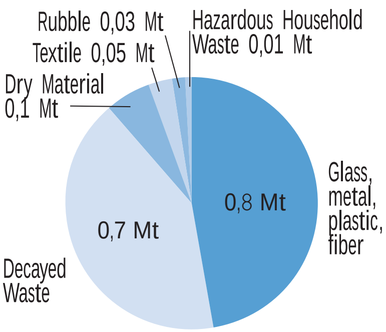
USW Composition in the United States



USW Composition in Havana



USW Composition Montreal

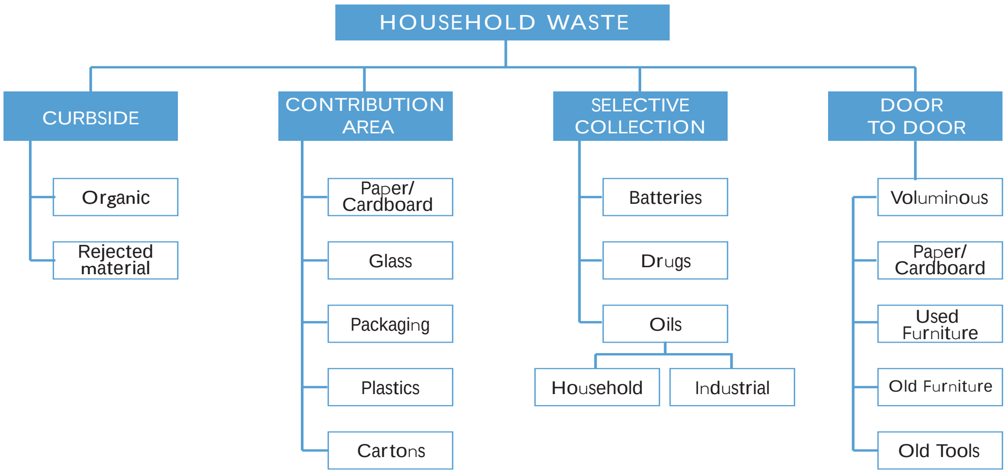


USW Composition of Cities in India

Type of Waste	Delhi	Chennai	Bangalore	Bombai	Calcutta
Paper/Cardboard	5.88	5.90	1.5	5.20	0.14
Metals	0.59	0.70	0.10	0.13	0.56
Glass	0.31	—	0.29	0.52	0.24
Textile	3.56	7.07	3.10	3.26	0.26
Plastic, Leather & Rubber	1.46	—	0.90	—	1.54
Wood	0.42	—	0.20	17.57	—
Organic	1.14	—	0.10	0.50	0.47
Rocks	5.96	13.74	5.90	—	10.56
Ash	22.95	15.38	12.00	15.45	53.68
Fermentable organic material	57.71	56.24	76.00	29.37	40.58

1.4.3. Comprehensive Municipal Waste Management

The comprehensive management of municipal waste can be simplified in line with the following diagram:



Comprehensive management includes the selective collection of different types of waste that can be collected in areas known as 'clean points'.

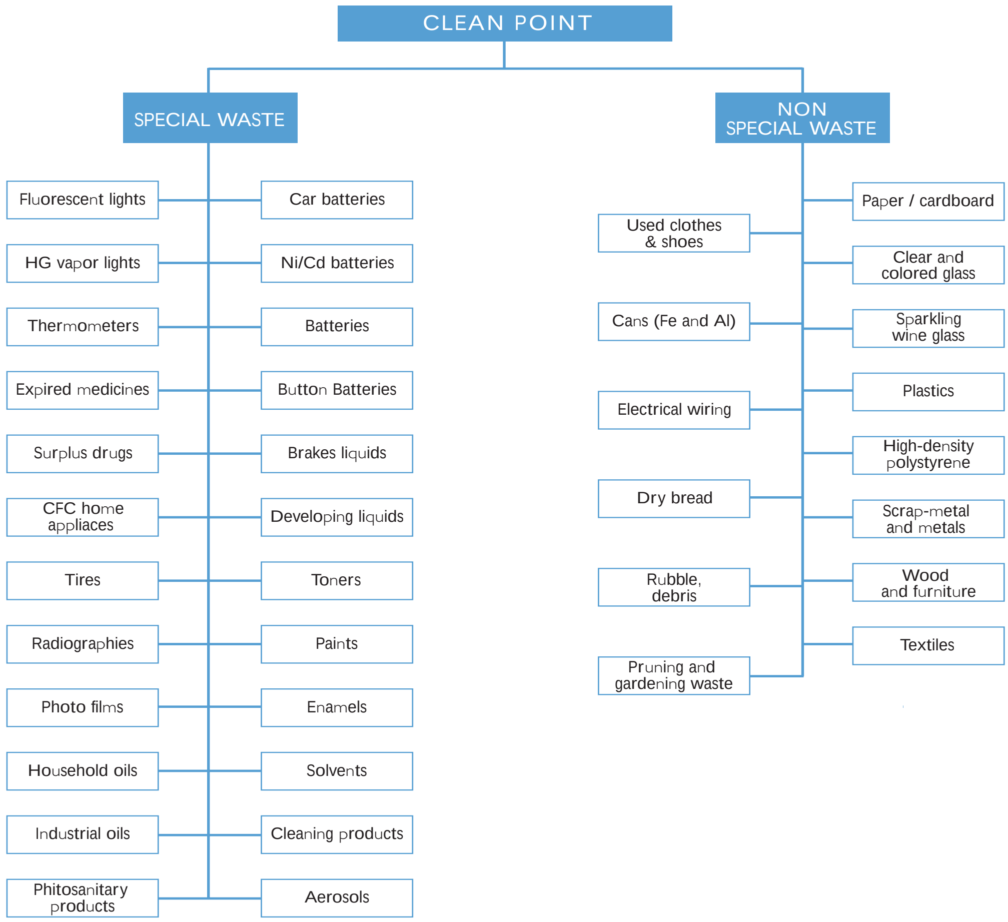
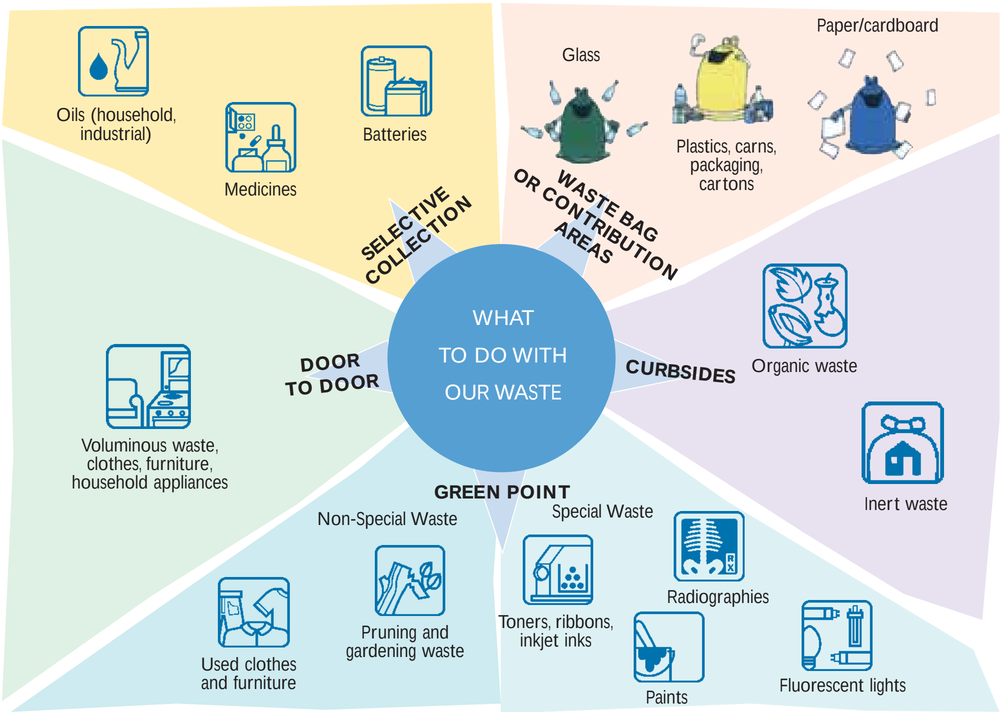


Fig. 1.4a
Household Waste Dumping Sites.



1.5. Waste Collection Systems

1.5.1. Containers in the Street, Close to Households

Since the 1980s, containers have been the traditional method for collecting the household and commercial waste generated by the public. This method represents a major advance over the door-to-door collection that was carried out previously.

Containers are usually located within 50 meters of people's homes.

The municipal evolution experienced by cities and the changes introduced in the waste management model have, however, required the incorporation of significant modifications to the container models used. The design has been gradually modernized and the way of emptying them optimized to adapt to the characteristics of the streets, the needs of the public and the new systems of selective collection.

In areas with new buildings or already constructed buildings, where town-planning and economic conditions allow, it is even possible to bury the containers underground or implement other waste collection systems.

Although most people have got used to using rubbish containers in the streets, the difficulty in placing them in particular parts of a city or the trouble that cleaning and collection operations may occasionally cause people have led to other systems also being developed.

Fig. 1.5a
Range of Containers for Collecting Municipal Waste.


Igloo container for paper


Igloo container for glass


Igloo container for tins

Metal container for paper


Metal container for glass

Metal container for packaging

Containers with different uses in different colors

Battery container


Animal excrement container


Swinging cylindrical paper bin


Polyethylene paper bin with stand


Double-opening polyethylene paper bin


Compost container


Compost container

Side-Loading Containers

Side-loading containers have a greater capacity than traditional containers. Increased capacity means fewer containers on the street and a rise in the volume/area ratio thanks to the installation of 3,200-liter side-loading containers, except in areas where particular street characteristics make their installation unadvisable (narrow or steep streets). They are called 'side loading' because of the adapted collection vehicles that automatically lift the containers: the truck parks near the container and lifts and empties it with the aid of articulated arms. This method was also designed with the idea that it would reduce sound levels. Side-loading containers are today used to collect different waste fractions. The fraction is determined by the color of the container or another type of visual identifier on the outside of the container.

Fig. 1.5b
Side-loading Garbage Trucks
(Barcelona Metropolitan Organization).

Two-Compartment Containers

Two-compartment containers are used to collect organic material separately from non-recyclable waste that cannot be deposited in any other type of selective-collection container or taken to a recovery and recycling center (e.g., dirty paper and plastic, aluminum paper, ceramic waste and leather, wool and cotton waste, etc.). Each compartment is identified through the use of a different color, facilitating separation at the point of generation.

The main advantage of this model is the reduction in the number of journeys the garbage trucks have to make because the especially adapted vehicles can remove both fractions at once. The system also makes it possible to reduce the number of containers located on the street.

Two-compartment containers have so far been implemented as a pioneering method in various areas of the cities of Barcelona, Hospitalet de Llobregat and Ripollet.

Collection of Organic Material in Containers

Some cities have chosen to collect organic material in containers exclusively for this purpose. The containers are located next to the other containers and allow people to deposit bags of previously selected organic waste fractions at the point of generation.

Simultaneous Collection in Colored Bags

Other cities have chosen to employ regular containers for collecting organic fractions at the same time as other fractions. In order to differentiate between the two fractions, people deposit organic waste in orange-colored bags and other waste in regular bags. The bags with different fractions are collected by a single garbage truck and separated according to their color, using an Optibag optical selection system at the Ecopark. Badalona and Barcelona have put this collection system into practice. The Optibag consists of a system of optical readers that distinguish the bag by its color. The Barcelona Ecopark uses this separation system to perform a differentiated and more efficient treatment of organic waste.

Underground Containers

These containers make it possible to store waste underground, which has a number of advantages including gaining space on the street, reducing the visual impact and noise and making a cleaner environment.

This system has been chosen by the city of Castellbisbal and is also applied in various parts of Barcelona (Rambla de Prat, Santa Madrona Square, Vila de Madrid Square, etc.). It is also being tried out across other points of the city.

1.5.2. Contribution Areas

These are areas located at a maximum of 150 meters from people's homes. They are usually placed at a ratio of 500 inhabitants/container. They include three containers for collecting inert waste, e.g., paper/cardboard, glass and packaging. Igloo containers are gradually being replaced by side-loading containers.

1.5.3. Door-to-Door

This involves different fractions of household waste (previously left in containers on the streets) being collected from people's homes on particular days of the week.

The idea behind door-to-door collection is to facilitate separation at the point of generation as much as possible and discourage non-participative attitudes, so that in practice it becomes almost impossible to not collaborate in the separation of household waste. In some areas with narrow streets that garbage trucks cannot access, it is the only way to offer an effective service.

In 2002, the city of Tiana, in Catalonia, initiated a door-to-door collection system with the goal of facilitating separation at the point of generation as much as possible and the dumping of each fraction through an appropriate channel. The system led to a cleaner city and made the public more aware of the problems of waste.

This new system makes it possible to recover up to 80% of waste, meaning Tiana was able to present premium results with respect to metropolitan selective collection. In the wake of this success, the city received various awards from the Department for the Environment at the Generalitat of Catalonia in recognition of the activities that made it possible to develop a better selective collection system. Torrelles de Llobregat began a door-to-door collection system in January 2003. All the containers, except the ones for glass, were removed from the public street and rubbish is now left in doorways at a particular time of the day. Organic material is collected three times a week, non-organic material twice a week and paper once a week. The aim of removing the containers was to make a cleaner, less smelly city that made optimal use of public roads. A further aim was to stop containers from being moved around, something that households had been long calling for.

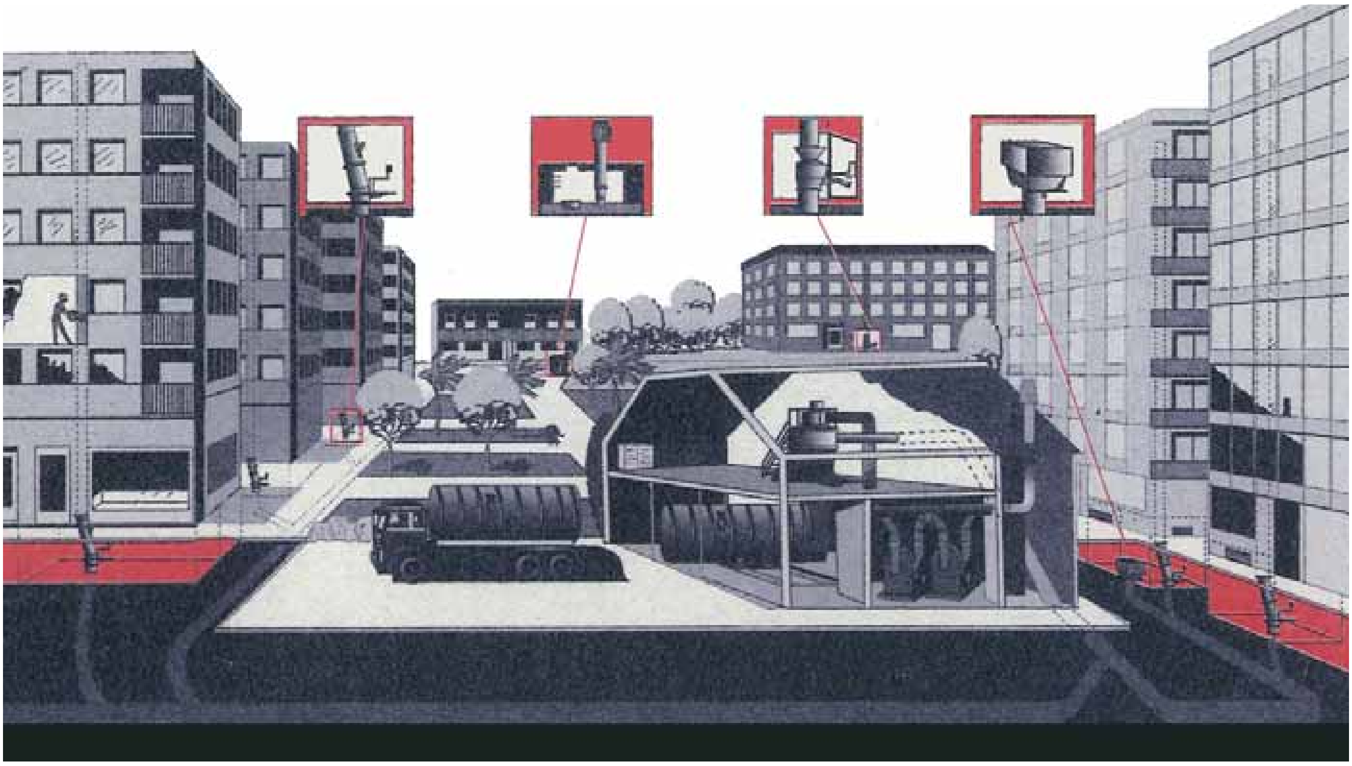
1.5.4. Pneumatic Systems

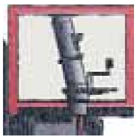
These modern and efficient collection systems are flexible and user-friendly and do not affect vehicle or pedestrian traffic on the streets.

With pneumatic collection systems, waste is transported via underground pipes from the point of generation (households, commercial premises, etc.) to a drop-off center or specific garbage truck. Rubbish is deposited in a number of boxes installed inside the buildings (in the case of new buildings that incorporate this system) or on the public street (in the case of older buildings) and compacted in hermetically sealed containers before being transported for final treatment. To date, the system has been successfully implemented in different areas of the cities of Barcelona, Badalona and Cerdanyola del Vallès.

Fixed System. The collection cycle begins inside apartment blocks or on the street. Garbage bags are deposited in a sluice at the top of a vertical pipe that runs downward. The bags fall with the effects of gravity to a valve installed in the basement, which is kept closed, where they are stored. The pneumatic operating valve connects to a network of horizontal pipes that carry the waste underneath the roads to a drop-off center.

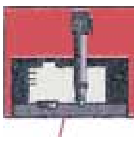
Mobile System. The collection cycle begins in the street, where containers that look like mailboxes have been installed and which are interconnected underground. Aspiration is carried out by a truck connected to one end of the circuit.



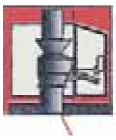


The rubbish is aspirated by the air current when the waste valves located at the bottom of the vertical pipes are opened.

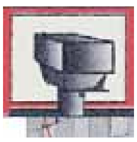
Fig. 1.5c
Pneumatic rubbish collection system in blocks of apartments (Subproducts Waste Stock Exchange, Barcelona).



In the case of free-standing houses, rubbish is aspirated by valves located underneath the rubbish boxes located outside the homes.



In reduced spaces, the rubbish is aspirated by specially designed valves.



Air is introduced into the system through air valves located at the ends of each arm.

1.6. Contribution Centers: Drop-off Centers or Green Points

Some municipal waste does not require a specific household-based collection system of the type used for glass, paper, plastic, or, in some places, organic material. However, the public may actively participate in selective collection for subsequent recycling, reuse or appropriate treatment. This involves waste such as ink cartridges, toners, consumer durables, electronic equipment, scrap iron and metals, motor oils, tires and car batteries, batteries, clothes and shoes, paints, varnishes and fluorescent bulbs, etc.

Recovery and recycling centers (also known as 'Green Points' or 'Clean Points') are selective receiving and storage centers for selective waste not subject to household-based collection. They reduce the amount of rubbish that will end up in controlled tips, separate hazardous waste, prevent uncontrolled dumping and make the most of waste that is potentially recyclable or reusable.

Management begins in the recovery and recycling centers, where material in a good state is separated to be reused by groups who request it, and other material that is potentially hazardous for health or for the environment is sent to treatment facilities.

The city of Barcelona has a mobile selective collection service called the Mobile Green Point that consists of four garbage trucks that meet all the functions of a Green Point. People can take their household waste to be distributed to the specific treatment plants, either to recycle it or prevent it from polluting.

The city of Barcelona also has a number of Green Points in the neighborhoods. These facilities meet the functions of recovery and recycling centers but are located close to people's homes, thus enabling people to take used material that can later be reused or recycled.

The Green Points in the neighborhoods can also be used to resolve any question about household waste management (clothes, accessories, household appliances, electronic equipment, computer equipment and aerosols) by approaching the staff that works there.

Each recovery and recycling center is run by a local manager who has the collaboration of a joint logistics manager, in charge of transferring the material collected in the different recovery and recycling centers to the specialized treatment centers. The recovery and recycling center is just a temporary facility for the waste, which will later continue the recycling process. The law that regulates waste in Catalonia states that all municipalities of more than 5,000 inhabitants must have their own recovery and recycling center. It is anticipated that there will be 42 up and running across the metropolitan area by 2006 and that each town will also have at least one such facility.

Fig. 1.6a
Recovery and Recycling Center, or Clean Point (Catalan Waste Management Agency, Barcelona).

1. Receiving and Information Office
2. Enclosure
3. Special Waste Warehouse
4. Unloading Bay
5. Containers
6. Loading Vehicle Access Road

1.7. Waste Transfer Plants

Transfer plants are designed as selection and separation facilities that work as an intermediate stage between the collection of material and its subsequent reuse as sub-products. Transfer plants cover a large area and receive the different waste, classify it according to type, store it until a sufficient amount has been accumulated and take it to a final manager who treats it and reincorporates it into the production chain. Transfer plants act as a storage center for receiving waste, creating a stockpile and distributing it to an appropriate manager.

Fig. 1.7a
Transfer Plant (Ros-Roca, Lleida).

1.8. Waste from Markets, Large Stores and Services

The central markets (fruit, vegetables, fish, flowers, meat), municipal markets or sales points, large stores and businesses, hotels and restaurants, university campuses, school canteens, ports, airports, fairgrounds, etc., are a major source of waste generation and in particular, of organic material and packaging.

Organic material should be collected separately and composted.

Paper/cardboard, glass and plastic packaging should be recovered and recycled in line with the specifications for these materials.

Some countries have initiatives that consider collection from the commercial sector as a type of industrial activity. This means that storekeepers should manage their own waste and use private management companies to carry out this service, while in other towns the service is provided by City Council.

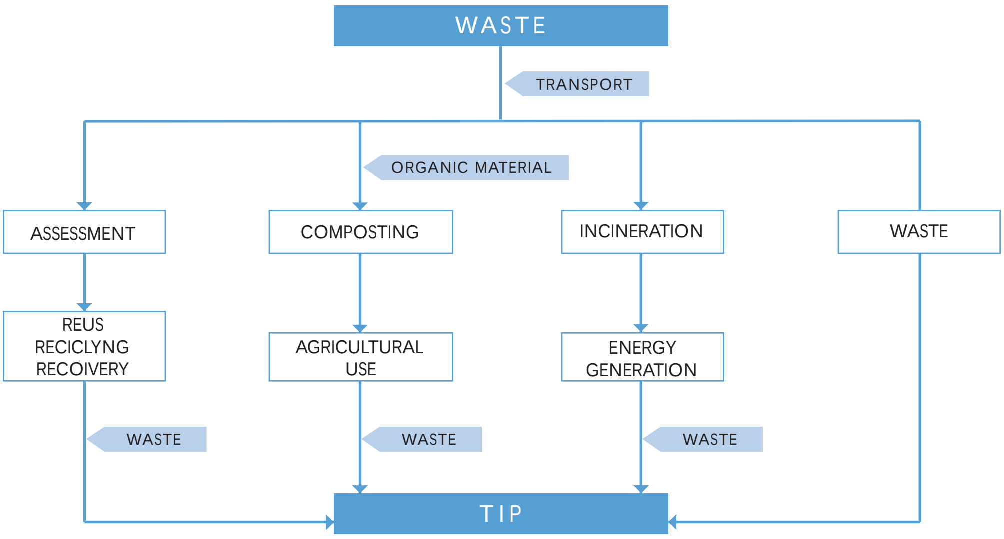
1.9. The Treatment of Household Waste

The Administration should have a coordination program for all the actions needed to promote:

- Prevention and minimization of waste and its hazardousness
- Selection waste collection
- Waste reuse
- Recycling and other forms of waste assessment
- Energy recovery from waste or incineration
- Controlled dumping
- The regeneration of contaminated land and affected spaces

Household waste managers should guarantee that:

- Management operations do not endanger people's health

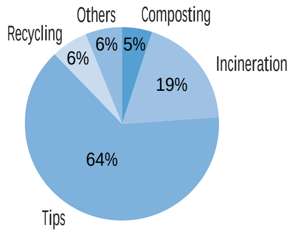


- Methods or procedures are not used that could harm the environment
- Methods do not lead to risk for the air, water, land, flora or fauna
- Methods do not bother people because of the noise or smell
- Methods do not affect the landscape or specially protected areas or elements

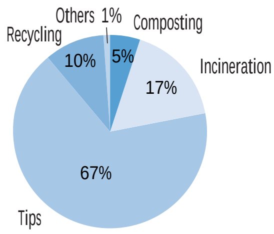
Evolution in the Treatment of MW in the European Union.
The figure shows that, despite the rise in recycling, there was no reduction in the fraction eliminated in tips.

The values of the following table were obtained for the years 1996-1999 and show tons of USW from treatments in different European Union countries:

Table 1.9a
Urban Waste Treatment in the E.U. 1985-90



Urban Waste Treatment in the E.U. 1995



	Recycling	Composting	Incineration	Uncontrol. incin.	Dumping	Uncontrol. dump.
Belgium	1982	831	1136	233	1473	
Denmark	710	420	1645	0	357	357
Germany	1384	2241	8552		27840	27840
Spain	4390	3004	2603	54	17477	9746
France	3231	2478	8906	1875	23352	23352
Ireland	167				1766	
Italy	1874	2542	1222	524	21262	
Luxembourg			123		62	
Holland	2292	2230		0	1136	1136
Portugal	190	228	349	0	3596	
Finland			80	0	1610	
Norway	579	202	374		1843	
Switzerland	1448	510	2130	0	1070	600

2000-2006 National Urban Waste Plan

Action Areas	Objectives
Prevention	• Reduction equivalent to approximately 6% in the generation of total UW • Reduction of 10% in weight of packaging waste before 30 June 2001.
Reuse	• Reuse of an average of 25% of water packaging. • Reuse of an average of 35% of soft drink packaging. • Reuse of 70% in beer packaging volume. • Reuse of an average of 15% of wine packaging (except Designation of Origin wines).
Recovery & Recycling	• Recycling a minimun of 50% in weight of all packaging waste by 2006. • Assessment of a minimum of 70% in weight of packaging waste by 2006. • Recycling a minimum of 20% in weight of every type of packaging by 2006. • Obtaining an overall recovery rate of 75% by 2006. • Increasing the recycling rate of glass packaging to 75% by 2006. • Obtaining an overall recycling rate for plastic packaging of 40% by 2006. • Increasing the total recycling rate of metal materials to 90% by 2006.
Assessment of Organic Material	• Recycling organic material using different composting techniques, at least 50% of organic material by the end of 2006. • Promoting initiatives that allow the energy assessment of organic material using systems such as biomethanization, up to 5% by 2006. • Promoting the agricultural-forestry use of compost by preparing regulations on its agronomic quality.
Energy Assessment	• Assessment of 17.7% of UW by 2006, using incineration facilities with energy recovery.
Elimination	• Eliminating uncontrolled dumping by the end of 2006. • Adapting existing tips to the environmental requirements of the Waste Directive. • Sealing and recovering all uncontrolled tips by the end of 2006.

1.10. Industrial Waste

Industrial waste is waste from solids, liquids or gases that results from a process of manufacturing, processing, use, consumption or cleaning that the producer or holder of the waste wants to get rid of and which cannot be considered municipal waste.

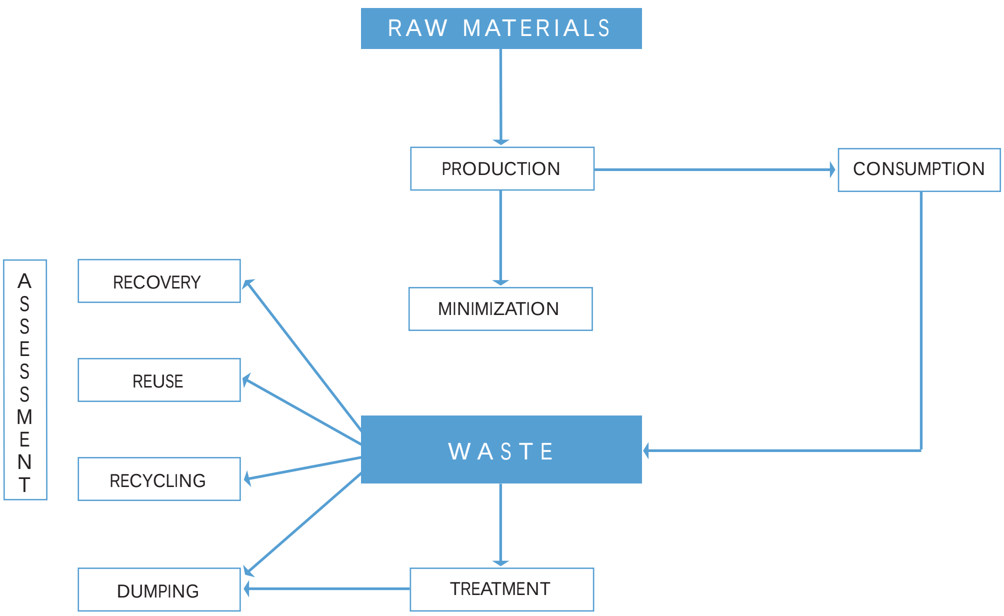
The composition is variable and depends on the type of industry. Industrial waste is classified as inert, non-special or special waste, in line with the European and Catalan Waste Catalogues.

In Spain, some 14 million tons of industrial waste are generated every year. In Catalonia, the figure is close to 6 million tons, i.e., more than 2.5 kg/inhabitant/day.

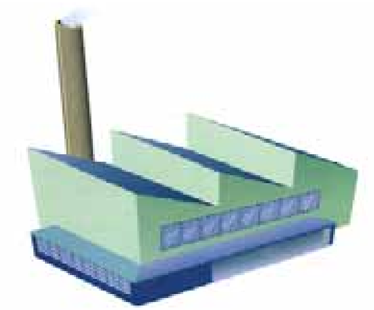
Management of this waste follows the order of minimization, assessment, controlled dumping, physicochemical and biological treatment, incineration and, finally, storage.

The most appropriate management for each type of waste is defined in the Catalan Waste Catalogue. The following graph shows the circuit that industrial waste must follow for correct management.

Initially, the producer has to know the problem and characterize his waste in order to contract a treatment, assessment or rubbish plant so that the waste generated can be accepted, using an acceptance card. At the same time, he must contract an authorized haulage contractor to take the waste to the plant, formalizing a monitoring sheet. Finally, the destination plant will receive the waste and should manage the allowed sub-product in the most appropriate form.



1.10.1. Diagram of the Industrial Waste Management Process



Waste generated in industrial activity

Waste declared
to the Administration

Characterization and analysis
by accredited laboratory

Classification and optimal management.
European Waste Catalogue

Acceptance by manager.
Haulage contractor monitoring sheet

Authorized haulage
contractor

Treatment, assessment or controlled
dumping plant

1.10.2. Objectives of an Industrial Waste Management Program:

	Vertical Bases				Criteria & Regulations
	Minimization & Prevention	Assessment	Management of the Non-Recoverable Fraction	Land Protection	Management of commercial and industrial packaging
Transversal Bases	Collaboration and flexibility of information and communications				
	Technology and research				

General Objectives:

- *Minimize the generation of industrial waste both in terms of quantity and quality.*
- *Raise the amount of assessment of industrial waste and improve the activities of the assessment sector and of obtained products.*
- *Reduce the amount of waste fractions earmarked for dumping and guarantee it is done in accordance with the strictest possible safety conditions.*
- *Integrate the objectives in social awareness programs that involve the participation and collaboration of the public, economic agents and all authorities of the Administration.*
- *Coordinate the program with joint and complementary actions to be included in the updating of the municipal waste management program and establish, where necessary, the cooperation and participation needed by local authorities.*
- *Improve industrial waste management and promote the new specific technologies considered necessary to optimize this management.*
- *Incorporate instruments that make industrial waste management more flexible and that facilitate improved management.*
- *Simplify the waste management model and facilitate its use in all industrial sectors, in particular SMEs, adopting new information technologies.*
- *Promote research and a network of technological innovation applied to the management field.*
- *Organize activities involving land protection and recovery of contaminated land.*
- *Promote the implementation of economic incentives favorable to improving industrial waste management.*

Local administrations with a special industrial waste treatment facility that consists of

- A physicochemical treatment plant
- An incinerator
- Controlled dumping

should participate in the provision of the service, meeting the control and monitoring functions of the facility and make the most of social and economic activities aimed directly at improving the quality of life of their citizens.

City councils can be the beneficiaries of an economic fund of a variable nature, determined according to the facility system and the number of tons treated per year.

1.10.3. The European Waste Catalogue

Since 1 January 2002, a European Waste Catalogue (EWC) has been available across the continent that groups waste into 20 chapters. See European Directives 94/904/EEC and 2000/532/EC.

Official Journal of European Communities

INDEX

Chapters of the List

1. Wastes resulting from exploration, mining, quarrying, physical and chemical treatment of minerals
2. Wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing, food preparation and processing
3. Wastes from wood processing and the production of panels and furniture, pulp, paper and cardboard
4. Wastes from the leather, fur and textile industries
5. Wastes from petroleum refining, natural gas purification and pyrolytic treatment of coal
6. Wastes from inorganic chemical processes
7. Wastes from organic chemical processes
8. Wastes from the manufacture, formulation, supply and use (MFSU) of coatings (paints, varnishes and vitreous enamels), sealants and printing inks
9. Wastes from photographic industry
10. Wastes from thermal processes
11. Wastes from chemical surface treatment and coating of metals and other materials; non-ferrous hydrometallurgy
12. Wastes from shaping and physical and mechanical surface treatment of metals and plastics
13. Oil wastes and wastes of liquid fuels (except edible oils, 05 and 12)
14. Waste organic solvents, refrigerants and propellants (except 07 and 08)
15. Waste packaging; absorbents, wiping cloths, filter materials and protective clothing not otherwise specified
16. Wastes not otherwise specified in the list
17. Construction and demolition wastes (including excavated soil from contaminated sites)
18. Wastes from human or animal health care and/or related research (except kitchen and restaurant wastes not arising from immediate health care)
19. Wastes from waste management facilities, off-site wastewater treatment plants and the preparation of water intended for human consumption and water for industrial use
20. Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions.

1.10.4. Generation of Hazardous Waste in Europe

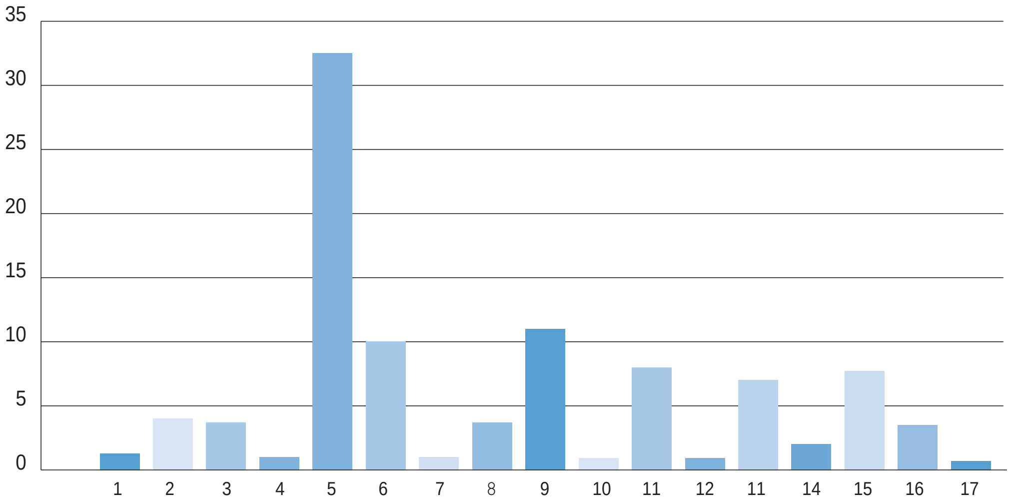
Tabla 1.10a
Position in the European Context.

	1990	1995	kg per capita
Austria	317[4]	577	72
Germany	13,079[1]	17,421[4]	169
Greece	450[1]	350[1]	33
Ireland	66	248	69
France	7,000[1]	9,000	150
Italy	3,246[2]	2,708[2]	317
Luxemburg	116[1]	197	481
Holland	1,040[1]	868	60
Portugal		668[1]	
Spain	1,700[1]	3,394[1]	84

Source: 1) Eurostat, 2000, Waste generated in Europe, data 1985-1997, European Commission.
2) OECD, 1997, OECD Environmental, data, compendium 1997.
3) Institut Francais de l'environnement, "The environnement in France" Orleans 1999.
4) Eurostat/OECD Joint Questionnaire 2000. Datos 1996.

Tabla 1.10b
Generation of Industrial Waste by Sectors (%).

1. Refining petroleum
2. Metal production and processing
3. Extraction of non-metallic minerals
4. Non-metallic product industry
5. Chemical industry
6. Metallic products manufacturing
7. Machinery manufacturing
8. Electrical materials manufacturing
9. Automobile manufacturing
10. Transport material manufacturing
11. Food and drinks
12. Textile industry
13. Leather industry
14. Wood industry
15. Paper industry
16. Hazardous urban waste
17. Other sectors



• No variation was observed in the distribution by sectors of the production of hazardous waste.
• The chemical industry generates 33% of the total.

