Project For Institutional Capacity Development On Nation-Wide Solid Waste Management In Dominican Republic

Manual for Final Disposal of Municipal Solid Waste

May 2017

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INTRODUCTION

The institutional, financial, technical-operative weaknesses of municipalities, as well as the lack of collaboration of the citizens, have been translated for years into an inadequate and inefficient management of urban solid waste at all stages, but above all, Concerning the final disposal: more than 350 open dumps scattered throughout the national territory, negatively impact the environment, natural resources and the health of the population, according to a survey conducted by the Ministry of Environment and Natural Resources.

Of all the stages of the management, it is the Final Disposal that at the moment causes greater impacts to the environment, since the local authorities are focused to make the "trash" that annoys the citizen disappear, neglecting the Final Disposal, which is without the slightest sanitary and environmental control.

In this context, the Ministry of Environment and Natural Resources started in January 2014 the "Project for Strengthening Institutional Capacity in Solid Waste Management at the National Level - FOCIMIRS", with the support of the Japanese people, through The Japan International Cooperation Agency - Japan, for a period of three years. During the project discussions, the need was identified for the preparation of support materials that would support municipalities in the preparation of their GIRS plans.

Hence, consideration will be given to the preparation of manuals that address all the stages of waste management, as well as other complementary aspects of vital importance in order to ensure a sustainable integrated management of solid waste.

This is how the "Manual of Final Disposal of Municipal Solid Waste" was born, with the purpose of providing a tool to support municipalities for the planning, design, construction and operation of controlled final disposal sites. This Handbook has three (3) parts. The first deals with general aspects related to the final disposal of solid wastes, including basic concepts; the second refers to the planning stage of the development of a FDS; and finally, the third part deals with the aspects related to the operation of the FDS already constructed. The document develops standard criteria for the design, construction and operation

of sanitary landfills, both mechanized for large municipalities that have greater financial resources, and manuals for small ones that, both for generation and for certain geographic conditions, must install and operate Its landfill completely by hand.

The document deals only with municipal solid waste - RSM, as defined in the regulations in force in the country. It does not include the planning, design, construction and operation of security landfills, since the management of special waste (except household waste) and hazardous waste (industrial and hospital waste) is not a municipal responsibility, but its management is the responsibility of its generators , Who must make use of authorized managers; Unless they have their own facilities.

The Ministry of the Environment and Natural Resources is pleased to put this document in the hands of the municipalities of the country, direct responsible for the management of solid waste, in order to contribute to the creation of the necessary capacities and, thus, to join efforts Decisive to transform the situation of one of the most serious environmental problems that the Dominican Republic has today.

PART I

1 General

1.1 Current situation and legal framework of the final provision in the Dominican Republic

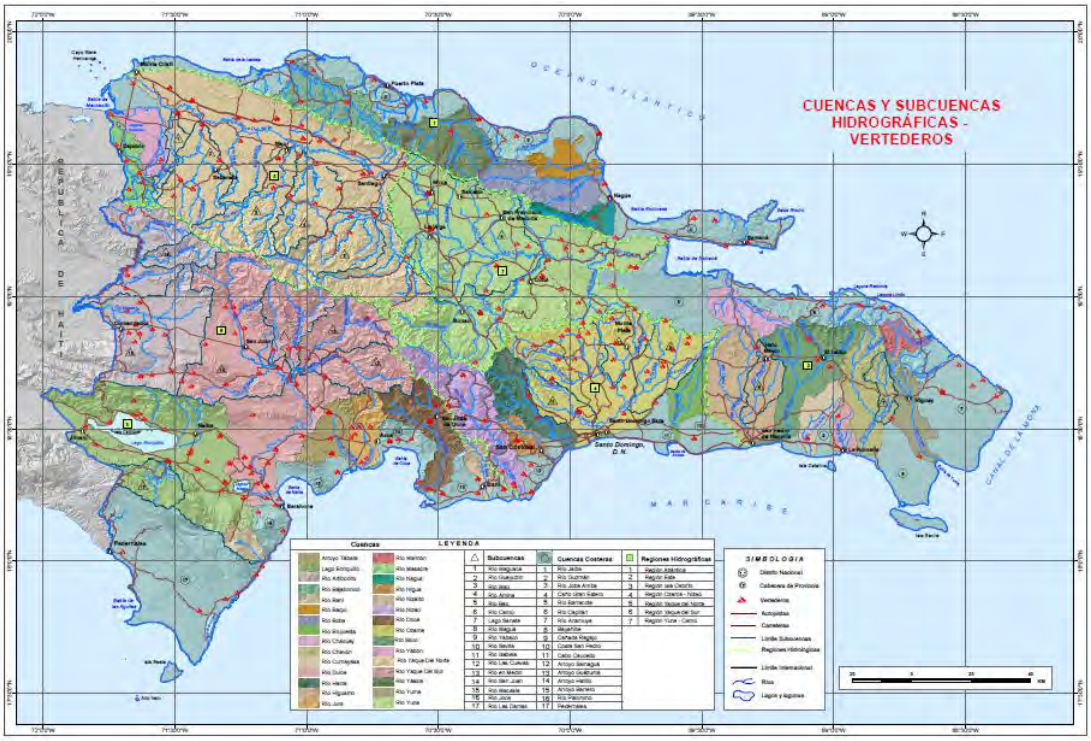
1.1.1 Current situation of the final disposal of MSW