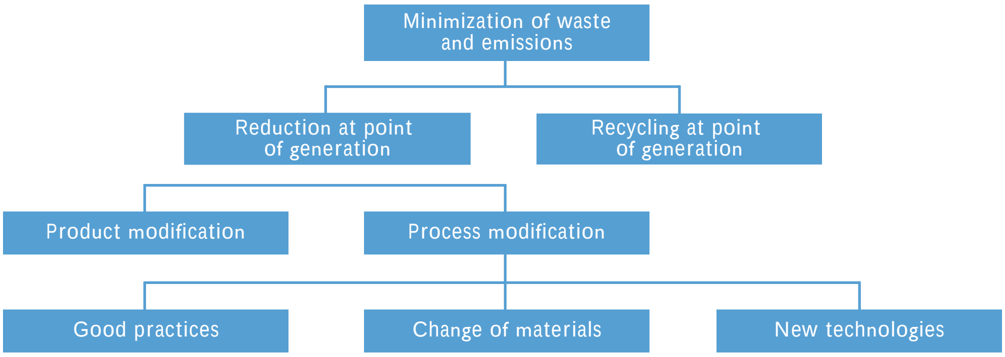
1.10.5. The Center for Enterprises and the Environment (CEMA)

In Catalonia, the Center of Initiatives for Clean Production was created in 1994 and later was transformed into the Center for Enterprises and the Environment (CEMA).

CEMA has the following objectives:

- To promote cleaner production in sectors and companies.
- To disclose, assess and be a meeting point between companies and the environmental administration.

Upon request by a company, CEMA assesses industrial activity and determines possible opportunities to prevent the contamination of the facility, preparing a confidential report on its status. It thus requires a profound knowledge of the sector: processes, materials, technology, suppliers, environmental characteristics, etc.



1.10.6. The Sub-Products Waste Stock Exchange

All industrialized countries have one or a number of waste stock exchanges. The reason for their existence responds to the general policy on waste management that advocates assessment, once the reduction method has been exhausted, as a management goal. The stock exchanges therefore form part of the 'three Rs', particularly the facets of reuse and recycle.

In short, the stock exchange consists of promoting a publication that features offers of waste from companies that want to get rid of it and demand in the same direction. The market puts the parties into contact, with the idea that waste can be used so it does not end up on a tip.

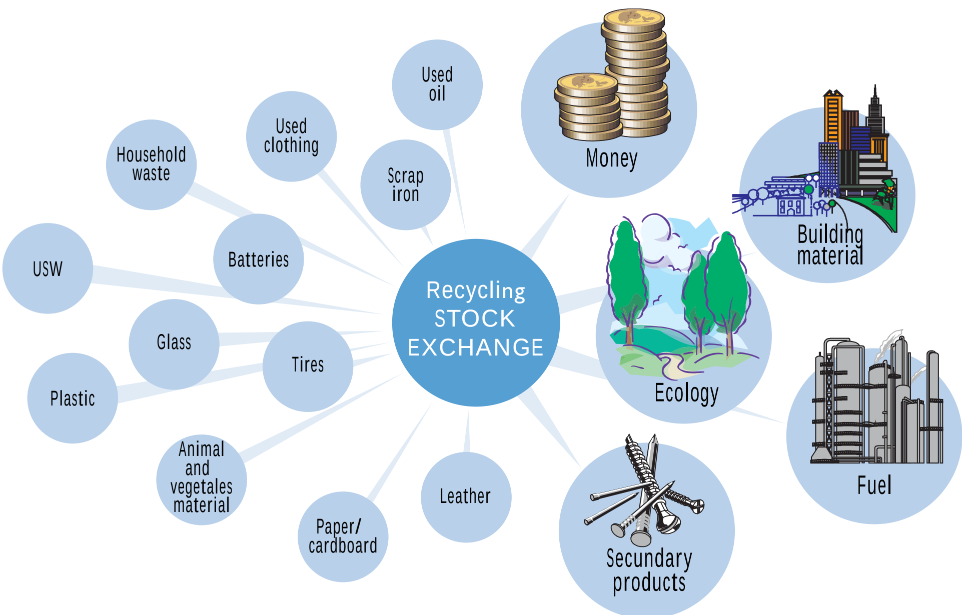


Fig. 1.10c
Recovery and Recycling Stock Exchanges.

To place an advertisement, waste is classified by categories, the number of which can change according to the industrial profile in which the stock exchange is found.

Generally speaking, there are usually sections for plastic, paper, textile, glass, wood and packaging, i.e., the types of waste that minimize waste handling and facilitate exchange and immediate use.

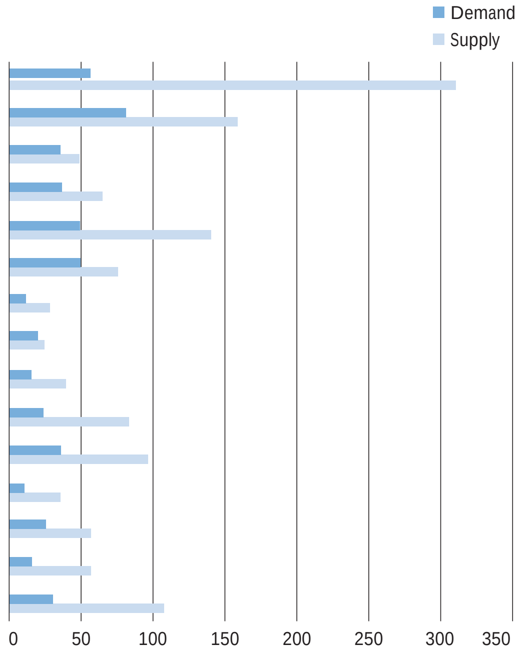
The stock exchanges are managed differently in every region and country. In the case of Catalonia, the exchange is owned by the Council of Chambers of Commerce and the Department for the Environment. It is usually the chambers of commerce who are responsible for managing the exchanges.

There are passive exchanges that simply release a regular publication, and active exchanges which, as well as the above, also propose waste recycling programs and systems.

Waste Supply and Demand

The different waste stock exchanges publish a bulletin that sets out the supply and demand for waste. In the case of the Catalonia Sub-Products Exchange (CSE), waste is grouped into the following chapters:

01	Chemical
02	Plastic
03	Metal
04	Paper/carboard
05	Wood
06	Textile
07	Rubber
08	Glass
09	Leather
10	Rubble and mining waste
11	Animal and vegetable material
12	Fuels and oil products
13	Scrap iron and slag
14	Others
15	Packaging and bottling



Waste is listed under sections of supply and demand for each chapter (in the case of the CSE, 75% of the advertisements are listed under ‘supply’ and 25% under ‘demand). The description of the types of waste covers the following concepts:

- Coded (the person placing the ad remains anonymous)
- Type of material (waste) supplied or demanded
- Main composition of the waste
- Production (waste generation line)
- Amount of waste and frequency
- Waste presentation (form of shipment)

1.11. Primary Sector Waste: Agricultural, Forestry and Livestock Waste

This is waste from living things. Agricultural and forestry waste involves vegetable matter, while livestock waste, which arises from animals, is basically excretion from livestock or slurry and also waste from related industries. This is waste that comes from the biogeochemical cycles of production by photosynthesis and which is generated in the production, processing and consumption phases.

It is considered that total world productivity in primary biomass is close to 150-170 gigatons/year (1 gigaton = 10^9 tones), of which only 16 Gtons/year is used by man, with the rest determined as wood in the forests and spontaneous forestry waste. The 16 Gtons/year handled by man generates a large amount of direct waste: 12 Gtons/year from harvests; 1.6 Gtons/year from food processing and 1.9 Gtons/year from animal production.

In total, waste from living things represents in our country around three tons/inhabitant/year, thus making up more than 52% of total waste generated.

Around 144 million tons of primary sector waste is generated in Spain each year.

Fig. 1.11a
Waste Minimization Diagram.

Type of Waste	Spain M/tons per year	
Agricultural waste	35.0	
Forestry waste	17.0	
Livestock waste	92.0	62 livestock animals/30 industrial slaughterhouses
TOTAL	144.0	

Around 19 million tons of waste from living things is produced in Catalonia each year, i.e., some 10 kg/inhabitant/day.

Recycling Agricultural Waste

Vegetable biomass waste can be used in at least four different ways:

- Returned to vegetable production: compost
- Food for livestock
- Energy production
- Chemical products production

Composting produces the biological degradation of lignocellulosic polymers, transforming them into humus, a mixture of humic and fulvic acids, which is a perfect organic material for the soil. It is estimated that the content of organic material in the soil should exceed 1.7% on non-irrigated land and 3.4% of irrigated land. However, in Spain, the average soil content does not exceed 1% of organic material.

Composting is an aerobic fermentation process of an exothermic nature carried out by microorganisms and involving two stages: a mesophilic stage of a degradative nature and a maturing stage, where the oxidizing processes are strengthened and perfected and the product is stabilized. Compost also returns to the soil a good part of the nutrients – nitrogen, phosphorous and potassium – contained in remains.

Food for livestock is common in the case of straw and the remains of wine, olives and sugar beet, but can also come from some industrial crops, such as sunflowers, cotton, peanuts and other forestry crops.

Other use options are to apply the crop remains of rice, tobacco or banana leaves or cotton waste, used as an agricultural compound in the substrata of mushroom plantations (champignons) and fast-production mushrooms.

Thermochemical Use of Forestry Remains:

- Pyrolysis, which involves decomposing organic matter in a poor and inert atmosphere without oxygen. This results in wood charcoal, used as a reducer in the metal industry and as a raw material in the manufacturing of activated carbon and as a source of energy.
- Gasification, i.e., the partial combustion of organic matter in a gas environment, adding an oxidant. This obtains town gas and synthesis gas ($CO+H_2$) to obtain organic compounds such as methanol, ammonia and certain hydrocarbons. It can activate gas turbines at 500ºC and combined cycles.
- Liquefaction, i.e., the conversion of the lignocellulosic matter in wood into a mixture of organic liquid products, such as phenols and polysaccharides.
- Combustion. 6MW stations are proposed in Catalonia to obtain electrical energy from the burning of wood waste.
- Cogeneration, i.e., electrical generation and making the most of heat at the same time. Applications are limited because the exhaust gases leave at a relatively low temperature (60-90ºC).

Livestock Waste: Slurry

This is mainly liquid excrement from pigs, cows and birds. It includes:

- Urine
- Solid excrement
- Food scraps
- Losses from troughs
- Bay cleaning water

There are 20 million pigs in Spain, six million in Catalonia.

Each pig produces 10 liters of slurry per day, representing more than four times the pollutants of humans.

Excrement is called slurry if it contains up to 15% of dry material and manure if it contains more than 30% of dry material.

Pig Slurry Composition		
Matter in suspension	500.000 mg/l	
DQO	100.000 mg/l	
DBO5	50.000 mg/l	
Macronutrients	N_T 5-8% P 6-7% P_2 O_5 K 3-4% K_2O	
Micronutrients	Fe 3000-4000 mg/kg Ca 3-5% Mg 1-1.5%	Heavy metals Cu 300-600 mg/Kg Zn 600-800 mg/Kg

1.11.1. Composting and Biogas from Livestock Waste

Below are two different processes for using slurry: aerobic and anaerobic digestion.

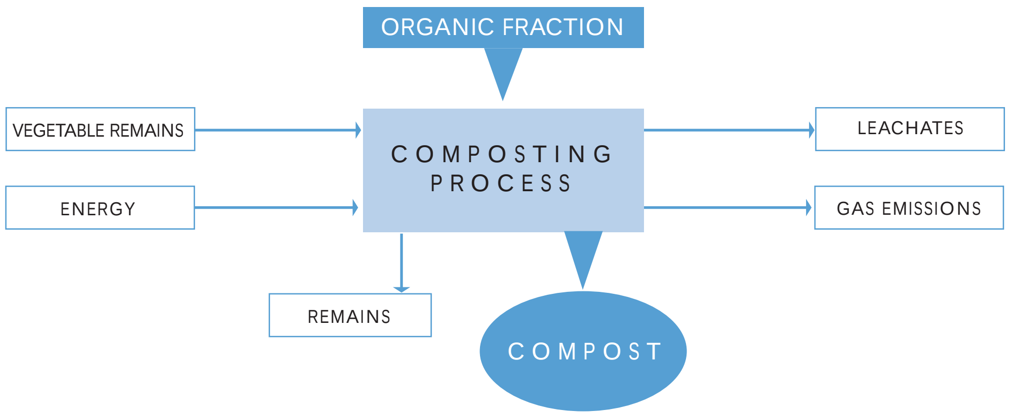


Table 1.11b
Composting or Aerobic Digestion

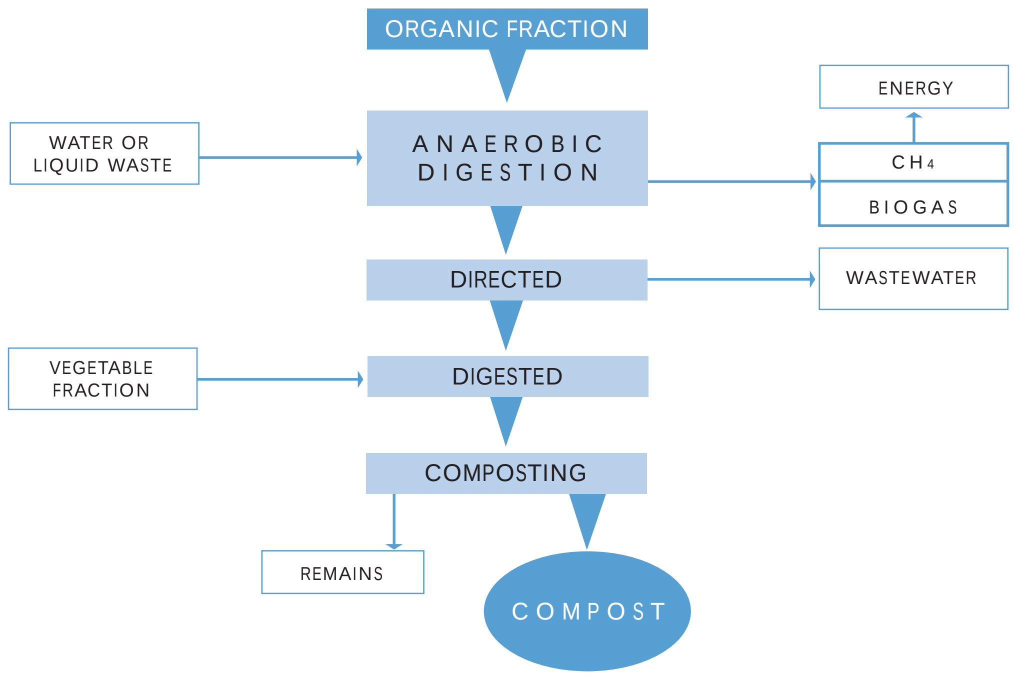
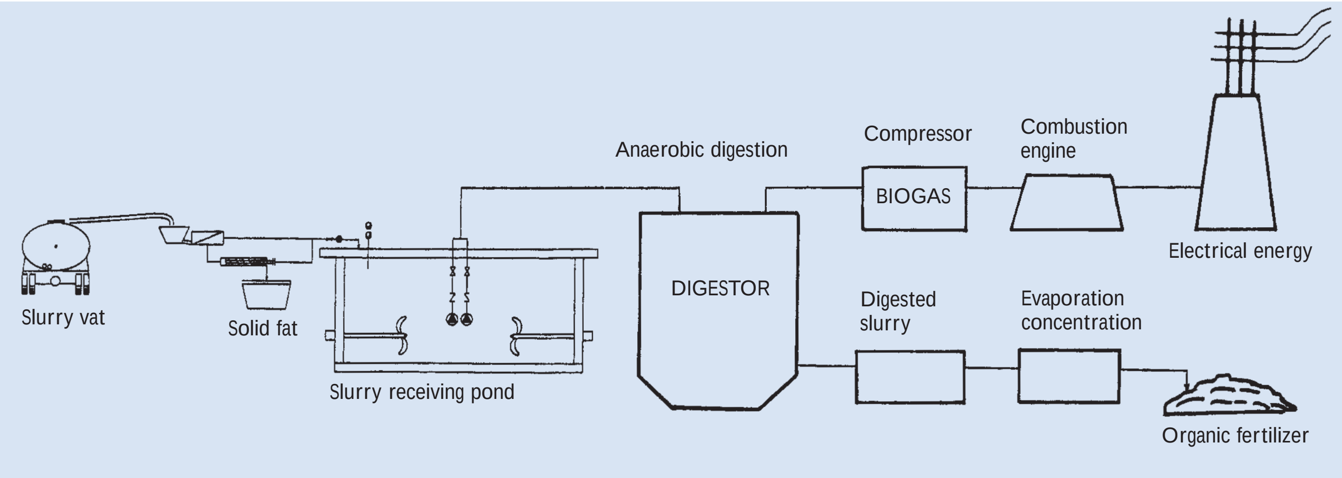


Table 1.11c
Biogas or Anaerobic Digestion

1.11.2. Slurry Biogas Plant



1.12. Waste from the Mining and Construction Industries

1.12.1. Mining and Quarry Waste

The mining industry and its activities represent one of the industrial sectors with the greatest capacity for waste generation. In Spain, the relative contribution of this sector represents between 25% and 30% of the total waste generated, with the aggravating factor that a large part of this waste is contaminated by chemical products used during the onsite treatment of the materials used.

The waste generated by these activities varies widely, from sterile waste from coal and metal mining through to a mountain of potash rubbish and significant earth movements generated in major public works. To begin with, it is necessary to indicate that underground mines have far less of an environmental impact on waste than surface mines. Catalonia is the leading Spanish region with regard to the volume of rocks extracted in surface mining. Figures for the year 1990 show there were 520 quarries in operation, which produced more than 40 million tons of aggregate.

Underground Mining

Potash mines in Cardona, Suria and Sallent; brown coal mines on the border area between Catalonia and Aragon and in Pedraforca and the ornamental rock mine in Gualba, in the Montseny region, are the main underground mines in Catalonia.

The waste that originates in the potash mines is sent to rubbish mountains and is made up of a large proportion of sodium chloride. This can later be used for animal feed, among other uses. It is necessary to mention that this rubbish is not classified as waste, but rather the Mines Act (Act 22/1973) and the current European Directive 85/337/EC, consider it a usable structure and it is included in the so-called Class B as a future resource.

Coal mining produces deads and waste that can be used as the bases of highways, in the manufacturing of ceramic materials, the construction of banks and as filling material for the mining hole itself.

The ornamental rock sector generates little waste, and that which is produced is introduced into the hole created during the mining process.

Open Air Mining

Catalonia is the leading community in Spain with regard to volume of rocks extracted in surface mining, with more than 500 quarries and around 50 million tons per year. Most of the aggregate goes to the construction and building industries, although it is also widely used in civil works: roads, highways and freeways, railroads, dams, etc.

When aggregate hardens in the air it is known as agglomerate and is used to make cement, concrete, lime, plaster, ceramics and other materials.

The deads or waste generated in this activity is used to fill the holes left by the materials themselves or as the bases for highways or for making banks.

The production of industrial rocks in Catalonia is distributed in line with the following table:

Material	Production TN/year
Construction aggregate	25,000,000
Lime and cement	13,000,000
Clay	2,500,000
Plaster	1,000,000
Chalk	850,000
Ornamental rock	600,000
Sand, glass	25,000

1.12.2. Construction Waste

Construction basically generates three types of waste: excavation waste, due to the movements of earth and excavations of the land; waste from construction work itself and the different operations involved with it; and, finally, waste from demolition works.

In the near future, we should think about undertaking construction work with a view to deconstruct, demolishing the work in a way that ensures most of the materials involved can be used.

The law establishes that it is necessary to create recycling and treatment plants for waste from construction, and to promote systems and techniques that can best recover and market waste.

In Catalonia, the construction industry moves more than 2 million tons of waste every year, around 1 kg/inhabitant/day.

The program anticipates recycling 65% of waste from the construction industry by the end of the established period.

Decree 161/2001 regulates demolitions and other waste from construction and Decree 1/1997 and European Directive 31/1999/EEC regulate adapting rubbish dumps for the construction industry.

The Construction Waste Management Program anticipates a deployment of infrastructure during this period as follows:

Infraestructures	2001	2006
Recycling plants	4	18
Transfer plants	3	64
Controlled dumps	41	69

The types of facilities needed to configure this integrated network are:

- Earth and rubbish dumps and monofills: the number of dumps in each province must be the minimum needed to guarantee enough controlled dumping capacity at a reasonable distance and with reasonable transport cost.

- Transfer plants: facilities for pouring construction waste with a basic logistical function of reducing transportation and serving the areas furthest away from each province's dumps. It is anticipated that a function of gathering and processing recyclable material shall be added in the medium term, and a system for classifying and assessing construction waste from containers shall be added in the long term.

- Recycling plants: mobile, semi-mobile and fixed plants, depending on proximity to large, medium and small urban centers and the volume of material available to recycle each year. It is initially anticipated to expand recycling areas within dumps and transfer areas, using mobile plants, and, beyond a particular production volume, channeling the construction of industrial plants in the areas that produce the most construction waste.

Fig. 1.12a
Dumping construction materials (Metropolitan Environmental Organization, Barcelona).

1.13. Sanitary Waste and Its Management

Also called clinical or hospital waste, sanitary waste is understood to include all waste generated in hospitals, medical clinics, sanatoriums, healthcare centers, medical consultancies and laboratories.

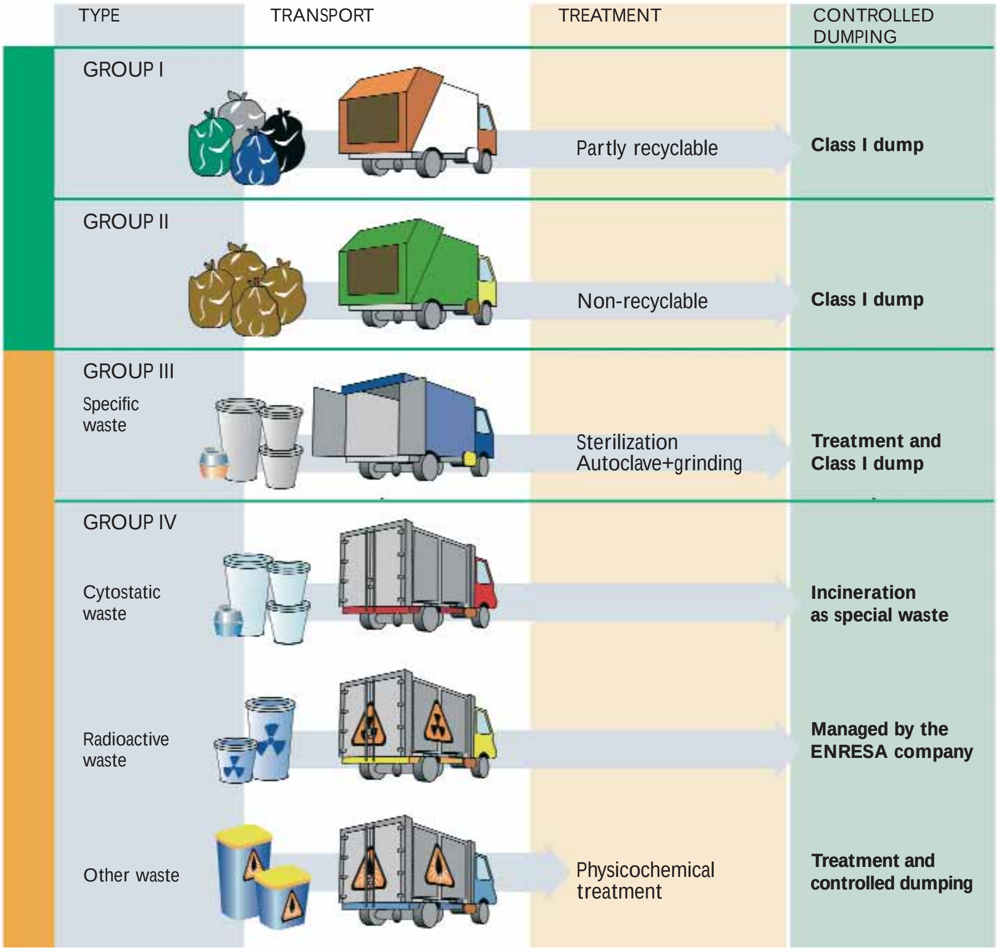
In Catalonia, it is currently classified into four groups. The first two groups are similar to municipal or non-specific waste. Group III includes specific or hazardous waste, i.e., waste that requires specific sterilization, and Group IV includes cytostatic, radioactive and other types of waste.

One estimate suggests that 40,000 tons of sanitary waste is produced in Catalonia each year.

The regulations that exist in Catalonia on sanitary waste date back to 1999, with the introduction of Decree 27/1999. The transportation and availability of sanitary waste is regulated by:

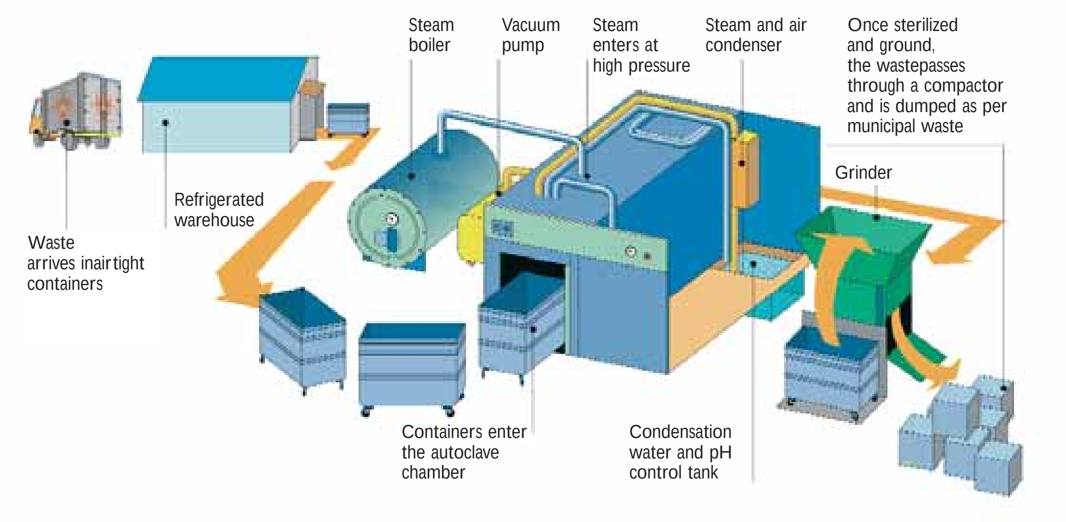
- Group I Waste: like municipal waste and part of which may be recycled.
- Group II Waste: should be treated by authorized companies and vehicles, although it may be treated with the same precautions, stored and transported as per municipal waste. Not recyclable.
- Group III or Special Biosanitary Waste: transport in especially authorized vehicles, without compacting or grinding. Disinfection in autoclave or incineration as special waste.
- Group IV or Cytostatic Waste: incineration as per special waste.
- Radioactive Type Waste: managed by ENRESA (Empresa Nacional de Residuos Radioactives, SA).

1.13.1. Classification and Management of Sanitary Waste



Source: Catalan Waste Agency (Barcelona).

1.13.2. Sanitary Waste Sterilization Plant



1.14. Small Quantity Special Waste

Small quantity special waste is waste that cannot be managed as ordinary waste but requires special treatment to prevent effects that may harm the environment or people's health. Because it involves small quantities, it is dispersed across the territory and is found in many production activities: small industry, warehouses, laboratories, commercial premises and even in our homes.

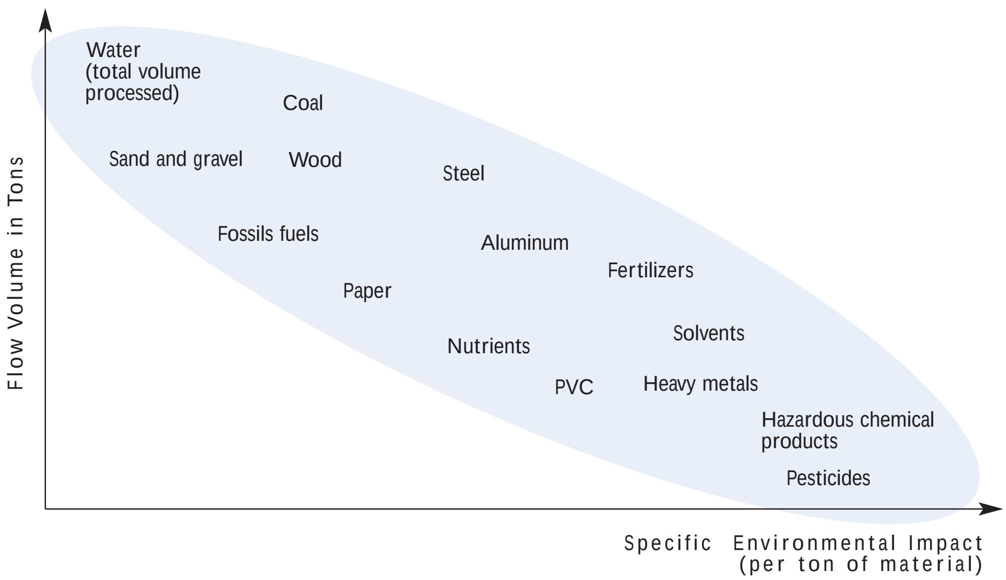


Fig. 1.14a
Material flow and environmental impact of some types of waste.

The environmental impact of waste is related both to its quantity and to the risk it involves. Waste production thus has two aspects: quantitative, i.e., the amount generated, and qualitative, i.e., the level of risk. This figure compares both aspects for some materials. Waste with a strong specific environmental impact per ton is usually found in small quantities and is thus much harder to separate and collect. To date, waste management has concentrated mainly on the flows located in the middle of the highlighted area.
Source: *Steurer, 1996*

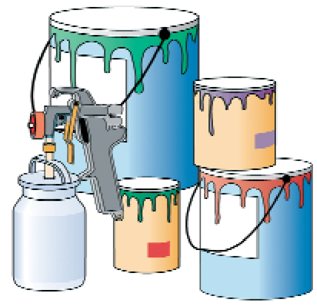
In Catalonia, a Center for the Reconditioning and Recovery of Small Quantity Special Waste has been built in Montmeló (Vallès Oriental) with a treatment capacity of around 3,500 tons per year. All types of waste are received, except for radioactive, sanitary and explosive waste, in amounts of less than a ton.

Industries and Activities that Generate Small Quantity Special Waste

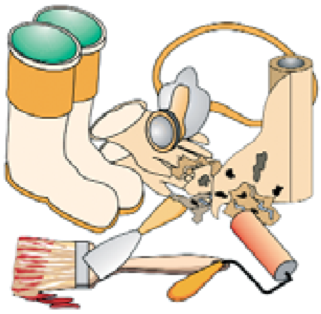
- Training centers, schools and universities
- Teaching, analysis and chemical laboratories, etc.
- Pharmacies
- Dry cleaners'
- Car repair shops
- Painting workshops
- The graphic arts industry
- The surface treatment industries
- The wood sector
- The application of phitosanitary products

Small Quantity Special Waste to Regroup

Solvents
Inflammable and toxic products.
Generated in workshops with the cleaning of parts and painting equipment, synthesis industries, laboratories, dry cleaners' and in the home (cleaning products, stain removers, etc.).



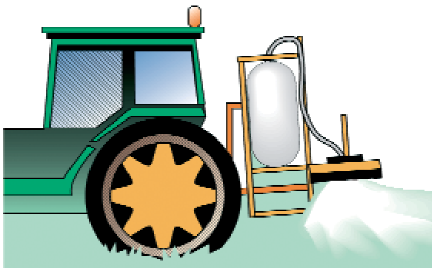
Paint
Contains solvents and pigments with heavy metal bases, which are very toxic. Inflammable products immiscible in water.
Generated in the home: from expired products, manufacturing remains, etc.



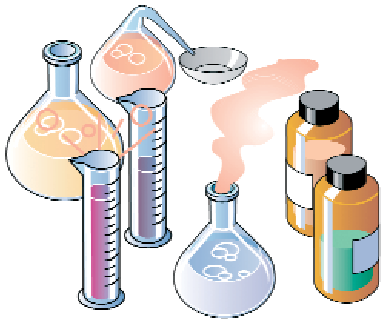
Dirty Chemical Products Equipment
Depends on the product involved.
Clothing, footwear, rags, papers, etc.
Generated in laboratories, cleaning, disinfection and rat removal companies, the controlling of dumps and other areas.

Small Quantity Special Waste to Recondition

Daily Cleaning Products
Oxidizing and harmful products: bleach
Corrosive and toxic products: E507.
Corrosive products: metal cleaning
Generated in homes, stores, small workshops, etc.



Pesticides and Insecticides
Toxic products sometimes diluted with inflammable products and which may be carcinogenic and/or mutagenic.
Generated by farmers and in homes, gardening works, agricultural cooperatives, etc.

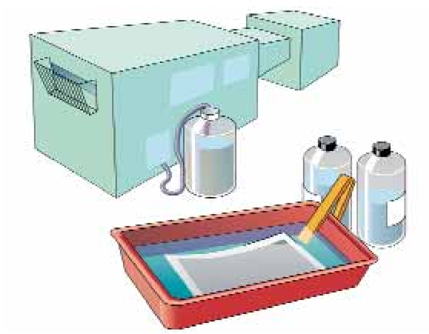


Laboratory Reagents
Depends on the product involved.
Toxic products: metals (mercury), heavy metal salts and cyanides.
Corrosive and toxic products: acids and bases.
Water reactive: sodium.
Air reactive: phosphorous.

Small Quantity Special Waste to Recover

Aerosols
Aerosol propellants affect the ozone layer because they are CFCs.
Some inflammable products, such as propane and butane.
Generated in stores and private households.

Contaminated Containers
From chemical products, paints, resins, solvents, etc.
Generated in laboratories, industries, private households.
Industrial containers also require cleaning and conditioning.



Metallic Watery Solutions
With 5.5>pH>12
Salts dissolved with toxic metals: Ag, Cd, Cr, Pb, etc.
Generated in photographic processes, engraving, metallic treatments, parts manufacturing, printed circuit boards, etc.

1.15. Radioactive or Nuclear Waste

Radioactive waste is considered to be any material that contains or is contaminated with radionuclides in concentrations above the legally established limits. One parameter to bear in mind with this type of waste is the period of semi-disintegration, remembering that it is generally considered that if the life of a radioactive material is greater than 30 years it is classified as long-life waste and vice versa if the life period is less than 30 years.

- Low- and medium-activity radioactive waste: waste that has a semi-disintegration period of 30 years or less and that emits at least 0.01 curies per ton of alpha radiations: Sr-90 (30 years); Cs-137 (30 years); Co-60 (5 years); Fe-55 (2.5 years).

- High-activity radioactive waste: waste with an active life of more than 30 years: Np-237 (2 million years); Pu-239 (25,000 years); Am-241 (460 years), etc.

Radioactive waste can be produced in numerous human activities, although the production cycle of nuclear energy is the main source of such waste. We can differentiate three types of sources:

- Nuclear generation of electricity, including investigation and closure of plants.
- Use of radiation and radioactive materials in medicine, agriculture, industry and research.
- Treatment of radioactive type materials, such as uranium minerals and phosphate fertilizers.

Systems for Storing Radioactive Waste

Radioactive waste should be stored in special geological repositories. Low- and medium-activity waste is immobilized in concrete dumps, while high-activity waste is currently conserved in pools in nuclear plants. In some cases it is vitrified or introduced into synthetic rocks prior to its definitive burying. In Spain, ENRESA is responsible for managing radioactive waste at the 'El Cabril' plant in Cordova, which collects low- and medium-activity waste and contains a system of three insulating barriers: drum, cover and storage and earth as the geological barrier.

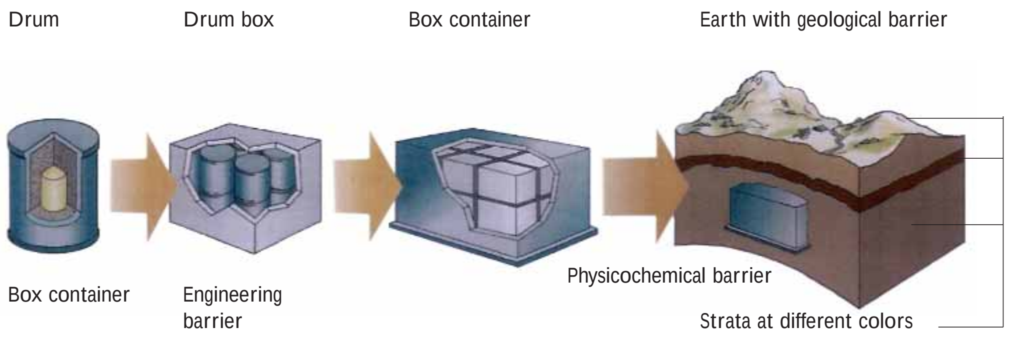


Fig. 1.15a
Storing low- and medium-activity radioactive waste

1.16. Monitoring, Characterizing and Analyzing Waste

Waste is characterized to learn the analytical parameters of the samples of waste collected in order to classify it properly and, where necessary, forecast its final destination. The analyses described below were made in accordance with the origin and qualitative composition of the waste and with the final destination.

In each case, it will have to be decided whether to carry out all the determinations listed below, or whether it is necessary to make other analyses not included on this list, such as organic metals or compounds, whether there is a consistency of its presence, or when the origin, qualitative composition or final destination of the waste make it advisable.

1.16.1. Waste Sampling

Waste sampling involves the planning and realization of a number of operations aimed at obtaining a representative sample of the material being studied and making it compatible with the subsequent characterization operations.

Waste Samples in Quantity

The sampling is carried out dividing the mass of the waste into units, applying a spatial criterion for the realization of the sub-samples in the final sample

Amount of waste less than 20 tons or m^3

A minimum accumulative sample of 1000 g or ml is gathered, composed on the basis of a minimum number of 10 sub-samples that will make up the final sample.

Amount of waste greater than 20 tons or m^3

As many accumulative samples of 1000 g or ml are gathered in accordance with the result of the operation:

$N = \sqrt{n} + 1$ N = number of samples to gather
n = number of units of 20 tons or m^3 the waste forms

If N or n are decimal numbers, an approximation of the nearest whole number will be done. Each sample should involve a minimum number of 10 sub-samples gathered at random from each of the units considered. If the waste is heterogeneous, the independence of the samples will be maintained. Otherwise, the total of the samples collected will be standardized and a single sample will be made for analysis.

Waste in Recipients

All recipients have the same product

An accumulated sample of a minimum of 1000 g or ml is gathered in accordance with the result of applying the formula:

$X = \sqrt{n} + 1$ X = number of containers sampled
x = total number of containers that exist

If X or x are decimal numbers, an approximation of the nearest whole number will be done.

If the volume of waste contained in recipients exceeds 20 tons or m^3, the same procedure as described in the case of large-volume waste shall be applied.

Not all the recipients have the same product

It will be necessary to collect samples from all the containers, maintaining the independence of each sample.

Obtaining Sub-Samples

If a number N of samples has to be collected, the total mass of the waste will be divided into n units, which shall be identical in size and/or volume, and collection will be from each of the corresponding samples, as described for the amount of waste greater than 20 tons or m^3.

This sample will be composed on the basis of a minimum of 10 sub-samples collected at random from the whole of the volume of each unit considered. If the waste is generated in a constant flow, the sub-sample will be preferably made with a time criterion, instead of doing it on the waste dumped in a pile or container.

Sample Materials

For sampling waste with content in organic products, stainless steel, glass or Teflon utensils will be used and the recipients will always be of glass. For sampling waste of an inorganic nature, plastic, glass or Teflon utensils will be used and the recipients will be of glass or plastic. When in doubt about the nature of the waste, stainless steel, glass or Teflon utensils will be used, along with glass recipients.

Sampling Procedure

This will be influenced by the geometry of the waste or the recipients containing it and limited by the possibilities of accessing the chosen sampling points. In general terms, these can be classified as:

Piles: The sampling will be done with cannulas that penetrate the external surface perpendicularly, preferably to the symmetry axis of the pile. The surface layer will not be used.

Ponds: The sampling will be done preferably with cannulas that collect continuous proof of the whole thickness of the waste. The surface layer will not be used.

Drums: If possible, continuous proof of the whole height of the drum will be gathered.

Waste Flow: The whole of the width of the waste vein should be collected in each sub-sample. In the event of doing analyzing a fraction of the latter, it is important to make sure that the utensil used can comfortably collect the largest waste particles.

Conserving Samples

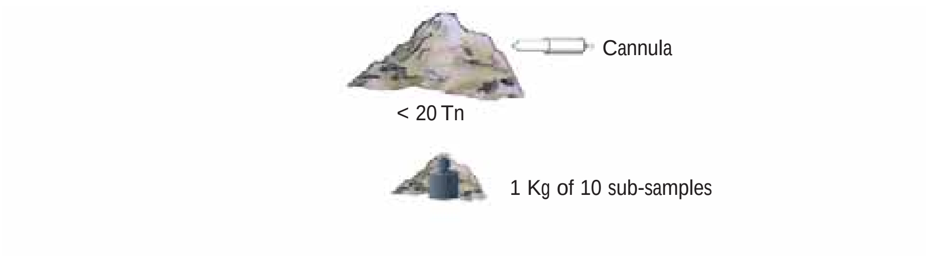
The collected samples will preferably be conserved at 4ºC until they are analyzed. If biological degradation of the sample is expected, it will be necessary to freeze it.

Summary of a Waste Sample

Waste in Quantity

1. Quantity of waste < 20 Tn o m^3

Sample to collect: N = 1 of 10 sub-samples. Total 1,000 gr or ml.



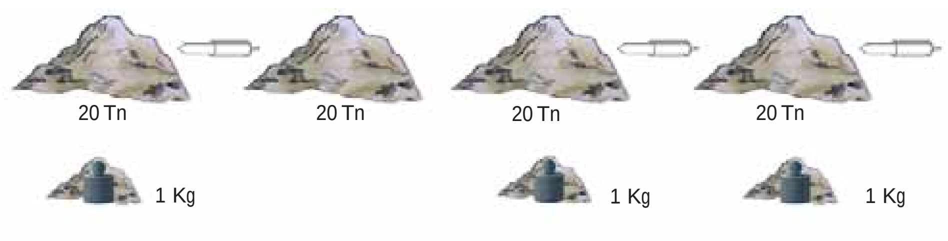
2. Quantity of waste > 20 Tn o m^3

Sample to collect: N = √n + 1, each composed of 10 sub-samples

N = units of 20 Tn o m^3 that form the waste

E.g., if n = 4, N = √4 + 1 = 3 samples, each composed of 10 sub-samples

Randomly



Waste in Recipients

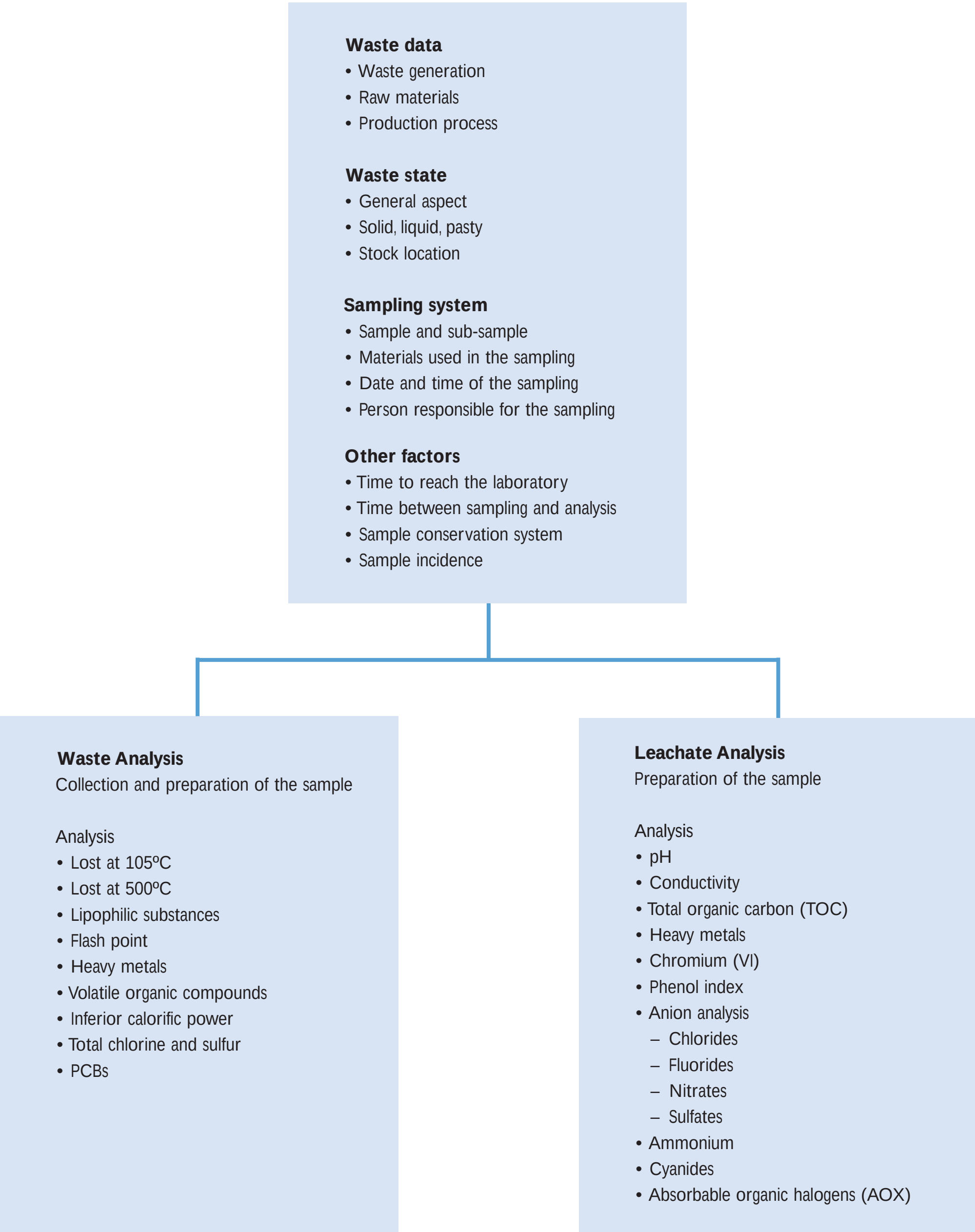
Containers sampled. X = √n + 1

X = total number of existing containers

E.g., if x = 5, X = √5 + 1 = 3.23 (4 containers)

If the volume of waste exceeds 20 Tn o m^3, the same procedure as in the previous case will be followed.

1.16.2. Waste Analysis Methods



1.16.3. Waste Analysis

Sample Collection and Preparation

The regulations that exist for collecting a sample must be followed to guarantee it is representative. If the sample presents a liquid phase and a solid phase, or if the lost water content at 105°C is greater than 90%, wherever possible the phases shall be separated via filtering, using a filter with a porosity of 0.45 µm and under inert gas pressure of 5 kg/cm^2.

If it is not possible to achieve the separation of phases as described, a previous separation will be done by decantation and the liquid phase will then be filtered using the same filtering system as indicated. The solid that results from this filtering will be added to the solid obtained by decantation.

The massic proportions of each phase will be calculated and noted on the results report, setting out the method followed in the separation of phases, and each phase will be analyzed separately.

The leaching test will be done on the solid phase of the sample and all the analytical determinations described. The same analytical determinations will be done on the liquid phase of the sample as were done on the leachate obtained from the solid phase.

Lost at 105ºC

Desiccation at 105ºC and weighted until it is a constant weight.

Lost at 500ºC

Calcination at 500ºC and weighted until it is a constant weight.

Lipophilic Substances

Extraction with pentane, using a Soxhlet device; the solvent is later evaporated from the extract and the waste obtained is weighed.

Flash Point:

Temperature at which vapor from the sample spontaneously alights in the presence of a flame, in line with the Tag Closed Cup method adapted to solids (Method ASTM D56/87)

Heavy Metals:

By atomic absorption and/or atomic emission by inductively coupled plasma (ICP-AES) or plasma masses (ICP-EM), following digestion of the original sample with irrigation water.

Volatile Organic Compounds:

Firstly a qualitative analysis is made using the head-space technique and gas chromatography with mass spectrometry (HS-GC-EM). Depending on the compounds found, the most appropriate chromatographic technique for quantifying them is chosen. (Methods EPA, SW-846, Vol. 1., Section B).

Inferior Calorific Power (ICP):

Determined using a Mahler-type calorimetric bomb

Total Chlorine and Sulfur:

The analysis is done by ionic chromatography, after combustion of the sample using a calorimetric bomb. (Method EPA 5050 SW-846).

PCBs:

The analysis is done by gas chromatography with capillary columns and an electron capture detector (ECD).

1.16.4. Leachate Analysis

Sample Preparation: Leaching Test:

The original structure of the sample used must be maintained as far as possible: large particles (over 1cm) must be ground and homogenized.

Method DIN 38414-S4, with these clarifications:

Leaching with reagent water (resistivity of 18M Ohms at 25ºC, maximum TOC level of 20 ug/l and free of particles and microorganisms). Use bottles of 8-10 cm in neck diameter, which shall be kept closed during agitation.

Rotary agitation system and rotation speed of 2 turns per minute, over 24 hours. Initial pH and conductivity levels are measured 15 minutes after agitation. After the leaching trial, it is filtered using 0.45 um filters under a pressure of 5 kg/cm^2 of inert gas.

Final pH and conductivity levels are measured after filtering.

pH:

By electrometry with the pH meter.

Conductivity:

By electrometry with the conductimeter.

Total Organic Carbon (TOC):

Determined by waste combustion at 900ºC measuring the CO_2 content obtained. (Method DIN 38409-H3-85; EPA 9060, SW-846).

Heavy Metals:

By atomic absorption and/or atomic emission by inductively coupled plasma (ICP-AES) or plasma masses (ICP-EM), following digestion of the leachate if necessary.

Chromium (VI):

By absorption spectrophotometry, diphenylcarbazide method (Method DIN 38405-D24).

Phenol Index:

By absorption spectrophotometry, 4-aminoantipyrine spectrometric method. (Method standard ISO 6439-1990).

Anion Analysis:

Chlorides: Analysis by ionic chromatography.

Fluorides: Analysis by ionic chromatography or with a specific electrode. (Standard Methods Edition 17, 1989, Method 4500F-C).

Nitrates: Analysis by ionic chromatography or by absorption spectrophotometry (Method ISO 677-1983).

Sulfates: Analysis by ionic chromatography.

Ammonium:

By specific electrode. (Standard Methods Edition 17, 1989, Method 4500 NH3-F) and/or absorption spectrophotometry (Method ISO 7150/1-1984).

Cyanides:

Absorption spectrophotometry after distillation (Standard Methods Edition 17, 1989, Method ISO 4500 CN-E).

Absorbable Halogenated Organic(AOX) Compounds:

By gas chromatography after concentration by purge and trap. (Method DIN 38409-H14-85; ISO DIS 9562).

1.16.5. Ecotoxicity

To know the ecotoxicity of the leachates of a waste, a standard leaching test is done along with some of the approved biotrials.

Daphnia Magna Test:

The beginning of the determination is based on the inhibition of the mobility of the Daphnia Magna Strauss, a microcrustacean that is exposed to particular conditions. In accordance with this trial, it is considered that waste is toxic if the leachate has an average lethal concentration ($C\ L_{50}$, i.e., 50% of the Daphnia Magna population is immobilized) less than or equal to 750 mg/liter.

Microtox or Bioluminescence of the Photobacterium Phosphoreum Test:

Based on measuring the reduction of light emission from the microorganism Photobacterium Phosphoreum in contact with toxins. The parameter measured is the concentration in the leachate sample of the waste that, in contact with the bacteria, reduces light emission to 50% (EC_{50}), which corresponds to an inhibition of the respiratory metabolism of 50%.

A waste is considered toxic if CL_{50} is less than or equal to 3000 mg/l, which corresponds to a concentration of 0.3% or in equitox/m^3 to 33.3 (1 Equitox/m^3 = l/EC_{50}).

1.16.6. Limits on Wastes and Leachates

Tabla 1.16a
Limits on Wastes and Leachates According to the Catalan Waste Catalogue

Parameters	Percentage of Waste	Of the DIN 38 leachate	Percentage of Waste
pH	—	4<X<11,5	4<X<11,5
Flash Point	55ºC	—	—
Unsaponifiable lipophilic substances	4%	—	—
Halogenated volatile organic compounds	0,1%	—	0,1%
Non-halogenated volatile organic compounds	0,3%	—	0,3%
Arsenic	0,2% o.d.m.	0,5 mg/l	0,5 mg/kg
Cadmium	0,1% o.d.m.	0,2 mg/l	0,2 mg/kg
Copper	—	5 mg/l	5 mg/kg
Total chromium	5% o.d.m.	2 mg/l	2 mg/kg
Chromium VI	—	0,1 mg/l	0,1 mg/kg
Mercury	250 mg/kg o.d.m.	0,05 mg/l	0,05 mg/kg
Nickel	5% o.d.m.	1 mg/l	1 mg/kg
Lead	5% o.d.m.	1 mg/l	1 mg/kg
Zinc	—	5 mg/l	5 mg/kg
Phenol Index	—	10 mg/l	10 mg/l
Fluorides	—	25 mg/l	25 mg/l
Nitrates	—	10 mg/l	10 mg/l
Cyanides	—	0,5 mg/l	0,5 mg/1
AOX	—	1,5 mg Cl/l	—
PCB	50 mg/kg	—	50 mg/kg

o.d.m. = of dry material

1.16.7. Experiences of the Barcelona Metropolitan Program on Municipal Waste

Población	3.056.505	Habitantes
Superficie	585,4	km^2
Densidad	5.221,22	Hab/km^2
Generación de residuos	1.611.481	Tn/año
	1,44	kgs/hab/día
	32,72%	Recogida selectiva

La gestión de residuos en el AMB: ***generación***

Año	RM, en Tm	kg/hab.año
1996	1.290.417	1,22
1997	1.374.711	1,30
1998	1.373.796	1,30
1999	1.449.717	1,37
2000	1.407.768	1,33
2001	1.428.817	1,34
2002	1.562.116	1,44
2003	1.611.481	1,44

La gestión de residuos en el AMB: ***composición***

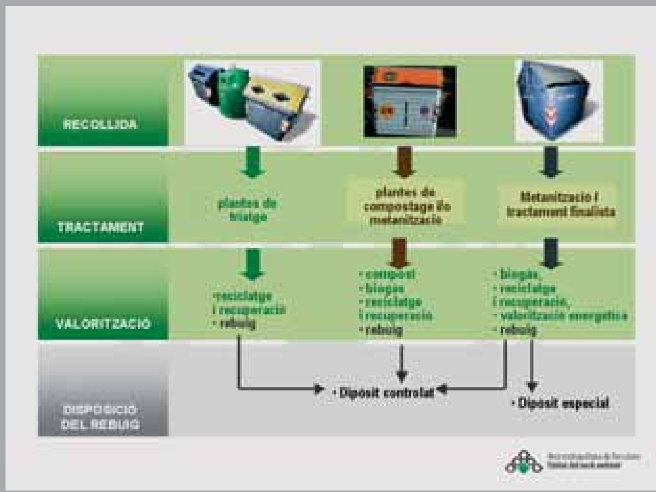
En peso	PMGRM 1996	2001
FORM	39,0%	37,2%
Papel/cartón	27,1%	21,4%
Vidri	7,0%	6,6%
Envases ligeros	11,0%	16,1%
Subtotal	84,1%	81,3%
Resto	15,9%	18,7%

La gestión de residuos en el AMB: ***objetivos del PMGRM***

- Promover la minimización de residuos
- Promover la reutilización, el reciclaje y la valorización de los residuos municipales
- Reducir la cantidad de residuos que van a depósito controlado sin tratamiento previo
- Diversificar las instalaciones y sistemas de tratamiento haciéndolo versátil y flexible
- Adecuar las instalaciones a la normativa más exigente para reducir su impacto ambiental
- Establecer y estimular los elementos comunicativos, informativos y participativos que permitan la corresponsabilización de los ciudadanos

La gestión de residuos en el AMB: ***objetivos de la recogida selectiva PMGRM 2006***

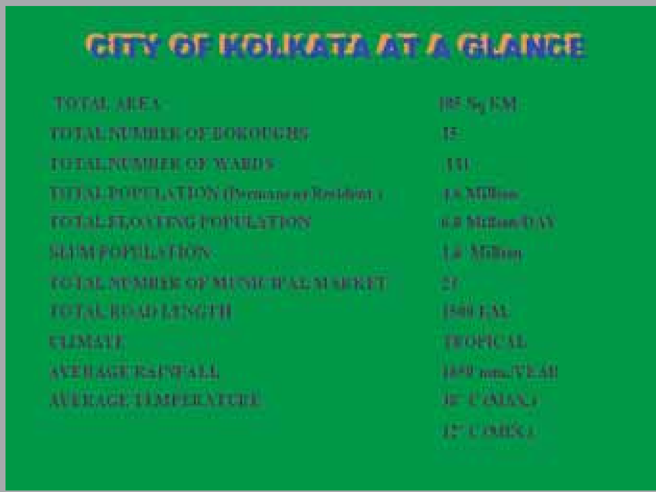
- 60 % = Reciclaje (30 % M.O. + 30 % M.I.)
- 7.1 % = Depósito Controlado
- 32.9 % = Incineración

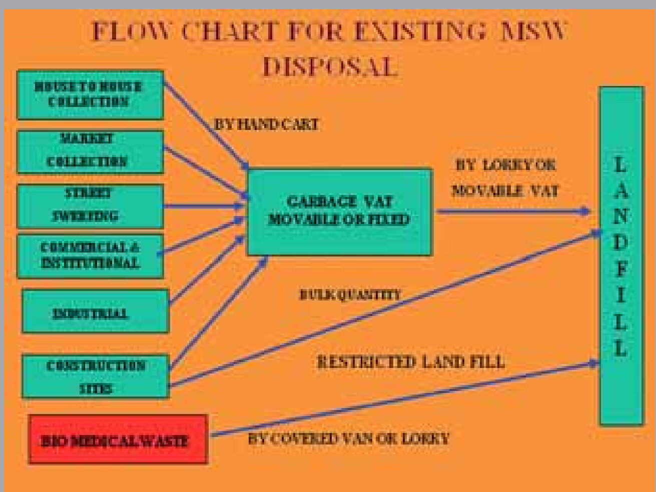


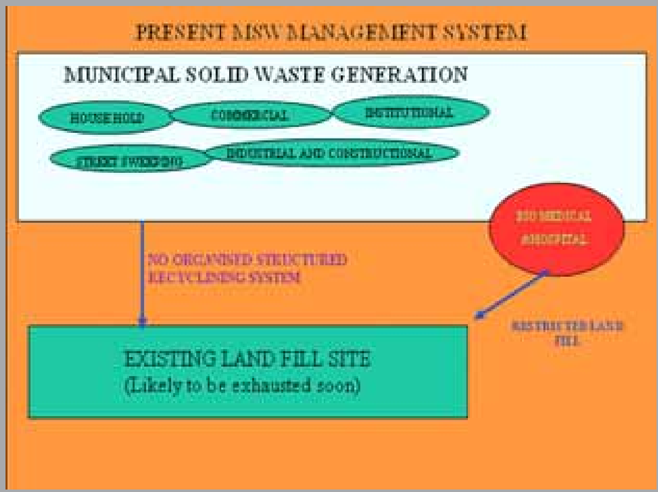
Costes previstos 2004

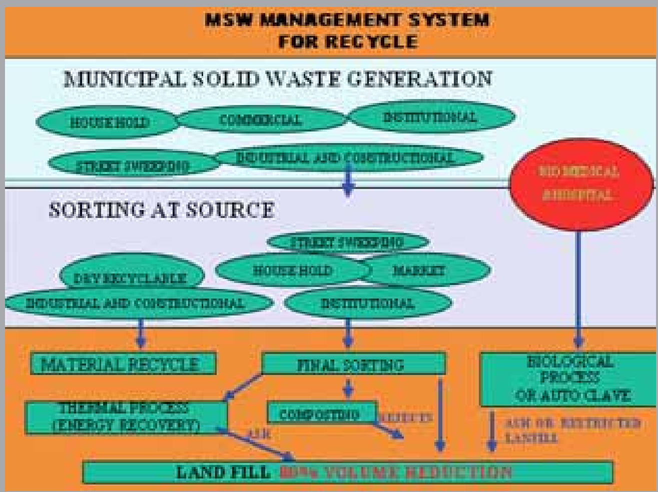
	M€	tn	€/tn
Vertederos	30,5	712.000	42,9
Ecoparques	17,1	345.000	49,7
Incineradoras	12,0	356.000	33,7
Recogida selectiva	10,1	113.000	89,4
Plantas selección envases	6,9	43.000	160,5
Deixalleries	2,3	54.000	42,6
Plantas compostaje	1,4	15.000	94,6
Comunicación ambiental	1,4		
Otros	4,5		
Gastos indirectos	6,6		
Flujos secundarios		-190.000	
Total	92,9	1.448.000	64,2

1.16.8. Experiences in Calcutta (India)






PRESENT MSW MANAGEMENT SYSTEM
MUNICIPAL SOLID WASTE GENERATION
HOUSE HOLD
COMMERCIAL
INSTITUTIONAL
STREET SWEEPING
INDUSTRIAL AND CONSTRUCTIONAL
BIO MEDICAL &HOSPITAL
NO ORGANISED STRUCTURED RECYCLING SYSTEM
RESTRICTED LAND FILL
EXISTING LAND FILL SITE
(Likely to be exhausted soon)


MSW MANAGEMENT SYSTEM
FOR RECYCLE
MUNICIPAL SOLID WASTE GENERATION
HOUSE HOLD
COMMERCIAL
INSTITUTIONAL
STREET SWEEPING
INDUSTRIAL AND CONSTRUCTIONAL
BIO MEDICAL &HOSPITAL
SORTING AT SOURCE
STREET SWEEPING
DRY RECYCLABLE
HOUSE HOLD
MARKET
INDUSTRIAL AND CONSTRUCTIONAL
INSTITUTIONAL
MATERIAL RECYCLE
FINAL SORTING
BIOLOGICAL PROCESS OR AUTO CLAVE
THERMAL PROCESS (ENERGY RECOVERY)
COMPOSTING
REJECTS
ASH
ASH OR RESTRICTED LANFILL
LAND FILL


PRESENT Cost/YEAR
CAPITAL COST FOR
TOTAL COST
TOTAL GARBAGE MANAGED
2500 x 365
COST PER TON


OUR ACHIVMENTS
DOOR TO DOOR COLLECTION
COMPUTERISED INVENTORY OF GARBAGE COLLECTION
INTRODUCTION OF PROPER GARBAGE TRANSPORTATION
TO INTRODUCE PROPER DISPOSAL OF BIO MEDICAL WASTE (WITH THE LOAN ASSISTANCE FROM ASIAN DEVELOPMENT BANK)
PLANNING SCIENTIFIC GARBAGE DISPOSAL WITH THE GRANT FROM JAPAN BANK OF INTERNATIONAL COOPRATION
INITIATIVE TO UPGRADE SLAUGHTER HOUSE


OUR GOAL
IT IS BUILD
IT HAS HERITAGE
IT HAS CULTURE
IT HAS AFFECTION
IT IS GREEN
IT HAS WATER
IT IS CLEAN
IT IS FULL OF ????
WHAT IT IS ? KOLKATA

URBAN SOLID WASTE MANAGEMENT

2. Waste Recycling, Composting and Methanization

INDEX

2.1. Waste Recovery

The term 'recovery' is used to designate management processes where the end aim is to obtain a resource from waste, either through the extraction of materials, the replacement of its original characteristics or by making the most of its calorific power, etc.

Within the general concept of recovery, there are different synonyms according to the type of use to be made of the waste or the type of return to its processing cycle:

- Reutilization: When waste is used again in its original form for the same or for a different use. For example: reusing packages, tires, solvents, etc.
- Recuperation: Extracting a resource from waste. For example: recuperation of building materials, metal from batteries, electrical cables, from agriculture, to be used as a charge in industrial processes, etc.
- Regeneration: When waste is partially or fully returned to its original qualities so that it can be used in the same state before becoming waste. For example: regeneration of mineral oils, solvents, acids, etc.
- Recycling: When waste is used in the manufacturing process of the same product or a product with a similar function. For example: recycling of paper and cardboard, plastic, textiles, glass, etc.

2.2. The Informal Sector in the Recovery of Materials (Scavengers)

The work of scavengers, as people who work informally on rubbish tips are known in different countries, undeniably provide society and its cities with a service of great environmental importance. It may be that for them, the environmental question is of secondary or no importance, but is a simple question of survival.

The activities developed in the so-called informal sector do not respect laws or work regulations, or physical or social rights of workers. Although the service is not illegal, its execution and commercialization are illegal as it does not meet labor laws. It is not a crime to work on tips, but it is a crime to work outside of the legislative protection for workers.

The search for solutions to integrate the informal sector in MW management is growing and experience has shown that this activity can be carried out in a more professional and standardized manner.

Informal work should be incorporated into waste management:

- Because of the technical incompatibility of operations that feature subhuman work conditions for scavengers.
- For safety reasons, because their presence in modern sanitary landfills should be avoided.
- Municipal authorities should seek ways of incorporating scavengers into the process where by they can continue with their work after having been trained in the use of modern technologies.
- Implementing selection collection to recover sub-products.

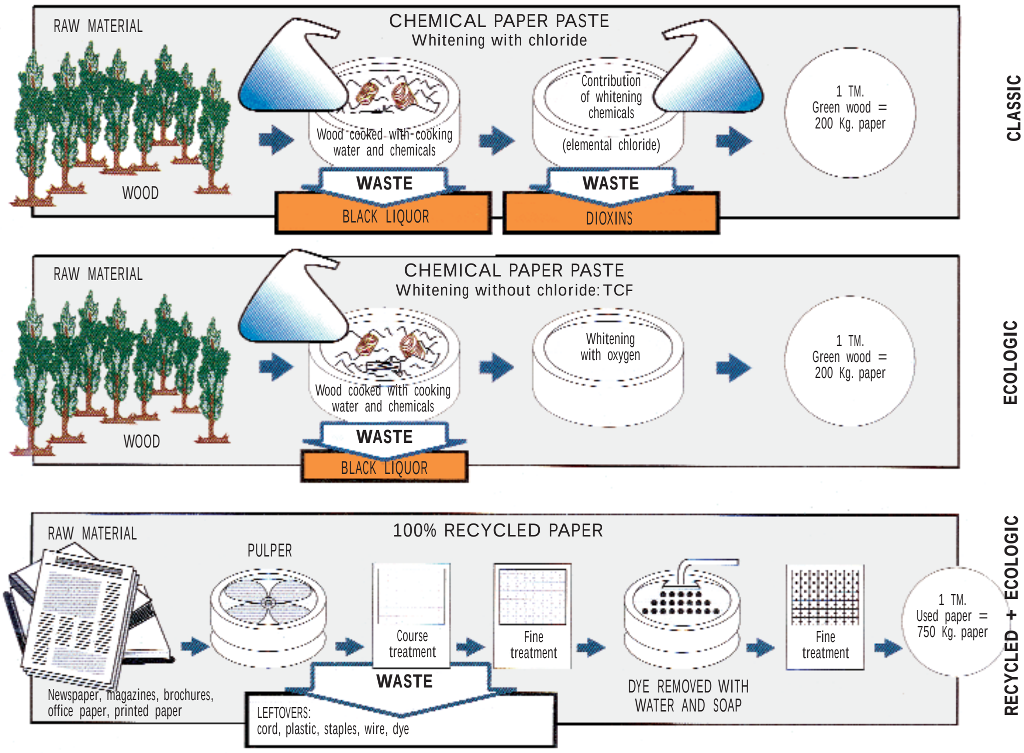
- Seeking imaginative work strategies to incorporate them as recyclers: cooperatives, associations, micro-enterprises, loan facilitation, etc.
- Getting technicians to follow their activity and professionalization.
- Changing the attitude of institutions, authorities and technicians.

2.3. Recycling Paper and Cardboard

Paper and cardboard are selectively collected for recycling. They include paper from newspapers, magazines, brochures, writing paper, computer paper, paper towels, cartons, etc. They have different characteristics depending on their composition and how they have been dyed.

The collection process is simple and has been well studied, but there is a problem of costs. It is sometimes cheaper to import foreign paper than have management companies collect it from the streets.

Fig. 2.3a
Types of Recycled/Environmentally Friendly Paper.



2.4. Recycling Glass

Mainly involves glass from single-use bottles such as those from soft drinks, jam, wine and liquor, baby food, glasses, etc.

In some countries, glass is separated by color, but in Spain it is transformed, without prior separation, into new glass for bottling, which is generally green in color, bearing in mind that Spain is a major exporter of wine and sparkling wine.

The recycling process does not involve greater technical complications.

Glass from bottling is subject to packaging and bottling laws and is practically self-financing.

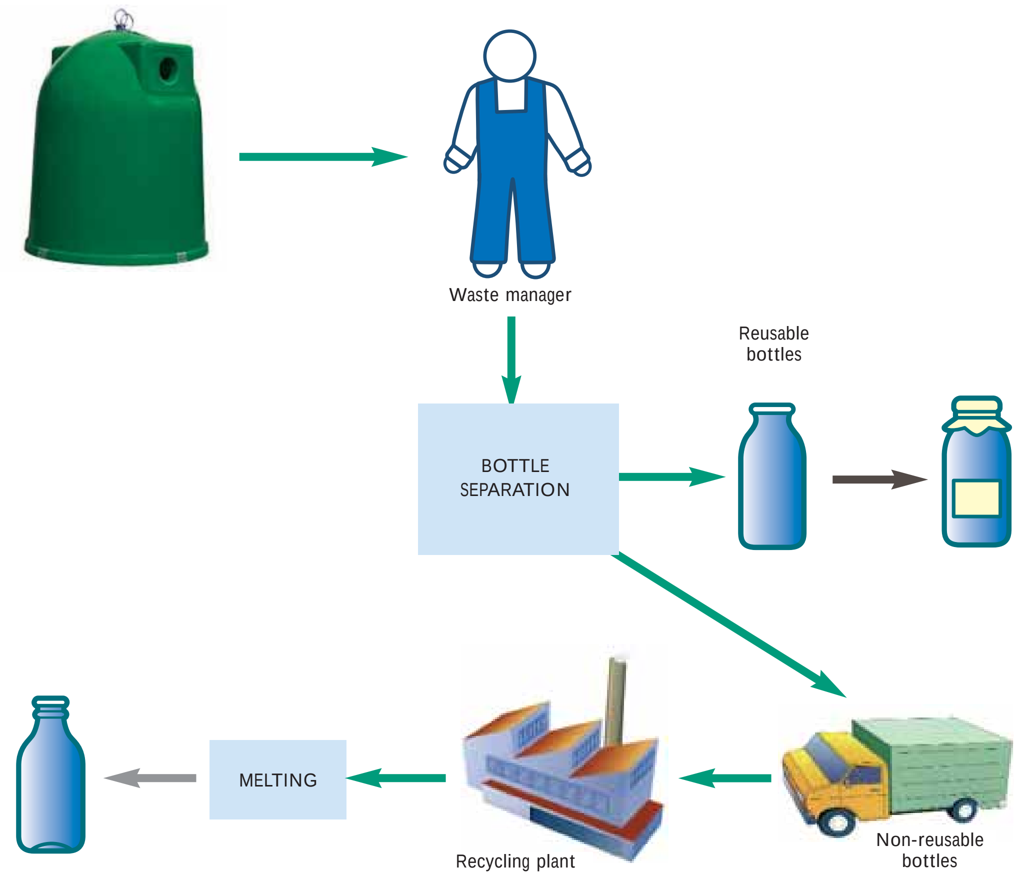


Fig. 2.4a
Glass Recycling.

2.5. Packaging and Bottling

Every day we use plastic packaging, tin and aluminum cans, cartons and other types of packaging. This waste constitutes approximately 25% of the volume of a domestic garbage bag.

Once collected in the container, it undergoes a selection process that separates the different recyclable fractions, in a suitable selection plant.

Tin and aluminum cans are 100% recyclable. Plastic packaging can be recycled for manufacturing plastic bags, urban furniture, signaling or to obtain new non-food use packaging (detergents, bleach, etc.).

Industrial packaging can also be recovered after a profound washing inside and out with hot water and caustic soda. Metal drums can be mechanically shaped, freshly painted and reused.

Cartons can be recycled by making use of their overall components for manufacturing agglomerate or by using each material separately, in processes such as paper recycling and energy recovery of the polyethylene and aluminum.

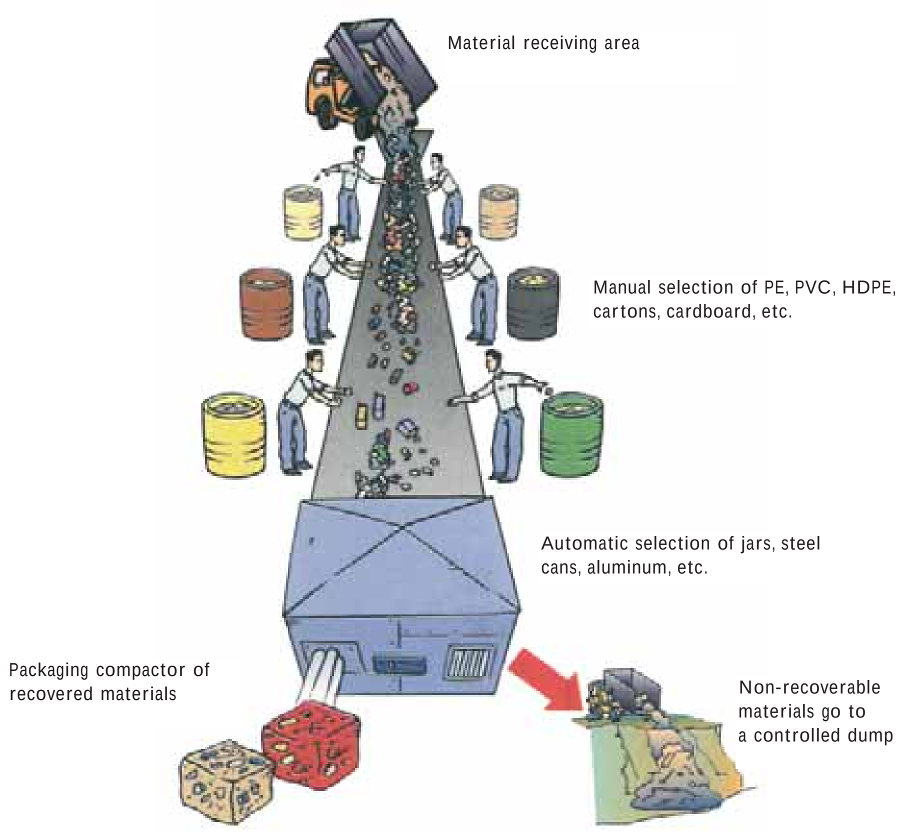


Fig. 2.5a
Selective Collection of Packaging
(Catalan Waste Agency, Barcelona).