This stage of management is undoubtedly the most neglected in the country, since in the great majority of cases, the minimum measures are not taken, nor are there control systems for the prevention of pollution. The final disposal has been made in so-called municipal landfills established throughout the entire national territory. Almost all of them are uncontrolled open-pit landfills, located on rented or state-owned land, which are often located in the vicinity of streams and streams, causing impacts, not yet studied, but presumably serious. This situation has been taking place for a long time, since according to the "Preliminary Diagnosis of the Solid Waste Sector in the Dominican Republic", carried out in 2001, a photo area of the country already reflected a territory of burned landfills, where 99% of municipalities Had not set up appropriate facilities to dispose of its municipal waste.

Photo 1 In landfills, there is no leachate management and there is smoke and / or biogas emissions affecting air quality.

In the 2010 survey of the Ministry of Environment and Natural Resources, in coordination with the German Technical Cooperation Agency (GIZ) and the National Coordinating Committee (CCN-GIRESOL), it was determined that there were more Of 350 open-air landfills, of which 325 were geo-referenced (see map below), resulting in about 148 / km2, a very high figure for an island country with

a reduced surface area. The number of landfills was of 3.44 / 100,000 inhabitants (9, 445,281 inhabitants).



Source: Ministry of Environment and Natural Resources - 2015

Figure 1 Hydrographic map of DR with georeferenced landfills in 2010.

It was determined that 66% of the georeferenced landfills are located in soils class I to IV, suitable for agricultural and livestock production; 60%, in areas with presence of aquifers of great, high and medium hydrogeological importance; 17%, in areas with water table less than 50 m; 6% to less than 100 m of lakes and lagoons; 89%, to less than 1,000 m of rivers, streams and glens; 5%, less than 3 km from airports; And 30%, located in flood areas.

Figure 2 Location of dumps in Hydrogeological Map - RD

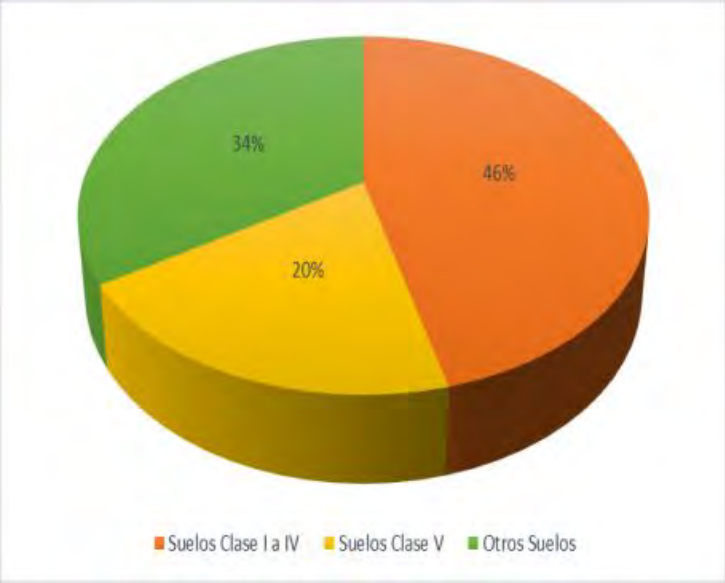


Figure 3 Location of dumps in Map of Productive Capacity-DR

According to the diagnosis, the proper management of the waste in the different landfills is practically nil. In more than 97% of the cases, the disposition of the same is done in the open. There is no regular coverage or compaction, nor an adequate management of leachate, nor of the biogas generated. Of the 354 landfills identified, 140 of them (39.5%) had the presence of animals (cows, goats, sheep and birds), which in turn allowed them to become vectors.