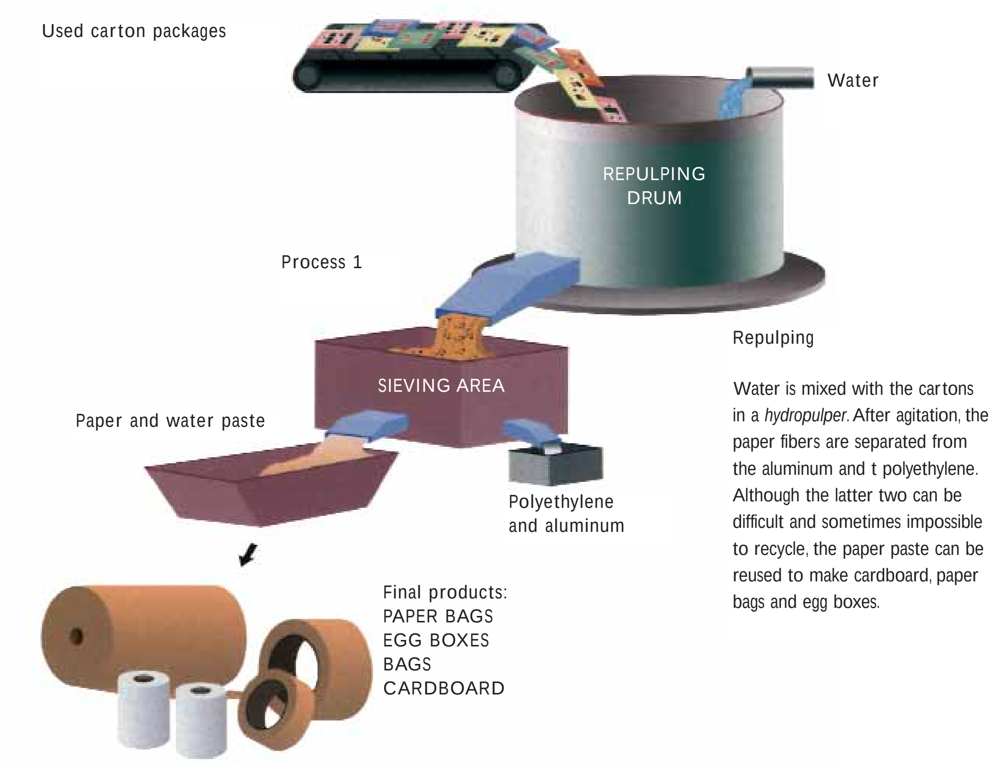


Fig. 2.5b
Carton Recycling
(BIQ Magazine, Madrid).

SAVINGS FROM RECYCLING

City ....
Inhabitants ....
Selected collection during the year ....

Paper and cardboard .... Tn. ....Kg./inhabitant/year
Glass .... Tn. ....Kg./inhabitant/year
Packaging .... Tn. ....Kg./inhabitant/year

Approximate Consumption of a Family

Family Consumption/Year	
Water	250 m^3/year
Light	4000 KWh/year
Heating (gas, diesel, butane)	6000 therms/year 600 liters petroleum/year
Vehicle (gasoline, diesel)	1200 liters/year

Saving Obtained

1 Tn. of recycled paper saves:

- 2,400 Kg. of wood
- 13 adult trees (20 years)
- 4 m^3 of water
- 6,000 KWh de energía

- Wood: ______________ Tn.
- Árbolies: ______________
- Water: ______________ m^3
- Consumption: ______________ families
- Energy: ______________ KWh
- Consumption: ______________ families

1 Tn. of recycled glass saves:

- 1,200 kg of raw material
- 500 KWh of energy

- Raw materials: ______________ Tn.
- Energy: ______________ m^3
- Consumption: ______________ families

1 Tn. of recycled aluminum saves:

- 4 Tn. of bauxite (Al_2O_3)
- 1 Tn. equivalent of petroleum
- 14,000 kWh of energy

Packaging, 20% aluminum

- Aluminum: ______________ Tn.
- Bauxite: ______________ Tn.
- Petroleum: ______________ Tn.
- Consumption: ______________ families
- Energy: ______________ KWh
- Consumption: ______________ families

2.6. Metals and Scrap Metal

The metal from various components, out-of-use machinery, packaging, wires, vehicle fragmentation and all types of instruments with ferrous and other components are easily recyclable. Once the different metals, shavings and crushed metal have been properly separated, they can be directly marketed or smelted and returned to obtain ingots of the original material.

A special case is the recovery of electrical wiring, which is separated by the different components involved: metals, such as copper or aluminum and lead and plastics (PE, PVC and others) and their recycling. The outside cover is cut open, the wire fragmented and the components separated using vibratory methods based on their different specific weights.

The obtained materials can be marketed as materials for recycling.

Fig. 2.6a
Separation of metals on a belt in a selection plant (Revista Sostenible).

2.7. Plastics and Tires

The packaging and bottling sector is the main consumer of plastic. The most common types of plastic in municipal waste are:

- Low-density polyethylene (LDPE): Bags, sacks, toys, household tools, industrial applications, construction, etc.
- High-density polyethylene (HDPE): wires, packaging, bottling, helmets, construction, gears, decoration equipment, milk bottles, etc.
- Polypropylene (PP): car components, household instruments, cords, the wrapping of some foodstuffs (cookies, margarine, potato chips).
- Polystyrene (PS): household appliance parts, particularly from fridges, telephones, household equipment, toys, etc.

• Polyvinyl Chloride (PVC): tubes, cables, packaging, bottles, trays, credit cards, etc.

• Polyethylene Terephthalate (PET): liquid packaging, particularly soft drinks, packaging for domestic and industrial frozen foodstuffs.

• Polyurethane (PU): upholsteries, soles of sports shoes, mattresses, car seats, etc.

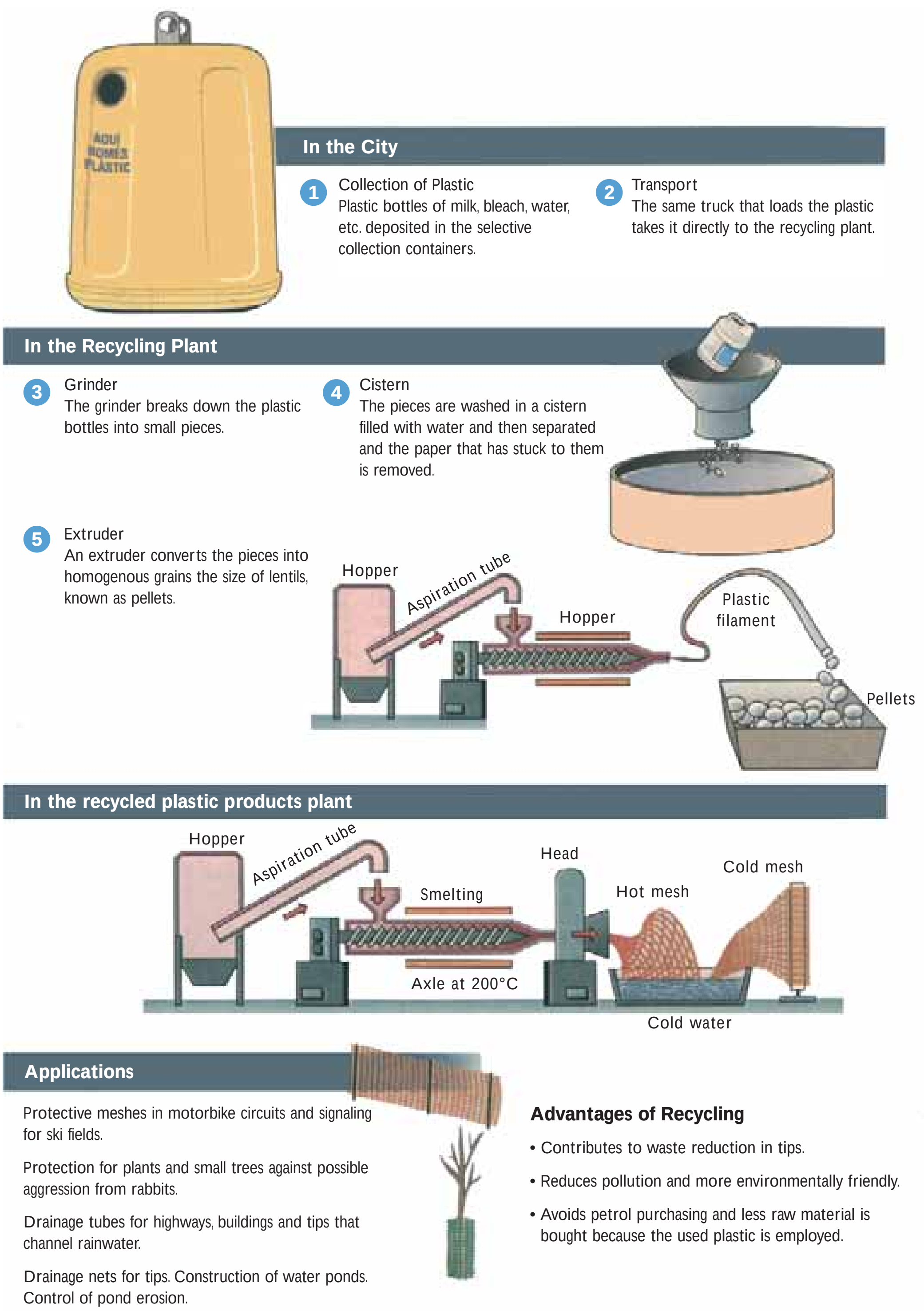


Fig. 2.7a
Recycling plastic.

Fig. 2.2b
Plastic packaging for recycling recovered waste in Barcelona (Metropolitan Environment Organization, Barcelona)

Car and truck tires are largely able to be recycled. However, nearly 50% today goes to the tip, 15% is recycled, part is incinerated and the rest has many different applications.

Some untreated tires are used in the protection of banks, breakwaters, artificial cliffs, for protection in sports tracks, climbing equipment in gardens and others.

One application for used tires that has a large market is to grind them and apply them with modified asphalt. Textile and magnetic fibers on the tires are removed, then they are ground and mixed with bitumen at a temperature of around 200ºC to obtain asphalt.

There are pyrolytic treatment plants for tires, where the rubber is decomposite to obtain cracking products. Other applications incinerate the tires in cement ovens, mainly in the US, using the tire as fuel as it has a calorific power of around 7,000 kcal/kg.

2.8. Oils and Lubricants

Mineral Oils:

These are petroleum-based oils and they have many applications. Engine oils, hydraulic oils, lubricants, transformer oils, mechanization oils, etc., from automotive workshops, industries and ports and craft.

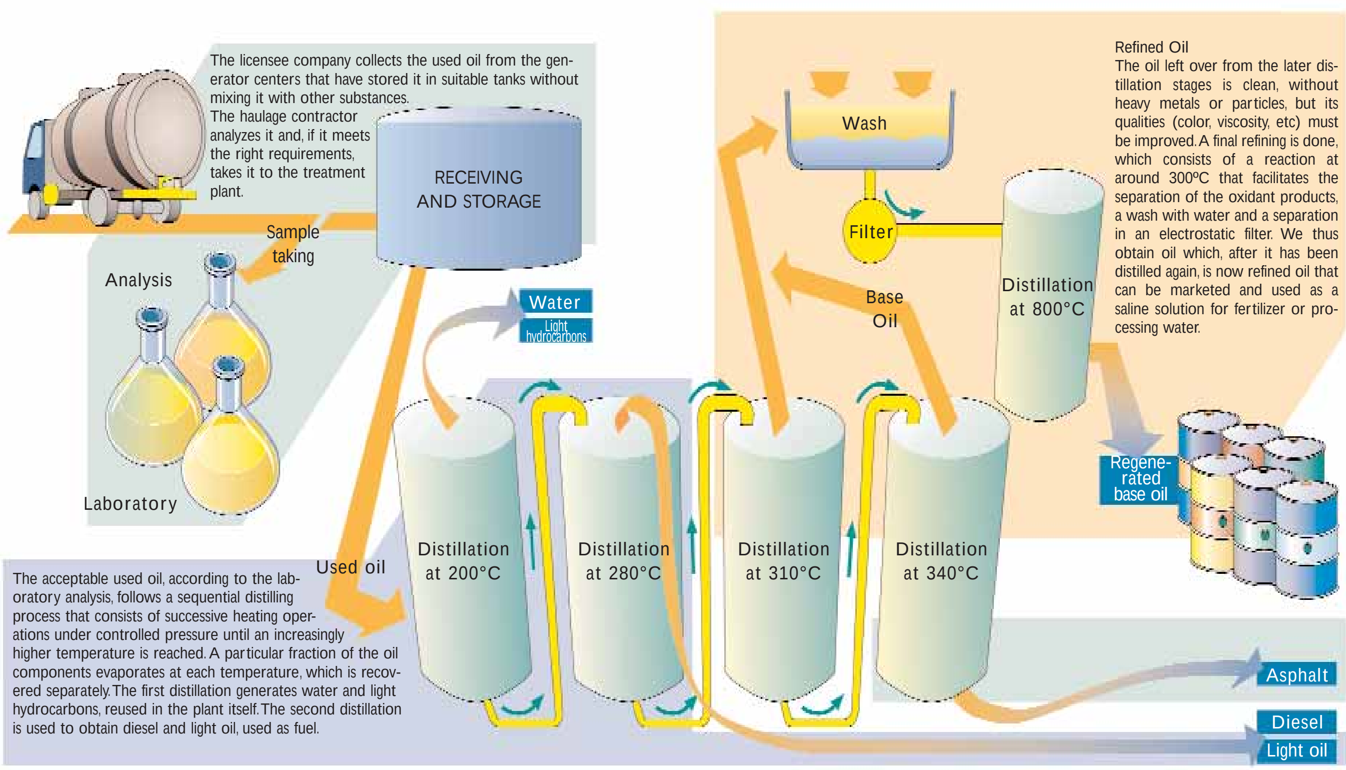
Based on the laboratory analysis, the used oil follows a sequential distilling process that consists of successive heating operations under controlled pressure until an increasingly higher temperature is reached. A particular fraction of the oil components evaporates at each temperature, which is recovered separately.

The first distillation (200°C) produces water and light hydrocarbons, reused in the plant itself. The second distillation (280°C) is used to obtain diesel and light oil, used as fuel. The oil left over from the later distillation stages (310°C and 340°C) is clean, without heavy metals or particles, but its qualities (color, viscosity, etc.) must be improved. A final refining is done, which consists of a reaction at around 300°C that facilitates the separation of the oxidant products, a wash with water and a separation in an electrostatic filter.

The result is oil which, after it has been distilled again, is now refined oil that can be marketed and used as a saline solution for fertilizer or processing water. The solid waste that cannot be distilled may be used as asphalt.

Fig. 2.8a
Regeneration of used mineral oil (Catalan Waste Agency, Barcelona).

Regenerating used mineral oil



Vegetable Oils:

Whether leguminous (such as sunflower, soy, ape, coconut, palm, etc.) or from used cooking oil, vegetable oils can be recycled to obtain a fuel called biodiesel.

Oils used in cooking create a serious problem if tipped directly onto water or in purifying plants. The layer of oil that floats on top creates a barrier to the entry of oxygen and sunlight, stopping some of the biological self-purifying processes.

That is why an interesting application of used cooking oil is to recycle it to obtain fuel. It is filtered and mixed with methanol at 50ºC to obtain a methyl ester or biodiesel and a sub-product, glycerin. Biodiesel is used in automobiles in a proportion of around 10% mixed with diesel fuel, without requiring any engine modification.

2.9. Household and Electronic Equipment

It is increasingly common to recycle white goods (major household appliances) and brown goods (TVs and electronic appliances) at the end of their useful life.

Fridges and cooling equipment that contain chlorofluorocarbons (CFCs) should stop emitting these gases into the atmosphere because of their effect on depleting the ozone layer. Specialized plants disassemble fridges, extract the oil and CFC mixture from the compressor and grind the fridge to recover metals such as iron, aluminum, copper and other elements, such as plastic and polyurethane foam. The CFCs obtained are incinerated.

Recycling Fridges

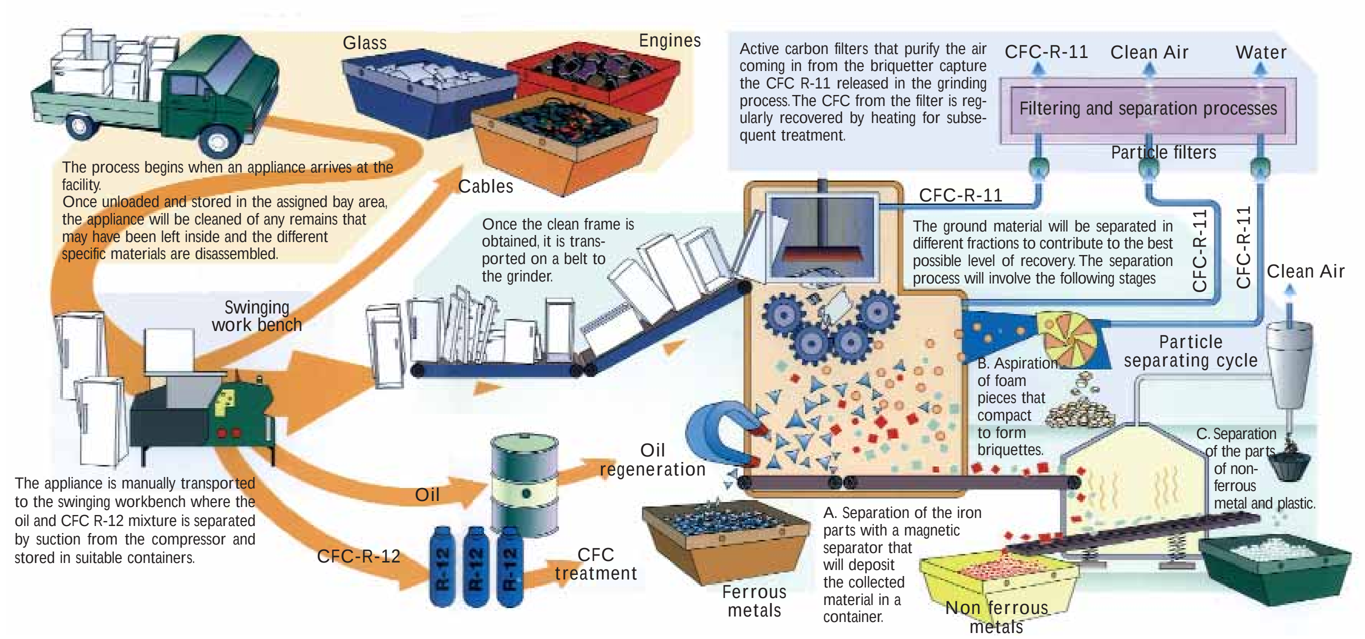


Fig. 2.9a
Recycling system for a fridge with CFCs (Catalan Waste Agency, Barcelona).

The growing amount of waste from electrical and electronic equipment makes their selective collection and specific treatment essential. Some appliances that have been thrown out but which are operative may be used for social economy projects. Kitchen appliances and office and personal materials (computers, mobile telephones), should be disassembled, with the recyclable material manually selected and the waste material ground in a mill, classifying the different ferrous and non-ferrous materials to recover: iron, copper, aluminum, plastic, etc.

Television sets and monitors need special treatment because of the risk that they may implode and because of dust present on the screens. Once disassembled, the wooden or plastic casing should be separated and ground. Glass screens are broken to prevent implosions, the cone is removed from the screen and the dust inside is vacuumed.

2.10. Vehicle Scrapping

European Directive 2000/53/EC states that when an automobile reaches the end of its useful life, a process of separation and recycling of the vehicle materials should be followed in order to minimize the amount of waste that goes to the tip.

The following flow diagrams show the process that vehicle scrapping should follow, the final stage of which will be fragmentation for use as material in the iron and steel industry.

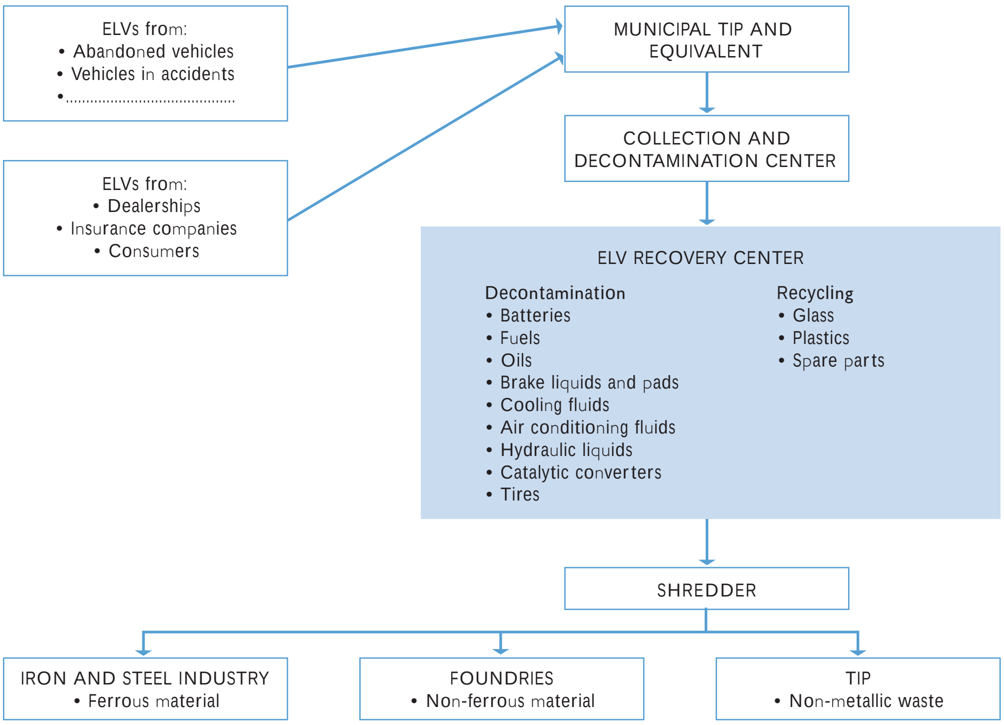
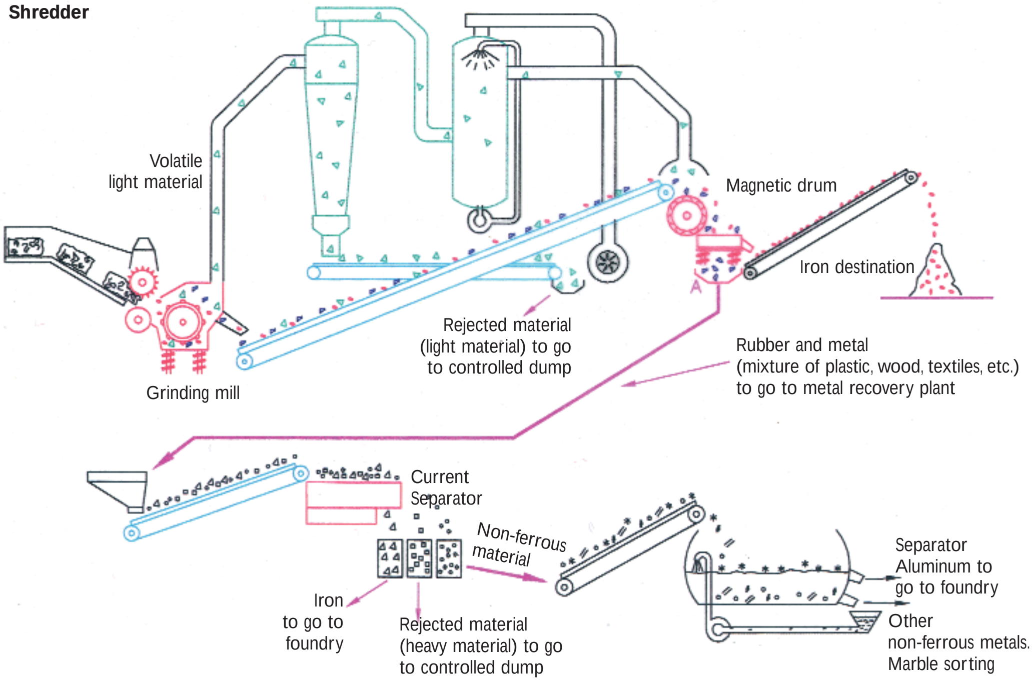


Fig. 2.10a
Flow diagram for End-of-Life Vehicles.

Fig. 2.10b
Vehicle Shredder.



2.11. Drugs and Laboratory Products

Drugs are collected by organizations that use them for social purposes if they have not expired. Otherwise they are made inert and dumped in tips.

Laboratories and training centers generate a wide range of special waste, the nature of which means it has the potential to contaminate.

The reagents used should be classified in the laboratory as solvents, halogenated compounds, acids and bases, solutions with heavy metals, etc. They should be collected in suitable containers and sent for a specific treatment according to the compound, whether neutralizing their effect, making them inert or distilling the volatile components.

2.12. Composting Based on Waste and Sludge

Composting is an accelerated decomposition process of organic waste, which turns into compost and is a good quality organic fertilizer. Organic waste collected from households is mixed in a proportion of 3:1 with vegetable waste from pruning or gardening work to give it greater porosity. The material is piled up, entered into a composting tunnel (other times in the open air) and should be turned each day for two weeks to begin the decomposition process. After this fermentation time, it should be taken to a covered bay where the composting process will continue for a further eight weeks. The action of the microorganisms and a number of sufficiently controlled humidity and ventilation conditions will see the material transformed into humus. Finally, a rotating sieve (trommel), a densimetric table (which separates the heavy particles, such as glass, metal, stones, seeds, etc., by vibration) and an aspiration system for plastic is used to eliminate impurities and obtain quality compost. Around 30 kg of compost can be obtained from each 100 kg of organic fraction.

Suitable humidity level: 45-55%
Optimal temperature between 45 and 50ºC, reaching points of 60ºC.

Compost based on sludge from wastewater purifying plants follows a similar process to that of municipal organic waste. It begins with sludge that has undergone an anaerobic fermentation process to stabilize it and with the drying of 25% of dry material. It is mixed with 30% of vegetable remains, pruning remains, grass, sawdust, etc. and fermented by ventilation and humidity for 10 weeks.

Fig. 2.12a
Turning waste for composting with a tractor truck.

Fig. 2.12b
Turning machine for compost (Fomento Construccions y Contratas, Madrid).

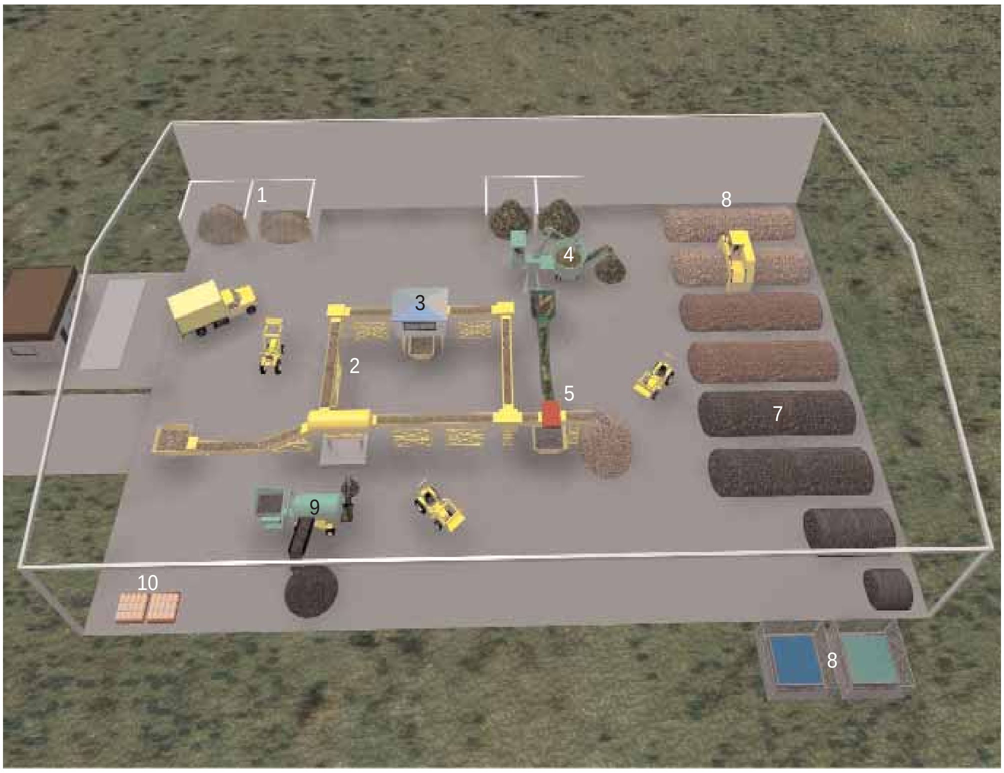


Fig. 2.12c
Diagram of a composting plant (Catalan Waste Agency, Barcelona).

1. Organic material receiving area
2. Trommel
3. Manual sorting cabin
4. Grinding of the vegetable fraction
5. Mixture and homogenization
6. Dumping in piles
7. Turning and control of the piles
8. Collection of leachates and rainwater
9. Obtaining mature compost
10. Dispatch of compost

2.13. Home Composters

It has always been common to produce compost from agricultural and household remains in manure heaps on farms. Today there is a wide range of composters for household use, which should be placed somewhere where they are not exposed to the elements (sun, rain, wind) to prevent them from becoming too dry from the sun or wet from the rain.

We can compost the remains of fruit and vegetables, flowers, dry plants, ashes, egg shells, the remains of coffee or tea, infusions with the paper filter included, expired yogurt, corks, kitchen paper, pruning remains, fallen leaves, grass, vegetable-garden remains, farmyard animal manure, straw, etc.

The fermentation process with humidity and in the open air lasts from four to six months until the compost is mature (when the ground is black or dark brown in color) and can be used to fertilize the soil.

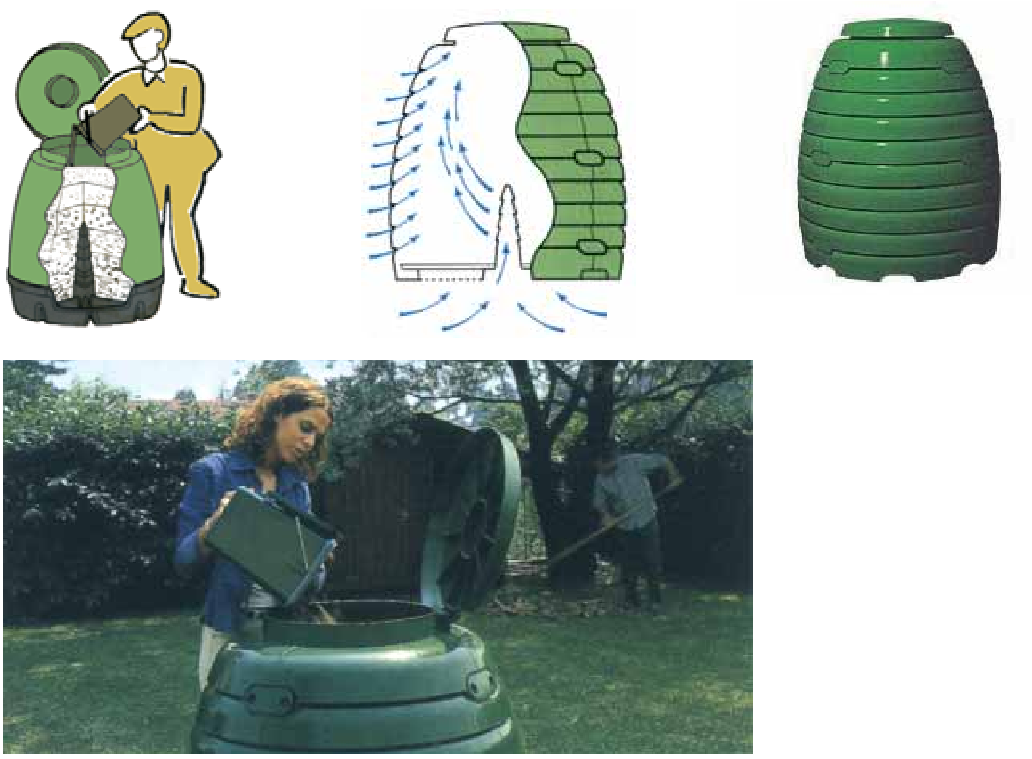


Fig. 2.13a
Home Composter Diagram (Alqui-Envas., Lleida).

2.14. Methanization and Biogas

Using biomass is a growing practice in all countries. In communities where the generation of electrical currents is promoted, there is a tendency to produce biogas based on all types of organic waste. It can include animal excrement, the remains of agricultural crops, manure, foodstuffs in a poor state, products from the agro-foodstuffs industry, etc. After a variable time (two weeks to two months), depending on the material used, anaerobic fermentation in large tanks produces biogas with 65% methane and 30% CO_2 and a calorific power of more than 5,000 kcal/kg. The biogas is led to a gasometer and from this to a cogeneration center with engines that generate electricity to deliver energy to the network.

2.15. Ecoparks

Some countries have started to develop Ecoparks to provide comprehensive waste treatment facilities that are efficient and environmentally friendly. Their main function is to assess the organic fraction and the rest (household and undifferentiated waste) by different auxiliary processes such as the selection and separation of recoverable material, composting and methanization.

The organic material found in the selective collection of household, commercial, market and gardening waste is destined to quality composting, which has fermentation and maturing stages.

From the remaining fraction, recyclable materials such as paper, glass, plastic and packaging are recovered by sorting systems such as rotating drums, electromagnets and induction-sorting systems, in addition to manual sorting.

The remaining organic fraction that is of poor quality and unable to be composted, can be methanized to obtain biogas. The methane is transformed into electrical energy by combustion.

The final waste from the remaining fraction that is neither recoverable nor recyclable may be inertized, compacted and disposed of in a controlled dump with no negative effect on the environment.

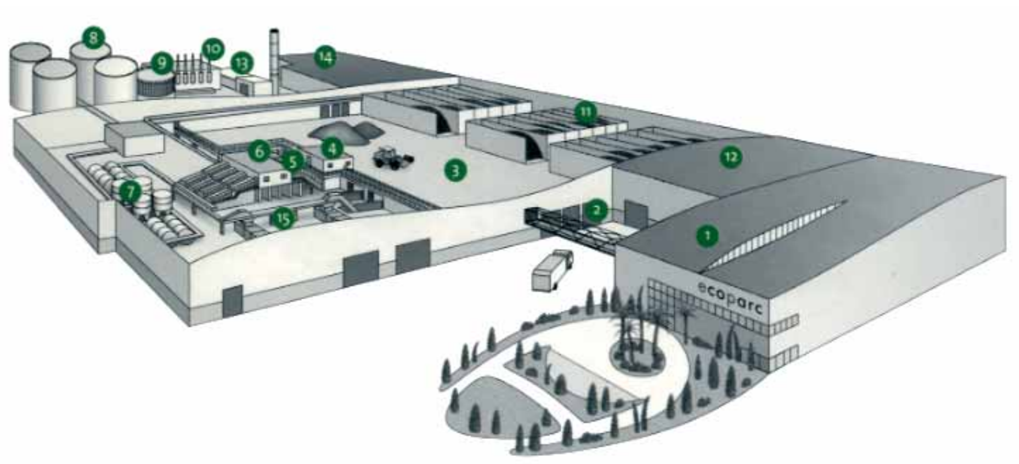


Fig. 2.15a
Ecopark in Barcelona (Metropolitan Environment Organization. Barcelona).

1. Offices and conference room
2. Entrance gate
3. Receiving platform and feeders
4. Control center
5. Conveyer belts
6. Selection station and rotating sifter
7. Disintegrator or agitation tanks
8. Digester
9. Gasometer
10. Electricity co-generation plant
11. Composting area
12. Processing area and compost storage
13. Water purification station
14. Biofilter
15. Waste treatment area

2.16. Cost Study

The costs involved are difficult to estimate as many factors come into play (technological, environmental, legal, socioeconomic, electricity rate systems, etc.) An analysis of municipal waste management costs should include:

2.16.1. Generation Costs

Communication and awareness campaigns to promote the selection process at the point of generation, the minimization of waste production, changes in generational habits and municipal services information.