For the management of landfills, the municipalities of the country had only 83 heavy equipment (mechanical shovels and bulldozers). It is noteworthy that this investigation revealed that in the landfills of Duquesa and Rafey, where more than 50% of the waste generated in the country was available, the management has some control when frequent waste coverage is made. In the same sense, in relation to Duquesa, the study carried out in 2005 in the D.N., recognizes that "although the landfill does not have an impermeable layer or an appropriate installation for the treatment of leachates, efforts have been made in the measures Of environmental protection "; The waste is somehow covered with dirt, records are kept of the waste deposited and pipelines have been installed for the evacuation of gases.

Below are some photos where you can see the situation of the inadequate management of the final disposal sites of the country.

Duquesa dumping site -August 2013

Higuey dumping site- August 2013

La Romana dumping site -August 2013.

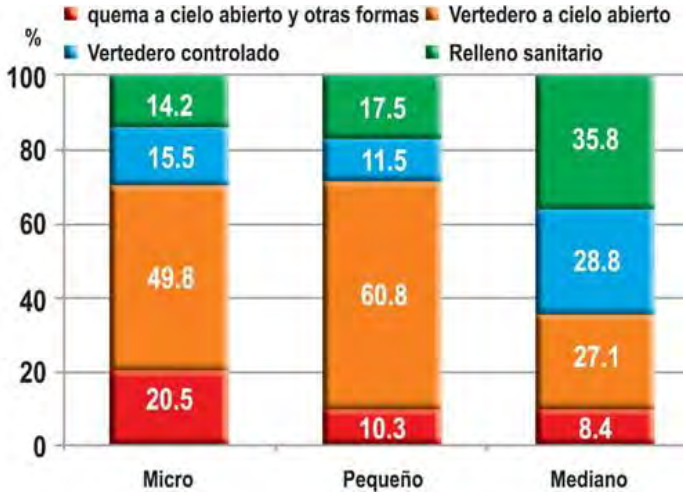
Puerto Plata dumping site - 2014

Photo 2 Actual situation of dumping site

It is worth highlighting the efforts made by the municipality of La Vega during the 2010-2016 management, which partially rehabilitated the existing open pit, covering the current shooting zone and enabling other areas where the waste was compacted and coverage was given on a regular basis. This simple measurement positively impacts the environment, as can be seen in the picture below; although it is worth clarifying that the readequation is not complete, since there is no management of leachate or biogas.

Photo 3 Landfill of La Vega - 2013

It is important to note that the fees paid do not allow the waste to be handled properly. According to the estimates of the operating company, the annual cost for 2010 of an optimal operation was RD $ 353, 936,668.18 or RD $ 29, 494,722.35 monthly, generating a cost of RD $ 258.32 / ton (US $ 6.88 / ton).[1] By 2014, this cost increases to US $ 9.04 / ton, according to data supplied by Lajun Corporation. However, at present the municipalities pay a much lower amount than indicated, being the one that pays the highest National District, about US $ 3.00 / ton. The average cost of final disposal in Latin America and the Caribbean, according to said study is US $ 20.43 / Ton.



Source: Report of the Regional Evaluation of the Management of Urban Solid Waste in LAC. 2010. Micro: ≤15,000 inhabitants; Small: 15,001 - 50,000 inhabitants; Medium: 50,001

Figure 4 Final provision in Central America and the Caribbean

The study "Master Plan for Integrated Management of Solid Waste in the Municipality of Gran Santo Domingo" carried out in 2012 yielded a final disposal cost of US $ 17.10 / ton. This cost, together with collection and transfer costs, results in values ranging from US $ 52.84 / ton (with modality 1) to 79.94 (with selective collection). The study concludes that "according to the analysis of the capacity to pay, it is possible to establish the economic and financial viability of the project, given that the incidence of the average residential bill in the average household expenditure amounts to 2%".

From all of the above, it could well be concluded that if we were to fly over the national territory fifteen years after the first diagnosis made in 2001, the

[1] Plan Maestro para Manejo Integral de los Residuos Sólidos en la Mancomunidad de Ayuntamientos del Gran Santo Domingo. IDB. 2011 - 2013

Dominican Republic remains a large landfill.