These comprise between 15 and 18% of the total.

2.16.2. Collection and Transport Costs

Distribution among personnel costs (60-85%), service operation (10-12%), investments (5-25%) and others (1-2%). Personnel costs increase with manual loading (85%) and investment is reduced (5%), while personnel costs decrease with side-loading (65%) and investment is increased (25%).

Collection and Transport Costs: Range between 30 and 50 Euros/ton, depending on the size and degree to which the fleet is mechanized, and the distance to the waste treatment plant.

Selective Collection Costs: Depends on the existing arrangement for the assessment of packaging. However, it is still over 60 Euros/ton.

2.16.3. Treatment Costs

Dump Costs: Vary according to the structure of the dump (sanitary landfill). For a non-insulated dump with a single covering operation, it could cost approximately 10 Euros/ton, while a dump with insulation and leaching treatment could cost between 30 and 50 Euros/ton.

Incineration Costs: In general it is more expensive than other treatments, costing over 50 Euros/ton.

2.16.4. Management and Control Costs

This includes management and control, research, legislation and studies, which could amount to 7% of the total cost. Industrial profit and general costs should be estimated at 10-12% of the total cost.

Fig 2.16b shows average treatment costs of municipal waste for dumps and incinerators in a number of European countries.

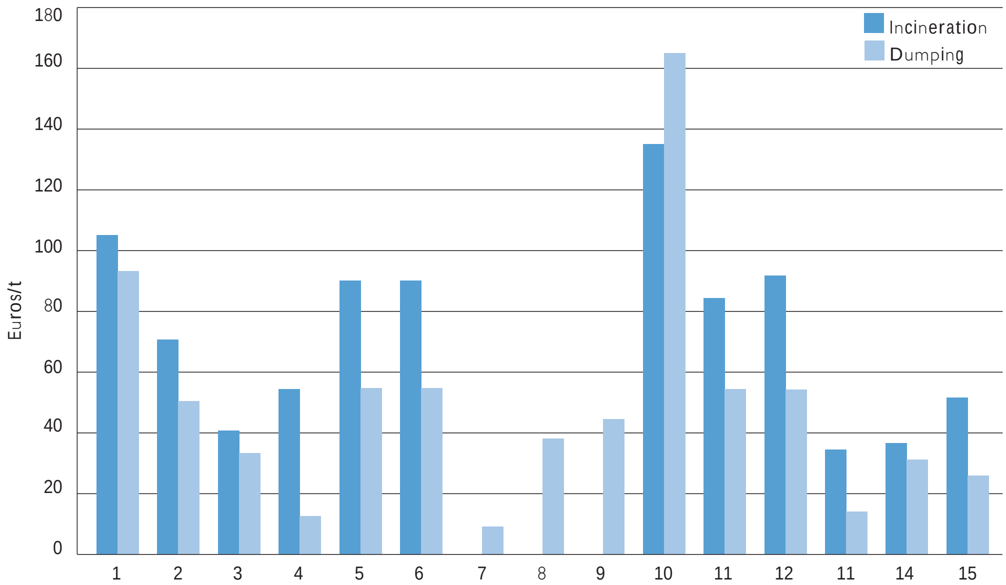


Fig. 2.16b
Waste Treatment Costs in European Countries.
Average cost of the treatment of non-hazardous waste in dumps and incinerators in various EEA member countries (not including VAT and waste tax). It is important to note that all the prices given here are averages and can vary greatly from plant to plant.

1. Austria
2. Belgium
3. Denmark
4. Finland
5. France
6. Germany
7. Greece
8. Ireland
9. Liechtenstein
10. Luxemburg
11. Netherlands
12. Norway
13. Spain
14. Sweden
15. United Kingdom

This pie graph shows the distribution of the approximate current costs in municipal waste management in Catalonia (Spain).

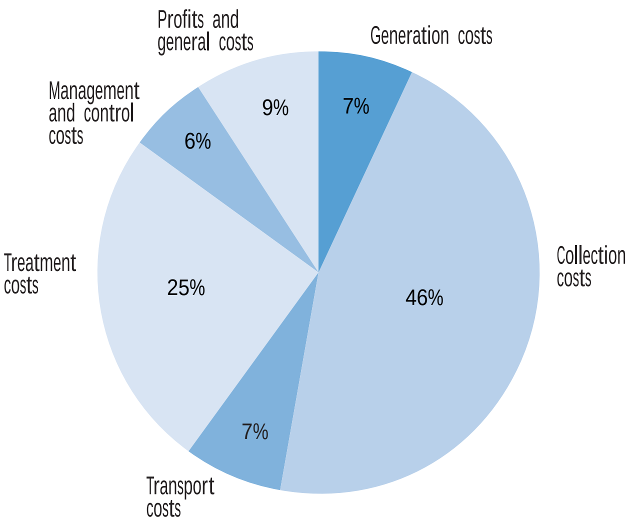
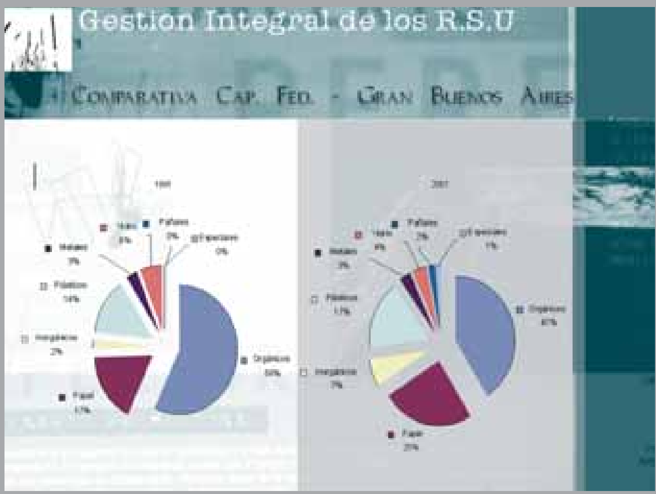


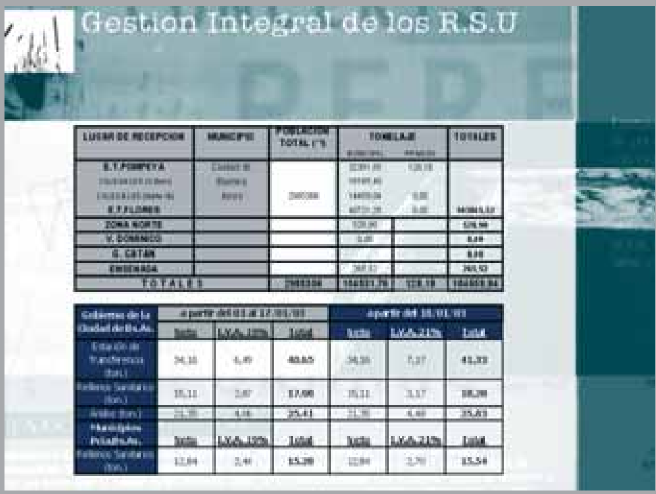
Tabla 2.16c
Current Cost Distribution of Municipal Waste Management

Tabla 2.16d
Costs of Waste Treatment at the Metropolitan Environment Organization in Barcelona.

	2003			2006		
	Euros	Tons	Euros/tn	Euros	Tons	Euros/tn
Controlled dumps	13,517,086	698,016	19.37	23,897,634	481,803	49.60
CD Garraf (without Ecopk waste)	13,517,086	698,016	19.37	0	0	0.00
CD others (without Ecopk waste)	0	0	0.00	23,897,634	481,803	49.60
Power plants	10,466,702	362,339	28.89	20,073,979	403,976	49.69
PP Besos	8,143,365	315,388	25.82	20,073,979	403,976	49.69
PP Montcada	2,323,337	46,951	49.48	0	0	0.00
Ecoparks (includes waste treatment)	16,928,505	351,178	48.20	50,811,692	762,523	66.64
Ecopark 1	16,928,505	351,178	48.20	22,890,050	330,634	69.23
Ecopark 2	0	0	0.00	12,378,533	183,900	67.31
Ecopark 3	0	0	0.00	15,543,110	247,989	62.68
Composting plants	1,835,575	32,372	56.70	1,601,486	24,757	64.69
CP Castelldefels	625,122	11,144	56.09	796,037	14,421	55.20
CP Torrelles	307,124	4,412	69.61	416,149	4,990	83.40
CP Others	903,329	16,816	53.72	389,300	5,346	72.82
Sorting plants	7,422,528	45,197	164.23	11,311,890	70,360	160.77
SP Gavà-Viladecans	3,760,107	12,018	312.87	4,037,090	12,125	332.96
SP BMA2	1,962,040	13,313	147.38	3,661,167	22,734	161.04
SP Molins de Rei (MW)	1,700,381	19,866	85.59	1,228,826	10,003	122.85
SP Sant Cugat (MW)	0	0	0.00	2,384,808	25,498	93.53
Collection & Storage Centers	2,446,145	44,597	54.85	2,887,643	59,065	48.89
Local management	300,506	0	0.00	0	0	0.00
Logistical management	1,923,456	44,548	43.18	2,402,071	58,937	40.76
Mobile units	222,183	48	4,610,09	485,572	128	3.807.69
TOTAL	52,616,542	1,533,699	34.31	110,584,325	1,802,484	61.35

2.17. Experience in Buenos Aires (Argentina)






Los Caminos de la basura (I)
Domiciliarios
0,924 Kg.
Hab/día


Los Caminos de la basura (II)
Poda y limpieza de calles
0,245 Kg.
Hab/día

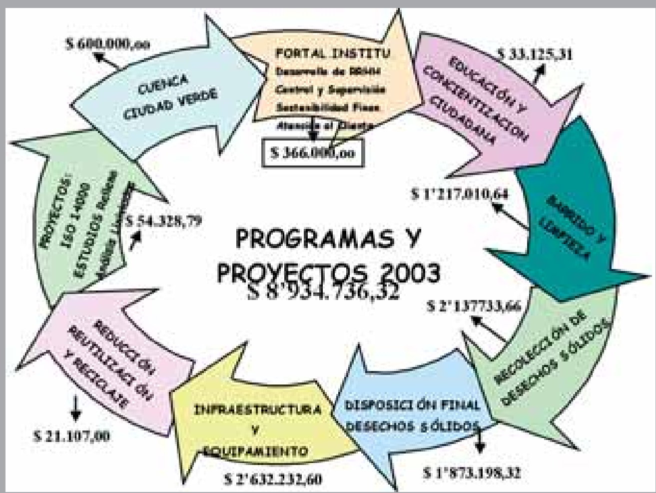

Los Caminos de la basura (III)
OTROS:
0,394 Kg.
Hab/día
Contenedores
Bocas de Tormenta
Voluminosos
Poda clandestina


Los Caminos de la basura (IV)
OTROS:
0,394 Kg.
Hab/día
Contenedores
Total promedio 2003:
1,581 Kg.
Hab/día


Los Caminos de la basura (V)
El 32 % de los residuos pasa por las Estaciones de Transferencia (2.003)
Inspección y balanza
El 68 % va directo a los Centros de Disposición Final (2.003)
Al relleno sanitario


Las Estaciones de Transferencia
Objetivo:
Minimizar costos de traslado en la recolección de residuos sólidos.
Colegiales
Flores
Pompeya
Ing. Graciela Gerola ARGENTINA

2.18. Experience in Cuenca (Ecuador)




RECOLECCIÓN DE DESECHOS SÓLIDOS
COSTO PROGRAMA $ 2'137.733.66
• Diariamente se recolectan 300 toneladas, 108.000 toneladas al año.
• Atendemos a 20 de las 21 parroquias rurales de Cuenca excepto Chaucha por falta de vías.
• Ampliación de la recolección diferenciada de los desechos biopeligrosos e incineración.


INFRAESTRUCTURA Y EQUIPAMIENTO
COSTO PROGRAMA $ 2'632.232.60
• Estamos por incorporar 12 recolectores, 10 de carga posterior y 2 de carga frontal, los vehículos nuevos serán controlados con el sistema GPS
• Terminación de las obras civiles y eléctricas en el relleno de Pichacay
• Terminación del Dispensario Médico y Cerramiento en la Planta de Operaciones
• Adecuación de la Casa de Servicios Ambientales
• Red informática


DISPOSICIÓN FINAL DESECHOS SÓLIDOS
COSTO PROGRAMA $ 1'873.198,32
• Anexión y permuta de terrenos aledaños al relleno
• Monitoreo de las variables ambientales, calidad de agua superficiales y subterráneas


ELABORACION DE HUMUS
COSTO PROGRAMA $ 21.107.00
• Implementación del sistema de Reciclaje en Cuenca, recolección diferencia de materiales reciclables.
• Producción de humus para el aprovechamiento de la materia orgánica de mercados.


MANEJO DE DESECHOS BIOPELIGROSOS
• Recogemos diferenciadamente el 70% de la basura biopeligrosa.
• Atendemos a 41 establecimientos de salud.
• En Cuenca se recogen 3.800 kg/mes de desechos biopeligrosos.
• Todos los desechos biopeligrosos son incinerados en el Hospital José Carrasco Arteaga del IESS.
• Las cenizas son depositadas en el Relleno Sanitario de Pichacay.
Proceso de recolección en los establecimientos de salud


MANEJO DE DESECHOS BIOPELIGROSOS - incineracion
Vista General del equipo de Incineración del IESS

URBAN SOLID WASTE MANAGEMENT

3. Waste Incineration and Controlled Dumping

INDEX

3.1. Thermal Treatment of Waste

What we would normally understand as waste incineration should more correctly be referred to as waste combustion, and in general terms it would be better to refer to the thermal treatment process of waste.

The processes involved in the thermal treatment of waste can be grouped as follows:

Pyrolysis:

This is the decomposition of waste by heat, generally at temperatures between 500 and 800ºC and in an oxygen-free environment. As a result of the thermal degradation reaction, depolymerization and cracking, gases, liquids and solid residues are obtained that can be used as fuel in other industrial processes. Condensables can be used as pyrolytic oils, methanol, etc, which have high added value.

Gasification:

The process by which solid fuel or waste is converted to a gas, generally used to transform a residue with low calorific value into a gaseous fuel, which has a higher calorific value. The process is carried out in an oxygen-free environment.

Incineration:

The waste undergoes thermal treatment at temperatures between 850 and 1100ºC in an aerobic environment (stoichiometrically sufficient oxygen), allowing the organic material to combust. The heat generated by the gases is collected in a boiler, which then produces steam that can be used directly or converted into electricity by way of turbo-alternators.

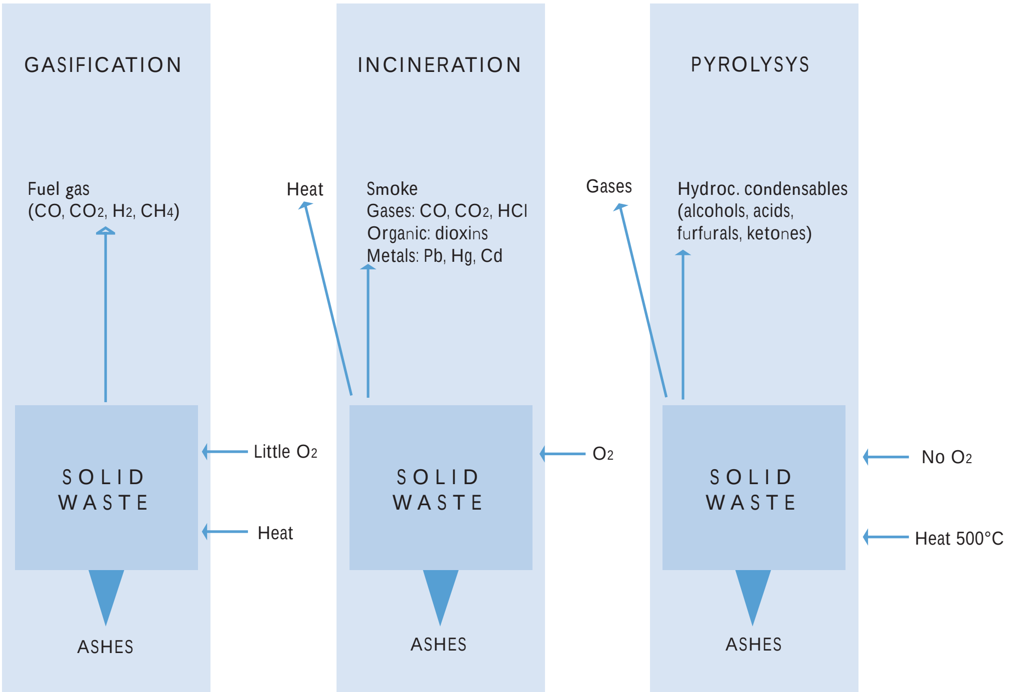


Tabla 3.1a
Thermal Treatment Systems.

3.2. Calorific Value of Waste

Combustion of a residue should generate sufficient thermal energy so that the process propagates without the need for large quantities of extra fuel. This is why a low calorific value is desired in order to maintain constant combustion.

High calorific value (HCV):

Obtained experimentally by burning fuel in a calorimetric bomb, where the combustion products remain at room temperature and the steam produced condenses whereby transferring the heat from the condensation (598 kcal/kg) to the water in the calorimeter.

Low calorific value (LCV):

Calculated on the basis of the HCV and including the heat released by the condensation of the water. The LCV is the closest value to reality and represents the calorific value of the fuel.

LCV = HCV – 5.98. H kcal/kg
LCV = HCV – 24.45. H kJ/kg
H = % water (moisture) content of residue.

If LCV is less than 2,200 kcal/kg, a pretreatment is required to concentrate the waste into combustible components (dry, segregate, inerts, etc.). For a LCV between 2,000 and 8,500 kcal, the waste can be incinerated, sometimes with extra fuel to assist the process (at the start). If the LCV is higher than 8,500 kcal/kg, the waste can be considered a fuel with regard to its calorific potential.

3.3. Types of Incinerators

Depending on the type of waste to be incinerated, there are several types of furnaces available, some of which are:

Fixed Chamber Incinerator (Liquid Injection Incinerator):

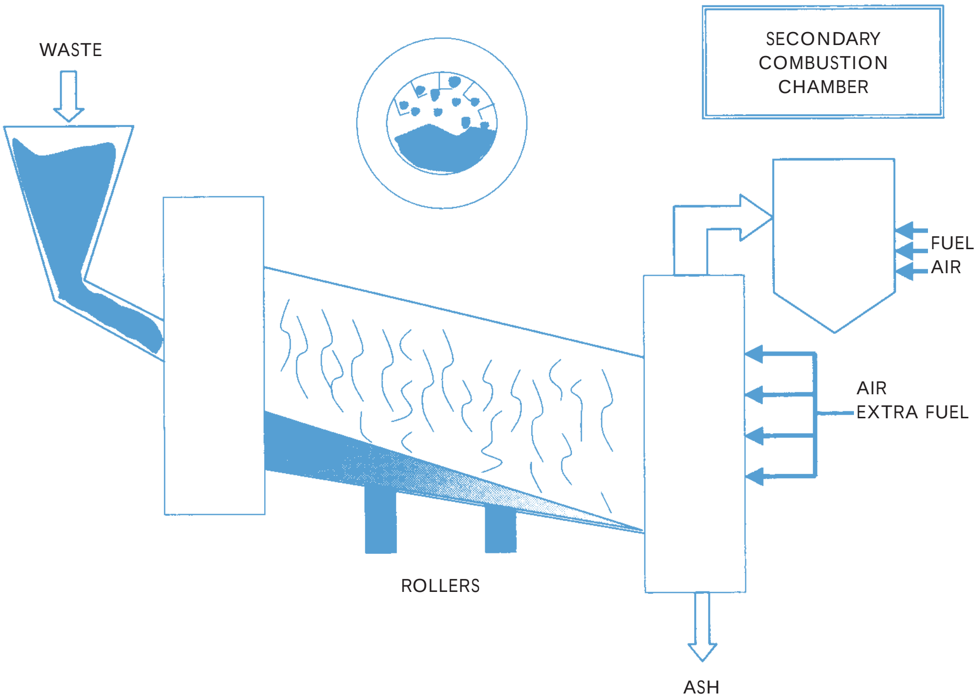
Used only for liquid or gaseous waste that has a low content of inert material. Can be used in small-sized plants that do not have continuous shifts, stopping the equipment periodically to remove the inert substances from the chamber. Liquid waste is pumped into the unit through spray nozzles, so that the small droplets react more readily with oxygen.

Rotary Kiln Incinerator:

The main feature is the rotating cylinder that is lined with heat resistant material inside. It turns slowly (at a rate of 1-5 revolutions an hour) and at a slight angle thereby moving the waste around. The gases go to a post-combustion chamber to ensure that the combustion is completed, while the ash and the inert material (slag) exit through the end of the cylinder.

Grate Incinerator:

Used in mass waste incineration plants such as municipal waste. The combustion chamber is fixed but the lower part of the chamber is made up of a moving grate through which the primary air required for combustion is injected. There are several designs, some of the more common ones are continuous, roller or swinging type grates.



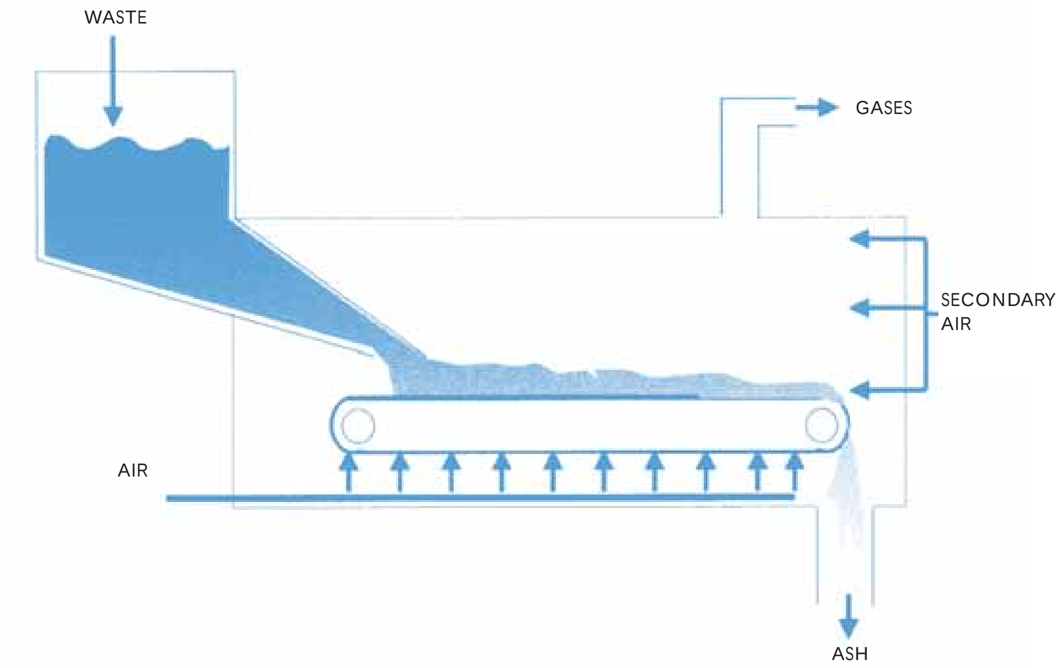


Fig. 3.3a
Rotary Kiln and Moving Grate Incinerator. (Los residuos peligrosos. Rodriguez and Irabien. Ed Sintes. Madrid 1999)

Liquid-Bed Furnace

This is basically a vertical cylinder where combustion takes place on a sand or aluminum bed that is kept in a state of suspension by pumped air. The waste has to be introduced uniformly in order to maintain a stable liquid environment. The air heats as it passes through the sand and combustion takes place in the liquid bed. The combustion gases draw part of the ash away. These furnaces have a highly efficient combustion system, but at the same time have problems of stability and material wear and tear due to abrasion.

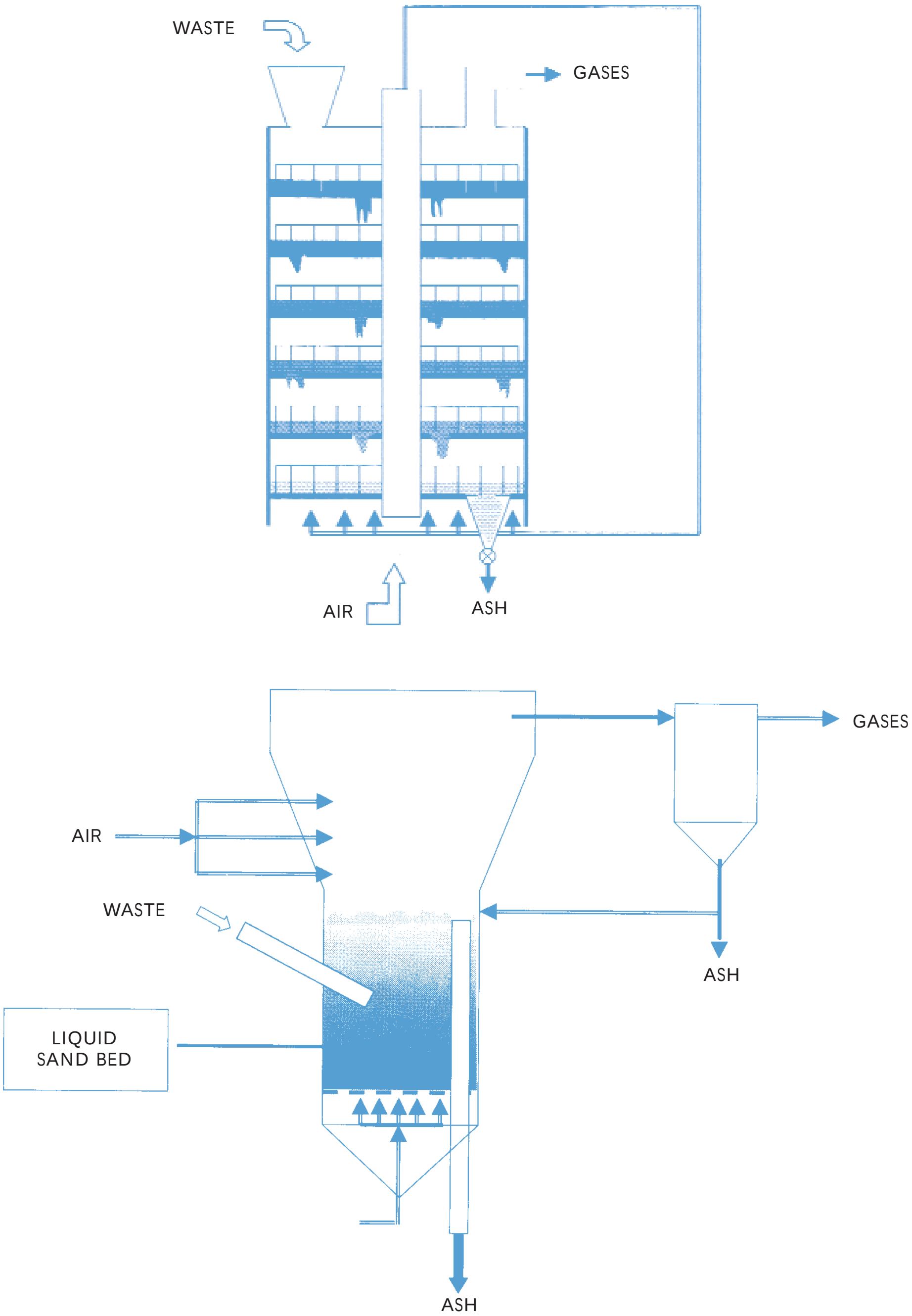


Fig. 3.3b
Liquid-bed Incinerator with Different Levels (Los residuos peligrosos. Rodriguez and Irabien. Ed Sintes. Madrid 1999).

3.4. Incineration of Municipal Waste

Waste that has been previously approved arrives at the plant in closed-body trucks and already compressed, and is then unloaded in the storage area. A crane is used to introduce the waste into the incinerator where it goes into the combustion chamber and post-combustion chamber.

The gases that are produced go to the recovery boiler, where reheated steam is generated and is then converted to electrical energy by way of turbo-alternators. The surplus is filtered and gases flushed before passing out the chimney.

The treatment of gases has special requirements. First they pass through a plant that removes the solid particles (ash), which, together with those from the boiler, undergo treatment as special waste. The gases that are still dirty go through a limewash spray treatment to neutralize them. Later, the absorbed particles are separated and the clean gases are released outside through a 50m chimney.

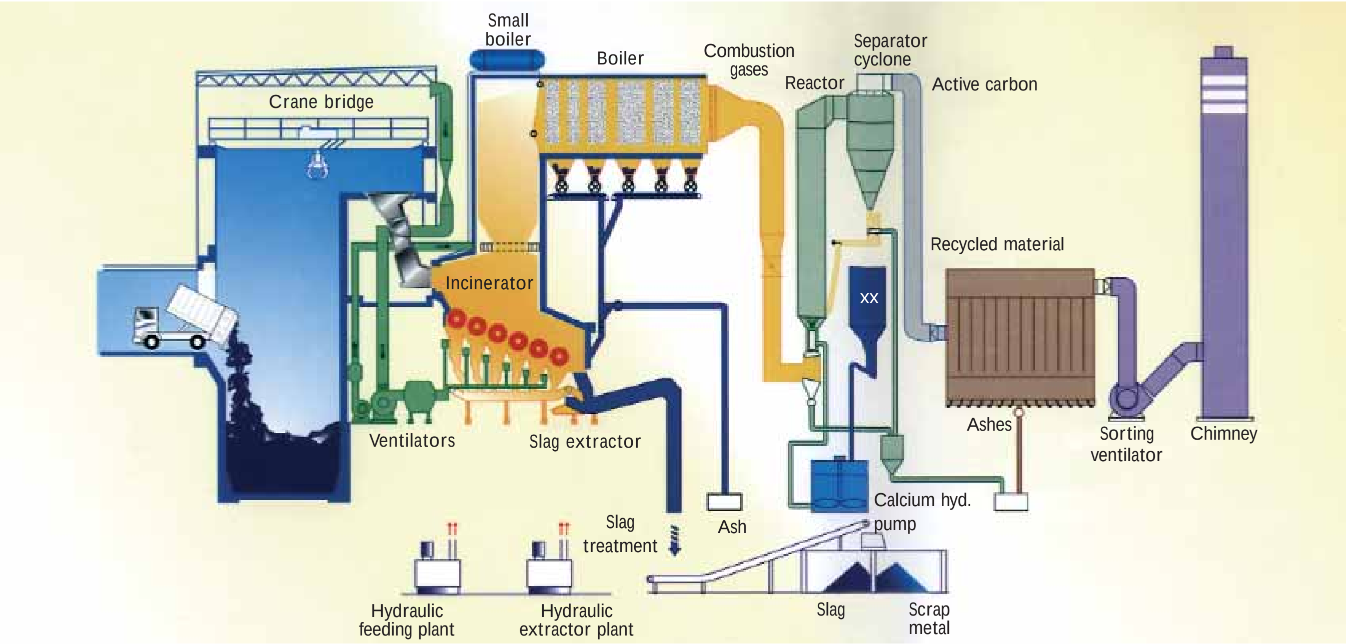
Slag:

Comprised of the inorganic material introduced into the incinerator and make up 20-25% of the initial weight of the initially incinerated waste. Includes scrap metal, glass, sand, stones, etc., and in some cases heavy metals.

Ash:

These are the finest particles made up from uncombusted material, heavy metals that stick to the particles and salts from the neutralization stages of acid gases. Ash is collected from the electrofilter and the steam boiler exhaust. It usually has a high leaching factor and should be made inert.

Fig. 3.4a
Municipal Waste Incinerator
(SIRUSA-Tarragona-Spain)



3.5. Incineration of Special Waste

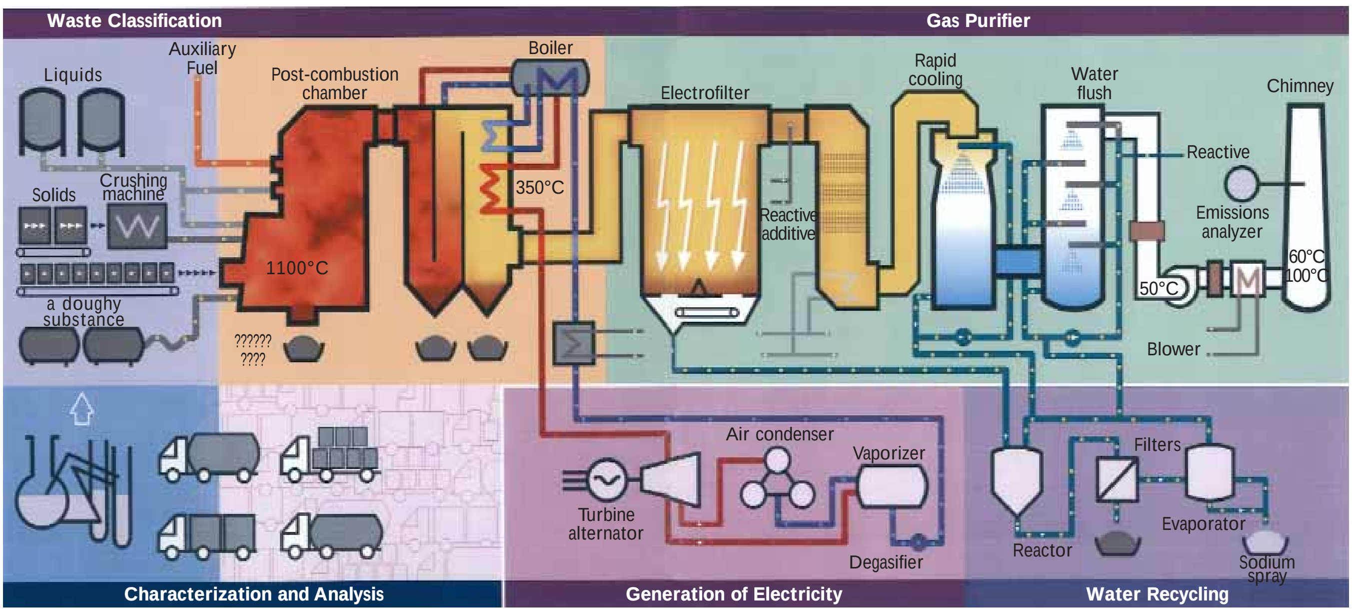
A thermal treatment plant for special waste uses a rotary kiln incinerator that has a heat recovery system for self-generating electricity and an exhaustive gas treatment process that guarantees gas emission levels below that allowed.

The combustion chamber controls the thermal oxidization of the waste, by combining time and temperatures (850-1,250°C) so complete combustion of the waste is guaranteed and the formation of contaminating compounds is minimized. The heat generated in the combustion process is recovered and used to generate steam and electricity. The resulting gases go through an electrostatic filter where the particles known as flying ash are trapped. Next, the gases go through a catalyzer that contributes to the destruction of nitrogen oxides (NOx), dioxins and furans. Finally, the gases are flushed with water to dissolve gases (HC_1, HF), and then with sodium hydroxide to absorb the SO_2.

The water used to flush the gases must be treated in a physicochemical plant and all sludge goes to a controlled dump.

The slag obtained from the incineration process can be recovered (public works) or deposited in a controlled dump. The ash removed by the electrostatic filter also undergoes physicochemical treatment.

Fig. 3.5a
Special Waste Incinerator Plant in Tarragona (Catalan Waste Agency, Barcelona)



3.6. Incineration of Sanitary Waste

This applies to biological waste such as those of a pathological, contagious and infectious nature. There are two types of treatment for this type of waste:

Non-destructive: Includes disinfection-sterilization in the autoclave, microwave systems and disinfection using chemical agents.

Destructive: This group includes all types of incineration using especially prepared incinerators that transform this type of waste into slag, ash and gases.

The most advanced technology used on hospital waste is pyrolysis or controlled combustion techniques. These incinerators have two differentiated chambers, a pyrolysis chamber and a post-combustion thermal reactor.

The pyrolysis process, which takes place in the first chamber, involves a slow and controlled combustion of the waste using 20-40% of the air required for stoichometric combustion. Distillation products are obtained made up of ashes, fixed carbon, liquid fraction and gas products (CO, H_2, CH_4). The gases go to the thermal reactor where they are completely oxidized in an environment of extra air and high temperatures to form CO_2 and steam. With this system you get a minimal amount of uncombusted gases, reduced dust emission and a saving on additional fuel, where the heat from the gases can be used to generate steam or electricity.

Rotary kiln incinerators are used so that loading and unloading is uninterrupted, and mobile facilities can be designed on this model.

The figure illustrates an incineration plant for hospital waste with heat recovery.

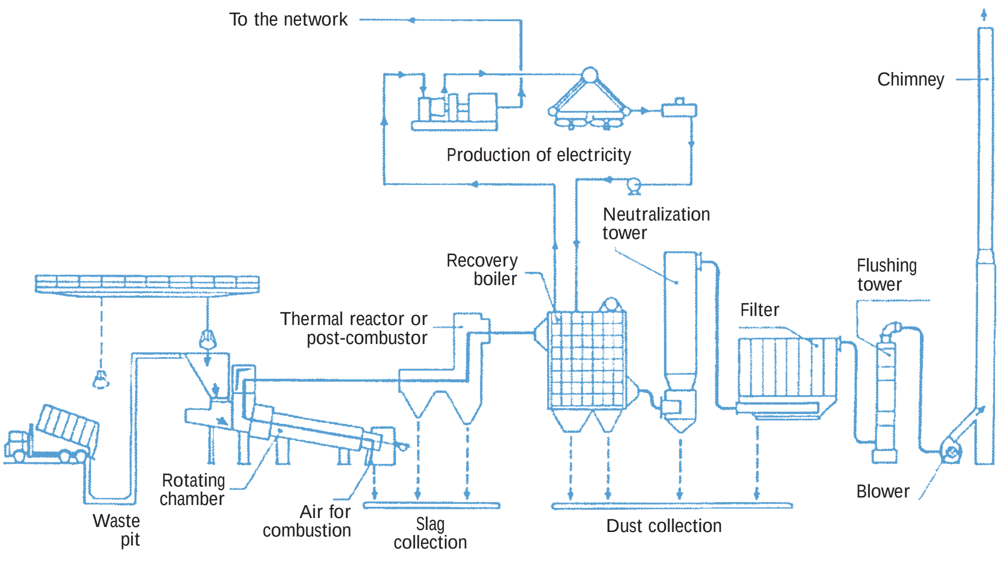


Fig. 3.6a
Illustration of a Sanitary Waste Incinerator.

3.7. Legislation Governing Waste Incineration

An incineration plant must have an exhaustive environmental protection program that includes regular analyses of water quality, the evolution of atmospheric emissions and immissions and studies on levels of dioxins, dibenzofurans and heavy metals that can be introduced into the physical and biotic environments and the population in the immediate area. It must have measuring systems at the plant, and control stations that control air pollution and chimney emissions continuously.

The table below indicates the limits that regulated the incineration plants in Catalonia (Decree 323/1994) and the new limits introduced by the European Directive that partially replace them.

Tabla 3.7a
Emission Limits for Incinerators in Catalonia.

Pollutant	Unit	Current limit Decree 323/1994	New limit Directive 2000/76/CE and Decree 80/2002[1]
Particles	mg/Nm3	30	10
HCl	mg/Nm3	50	10
CO	mg/Nm3	100	50
TOC	mg/Nm3	20	10
HF	mg/Nm3	2	1
SO2	mg/Nm3	300	50
Pb+Cr+Cu+Mn	mg/Nm3	5	
Ni+As	mg/Nm3	1	
Sb+Co+V	mg/Nm3		
Hg	mg/Nm3		0,05
Cd	mg/Nm3		
Tl	mg/Nm3		
Nox	ppm/mg/Nm3[2]	300	200/400[3]
Dioxins and Furans	ng/Nm3	0,1[4]	0,1

1. Partial transposition of Directive 2000/76/EC
2. Current limit in ppm and new Directive limit in mg/Nm3 of NO2
3. Limit 200 for existing facilities of over 6 t/h or new facilities; 400 for existing facilities with capacity under 6 t/h (Girona and Vielha).
4. Recommended value
5. No other available values for representative emissions under current operating conditions.

3.8. From Dumps to Sanitary Landfills

Waste was once thrown straight out into the streets, in front of the house, and gutters were used for dead animals, lavatory water and all types of waste. Many Latin American countries have created today's controlled dumps from these early open dumps, or places where people would leave their waste. These areas, which have not been suitably prepared, where there has been no control over the waste being dumped nor monitoring of its impact on the environment, have for many years been a source of pollution that has affected the air with unpleasant odors, the lavatory water (a source of contamination and disease) and the soil. The poor scavenge the dumps in search of food or useable materials; they are known as scavengers or pickers.

These days legislation and programs address the general problem of waste. Open dumps should be inventoried and closed, wherever they may be, and suitable areas chosen according to the characteristics of the land and distance from the population to create dumps that meet local needs. This phase in some communities should integrate the work done by the current collectors, involving them in the recycling process in transfer areas and in the preparation and operation of the sanitary landfill.

In the near future, selective collection at source should be progressively introduced so that only non-useable waste is taken to the dump, having already separated organic material and other materials that can be recovered economically or environmentally. A new mindset should be developed regarding waste disposal that promotes creative systems that meet the needs of different lifestyles and which minimize both the generation and disposal of waste materials.

3.9. Basic Principles of a Sanitary Landfill

We will address controlled waste disposal facilities (sanitary landfills) for waste that cannot be recovered or that comes from recovery or treatment operations.

Due to their potential to pollute, these areas must be conditioned to prevent any contamination of soil, water resources or air.

Currently there are thoughts of recovering the energy produced by the biogas released from the fermentation of organic material that is disposed, and depending on the situation, the future possibility of extracting disposed materials in order to recover them.

A controlled dump is a large chemical reactor where there is interaction between the waste materials and rainwater, with processes that can last from seconds to many decades, producing mineralized compounds (solids), leachates (liquids) and biogas (gas).

The Disposal of Waste

Conventional systems involve spreading the new incoming waste over an area and then covering it with a layer of soil, creating alternating layers.

Controlled dumps require insulation of the land below the waste layer, and clay drainage areas and vegetable soil on top. They must be sealed at the end of their useful lives.

Leachates

Leachates are the result of the reaction and dissolution of the soluble compounds in the waste with the added water or the moisture contained in the waste itself.

To guarantee that the leachates do not pollute underground water resources, the controlled dump must first be insulated and have in place a collection system for the leachates, comprised of gravel or sand, for its subsequent treatment.

Clay makes good insulating material and, because of its characteristic chemical composition, can also act as a filter to trap heavy metals. Other materials commonly used for insulating are high-density polyurethane and bentonite.

Gases

The decomposition of organic matter produces gases such as nitrogen (N_2), carbon dioxide (CO_2), methane (CH_4), and in smaller amounts, carbon monoxide (CO) and others. In general there are gas drainage systems in place in the way of metallic tubes filled with gravel or similar materials. There is also an energy recovery system that collects the gas (biogas) and uses it to generate electricity.

Legislation Governing Controlled Dumps

Based on Decree 1/1997 from the Generalitat of Catalonia (DOGC 2307 of 13-01-1997) on the disposal of waste in controlled dumps, and the European Community Directive 31/1999/EC of 16 July 1999.

According to Decree 1/1997	According to Directive 31/1999
• Class III dump: Special waste	Hazardous waste
• Class II dump: Non-special waste	Non-hazardous waste
• Class I dump: Inert waste	Inert waste

Waste Admission:

The Community Directive establishes what can be categorized as treated waste, where treatment can be defined by any physical, chemical, thermal or biological process, including separation, that changes the nature of the waste so that its volume or hazardousness is reduced, making handling easier or increasing its recovery value.

Biodegradable waste should be reduced, this being waste made up principally of organic matter that decomposes aerobically or anaerobically, such as food and gardening waste, paper and cardboard.

Fig. 3.9a
General Appearance of a Controlled Dump.

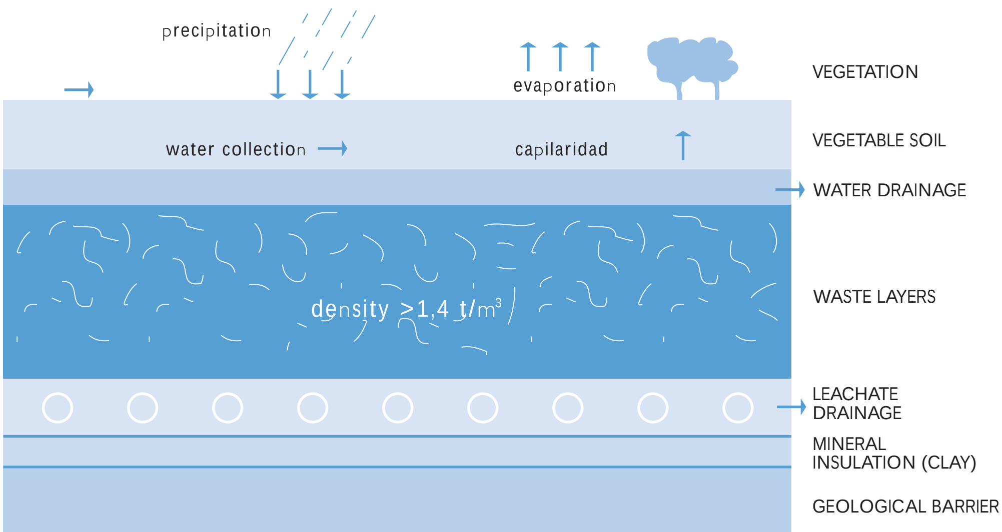
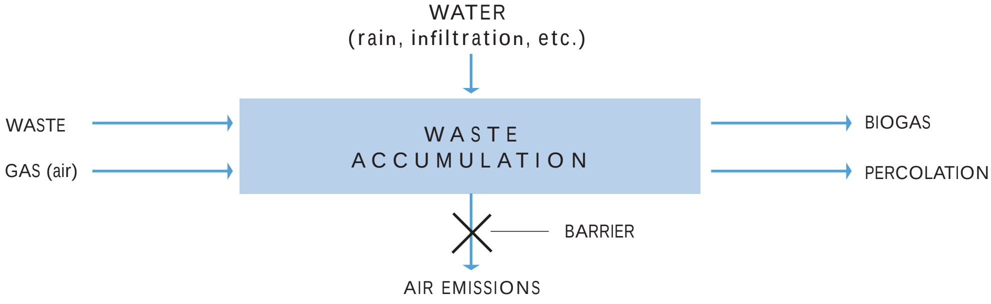


Fig. 3.9b
Entry and Exit Material Flows in a Controlled Dump.



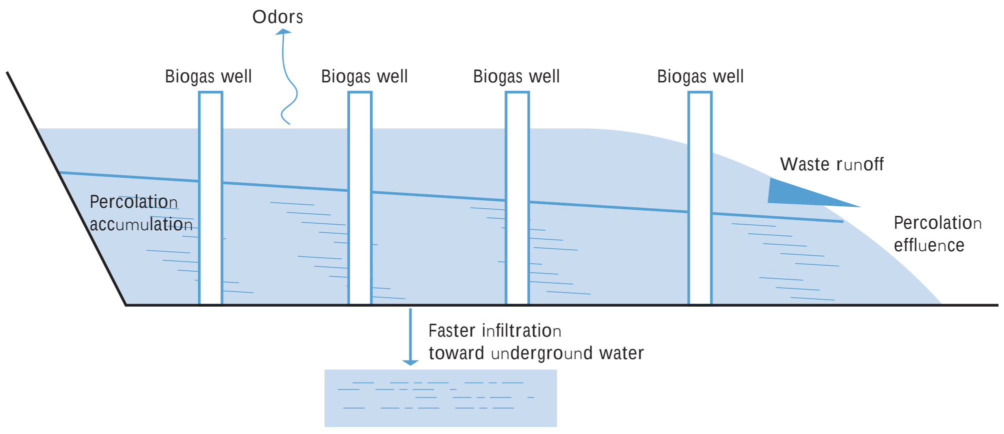


Fig. 3.9c
Potential Problems of Waste Accumulation

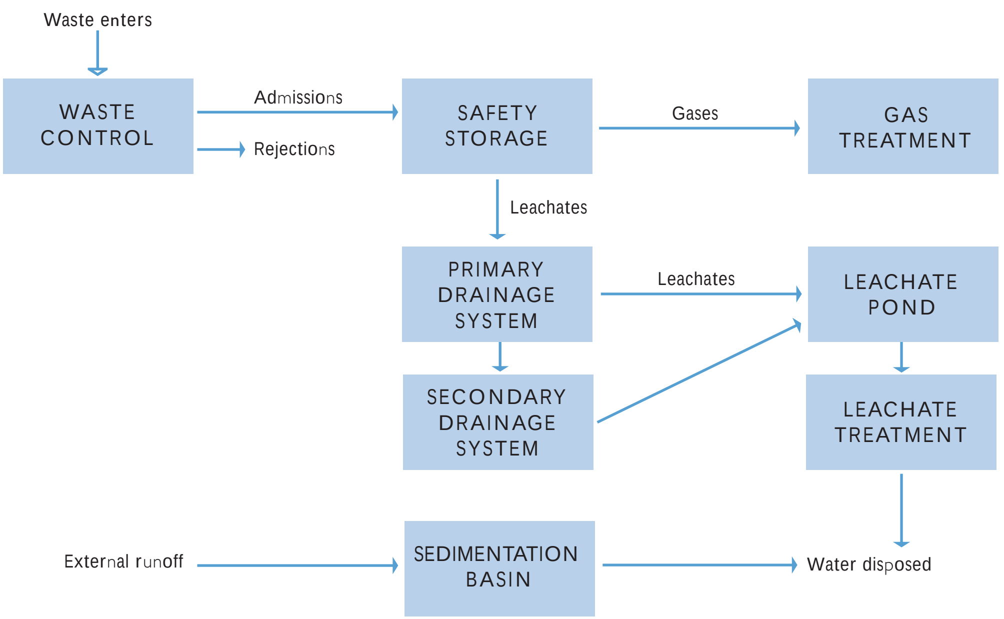


Fig. 3.9d
Management of Waste, Leachates and Gases in a Controlled Dump

3.10. Geological Bases and Preparation of the Controlled Dump Basin

When deciding on the location of a controlled dump, the geology of the area must be employed on all accounts.

The land needs to be naturally impermeable, which should be confirmed by a series of geological and hydrological studies.

- Geological mapping on a scale of 1:25,000 or 1:10,000, with descriptions of the lithological nature and structural availability of the materials. Most significant geological cross-sections and lithostratigraphic columns.
- Study of the surface drainage network and the hydrological system taking into account the meteorological conditions of the area.
- Recording of points where there is underground water, including wells and fountains, introducing them on the geological map and drawing the corresponding isopiestic lines.
- Study of the underground water, aquifers, loading and unloading areas. Analysis of the underground water.

- Assessment of natural risks: flooding, land sinking, collapses, earth movements, etc.
- Examine available materials to artificially insulate the basin, cover the waste, build retainer walls and seal the controlled dump.
- Lithographic study of the controlled dump basin with 1:5,000 mapping, together with corresponding lithostratigraphic columns and geological cross-sections of the differentiated geological units. Description of identified material: petrographic composition, granulometry, grade and alteration of foundations, porosity, state of fissures, etc.
- Local prospecting to know the geological, hydrogeological and fissuring characteristics of the area. 1:5,000 mapping.
- Estimation of the permeability of the geological formation. Assessment of the potential risk of land sinking and surface run-off.

If the controlled dump is for earth and building rubble, the site should not be located in an area with a significant thickness of the following materials:

- Materials that have high permeability due to carstification, or fissuring.
- Unconsolidated porous material such as alluvial deposits.
- Poorly settled terraces or alluviums.

Natural Impermeability

Levels of natural impermeability of the land for each type of dump are given in the table below:

Type of Dump	Permeability (m/s)	Ground thickness
Special waste (class III)	$\leq 10^{-9}$	≥ 5
Non-special waste (class II)	$\leq 10^{-9}$	≥ 2
Inert waste (class I)	$\leq 10^{-7}$	≥ 1
Earth and rubble (single-purpose dump class I)	$\leq 10^{-7}$	≥ 1

Mineral Impermeability

If the geological formation does not naturally comply with the insulation conditions given, and taking into account that it is not an area with the thickness of materials required for earth and building rubble dumps, a mineral impermeability can be used (clays) with a thickness of >150 cm for dumps for special waste; >90 cm for non-special waste and 50 > for inert waste.

Synthetic Impermeability

Special waste dumps (class III) and non-special dumps (class II) can be insulated with a mechanically resistant synthetic sheet (high-density polyurethane) in addition to the mineral layer. The sheet must be biologically and chemically compatible with the leachates produced by the waste. The sheet must be 2.5 mm thick for class III dumps and 1.5 mm thick for class II dumps.

Draining Material

The synthetic insulating sheet, or in the case of class I dumps, the mineral insulation material, shall be covered with draining material (gravel) that has the following characteristics:

Type of dump	Drainage thickness	Permeability	Draining material
Class III	$\geq$50	$\geq 10^{-3}$	Siliceous gravel
Class I)	$\geq$50	$\geq 10^{-3}$	Gravel
Class I	$\geq$30	$\geq 10^{-3}$	Gravel
Earth and rubble	$\geq$20	Not specified	Not specified

A network of drain pipes shall be fitted to the bottom of the basin at the draining level to facilitate the draining of leachates and the sides of the basin fitted with a drainage system adapted to its shape.

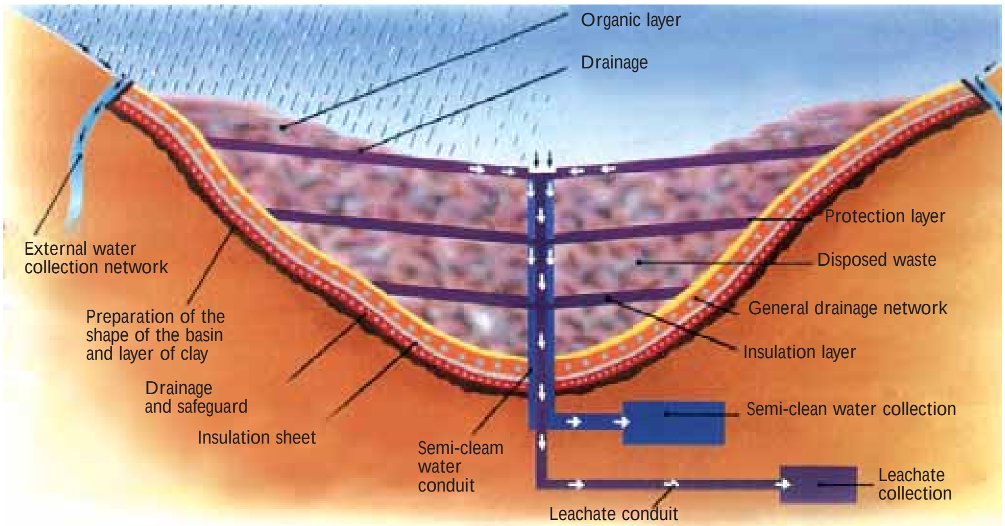


Fig. 3.10a
Diagram of a Controlled Dump Showing the Different Insulation Layers

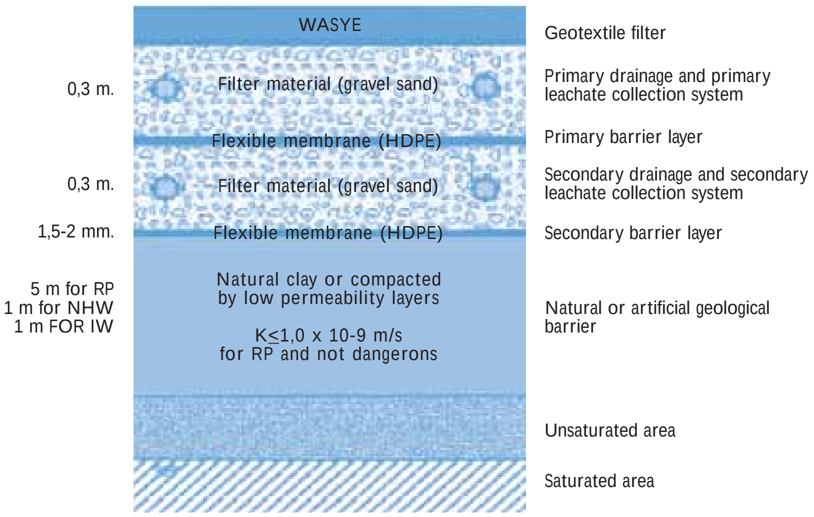
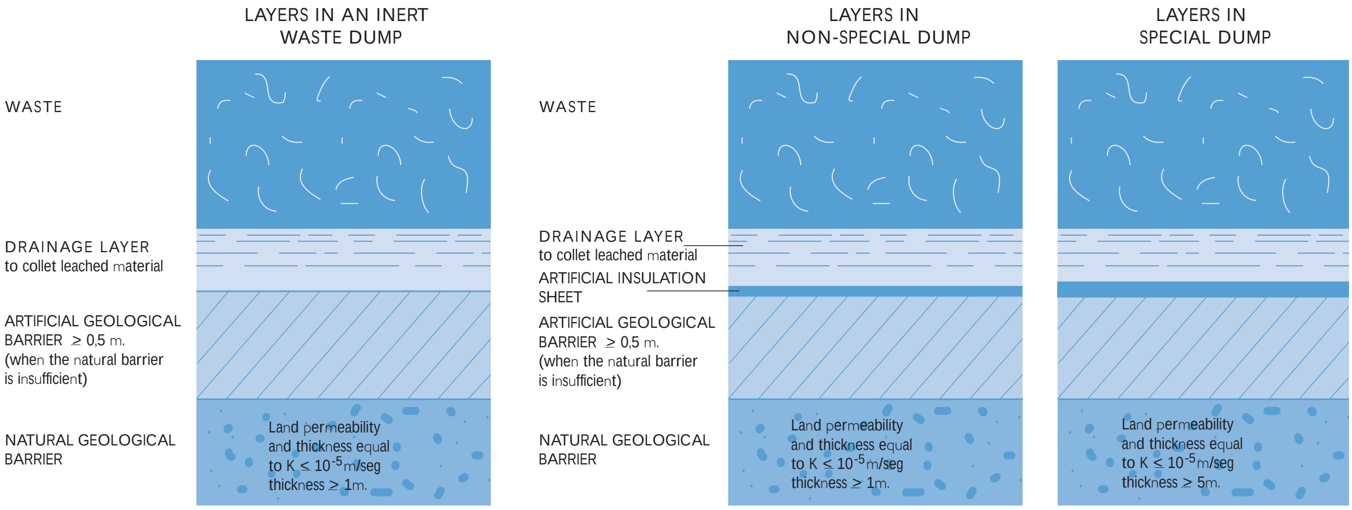


Fig. 3.10b
Insulation Barriers and Levels in Controlled Dumps

Comparison of the Various Insulation Layers for Class I, II and III Dumps



3.11. Dump Infrastructures

Some of the controlled dump infrastructures are:

- Locating the bottom of the controlled dump above the maximum phreatic water level given for a significant time period
- The surface of the controlled dump basin will be leveled so that it has a slope of no less than 2%, and that it drains completely toward one or more pre-established points.
- Registration collection wells will be installed to control and empty the leachates that collect inside the waste mass. Suitable pumps will also be installed.
- Trenches around the perimeter to carry rainwater (for a return period of 25 years) away.
- A pond for run-off rainwater from the in-use dump. The water will be analyzed and if suitable can be released into the natural environment. The pond must be large enough to handle a maximum daily amount of rainfall for a return period of 25 years.

Table 3.11a
Preparation, Insulation and Drainage of the Dump Basin

Concept	Directive	Decree 1/1997
Natural land permeability	Hazardous waste 5m at 10^{-9} m/s Non-hazardous waste 1m at 10^{-9} m/s Inert waste 1m at 10^{-9} m/s	Class III: 10^{-9} m/s in 5m Clase II: 10^{-9} m/s in 2m Clase I: 10^{-9} m/s in 1m
Artificial mineral permeability	Minimum 5 cm for all types of dumps	Class III: 150 cm Class II: 90 cm Class I: 50 cm Earth and rubble: 30cm
Synthetic sheet	Compulsory for both hazardous and non-hazardous waste	Class III: 2,5 mm Class II: 1,5 mm Class I: not required
Drainage for leachates in dump basin	Minimum 5 cm for all types of dumps	Class III: 50 cm Class II: 50 cm Class I: 30 cm Earth and rubble: 30cm

Leachate Pond

The leachate produced drains into a leachate pond by gravity, or is pumped out from the bottom of the dump.

For class II and III controlled dumps, the leachate pond will be insulated with a 20-cm thick layer of compacted clay with drainage toward a specific area. A synthetic 2.5-mm thick sheet will be laid down in class III dumps; 2 mm for class II and 1.5 mm for class I.

Volume for one week of dump operation. If the pond is uncovered, it must have the capacity to handle a maximum daily rainfall volume for a return period of 100 years for class III dumps; 50 years for class II and 25 years for class I.

The treatment of the leachate will be determined by its analysis results and in accordance with legislation.

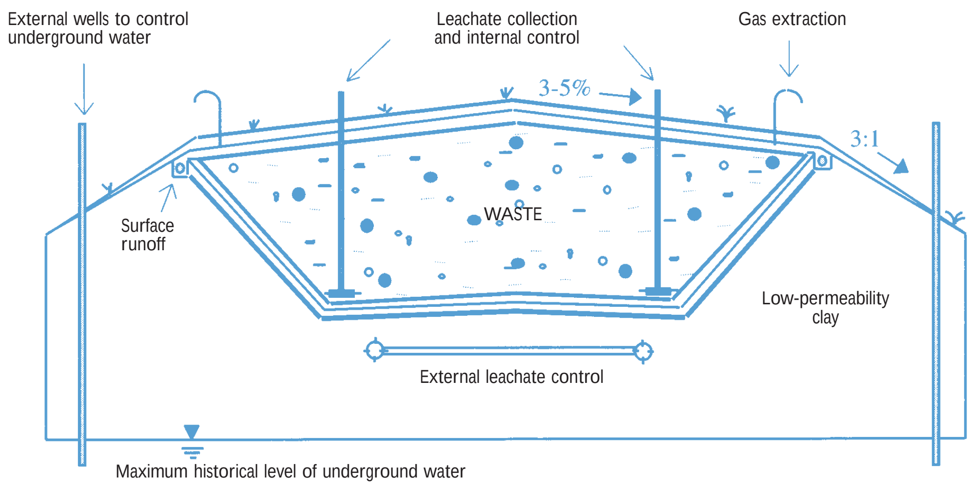


Fig. 3.11b
Leachate and Gas Control and Extraction System in a Controlled Dump (Los Residuos Peligrosos. Rodriguez and Irabien. Ediciones Sintes. Madrid. 1999)

Table 3.11c
Control of Leachates and Underground Water

Concept	Directive	Decree 1/1997
Control of leachates during dump operation period	Monthly sample-taking No specified parameters	Monthly, three monthly and six monthly. Analysis parameters established for each period in annex 5 of the Decree
Control of underground water during dump operation period	A baseline taken before operation. Frequency: to be determined for each site	A baseline taken before operation. Frequency: monthly, three monthly and annually. Analysis parameters established for each period in annex 5 of the Decree
Control of leachates in dump post-closure period	Six-monthly No specified parameters	Six-monthly for Class II and III, and annually for Class I Six-monthly analysis parameters
Control of underground water in dump post-closure period	Frequency determined for each site No specified parameters	Monthly and six-monthly tests Monthly and annual analysis parameters respectively

Biogas

Dumps designed for the disposal of fermentable organic waste with an organic content greater than 15%, should have a network of chimneys to efficiently collect and remove the fermentation gases.

The gases should be treated if they are of any threat to the population or the environment.

In any case, the gas should be harnessed to produce energy, or combusted through a flare stack into the open air.

Fig. 3.11d
Connections for biogas and flare stacks.

Table 3.11e
Management and control of biogas.

Concept	Directive	Decree 1/1997
Action	Compulsory collection and treatment. Biogas used to produce electricity, or combusted through a flare stack	Compulsory collection. Treatment if it should have any impact on the population or the environment
Control of biogas during dump operation period	Monthly Control: CO_2, CH_4,O_2 and other gases (depending on type of waste)	Three-monthly. Control: CO_2, CH_4
Control of biogas in dump post-closure period	Six-monthly Control: CO_2, CH_4,O_2 and other gases (depending on type of waste)	Six-monthly for class II and III, and annually for class I Control: CO_2, CH_4

3.12. Operating a Controlled Dump

When a controlled dump is in operation, the following must be controlled:

- The waste being taken to the facility: origin, type, characteristics and amount.
- Settling of the deposited waste mass and of the land where the dump is located by way of topography indicators.
- Leachates: amount, quality and level inside the dump.
  Monthly analysis of: Ph, conductivity, DQO, chloride and ammonia.
  Every three and six months a comprehensive analysis that includes heavy metals and organic compounds will be carried out.
- Underground water: quality and level.
  Monthly analysis of: pH, conductivity and chloride. Every three and six months a comprehensive analysis that includes heavy metals and organic compounds will be carried out.
- Available space and impermeability of the leachate ponds and decantation of rainwater from operation and biogas.

3.13. Closing a Controlled Dump

All types of controlled dumps must be definitively sealed from rainwater infiltration and fully integrated into the local environment. The future use of the site must be compatible with the presence of waste. On top of the last layer of waste:

- Install a 50-cm thick settling layer.
- Install a draining level for the removal of gases.
- Install a layer of natural mineral insulation (clay, k > 10-9 m/s), minimum thickness 30 cm for inert waste dump (class I), and 90 cm for special and non-special waste (class III and II).
- For class II and III dumps, a 2 mm thick synthetic insulation sheet could be required on top of the mineral insulation layer.
- A 30-cm thick draining level should be installed on top of the insulation layer, and on top of that a 50-cm thick layer of vegetable soil that will be able to support vegetation and a second 30-cm thick layer of fertilized soil.
- Once the dump has been sealed, it should be integrated into the local environment by having suitable species planted that will adequately protect the area against water and wind erosion and minimize rainwater infiltration.

The mechanical stability of the complex formed by the closure system and the mass of disposed waste must be justified with the corresponding calculations.

Fig. 3.13a
Closing a Controlled Dump

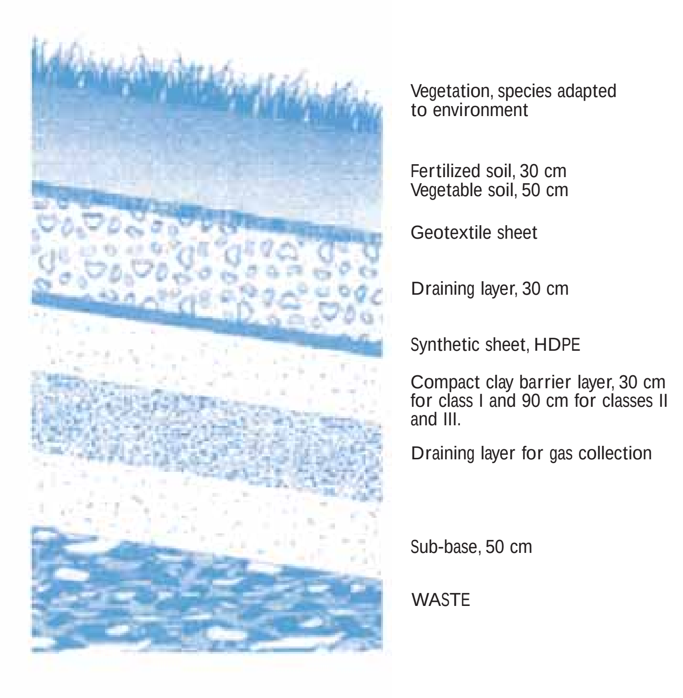
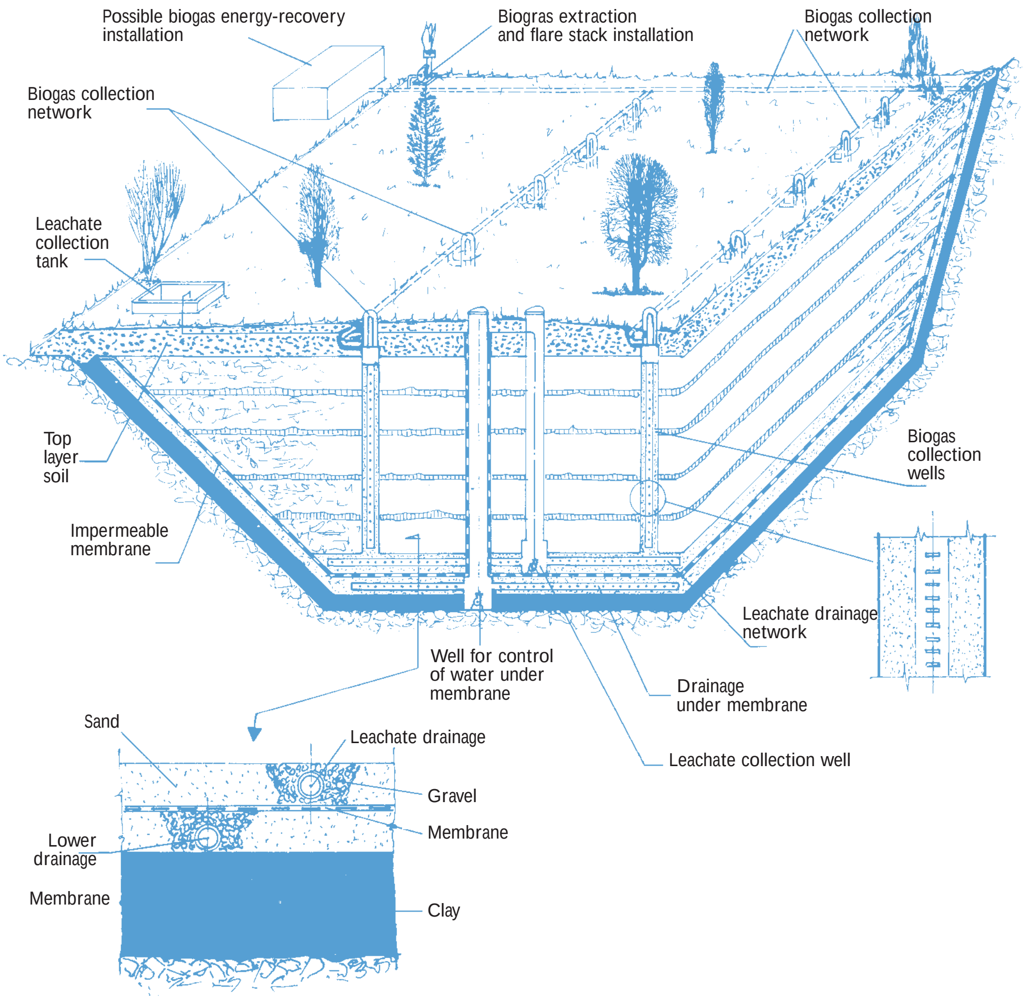


Fig. 3.13b
General Appearance of a Sealed Dump
(Conveco, Italy)



3.14. Dump Management and Control in Post-Closure Period

The duration of dump management in its post-closure period will be a minimum of 5, 10 and 15 years for dumps classes I, II and III respectively.

Once closed, a detailed topography plan of the site is prepared on a scale of 1:1,000 that includes the following:

- The limits of the closure layer, leachate pond, perimeter rainwater-removal trenches, drainage ditch, etc.
- Exact position of control dump: pressure gages, chimneys for gas evacuation, wells for registration and removal of leachates.
- At determined times, the volume and quality of the leachates produced will be controlled.
- Periodic control of pressure levels and quality of underground water taken from the pressure gages in the control network.

Table 3.14a
Conditions for Closing a Controlled Dump

Concept	Directive	Decree 1/1997
Layer settled over waste		Class III: 50 cm Class II: 50 cm Class I: 50 cm Earth and rubble: not required
Gas drainage	Hazardous waste: required Non-hazardous waste: not required Inert waste…	Class III: if necessary Class II: if necessary Class I: if necessary Earth and rubble: not required
Impermeable mineral layer	Hazardous waste: required Non-hazardous waste: required Inert waste…	Class III: 90 cm Class II: 90 cm Class I: 30 cm Earth and rubble: 30 cm
Synthetic insulation sheet	Hazardous waste: required Non-hazardous waste: not required Inert waste…	Class III: 2 mm Class II: 1.5 mm Class I: not required Earth and rubble: …
Rainwater drainage	Hazardous waste: min. 50 cm Non-hazardous waste: min. 50 cm Inert waste…	Class III: 30 cm Class II: 30 cm Class I: 30 cm Earth and rubble: 20 cm
Earth and vegetable soil	Hazardous waste: min. 100 cm Non-hazardous waste: min 100 cm Inert waste…	Class III: 50 cm + 3 cm veg. soil Class II: 50 cm + 3 cm veg. soil Class I: 50 cm + 3 cm veg. soil Earth and rubble: 50 cm support

Table 3.14b
Monitoring and Analysis of a Safe Dump During Operation and Maintenance in Post-Closure Period.

Measures	Operation	Post-closure maintenance
Meteorological data		
Rainfall volume	Daily	Daily and monthly
Temperature (min. and max.)	Daily	Monthly average
Wind direction and speed	Daily	
Evaporation	Daily	Daily and monthly
Humidity	Daily	Monthly average
Surface water and leachates		
Volume and composition of surface water	3 monthly	6 monthly
Volume of leachates	Monthly	6 monthly
Composition of leachates	3 monthly	6 monthly
Gases		
Emission potential of gases and atmospheric pressure (CH_4, O_2, $H2S_4$, H_2)	Monthly	6 monthly Periodic checking of efficacy of extraction system
Underground water		
Level	6 monthly	6 monthly
Composition (pH, TOC, F, As, Metals, Phenols, HC, petrol)	Depending on flow speed of underground water. Intervention in the event of any significant change	Depending on flow speed of underground water. Intervention in the event of any significant change
Topography		
Structure and composition of basin.	Annual	Annual
Basin level settlement behavior	Annual	

3.15. Dump Costs and Bonds

The European Directive establishes that controlled dump prices must cover all real dump costs: opening, operation, bonds or financial guarantees, controls, dump closure and post-closure maintenance for a minimum of 30 years.