1.2 Legal framework

1.2.1 The Constitution of the Dominican Republic

The current Constitution was enacted on June 13, 2015. Section IV: Collective rights and the environment, Article 66, paragraph 2, establishes the protection of the environment as a collective right. Article 67 indicates that the state has a duty to "prevent pollution, protect and maintain the environment for the benefit of present and future generations," while enshrining the right of everyone to "live in a healthy environment".

1.2.2 The General Law on Environment and Natural Resources (Law 64-00)

Promulgated on August 18, 2000, Art. 1 states as an object of the law "to establish the norms for the conservation, protection, improvement and restoration of the environment and natural resources, ensuring their sustainable use".

In the Final Disposal issue, Chapter IV on Environmental Assessment (Sections 38-48) and Chapter VI "Domestic and municipal waste" should be taken into account (Article 107, paragraph II).

Articles relating to environmental assessment include provisions relating to the environmental assessment process to be followed by "any activity, project or infrastructure work that, by its characteristics, may affect the environment". This process includes the submission of an environmental impact study (EIA). There are different categories of study, depending on the nature and magnitude of the project in question. Article 41 specifies the infrastructure projects and works that require to be submitted to the environmental assessment process and present the corresponding studies, including sanitary landfills (numeral 15).

Paragraph II of Article 107 ratifies the provisions of Article 38, in the sense that the installation and operation of a municipal landfill requires the relevant environmental assessment study.

1.2.3 The Environmental Impact Assessment Procedure

Annex A of the Environmental Assessment Procedure indicates the categories corresponding to the processes and / or facilities for the management of solid

waste, according to "the potential environmental impact or the environmental risk and / or the introduction of harmful modifications Or notorious to the landscape and / or cultural resources of the national heritage: collection of non-hazardous urban waste, non-hazardous solid waste disposal, reuse and recycling of non-hazardous waste, battery recycling and collection, transportation, storage and export of pieces of Metals Annex A of the Environmental Assessment Procedure indicates the categories corresponding to the processes and / or facilities for the management of solid waste, according to "the potential environmental impact or the environmental risk and / or the introduction of harmful modifications Or notorious to the landscape and / or cultural resources of the national heritage: collection of non-hazardous urban waste, non-hazardous solid waste disposal, reuse and recycling of non-hazardous waste, battery recycling and collection, transportation, storage and export of pieces of Metals".

1.2.4 Law on the National District and Municipalities (Law 176-07)

Article 19, in subparagraph (f), orders the municipalities to "Regulate and manage the protection of public hygiene and sanitation to guarantee environmental sanitation. While the (m), ratifies the competence of the municipalities in the services of cleaning and public adornment, collection, treatment and final disposal of solid waste.

1.2.5 The Standard for Environmental Management of Non-Hazardous Solid Waste

This standard issued in June 2003 establishes the guidelines for the management of non-hazardous municipal solid waste and specifies the sanitary requirements to be met in storage, collection, transportation and final disposal (Item 6), as well as the general provisions for the reduction, reuse and recycling of solid waste0.

1.2.6 The Policy for the Integrated Management of Municipal Solid Waste

Through this Policy, issued through resolution No.19-2014, the Ministry of Environment and Natural Resources establishes the foundations, principles, objectives and lines of action for the integrated management of municipal solid waste. Regarding the Final Disposal, this policy presents, as lines of action:

- Establish regulations regarding final disposal
- Ensure a final disposal without danger to the population and the environment (air, soil, water).
- Implement as a general rule the final disposal of MSW in "landfills / regional / provincial controlled landfills" for large cities and / or municipal associations.
- Promote "hand-controlled landfill" solutions for small towns and rural areas whose geographic location and / or waste generation impedes the economic viability to deposit in landfills / regional / provincial controlled landfills.

1.3 Final Disposal: Basic Concepts

Why is an adequate Final Disposal necessary?

Figure 5 Problems in open dumping site

The disposal of solid waste without any type of control, as occurs in open landfills, generates direct negative impacts on the surrounding environment. The most important are:

- Soil contamination.
- Contamination of groundwater (aquifers) by percolation of leachate.
- Contamination of surface waters by surface and subsurface runoff.
- Generation and emission of biogas, containing greenhouse gases, product of the decomposition and the uncontrolled combustion of the waste there.