The unexecuted bond will be returned to the proprietor in the following way:

- 50% of the bond a year after closure of the dump has been accepted.
- 50% of the bond at the end of the post-closure period.

3.16. Waste Admission Criteria

The specified values of the various parameters must be considered as the upper limits for admission for all three types of dumps, except flash point, which is understood as the minimum value.

Table 3.16a
Waste admission criteria for the different classes of dumps, for inert waste (class I), non-special waste (class II), and special waste (class III).

* The dump will not be able to admit more than 10% of the waste received in a month that is above the value indicated in the table. Liquid waste cannot be accepted.

**When the dump has been designed to accept organic waste, this value can be exceeded. It can also be exceeded when it is non-fermenting waste.

+ No individual compound can exceed 100 mg/kg. Their sum cannot exceed 0.05%

++ No individual compound can exceed 300 mg/kg. Their sum cannot exceed 0.15%.

---- Unlimited maximum content.

Parameter	Class I	Class II	Class III
Loss 105°C(%)	65	* 65	* 65
Loss 500°C loss 105°C (%) o.d.m.	5	**15	**15
Flash point (Co)	55	55	55
Lipophilic subst. %	0,5	4	10
Halog. vol. org. components %	+-0.05	0.1	1
Non-halog. vol. org. components %	++0.15	0.3	3
Arsenic (mg/kg) o.d.m.	250	2000	----
Cd (mg/kg) o.d.m.	50	1000	----
Cu (mg/kg) o.d.m.	6000	6%	----
Cr (mg/kg) o.d.m.	3000	5%	----
Hg (mg/kg) o.d.m.	25	250	----
Ni (mg/kg) o.d.m.	2000	5%	----
Pb (mg/kg) o.d.m.	2000	5%	----
Zn (mg/kg) o.d.m.	8000	7.5%	----

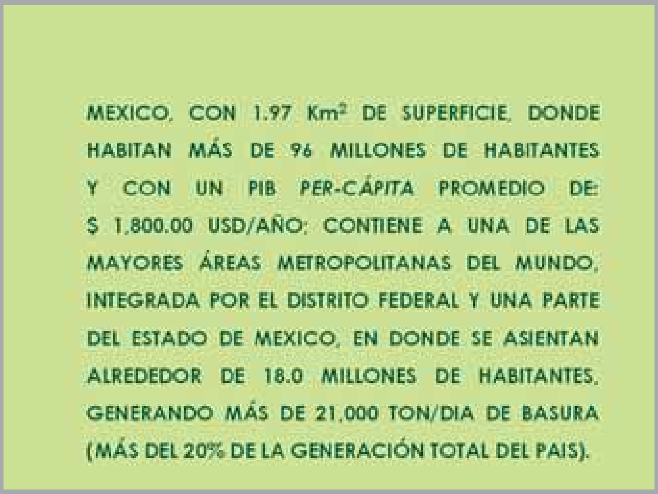
o.d.m. = of dry material

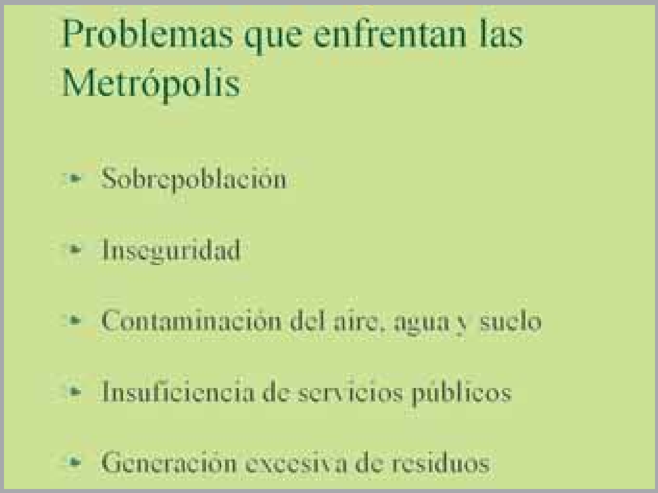
Tabla 3.16b
Leachate DIN 38414 S4 Acceptance Criteria

** Solution obtained through a leachate simulation test in the laboratory

Parameter	Class I	Class II	Class III
pH	5,5≤ X ≤ 12	4 ≤ X ≤13	4 ≤ X ≤ 13
Conduct. mS-/cm	6	50	100
TOC mg c/l	40	**100	**200
Arsenic (mg/l)	0.1	0.5	1
Cd (mg/l)	0.1	0.2	0.5
Cu (mg/l)	2	5	10
Cr VI (mg/l)	0.1	0.1	0.5
Total Cr (mg/l)	0.5	2	5
Hg (mg/l)	0.02	0.05	0.1
Ni (mg/l)	0.5	1	2
Pb (mg/l)	0.5	1	2
Zn (mg/l)	2	5	10
Phenol index (mg/l)	1	10	50
Fluoride (mg/l)	5	25	50
Chloride (mg/l)	500	5000	10000
Sulfates (mg/l)	500	1500	5000
Nitrites (mg/l)	3	10	30
Ammonia (mg/l)	5	200	1000
Cyanide (mg/l)	0.1	0.5	1
AOX (mg/l)	0.3	1.5	3

3.17. Experience in State of Mexico






ENTIDADES CON UNA GENERACION MAYOR A UN MILLON Y MEDIO DE TONELADAS AL AÑO DE RESIDUOS MUNICIPALES

ESTADO	POBLACION	GENERACION		
	HABITANTES	PERCAPITA Kg/hab/día	TOTAL Ton/día	TOTAL Ton/año
DISTRITO FEDERAL	9,683,942	1.318	12,743	4,658,495
MEXICO	11,541,835	0.956	10,016	3,655,840
VERACRUZ	7,232,432	0.788	5,771	2,106,415
JALISCO	6,235,129	0.878	5,474	1,998,010
PUEBLA	4,833,146	0.910	4,398	1,605,270
TOTAL	39,526,484	0.972	38,422	14,024,030

RELLENOS SANITARIOS QUE OPERAN EN EL PAIS.

LOCALIDAD	VOLUMEN DE OPERACION	
	Ton/día	Ton/año
Nvo. LAREDO, TAMPS.	220	80,000
NOGALES, SON.	120	44,000
HERMOSILLO, SON.	411	150,000
ZONA METROPOLITANA DE MONTERREY, N. L.	2,150	785,000
TORREON, COAH.	425	155,000
QUERETARO, QRO.	507	185,000
PUEBLA, PUE.	1,200	438,000
TLALNEPANTLA, MEX.	713	260,000
DISTRITO FEDERAL	11,000	4,015,000
MERIDA, YUC.	836	305,000
AGUASCALIENTES, AGS.	600	219,000
TOTAL	18182	6,636,000

(1) Valores correspondientes al 90 % aproximadamente de la generación

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(1) Valores correspondientes al 90 % aproximadamente de la generación

Elaborar un Plan Rector Metropolitano a mediano y largo plazo, para la Valorización y Manejo Integral de los Residuos Sólidos, que permita integrar diferentes tecnologías, en función del tipo de aprovechamiento que se le puede dar a distintas corrientes de residuos (Relleno Sanitario, Incineración, Composteo y Reciclaje).

El manejo de los residuos, se hace a través de la siguiente infraestructura y recursos:

- 14 estaciones de transferencia, 13 ubicadas en territorio del DF, que manejan más de 3.12 millones de toneladas de basura al año: y la otra operando en el Municipio de Tlalnepantla.
- Una Planta Incineradora para 100 Ton/día, ubicada en terrenos del DF, la cual lleva más de 8 años sin operar.
- Más de 3,500 vehículos recolectores y aproximadamente 250 camiones de transferencia.
- Personal: más de 30,000 (entre empleados, voluntarios y pepenadores).

3.18. Experience in Quito (Ecuador)


UNA GRAN DIFERENCIA


Relleno sanitario
• Construcción de celdas y cubetos
• Impermeabilización de piso y taludes
• Drenaje y recolección de lixiviados
– Tratamiento de lixiviados
• Colocación de chimeneas para biogás
• Mitigación ambiental
– Control de vectores
• Insectos
• Roedores


PISCINAS PARA TRATAMIENTO DE LIXIVIADOS


CHIMENEAS DE BIOGAS INSTALADAS


Desechos hospitalarios
• Transporte a estación de transferencia
• Proceso de encapsulamiento
– Se recubre la cabeza de tanques con hormigón
– Se sella la tapa con suelda
• Transporte y disposición final
- Celda especial debidamente confinada


Visitas de las comunidades

URBAN SOLID WASTE MANAGEMENT

4. Legislation, Human Resources and Financial Resources

4. LEGISLATION, HUMAN RESOURCES AND FINANCIAL RESOURCES

4.1. Legislation

When we compare legislation for waste management in different countries we find some similarities and quite a few differences. We can find vast differences in the very organization of the States, and therefore in the distribution of responsibilities and powers between the various levels of the public administration and private companies that operate in the sector. We also find vast differences in the type of waste produced and the economic systems that generate it. While some countries try to recover electronic waste (computers, cell phones, etc.) others try to eradicate the extreme poverty that some citizens live in around the dumpsites.

Some of the decisions made, at least in Europe, go beyond national borders. Given that the strictest limitations that environmental issues do not know limits as strict as those of political boundaries, it would seem logical to try to come to an agreement regarding the management of situations that could affect various countries.

Nevertheless, it is difficult to keep up with the change that legislation in this sector constantly undergoes. For example, it would have been hard to imagine a few years ago that out-of-use vehicles and motor oils could be a waste problem. In this area, as in many others, general legislation does not give any sort of regulation to the issue. On the other hand, we have to take into account the constant increase in the amount of waste being generated, which seems to be a worldwide problem as a result of the population increase and the ease with which we dispatch materials from one side of the planet to the other in a matter of hours.

Making a detailed analysis of the legislation of all the member States of Metropolis would be a field of work that greatly exceeds what is expected of this manual. Nevertheless, as illustrations, we will highlight the legal constructions used in some areas in the hope that they might be an example and a model to either imitate or reject.

4.1.1. European Directives

The conceptual orientation that the European Parliament proposes, by way of guiding the Member States, is aimed at promoting two main and complementary ideas:

1. Separate waste by fractions that can be recycled. The need to incorporate in the design of new products the obligation to think about their disassembly and reutilization has been insisted upon in recent years.
2. Have alternative treatments to controlled dumps to avoid occupying the little space there is.

Along these lines, there are the following documents:

– Directive 75/442/EEC (amended by 91/156/EEC) establishes the general framework for Community policy-making regarding waste management.

- Directive 99/31/EEC establishes the need to reduce the amount of waste disposal in dumps, while directive 2000/76/EC refers to the incineration of waste and the procedures to follow.
- The European Union Treaty of 1992 (Maastricht) establishes the precept of promoting sustainable development.
- In the framework of the 5th EC Environmental Action Programme, Directive 94/62/EEC on Packaging and packaging waste indicates the orientation of Spanish Act 11/1997 and those of the other Member States.
- The 6th EC Environmental Action Programme, "Environment 2010: Our Future, Our Choice" (2001), proposes two very specific aims for the future: significantly reducing the volume of generated waste and reducing elimination in controlled dumps by 50% before 2050.

In recent years work has been carried out on various Directives:

- Directive 2002/96/EC on Waste Electrical and Electronic Equipment establishes that the manufacturers of these products must organize selective collection systems for old equipment so that they can be returned by their users free of charge, thereby ensuring their recovery and correct treatment. The law is expected to come into force across the States in 2005. This directive has been developed through various decisions.
- Directive 2004/12/EC amending Directive 94/62/EC on packaging and packaging waste.
- Directive 2000/53/EC establishes the procedure to follow when a vehicle has reached the end of its useful life. On 27 February 2003, the Commission made a decision regarding classification guidelines for vehicle components and materials in order to simplify dismantling processes.
- Decision 2000/532/EC establishes the European waste list.

We would like to also highlight that as a result of the economic agreements in the European Union, goods and people may move freely between countries. In practice, this also means that waste can move freely if agreements are made between countries. In such a globalized society we can come across some very surprising arrangements. Spain, for instance, must import used paper to manufacture recycled carton to make packaging (for shirts, biscuits and detergent powders) as its industry has the capacity to treat more paper than it actually collects across the country. Once manufactured, the recycled carton is distributed to various countries. It may be printed before or after being dispatched abroad. We also find that some multinational companies manufacture a product in one country while the packaging is manufactured in another, and the goods are sold in a third country. A company that markets detergent may have the factory in Germany, buy the carton for the packaging in Spain and sell the product in Holland.

4.1.2. Legislation in Spain and the Autonomous Regions

The legislation in Spain governing waste is partly due to the transposition of the European Directives. We must stress that Spain is organized into autonomous communities that in some cases have authority to legislate environmental matters. Obviously these guidelines cannot go against the more general European or Spanish ones. They can only establish how certain procedures are to be carried out, or establish new restrictions to certain practices.

The Autonomous Community of Catalonia has the brief for waste management, and therefore the legislation covers the whole autonomous territory of Catalonia. Catalonia occupies the NE corner of the Iberian Peninsula. It has a population of just over six million people and an area of 32,000 km^2. The gross disposable household income (per capita) in 2002 was 12,356 euros according to the *Instituto Nacional de Estadistica* (www.ine.es). During the same period the Spanish average was 11,016 euros.

The capital of Catalonia is the city of Barcelona that covers a very small area (97.6 km^2) and has 1.5 million inhabitants. This is almost a quarter of the entire population of Catalonia.

Spanish Legislation

We would like to highlight three fundamental laws applicable across the territory:

– Act 7/1985 of the Basis for the Local System establishes the collection of waste as a compulsory service in municipalities, regardless of their size: up to 5,000 inhabitants, from 5,000 to 50,000 inhabitants, and over. In actual fact, since 23 June 1813, the municipalities have been responsible for collecting household waste. Municipalities with over 5,000 inhabitants must also guarantee the treatment of the waste. Municipalities may group together and pool resources or outsource the service together.

– Act 10/1998 of 21 April pertaining to waste establishes the basic direction and obligations for municipalities and producers. Currently in Spain, selective collection of waste is compulsory, in that waste cannot be collected in one container where the different types of waste are mixed. On the basis of this law comes the National Waste Plan (2000-2006), approved 7 January 2000.

– Act 11/1997 of 24 April pertaining to packaging and packaging waste, establishes that packaging is the property of the producer or packer, and that users must return these to the stores through a deposit-return system or through an integrated management system. The municipality plays an important role in the integrated system as it is responsible for street waste bins, emptying these and transferring the waste to the recycling plants. The association of producers must be responsible for the extra cost of the operation making economic contributions to the municipality.

Autonomous Community of Catalonia

In the Autonomous Community of Catalonia, the role of the municipal administration is reinforced through Act 8/1987 of Catalan Municipalities and Local Systems, which establishes waste collection as a compulsory service in the municipalities.

Also worth highlighting:

- As a general guideline, Act 6/1993, which regulates waste management, and amended by Act 15/2003. This basic regulation establishes the separation of municipal waste and waste generated by businesses and economic activities. Each business may choose to contract a private waste collection service, or pay for the municipal service. It also establishes the obligation for municipalities to organize selective collection of organic waste and provide a drop-off center where people may leave hazardous or voluminous waste.
- Decree 201/1994 regulates the management of building rubble.
- Decree 1/1997 regulates the type of waste at the dump.
- Decree 277/1999 regulates sanitary waste
- Decree 92/1999 approves the Waste Catalogue
- Decree 217/1999 regulates the management of out-of-use or abandoned vehicles.
- Act 9/2000 regulates publicity material in Catalonia.The guidelines seek to avoid an indiscriminate generation of publicity on paper distributed to people's homes.
- Act 11/2000 regulates waste incineration.
- Act 16/2003 governs the funding of infrastructures and rates. This guideline, implemented in 2004, establishes a rate of 10 euros per ton of waste at the controlled dump. This rate is in addition to the amount paid to dump the waste and is used to finance non-final treatment infrastructures such as composting plants or ecoparks, which apply composting and methanization technology to waste that has been previously segregated in households.

Municipal Bylaws and Metropolitan Management

Each municipality can organize their own waste collection service in accordance with current guidelines. Normally each city hall prepares and approves environmental bylaws that establish, as a minimum, the street cleaning and waste collection conditions. Therefore they describe people's responsibilities in these areas. The bylaws establish the fractions and the schedule for waste collection. They also establish the type of bins or bags that should be delivered to the authorized managers. The bylaws of Barcelona City Hall can be looked up on the municipal web page (www.bcn.es) in .pdf format. The environmental bylaws are usually found with the tax bylaws that establish the prices of the services for citizens and businesses.

The city of Barcelona and the 32 municipalities that surround it decided to come together to manage their waste. The organization *Entitat Metropolitana de Serveis Hidràulics i Tractament de Residus* was created to manage the treatment facilities that were necessary in order to apply the Metropolitan Program of Municipal Waste Management. This program, with an application period between 1997 and 2006, establishes the fractions into which waste is to be separated and the necessary plants to treat it. In 2004, 40 drop-off centers, 2 ecoparks that include composting and methanization plants, 3 composting plants, 2 incinerators, 1 packaging and packaging waste selection plant, and 1 dump that is in the process of being closed.

The *Entitat Metropolitana* was created through Act 7/1987 of the conurbation of Barcelona in order to offer services for municipal solid-waste management and waste-water management in water-treatment plants. In total, over 1.5 million tons of waste from three million citizens is treated each year.

4.1.3. Legislation in Latin America: Argentina, Bolivia, Ecuador and Mexico

In Argentina, the Constitution (reformed in 1994) establishes the rights and responsibilities of citizens with regards to living in a healthy environment. Likewise, it has created new environment protection institutions and establishes the right to information regarding environmental protection. According to the National Constitution, it is the nation's responsibility to dictate minimal budget guidelines for environmental protection, and it is the responsibility of the provinces to complement these without altering local jurisdiction.

The legal constructions are based on two fundamental laws: (www.medioambiente.gov.ar/mlegal), even though neither exclusively refers to municipal waste:

– General Environment Act No. 25,675, published 28 November 2002. The text establishes general considerations regarding sustainable development, public participation and environmental education.
– The law governing the Minimal Environmental Budget for Industrial Waste and Service Activities No. 26,612, published 29 July 2002. This law complements the National Law for Hazardous Waste No. 24,051, approved December 1991, before the constitutional reform. The minimum budget legislation expressly excludes municipal waste, which is to have its own guidelines. At the time of preparing this manual, there was no knowledge of any general legislation that covers waste, or any particular law on municipal waste.

In the province of Buenos Aires, Decree-Law No. 9111/78 regulates the final disposal of all types of waste (www.gob.gba.gov.ar/legislacion/) in the districts of the metropolitan area. It establishes that the final disposal of the waste will be carried out exclusively in sanitary landfills, and exclusively through the *Cinturón Ecologico Area Metropolitana Sociedad del Estado* (CEAMSE). This organization is also the only official technical advisory body for all the municipalities that comes under the law in relation to urban cleaning and, especially, the final disposal of waste. It has banned burning or incinerating waste, or any other system that has not been expressly authorized. Article

11 prohibits any type of waste recovery tasks, including what is known as *'cirujeo'* or scavenging, even on private property.

CEAMSE has the brief for the establishment of tariffs for waste treatment in its sanitary landfills, and also for organizing environmental education campaigns that address waste minimization and recycling (www.ceamse.gov.ar). The website also contains projects and studies.

Act 20,284/73 classifies waste into six categories and only authorizes direct disposal of degradable material or toxic waste at the *Cinturón Ecológico*. Other types of waste must be treated first.

As an option, the collection companies offer special services to producers of large amounts of organic waste and paper and cardboard, whereby supplying pig breeders with organic material and the scarce paper recycling plants with paper.

Household waste collection costs are charged through the street sweeping, lighting and cleaning rates, and are charged according to size and activity of the business, where a certain base category will be applied for the rate, if there is not a direct link between the producing body (quality and quantity) of the waste and the cost of the service.

Regarding hazardous waste, there is a register that lists hazardous producers and operators on a national and municipal level that the city must adhere to. Hazardous waste undergoes a different treatment.

Under resolution 115/95, the services must present a daily report on: out-of-hours household waste, litter, industrial waste, out-of-hours street cleaning and flushing.

In 1998, the city collected 1,817,540 tons of waste, 55% corresponding to household urban solid waste, 14% street sweeping and the rest, 36%, belonged to big producers such as supermarkets and restaurants. Currently it is estimated that 4,750 tons are generated a day, which means that 1,710,000 tons are generated a year, a decrease that can be explained by the drop in business activity and consumption.

Household waste collection in Buenos Aires is governed by Decree 1033/80 (DII 780 and Decree 613/982 D II 780). It establishes the time waste is to be deposited on sidewalks as between 8 p.m. and collection time (Sundays to Fridays from 9 p.m. to 7 a.m.).

In Bolivia, waste legislation is supported by the Environment Act No. 1333 that establishes in the first article the aim of preserving the environment and natural resources by regulating human activities related to the natural environment. In 1996, the Regulation of the Law through the Supreme Decree No 24,176 was approved. This regulation gives the municipalities authority to carry out street-cleaning services either directly or by outsourcing. In order to do this, each municipality must organize a specific unit responsible for the planning, administration and supervision of urban cleaning and propose a rate to charge for the service.

The Municipalities Act No. 2028 establishes that the municipal government must directly regulate, control and administer urban-cleaning services and the handling and treatment of solid waste. It must therefore establish the necessary regulations and determine the rates for urban cleaning that will guarantee the sustainability and efficiency of the service.

To standardize correct waste management, a series of Bolivian guidelines (NB) were established, that go from NB 742 to NB 760 and NB 69,001 to NB 69,007. The document NB 743, for example, establishes the procedure to determine the generation of municipal solid waste. For more information you can refer to www.sias.gov.bo.

The city of La Paz, the capital of Bolivia, sits at 3600m above sea level and has a population of approximately 800,000 inhabitants. It is estimated to generate about 500 tons of solid waste a day, mostly household waste (60%), the majority of which is collected by an urban-cleaning company that operates in the center of the city and nine smaller companies that operate in the peripheries.

Some of the most important points are:

- In December 2003 the municipal regulation for handling hazardous substances was approved.
- During 2004 the regulation and manual for handling hospital waste was prepared, as well as the project for comprehensive management of solid waste.

City waste was disposed at the Mallasa Tip that covered an area of 30 hectares. It was located in the southern end of La Paz municipality, 16 km from the urban center. It started to operate in 1991 and the idea was it would remain in operation until 2017, but it has now closed. The dump usually received about 500 tons a day of solid waste, collected 24 hours a day by both the operating company servicing the urban center (90% of the area) and the nine smaller companies servicing the remaining 10% with street sweeping, waste collection and transport services in areas of the city with limited vehicle access due to the steepness of the land. In April 2003, the Mayor of La Paz and the Mallasa Environment Committee, in representation of the residents in the area, signed a 'Commitment Act' where the municipal government committed to carrying out a series of compensatory projects that would benefit the neighborhood and transfer the dump to another site before 29 September 2004. The most up-to-date reports available confirm this was carried out.

In the Republic of Ecuador, article 32 of the Constitution establishes the control the municipalities can establish over the territory to put into effect the right to dwellings and the conservation of the environment.

The Municipal Systems Act (in article 163) gives the municipality the brief for cleaning, collection and treatment services for garbage and waste from slaughterhouses, market places, cemeteries and funeral services.

The Unified Text on Environmental Legislation, approved by Decree No. 3516 in 2003, declares the comprehensive management of solid waste as a national priority, with shared responsibility across society.

Bylaw 100 regulates the stages of waste collection, sweeping, transport, transfer and final disposal of solid waste. It establishes the mandatory nature of disposing waste in sanitary landfills with an environmental license.

In the specific case of Quito where the population is 1.4 million people in an area of 403,353 hectares, waste production is estimated at 250 kg per person per year. It is estimated that the municipal service manages to collect around 85% of the waste produced.

The Constitution of Mexico also mentions environmental protection, and to regulate waste management across the national territory, the Congress of the Union approved the General Law of Prevention and Comprehensive Waste Management . It was published in the official bulletin of the Federation on 8 October 2003 (www.cddhcu.gob.mx). The text comprises 125 articles and 13 transitory articles. The legislation describes the various levels of responsibility and defines the most important concepts. The responsibility for comprehensive management (collection, transfer, treatment and final disposal) of urban solid waste belongs to the municipalities (article 10) that can collaborate to carry out the functions stipulated by the law. Waste is divided into three basic categories: hazardous waste, urban waste and waste that requires special handling. Urban waste can be sub-categorized into organic and non-organic in order to facilitate primary and secondary segregation, in compliance with the State and Municipal Program (article 18). Waste that requires special handling includes waste from big producers such as the building and health industries, etc. The Law makes provisions for the creation of a national program for the prevention and comprehensive management of waste and handling plans in order to establish the best management modules. A minimum of 15 handling plans is anticipated. Articles 35 to 39 refer to social participation and the right to information. Article 125 clearly specifies that each person or social group can report a fact, act or omission that could result in damage to the environment, natural resources or public health.

In order to prevent waste generation and carry out comprehensive handling, the Law establishes a minimum of 12 obligations for municipalities and federal organizations that can be carried out according to their own regulations. Nevertheless, the legislation, as a general framework, states that future official Mexican guidelines will establish the details of comprehensive management. The guidelines will stipulate the terms that will determine the location of sites and the design, construction and operation of facilities for final waste disposal. They will also outline the situations where biogas may be harnessed.

Federal organizations will establish the obligations the waste producers have, making a distinction between big and small ones, and the obligations of special-handling service companies. They can, if they consider it beneficial, prohibit leaving waste on the street and in unauthorized areas, open-air incineration and the opening of new disposal areas.

The municipalities will carry out the necessary measures to prevent the generation of urban solid waste, its recovery and comprehensive management, in consideration of the producer's obligations, the requirements of the service companies and the revenue generated from delegating the comprehensive handling service (article 99).

4.1.4. African Legislation: Democratic Republic of the Congo

The management of solid waste in the Democratic Republic of the Congo, whose capital is Brazzaville, poses a number of problems from a European perspective.

Within the legal framework, the country's Constitution, approved on 20 January 2002, establishes the general principal of respect for the environment, especially referring to the accumulation, transport and incineration of toxic waste.

Before the Constitution, Act 3/91 on environmental protection prohibited disposing of or abandoning waste in such a way that could give rise to disease, cause injury to people or property, or produce unpleasant odors or discomfort. It also stipulated that waste was to be disposed of in such a way that materials and energy could be recovered. According to the law, the Local Collectives would be responsible for correct urban waste removal. As a result they had to formulate management plans that would have to be approved by the Ministry for the Environment. However, local experts acknowledged that in July 2004 no plan had yet been approved, because the country had until recently been immersed in a war.

In the capital, Brazzaville, the city is responsible for waste management. In order to get management funds, Deliberation 08/77, later amended by Deliberation 03/99, established a variable rate in accordance with producer type: apartments, workers, markets, hotels, restaurants, etc. Brazzaville has a population of over 1.3 million inhabitants.

Due to a lack of trucks and bins, solid waste is often incinerated right on the doorstep. Alternatively, waste accumulates in storage areas within the very city, without any sort of protection. Waste collectors use a wheelbarrow to collect waste. The collector is paid directly for the service.

4.2. Human Resources

4.2.1. Administration Staff

There are two basic municipal waste-management models in Europe.

The first consists of a public company that has been created by the Administration for that exclusive purpose. In these cases, uncommon in big cities, the waste collection equipment and staff belong to the municipality.

Another quite different model involves management by the Administration of the available resources and giving the service over to the private company that was successful in the service bid. In this second model, the Administration has a small number of professionals that manage the collection and treatment contracts. They are often senior and highly qualified members. Their work is often complemented by publicity and environmental-education teams. In order to control billing, automatic identification of the vehicle is used, as is instant data transmission. The system relates the weight of the vehicles with their license number, identifies the material they are transporting and carry out detailed studies regarding needs. There are also mixed procedures that combine both models. A particular municipality, for example, could have the means to collect household waste and give street sweeping or litter bin emptying tasks to the successful company in the service bid. However, the trend is moving toward concentrating all the different tasks in order to avoid confusion regarding the various duties. An extreme, but real, example is who is responsible for a garbage bag that has been left next to a full bin.

In the city of Barcelona, Spain, the current contract divides the city into four zones. The companies contracted can choose to operate across the whole city or only in one area. There are currently three companies responsible for waste collection and a fourth that is responsible for emptying litter bins. The intention of the administrators is to create competition between the companies and therefore improve the quality of the service.

Nonetheless, the Administration must guarantee that the services are indeed carried out, and to do that they must have the necessary mechanisms to verify and control activity. Sometimes an index of customer satisfaction is established through telephone surveys. Other times quality indicators are based on customer complaints, which could have repercussions on the price of the service.

4.2.2. Waste Collection Company Staff

Staff from waste collection companies are linked to the contracts with the Administration. Because waste collection contracts have a finite period (normally between seven and ten years to amortize the investment made in machinery) workers can change companies several times over their professional lives.

When a cleaning and waste-collection company gets a new contract, it must take on the staff from the previously contracted company. This ensures the right of workers, especially with regard to length of employment. Their category is based on the type of task they perform: drivers and laborers, basically. They are generally unskilled and have few professional prospects. A few problems have been detected regarding the integration of migrant staff from other countries. In few cases the waste collection staff are the staff from the municipality.

The work is hard and there is a high rate of injury, turnover and substitutions. There is a need for good personnel identification and stringent health control.

In Europe, the working conditions for the personnel in this sector are regulated through collective agreements. As a general orientation, the working week cannot exceed 40 hours per person, the company must supply uniforms, training and provide medical check-ups for the workers. You can easily find collective agreements for the various companies on the Internet.

Below are some of the elements that are governed by the collective agreement of waste collectors:

– The shift between 9.30 p.m. and 6.30 a.m. has an extra night rate. (Compulsory rotation if shift not covered by volunteers).
– A right to transport expenses.
– A 37-hour week, with a 30-minute break a day. 1,728 hours of work a year.
– Rotating weekly days off.
– 31 days of paid vacation.
– Subrogation of personnel.
– Compulsory use of work uniform.

In relation to wages, we can take a comparative look at teacher's wages in Spain that range between 18,000 and 21,000 euros gross a year for approximately 1,200 hours' work, of which 850 are student contact hours.

In the waste-collection sector, the current collective agreements establish the following average wages:

(1) Municipality of Pals at June 2004
(2) Incinerator
(3) Municipality of Ripollet
1 euro = 1.20 USD at end of February 2004

Orientation of wages for operators of the waste-collection services in Catalonia (Spain)

Annual wage, driver	16.852 EUR (1)	Head of maintenance	24.178 EUR (2)
Annual wage, driver	21.363 EUR (3)	Specialized laborer	14.364 EUR (2)
Annual wage, laborer	14.625 EUR (1)	Cleaner	17.764 EUR (3)

Women have been incorporated into this type of work. The communication campaigns are endeavoring to improve the position of the workers.

4.2.3. Treatment Plant Staff

Waste treatment plants are managed by private companies or mixed public-private sector companies. The staff have contracts that are linked to the operation of the plant (between 7 and 25 years). The wages are set in accordance with the most closely related collective agreements.

The staff must be well identified and must undergo regular medical check-ups, especially in plants with enclosed spaces.

The work is carried out under tough conditions at times, which is why it calls for a mandatory rotating work system or technical breaks every hour so that staff doing manual work, especially classifying plastic, do not develop health problems. Some treatment plants such as ecoparks and packaging selection plants are beginning to install air-conditioning at the selection stations and reduce manual selection to a minimum if there is available technology that will automate it.

Nevertheless, management experience reveals the need to have someone responsible for safety on behalf of the company and on behalf of the workers. Sometimes workers are reticent about working with protective equipment such as helmets, gloves or facemasks.

4.3. Financial Resources

Waste management, like almost all services provided by the municipality, has an economic cost that must be met by the municipality. In some cases the citizens meet the entire cost of the service, while in others the cost is distributed amongst the various budgetary items.

In the case of Cuba, the public makes no contribution at all to the municipality for waste collection. The management of the service forms part of the general state budget that does not rely on public contribution. Only hotels because they generate large volumes of waste are required to pay a certain amount for their waste service.

Below are some financing methods used to cover the economic costs of the service.

4.3.1. Property Tax

Some municipalities, such as Barcelona, use this tax as a means to collect revenue from citizens. It includes various services that are compulsory: cleaning, lighting, waste collection, etc. The city hall collects the tax either through a financial entity or directly. The amount paid depends on the value of the property, which is calculated according to parameters such as location, size, etc. In this case the citizens do not know what amount corresponds to the waste-collection service. It is the proprietor's responsibility to pay this tax. If the property is leased to a third party, the tax is included in the rent.

4.3.2. Waste Collection Rate

Some city halls have decided to bring the waste collection issue into the open, and charge the corresponding rate separately. This could come to $US30-40 a year per family.

Since January 2003 in a small municipality of Catalonia, new methods are being tried such as 'pay to produce waste', so that the rate is paid with the bags for the different fractions collected. Some bags are subsidized, while others carry a fine. The system functions as a household door-to-door collection arrangement. A bag of waste can cost $US0.60. Only waste in official waste bags is collected. A type of "waste tourism" has been discovered where some citizens transport their waste to a neighboring municipality in order to avoid paying for the service.

In some municipalities in the north of Italy, they have started to employ a payment system that uses cards with a magnetic strip that identifies the user. Street bins can only be opened with these cards that record information used to calculate the annual rate the user will have to pay. The system allows the introduction of incentives. Taking voluminous waste to a drop-off center, for example, can reduce the annual rate. The method also has its detractors, who believe the system is a violation of individual rights because of the amount of information the municipality has on the people.

In Quito, Ecuador, the waste collection rate is a proportional part of the electricity bill. There are virtually no cases of failure to pay because to do so could result in having your electricity cut off. It is 10% of the amount billed for electricity. Some drawbacks could be possible fluctuations linked to the price of electricity or substitution by another form of energy.

4.3.3. Metropolitan Rates for Waste Treatment

This is a waste treatment rate that finances disposal, incineration or composting. It is paid every three months in the water bill. It could amount to about $US30 per family per year. It is collected by the *Entitat Metropolitana de Serveis Hidráulics i Tractament de Residus* and destined directly to the treatment process.

In the Barcelona metropolitan area, 33 municipalities decided to have a common waste-treatment system, so that each municipality is responsible for collecting waste and the *Entitat Metropolitana* for management waste. The municipality collects the necessary amount from the citizens for waste collection and street sweeping. The *Entitat Metropolitana,* through the water bill collects the amount necessary for waste treatment. This rate is reviewed annually. For more information: www.ema-amb.es. The citizens pay according to the general consumption of drinking water in their dwellings and the social level of their neighborhood.

4.3.4. Economic Contribution from the Packaging and Packaging Waste Act

In Spain, Act 11/1997 (which has equivalents in other EC countries) determines that packaging belongs to the producers and not the consumers. Therefore, they have the obligation to collect it using their own means or pay an amount to compensate for the extra cost it incurs on the Administration. The law also includes an economic contribution for matters concerning public environmental awareness campaigns. The Green Dot is the logo used across Europe.

It is compulsory for all packagers who cannot show they have their own selective-collection circuits. The amount to pay is usually proportional to the part of packaging included in municipal waste.

In the case of paper and cardboard, it is calculated that 40% of collection involves packaging. Management companies only contribute this proportion. The paper is sold to the highest bidding company. It currently goes for 36 USD per ton.

The agreement and regulation governing this area establishes different forms of compensation according to the type of municipal structure (rural, semi-rural or urban).

4.3.5. Economic Contribution from the Rates Act

In 2004, a new Rates Act began in Catalonia (Spain) that taxes mass waste dumping to fund the recycling of other waste. It is not applied directly to the public but rather to the municipalities. Each ton of waste in the tip means 10 euros towards paying for other treatments.

It is still too soon to evaluate the changes it may make. It is expected it will lead to less production of undifferentiated waste and that not so many tons of material will end up in the controlled tip.

4.3.6. Supranational Contributions

In the case of Europe, there are types of supranational aid to reduce differences between member states. Processes for choosing projects that require high levels of economic contribution are held on a regular basis. The aid is usually for helping build new facilities or closing obsolete ones such as old tips. In some cases the subsidies can be more than 50% of the cost of a treatment plant.