- Fires caused by the presence of biogas and by the increase in temperature in the waste mass, due to the action of the sun on them and the heat generated in the decomposition process.
- Emission of other gases and particulate matter into the atmosphere.
- Uncontrolled occupation of the territory generating changes and negative impacts on the landscape and natural spaces.
- Generation of bad odors.
- Feeling of abandonment and dirt, produced by the presence of scattered waste.
- Visual pollution by altering the aesthetics of the landscape.

On the other hand, this uncontrolled dumping has important effects on human health:

- Diseases due to the proliferation of pests and vectors transmitting them, for example rodents and insects (flies, cockroaches, etc.).
- Creation of infectious foci.
- Aggravation of respiratory diseases due to natural or induced burning of waste.

In addition to these direct consequences of inadequate management of municipal solid waste, there are indirect effects, such as overexploitation of natural resources. Waste is made up of resources that in most cases are non-renewable. This is why the final disposal of waste that can be used as input in a production cycle contributes to a greater consumption of virgin natural resources. In another order, the installation of a site of Final Disposal of waste causes, in general, the loss of economic value of the surrounding properties.

One cannot fail to mention the social problem represented by the presence of basic recyclers, popularly known as "Waste Pickers", who perform their work in subhuman conditions, without any personal or social protection, exposed to high risks to their health.

In summary, uncontrolled or open-air dumping has multiple negative effects on human health and environmental, economic, social, ecological and aesthetic impacts.

The final disposal is the last stage in the management of municipal solid waste

and comprises the set of operations aimed at achieving the permanent deposit of solid waste. Ideally, the products of the inevitable rejection fractions resulting from the recovery processes should be used for disposal. However, in practice, the waste that is destined for final disposal are those that for various circumstances have no economic value in the context in which they are generated. The lack of value can be because they cannot be reused, because the recovered materials cannot be commercialized or the technology does not exist suitable for their recovery.

The most commonly used final disposal method for municipal solid waste is the sanitary landfill and / or controlled landfill. Then the question fits: **What is and what is a sanitary landfill / controlled landfill?**

1.4 Landfill

The regulations in force in the country define sanitary landfill or controlled landfill as the "engineering technique for the adequate confinement of municipal solid waste; Comprises the spreading, accommodation and compaction of the waste, their coverage with soil or other inert material, at least daily; The control of gases, leachate, and the proliferation of vectors in order to avoid contamination of the environment and protect the health of the population "2.

A sanitary landfill can also be defined as a method and at the same time a place, where the waste produced by a given inhabited area is deposited in the soil, using engineering principles, in such a way as to control and / or minimize impacts to the environment And the health of the population subject to the risk of their effluents. In addition it can be said that it is the place where the waste is received daily, scattered, compacted, covered; and where environmental control (mainly of gases, leachates and odors) is carried out. Stability control is also performed to prevent slippage.

The main purpose of the sanitary landfill is to conserve and protect the environment in its area of influence. The technique seeks to avoid and / or minimize the effects derived from an uncontrolled disposition, as was pointed out previously. To achieve these objectives requires a series of well-designed

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[2] Standard for Environmental Management of Non-Hazardous Solid Waste. Page 14.

infrastructures, adequate equipment and correct operation.

Photo 4 Spreading, compaction and coverage in a landfill

Photo 5 Leachate pond in the ASINORLU Landfill, Santa Rosa de Lima, El Salvador

1.4.1 Types of Landfills

There are different types of landfills. According to the method of operation, these can be: manual and with mechanized compaction; And according to the process of aerobic, anaerobic or semi-aerobic decomposition.