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www.bcn.es/neta
(available in Spanish). Bylaws
www.mediambient.bcn.es
(only in Catalan).
Entitat Metropolitana del Medi Ambient: www.ema-amb.es
(mostly in Catalan)
Generalitat de Catalunya (Catalan Government): www.gencat.net
Guidelines in http://unres.gencat.es
(mostly in Catalan)
Ministry for the Environment of Spain: www.mma.es
European Union
Municipality of Quito
Havana
CEAMSE Argentina
Mexico

4.4. Experience in Jalisco (Guadalajara- Mexico)


Relleno Sanitario en: La Manzanilla.
• Nombre del Predio: La Manzanilla
• Superficie Total del Predio: 1.0 Has.
• Población Beneficiada: 2,250 Hab.
• Capacidad de 1ra Etapa: 2,500 Tons.
• Terminado
• Delegación La Manzanilla


Relleno Sanitario en: Tomatlán.
• Nombre del Predio: Los Cocos
• Superficie Total del Predio: 4.47 Has.
• Población Beneficiada: 29,820 Hab.
• Capacidad de 1ra Etapa: 15,000 Tons.
• Terminado

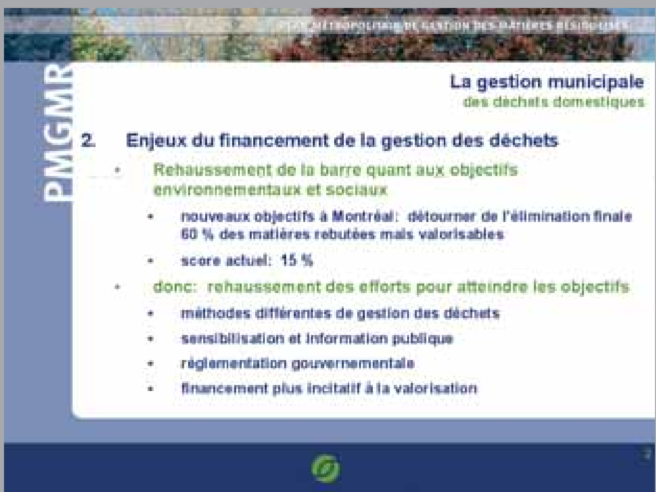

Relleno Sanitario en: Cabo Corrientes.
Vialidad Principal
Vialidad Principal
Vialidad Principal
• Nombre del Predio: La Puerta
• Superficie Total del Predio: 1.14 Has.
• Población Beneficiada: 9,345 Hab.
• Capacidad de 1ra Etapa: 5,360 Tons.
• Terminado


Relleno Sanitario en Operación: Los Laureles.
• Nombre del Predio: Los Laureles. Tonalá.
• Superficie aprovechable: 40 Hectáreas.
• Poblacion Beneficiada: 1:100,000 habitantes
• Situación actual: En operación.

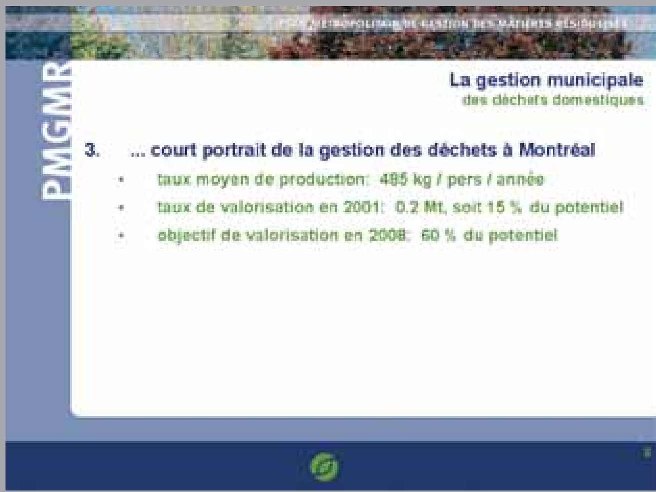

Relleno Sanitario en Operación: Picachos
• Nombre del Predio: Picachos. Zapopan.
• Superficie aprovechable: 70 Hectáreas
• Poblacion Beneficiada: 1 100,000 habitantes
• Situación actual: En operación.


Relleno Sanitario en Operación: Hasar's
• Nombre del Predio: Hasar's. Zapopan.
• Superficie aprovechable: 20 hectáreas.
• Poblacion Beneficiada: 700,000 Habitantes
• Situación actual: En operación.

4.5. Experience in Montreal (Canada)




PMGMR
La gestion municipale
des déchets domestiques
3. ... court portrait de la gestion des déchets à Montréal
• Composition des matières domestiques mises au rebut en 2001
Composition des 1.7 Mt de déchets domestiques
verre, métal, plastique, fibres: 0.8 Mt
résidus putrescibles: 0.7 Mt
matériaux secs: 0.1 Mt
textiles: 0.05 Mt
encombrants: 0.03 Mt
résidus domestiques dangereux: 0.01 Mt
7


PMGMR
La gestion municipale
des déchets domestiques
3. ... court portrait de la gestion des déchets à Montréal
• taux moyen de production: 485 kg / pers / année
• taux de valorisation en 2001: 0.2 Mt, soit 15 % du potentiel
• objectif de valorisation en 2008: 60 % du potentiel
8


PMGMR
La gestion municipale
des déchets domestiques
3. ... court portrait de la gestion des déchets à Montréal
Coûts métropolitains de gestion des déchets en 2008 (total 225 M$)
matières éliminées: 85 M$
matières recyclables: 55 M$
matières putrescibles: 40 M$
résidus domestiques dangereux: 5 M$
financement nouvelles infrastructures: 35 M$
campagne de sensibilisation: 5 M$
10


PMGMR
La gestion municipale
des déchets domestiques
3. ... court portrait de la gestion des déchets à Montréal
Coûts métropolitains de gestion des déchets en 2001 (total 127 M$)
matières éliminées, collecte régulière: 90.1 M$ = 68 $/t
matières éliminées, apport volontaire: 1.6 M$ = 3 $/t
matières recyclables: 27.1 M$ = 142 $/t
matières putrescibles: 1.2 M$ = 41 $/t
résidus domestiques dangereux: 1.9 M$ = 1120 $/t
encombrants et autres: 1.9 M$
campagne de sensibilisation: 3.2 M$
9


PMGMR
La gestion municipale
des déchets domestiques
4. Remarques en conclusion
• Volonté de payer des citoyens
• Constats lors d'enquêtes et sondages
• coûts actuels (< 10$/mois) peu élevés pour un service public essentiel
• relativité des coûts pour d'autres services publics:
• eau potable 20 $/mois
• eaux usées 30 $/mois
• téléphone 30 $/mois
• électricité > 100 $/mois
• acceptabilité sociale de payer 10 $/mois de plus pour une saine gestion des déchets
11


PMGMR
Merci de votre attention !
Jacques J. Trottier
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URBAN SOLID WASTE MANAGEMENT

5. Environmental Education, Communication and Public Participation

5. ENVIRONMENTAL EDUCATION, COMMUNICATION AND PUBLIC PARTICIPATION

5.1. Environmental Education, Communication and Public Participation

5.1.1. Social and Psychosocial Factors in Environmental Management

There is no question that in the challenge that environmental management has become for the Administration, institutions and citizens, especially in a globalized world (which some people believe is on the verge of environmental collapse), it is not enough to approach the problem from a strictly technical or technological perspective, but rather a lot of attention must be given to the 'human factor'.

Technology, economy, science, etc. shows us the way, the most efficient model for solving our environmental problems. But behind the science there are people and the complex world of psychology and sociology. Aspects such as learning, motivation, changes of habits, etc. are vital not only to explain what is happening, but also how to promote sustainability.

5.1.2. Recent International Agreements. A New Vision.

In 1987, the Brundtland Report "Our Common Future", not only advocated sustainable development, but also stressed the need to guarantee effective participation from the public in the adoption of decisions. Since The Earth Summit of Rio de Janeiro in 1992, the representatives of the countries that attended continue to reiterate the importance of public involvement in the processes of change and environmental protection. This concern has since been manifested in all environmental protest events and declarations, in the 1994 Aalborg Charter, the Rio+5 and Rio+10 Summits, and in the interesting process of Local Agendas 21 that emphasize the role of the cities and municipalities.

In fact it is chapter 28 of Local Agenda 21 that establishes the need to revitalize democracy as a means of giving all collectives opportunities (indigenous communities, women, youth, farmers, business people, scientists, unions, local administrations and non-governmental organizations) to decide on the future of their community. Consequently, with the inclusion of chapter 28 in Agenda 21, the international community acknowledges the role of local authorities as the drivers of sustainability strategies. During the 2002 World Summit on Sustainable Development in Johannesburg, there was a session about local government titled "Local Action Moves the World". In this session a call was made to all local governments to move from the agenda of sustainability to the action, through Local Actions 21. The local authorities made a commitment to develop practical and realistic development plans which they would implement through the programs of Local Action 21 in order to meet their objectives.

The objectives set by Agenda 21 regarding waste refer to a change in production and consumption habits so that waste production is reduced and minimization and recycling increased. In other words, it strives toward a new culture leaving the old 'throw-away' one behind. It does not consider waste to be the problem *per se*, but rather certain consumption habits and our behavior as citizens and human beings.

The concept of sustainability, which is much more political and social, has opened new avenues and promoted new strategies. There is no doubt a need for greater decision-making, political willingness and more administrative resources in order to match economic development and environmental respect with the population's willingness.

5.1.3. Waste and Environmental Education

First of all, it is necessary to stress that the management and general issue of waste today, whether industrial, business or household, and in particular municipal waste, has become a serious problems for 21th century society. The problems have different levels of seriousness depending on the culture and region of the planet in question, or on the type of territorial, town-planning and human structure. Everywhere, however, the increase in waste production and the wasting of raw materials and natural resources are having devastating effects on the planet and it inhabitants.

To solve the problem it is important to analyze the causes, possible solutions, and above all, the active agents in this process.

Until today, the general belief about environmental management and elements of communication has been that technology can solve all problems, provide solutions to all questions posed, that the issues to be solved are basically related to economic questions and that it is enough that the public be informed so that the system continues to function. In other words, that we simply have to provide instructions and guidelines to determine behavior in accordance with the programs established.

However, experience tends to show that that is not enough, and that grand waste-management plans with millions spent on infrastructure and material can fail if at the end of the chain, the main agent – the everyday citizen - does not understand their role and does not become involved in the process, i.e., if he or she thinks it is not their responsibility, for example, to segregate organic material, paper or glass.

What does the future hold? Above all, the observation that we are facing greater complexity and seriousness in environmental problems. With the effects of globalization, the internationalization of the market, together with the general increase in emissions and other pollutants, and waste production, we have to adopt new approaches to environmental management.

The growing complexity calls for greater involvement by all of society; with the active and dedicated participation by citizens based on awareness and cooperation, and management that is more socialized, democratic and involved.

It is vital that each citizen realizes his or her involvement along the lines defined in the declaration of Rio '92 and later included in the Local Agendas 21. We support the promotion of radical democratization and the globalization of human movement.

5.1.4. Inform, Educate and Participate

We can see that a management model based solely on public information does not work. It is necessary to educate and raise awareness in order to influence and empower environmentally responsible behavior. Effective educational programs have to be developed that are aimed at age groups, schools and the general public, and that are delivered continuously and relentlessly to try to especially reach those sectors of the population that are more directly related to the production and management of waste.

Nevertheless, the biggest issue is still the lack of participation. We will only be successful in our efforts to actively involve the people, if we are able, as state and regional municipal authorities, to open the management and study processes to participation, in particular decision-making.

We must educate to foster participation, seeking to create cooperation to avoid conflict (the social and territorial conflicts that are inherent in waste management) and the NIMBY (Not in My Back Yard) effect.

The idea of public participation still contains a number of questions that have to be solved quickly: Who participates? How? Where?

We should go beyond the normal consultation processes to generate participative dynamics that can favor change processes that in turn would open new ways of understanding waste management as resource management.

In the attached table the principal differences between consultation and participation are summarized

Consultation	Participation
Agreement on an issue	Come to a practical objective
Individual responses but also public meetings	Different agencies, groups and/or individuals
Sporadic meetings	Frequent periodic meetings
No need to establish a relationship with representatives	Relationships between people and the agents of the various sectors vital
A series of formal rules	A mode of work that evolves over time
Those that look for different points of view often decide on the result	Shared decision-making

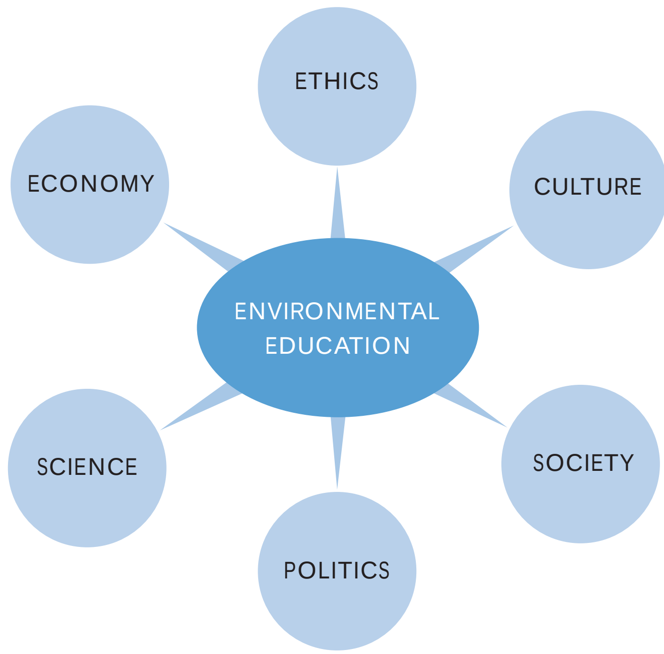
5.2. Environmental Education and Awareness

5.2.1. Education and Awareness, or Training

Environmental education is a multi-dimensional and comprehensive process of acquiring knowledge, skills (know-how: experiences and responsibilities) and values (approaches) that combined allows one to take action against the environmental crisis.

Environmental training defines the teachings that a specific and specialized field in science takes as a reference point with regards to the environment (Sauvé 1994).

Illustration: Dialectic Poles in Environmental Education



5.2.2. Environmentalism in Schools and Society

Gone are the days of specialization in environmental studies, of the first environmental suppositions based exclusively on the study of natural sciences. These days, the phenomenon of globalization, and especially that of urbanization where most of the world's population is found in large urban nuclei, means we have to seek new work strategies and methods.

5.2.2.1. Curricular Design and Across-the-Board Content

There are two fundamental ideas. The introduction in teaching curricula of all the aspects related to the environment, in its broadest sense, that includes a theoretical base and aspects of management, and, of course, public co-responsibility and awareness.

Education must foster critical thinking and action.

The other idea is quite obvious, and it is that this must permeate all other subjects and fields of study. Environmental awareness should be an ideology whose undercurrent is present in the training of the educational community.

5.2.2.2. Environmental Management in Schools

In order to be coherent with the above suppositions, schools and institutional offices and centers must be environmentalized, as a first step toward a true environmentalization of the city.

This means that schools must look at practicing what they preach and become model examples. This means control over the building design to incorporate bioclimatic elements, alternative energy, clean and non-contaminating materials and/or recycled ones, non-toxic paint, etc.

It also means that schools and offices must provide the channels and mechanisms for separate waste collection; organic, packaging, paper, etc, and its subsequent reuse or recycling.

5.2.3. Educational Programs. Experiences.

Some of these ideas have started to take hold. In Catalonia, the Generalitat is promoting together with some municipalities "The Green School Network", fostering comprehensive sustainable management in schools.
www.mediambient.gencat.net/ciutadans/educacio_ambiental/escoles_verdes

5.2.3.1. Specialized Centers

Other experiences involve the construction and activation of specialized centers such as the Centers for Environmental Education, Centers for the Interpretation of Nature, Nature Houses and Centers for the Promotion of Waste Management.

5.2.3.2. Publications and Campaigns

There are many experiences involving a multitude of informative and promotional publications on a vast number of environmental issues and on the broad mosaic that is waste management (Sharing the Future; Door-to-Door Campaign).

Seasonal campaigns in the different media, i.e., audiovisual, printed, etc, and especially group visits to waste treatment centers, usually give good results. A visit to a dump or a composting plant gives the message loud and clear of the type of problems we are facing.

5.3. Information and Communication

Unlike environmental education, whose basic objective is to transmit values, information and communication in principal aim to reach citizens with information or practical guidelines that will help them carry out their responsibilities. In this case for example, it would address the aim of the environmental treatment of waste, and what the procedures for its separation are.

Information and communication activities that can be carried out include: specific awareness campaigns, websites with an interactive consultation section, local magazines and bulletins, radio and television programs, posters, exhibition of materials and recycled products, visits to waste management facilities or workshops on home composting or paper recycling.

5.3.1. Information and Instruction

When we talk about information we refer to the unidirectional transmission of information and knowledge whose principal aim is to transmit data, objectives, results and messages.

Instruction requires a change in attitude and habit, and through these changes it seeks adaptation to the new management model, in this case, waste, i.e., separating paper, organic material, going to collection centers or bins, etc.

5.3.2. Publicity and Marketing

In publicity and environmental management, in order to establish strategies that will modify habits and behaviors making them more environmentally responsible, we have to address four different areas in personal and group behavior patterns, in a coordinated manner.

- Rationality
- Emotional, i.e., appealing to emotions associated with certain living conditions, places and situations (real or imaginary). It could have positive or negative connotations.
- Functionality and commodity. All living things tend to adapt, but there is also the law of 'the path of least effort'.
- Belonging and social control. People need to belong, to be affiliated and feel a part of something, which is the basis of their socialization. Their group of peers and norms.

5.3.3. New Technologies

In today's society, new technologies are gaining more ground and protagonism. Primordially there is the phenomenon of the Internet that gives us quick access to large amounts of information on virtually every subject and from virtually any part of the world. With the help of the Internet and emails, we can be in constant contact with others to interchange experiences, make consultations, etc.

Two clear examples are:

The website of Metropolis Commission 3:
http://topics.developmentgateway.org/urban/urbanwaste
and
The website of the Barcelona-based Metropolitan Environment Organization:
www.ema-amb.com

Both of these work on the basis of a virtual community, together with technicians and experts that form part of these organizations, and on a different level with all those people who are interested in environmental problems and waste management.

5.4. Public Participation

Various objectives can be met with effective public participation:

- Education, i.e., helping to form an opinion, change attitudes and modify behavior.
- Accessing more detailed and reliable information that facilitates informed decision-making.
- Legalizing certain policies.
- Ensuring co-responsibility in the management of matters of general interest.

In short, participation is related to involvement, interaction, a sense of ownership and the sense of achievement.

Hart explains different phases of participation.

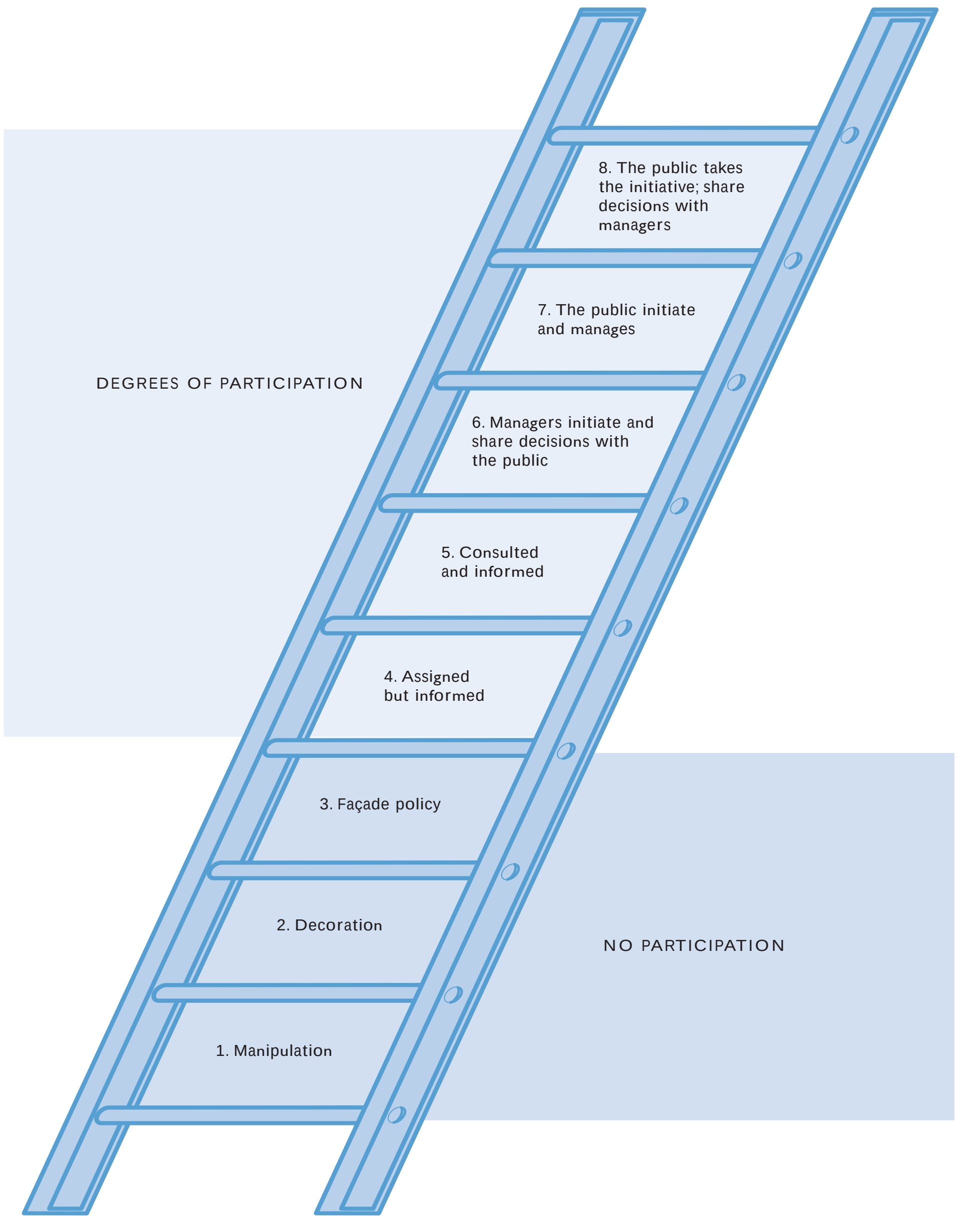


Fig. 5.4a
Different Phases of Participation According to Hart, 1992 (from Pol, 2000, p.55).

Because society is increasingly more critical and reflective, traditional democratic governments find it increasingly difficult to manage environmental issues efficiently.

This is why we need a government with more wide-ranging powers that will involve different actors in a multidisciplinary network that uses new instruments and takes on new roles to advance toward new waste management models that encompass sustainability criteria. Technocratic alternatives, or those that base participation on the lower levels of Hart's ladder, do not reinforce democracy but rather worsen it. Many of the decisions made in the area of waste management and that require a large degree of technical consensus will not easily move toward social consensus if alternatives, costs, benefits and the best available solutions from every aspect of sustainability are not put on the table and widely discussed.

5.4.1. Agents That Obstruct Participation

Amongst the agents that obstruct participation we find the tendency to take the path of least effort, the NIMBY phenomenon, feelings of frustration and vulnerability, lack of training, inaccessibility to decision-making bodies, the inhibition of responsibility, a profit-orientated culture, contradictory messages by the mass media, lack of credibility and prestige, no understanding of the channels of participation, etc.

We need to expand a little further on the NIMBY phenomenon, as it is becoming the most commonly adopted attitude when there is a proposal for waste facilities near inhabited areas where certain projects end up being rejected by the people. This attitude is often the result of the uncertainty regarding the true risks that certain activities involve, and a reflection of the mistrust people have of the Administration or of the promoters of the project. The people that would be potentially affected by the activity or facilities could think that they have to put up with the negative effects of an activity that benefits the rest of society. Therefore, social-perception studies on environmental risks suggest that the NIMBY syndrome is a reaction with quite a complex nature that is made up of fear of environmental and economic deterioration, mistrust of industry and institutions, and feelings of victimization. Other concepts related to NIMBY are LULU (locally unacceptable land use) and BANANA (Build Absolutely Nothing at All Near Anybody).

Participative dynamics can help reduce these types of phenomenon; communication of problems, examination of alternatives, explaining risks, creating a co-operative spirit and sharing responsibility. This is why an accountable decision-making process is fundamental.

5.4.2. Agents That Promote Participation

These include feelings of attachment and identification with a place, and of ownership. Identification with a place promotes responsibility, habits and lifestyles, accessibility to real decision-making bodies and the possibility of having a part in decision-making. Effective participation promotes participation, presentation and availability of understandable information, the satisfaction of being a cause, etc. (for further information, see Pol, 2000 or visit http://mediambient.gencat.net/Images/43_74483.pdf).

In short, the table below outlines the main arguments of the defenders and skeptics of participative processes.

Defenders:	Skeptics:
• Participation and efficiency are complementary concepts.	• The whole process becomes drawn out and complicated.
• Allows the public to be involved, have their opinions heard and bear them in mind when decisions are made.	• The decision-making process incurs extra time and resource costs.
• Helps maintain the vitality of democratic institutions.	• There is no added value to the decision.
• The quality of the decision-making process can improve.	• Problems debated take on an individualistic nature.
	• Short-term views considered only.
	• Erodes institutions and political parties.

Source: adapted from Subirats (2001)

5.4.3. Examples and Experiences

In the PARTICIPATION chapter, the Barcelona Metropolitan Area has created a participative body to monitor the Waste Program, which brings together all sectors of society and active agents. It is the Monitoring Council for the Metropolitan Program of Municipal Waste Management.

The Council is made up of political representatives, representatives from all Catalan universities, union representatives, business organizations, environmental groups, neighborhood associations and experts in waste management.

The basic purpose of the Council is to follow up the implementation and development of the Metropolitan Program, study and discuss its theoretical elements, propose alternatives, and in short, act as a government advisory body in this field and help communicate its proposals in a better way.

The Council has three work commissions to study specific issues. The Commissions are chaired by university representatives and include the Financing Commission, which looks at aspects related to program economy, revenue, taxes, etc.; the Infrastructure Commission, responsible for studying proposals for facilities, plants, technologies, etc., and the Action Commission, responsible for the general advancement and development of the program and its implementation in the municipalities, etc.

The Commissions prepare proposals and documents that are then presented to the Monitoring Council for approval and taken to the corresponding political organs, i.e., the Board of Directors of the Catalan Waste Agency or the Plenary Council of the Metropolitan Environment Organization.

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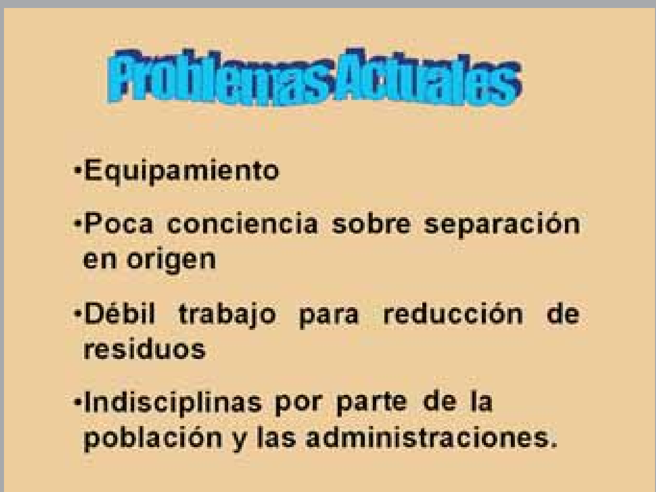
4. Metropolitan Program for Municipal Waste Management, Metropolitan Environment Organization, Barcelona 1997.

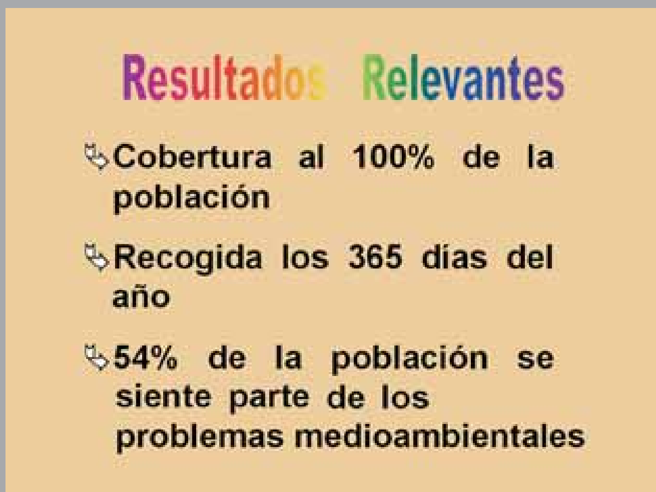
Legislation and Guidelines:
1. Declaration of Rio 1992
2. Aalborg Charter 1994
3. Declaration of Lisbon 1996
4. The Hannover Call 2000
5. Act 15/03 of 4 June 2003 that regulates waste.

5.5. Experience in Habana (Cuba)


Participación Ciudadana
•Más de 40 años de trabajo con la población
•Participación Masiva en las Medidas
•Aún no es suficiente el trabajo de concienciación
•Población e Instituciones indisciplinadas
•Decreto 272. Cuerpo de inspectores.
(260 miembros)
•Reglamento de la Asamblea Provincial
•Organizaciones de Masas
•Prensa , Radio, Televisión


Financiamiento
•Más de 50 millones de pesos (27 de ellos para salario). Por habitante 22,7 pesos al año
•Servicio gratuito
•Costos por toneladas métricas:
Recogida y Disposición Final $ 1933
•Experiencia Empresarial

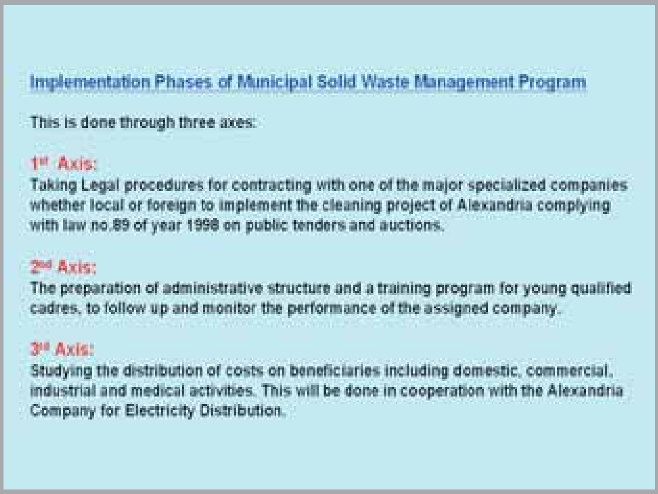

Problemas Actuales
•Equipamiento
•Poca conciencia sobre separación en origen
•Débil trabajo para reducción de residuos
•Indisciplinas por parte de la población y las administraciones.


Resultados Relevantes
Cobertura al 100% de la población
Recogida los 365 días del año
54% de la población se siente parte de los problemas medioambientales


Resultados Relevantes
Inicio del Proceso de Concienciación para la Separación en Origen en la Cuenca de la Bahía de La Habana, Miramar, Guanabo, y Santa María del Rosario
Sistema permanente de saneamiento intradomiciliario
Mejoramiento de las condiciones de los Vertederos Oficiales y eliminación de Vertederos de Período Especial

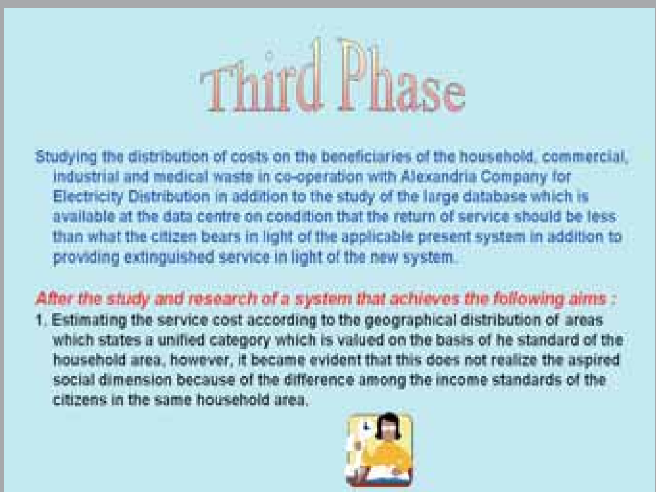

Resultados Relevantes
Reducción de enfermedades tropicales
Reducción del índice de afectación del mosquito a menos del 0,05%
Eliminación de la epidemia de dengue en 70 días en el año 2002
Mortalidad infantil de 6,2 x mil nacidos vivos
La expectativa de vida es de 76 años

5.6. Experience in Alexandria (Egypt)

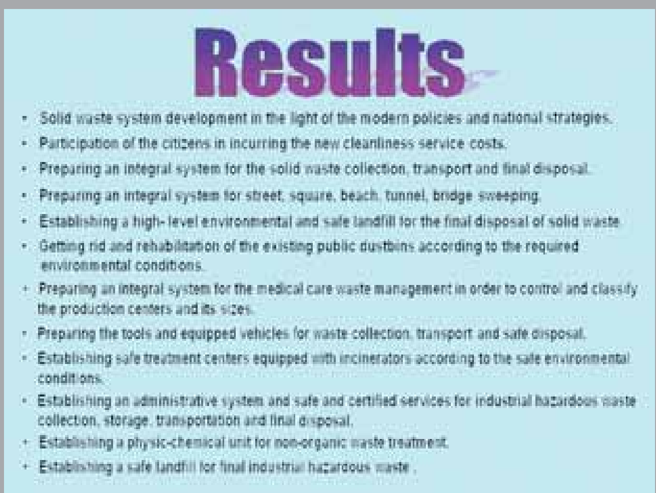



1st. Phase
Work progress :
First:
• Preparing a tender for Alexandria cleaning project.
• Preparing tender documents:
- Contents of tender documents.
- Terms and conditions of tender.
- Tender documents.
- A summary for the project.
- Work sites.
- Qualification forms for solid waste management services.


Second Phase
• Setting up an administrative system and a training programme for young qualified people to monitor the execution of the commitments of the company which is contracted to manage the project of solid waste collection, transfer and complete disposal.
• The training programme aims to prepare a guidebook for instructions concerning monitoring, supervision and management of solid waste to be available for all governorates.


Third Phase
Studying the distribution of costs on the beneficiaries of the household, commercial, industrial and medical waste in co-operation with Alexandria Company for Electricity Distribution in addition to the study of the large database which is available at the data centre on condition that the return of service should be less than what the citizen bears in light of the applicable present system in addition to providing extinguished service in light of the new system.
After the study and research of a system that achieves the following aims :
1. Estimating the service cost according to the geographical distribution of areas which states a unified category which is valued on the basis of he standard of the household area, however, it became evident that this does not realize the aspired social dimension because of the difference among the income standards of the citizens in the same household area.


• Preparing an integral system for collecting, transferring and final disposal of the medical waste.
• Cancelling the previous public dumping sites and re-habilitate their sites according to the necessary environmental specifications.
• Establishing a safe environmental landfill of a high standard for final disposal of the solid waste.
• Introducing the service of washing the streets which was not available for a long time.
• Providing specialized cleanliness for the beaches of Alexandria.
• Modernizing special services for the cleanliness of squares, fountains, statues and memorials.
• Innovating the service of picking in the streets in the period following the sweeping.


Results
• Solid waste system development in the light of the modern policies and national strategies.
• Participation of the citizens in incurring the new cleanliness service costs.
• Preparing an integral system for the solid waste collection, transport and final disposal.
• Preparing an integral system for street, square, beach, tunnel, bridge sweeping.
• Establishing a high- level environmental and safe landfill for the final disposal of solid waste.
• Getting rid and rehabilitation of the existing public dustbins according to the required environmental conditions.
• Preparing an integral system for the medical care waste management in order to control and classify the production centers and its sizes.
• Preparing the tools and equipped vehicles for waste collection, transport and safe disposal.
• Establishing safe treatment centers equipped with incinerators according to the safe environmental conditions.
• Establishing an administrative system and safe and certified services for industrial hazardous waste collection, storage, transportation and final disposal.
• Establishing a physic-chemical unit for non-organic waste treatment.
• Establishing a safe landfill for final industrial hazardous waste .


Recommendations
• The issue of environment protection is a joint issue that interests all people; so dealing with all kinds of waste necessitates the integrity and engagement of the official and public efforts.
• The particulars of waste management and treatment are related to the economic and cultural climate, so the local culture plays a prominent role in the success of that system through awareness program.
• Adopting an integral environmental publicity strategy that makes the environmental awareness part and parcel of the tasks to be undertaken by the competent entities and administrations.
• The necessity to encourage the private sector to invest in all kinds of waste management project and use the recent technologies.

URBAN SOLID WASTE MANAGEMENT

6. Bibliography, Websites and Waste Sector Companies

INDEX

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Estado del mundo
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www.eel.nl/
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www.acrr.org/resourcities

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Agencia Catalana del Agua
www.aca.net
Entitat Metropolitana del Medi Ambient. Barcelona.
www.ema-amb.com
Universidad Politécnica de Catalunya. Barcelona
www.upc.es
Legislación de Cataluña. España
www.gencat.net/diari/

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www.arc-cat.net

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Fundació Fòrum Ambiental
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www.forumambiental.org

AIRES
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www.airescat.org

Fundación ENRESA
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Dragados y Construccións
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Ros Roca
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Senda Ambiental
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08254 Pont Vilomara (Barcelona). España

Técnicas de Protección Ambiental(TPA), S.A.
Centre de tractament i reciclatge de frigorífics
08254 Pont de Vilomara (Barcelona). España

Electrorecycling, S.A.
Plata reciclaje chatarra electrónica
08254 Pont de Vilomara (Barcelona). España

Westfalia Separator Ibérica S.A.
Técnicas de separación lodos y residuos
Pol. Ind. Congost- Avda. San Julián, 147
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FELEMAMG
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CAYVOL
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Maquinária para vertederos
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