1.4.2 Manual Sanitary landfills

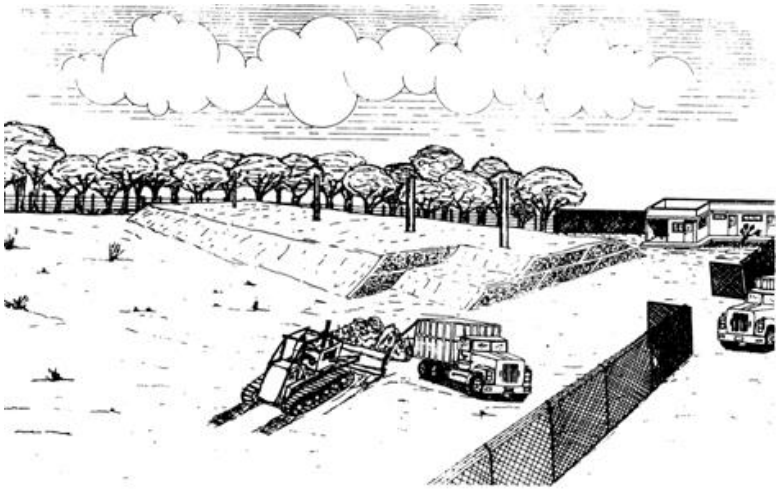
Manual sanitary landfills are the most suitable solution for municipalities and small communities (up to 30,000 inhabitants), whose generation is equal to or less than 15 tons / day or for municipalities located in isolated sites and / or with limited economic resources. In this type of landfill, the workers carry out the activities manually: unloading, spreading, compacting and covering waste, as well as maintenance of ditches, construction of chimneys and drains, excavation of new modules, etc. It must be taken into account that the compaction of the material is less efficient and, therefore, the instability of the confined waste does not allow to reach great heights (generally 3 meters). This situation results in more surface area and therefore an increase in the production of leachate.

Source: Manual for the operation of landfills. SEDESOL, Mexico.

Figure 6 Manual sanitary landfill

1.4.3 Landfills with mechanized compaction

In contrast to manual sanitary landfills, mechanized compaction, total or partial, has its application in medium and large municipalities, which by the amount generated, the landfills could not be completely handled, and therefore require the use of machinery For carrying out the basic operations: spreading, compaction and coverage of waste; As well as for the excavations and transportation necessary to supply new roofing material. If the daily generation is 16-40 ton / day, the landfill can be operated semi-mechanically. Machined landfill applies to populations that generate more than 40 tons / day. These municipalities usually have more adequate funds and also of trained technical personnel.



Source: Manual for the operation of landfills. SEDESOL, Mexico.

Figure 7 Landfills with mechanized compaction

As can be observed, each method has a field of application. When the

municipality plans the construction of a final disposal site, it is recommended to carry out a feasibility study comparing the advantages and disadvantages of both technologies for the case in question.

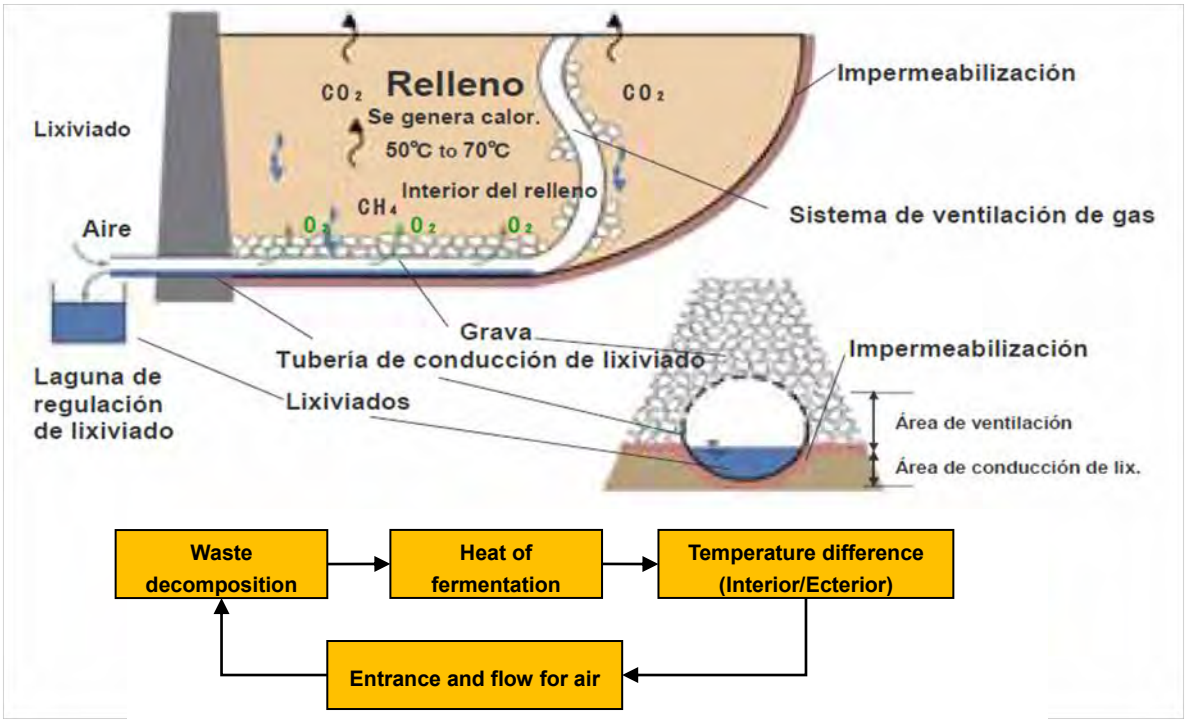
Proper management of a final disposal site involves the successful development of the planning, design, operation, closure and post-closure stages (suitability and end use); which will be addressed in this manual.

The experience in the facilities of the few sanitary landfills operated to date in the country (if one can be said to exist in the full meaning of the term) has not been satisfactory; Making it clear that only through a careful design together with an appropriate operation, using technologies appropriate to the environment and taking into account the sociocultural conditions, will be able to respond to the imperative need to dispose adequately the non-usable solid waste.

1.4.4 Semi-aerobic and anaerobic landfills

The classification of semi-aerobic and anaerobic sanitary landfills is due to the presence of oxygen in the decomposition process of organic waste once deposited, compacted and covered; Resulting in a different composition in the biogas resulting from said process.

In the first case, semi-aerobic sanitary landfills, the conditions for the entry of oxygen into the waste mass are created and therefore the resulting gas is mainly formed by carbon dioxide. This method was developed by the Japanese and is known as the Fukuoka method.



Source: Guidelines for the formulation of the solid waste plan for municipalities, El Salvador. 2009

Figure 8 Semi aerobic sanitary landfill

Photo 6 Semi-aerobic sanitary landfill in Santa Rosa de Lima, El Salvador.

In the second case, anaerobic sanitary landfills, the entry of oxygen into the body of waste is prevented, a fermentation process under anaerobic conditions and the resulting gas, once stabilized the process, has a high concentration of methane. Both carbon dioxide and methane are greenhouse gases. However, it has been established that methane contributes 20-23 times more to global

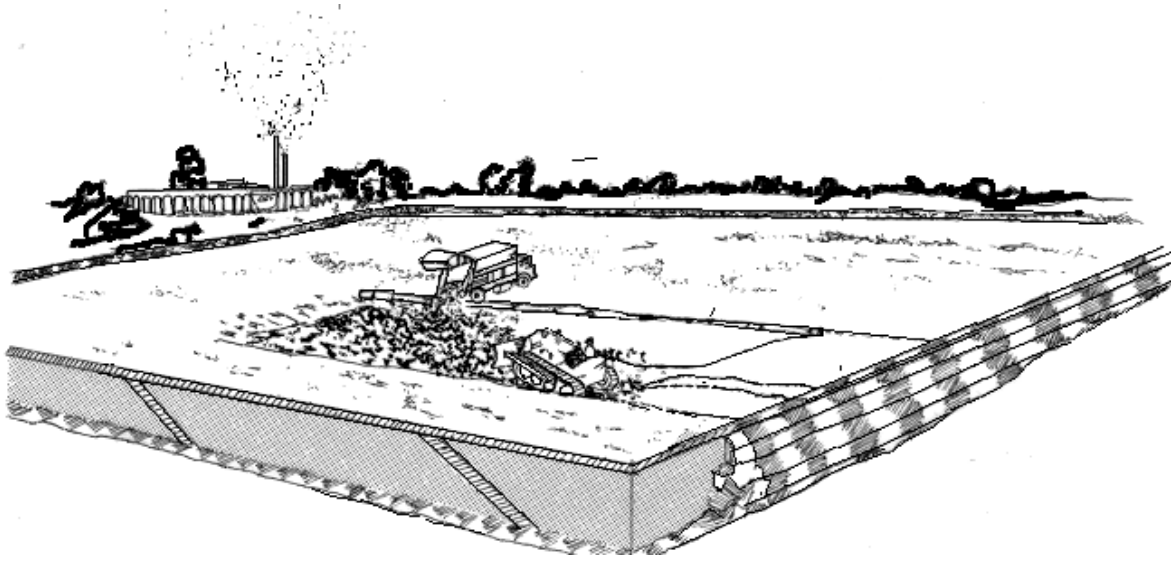
warming than carbon dioxide.

1) Landfilling methods

The main methods used to dispose of MSW in a landfill can be classified as: 1) Trench, 2) Area, and 3) Combined. The main features of each of these methods are described below:

2) Trench method

This method is usually used where groundwater level is deep, terrain slopes are smooth and trenches can be excavated using normal earth-moving equipment. This method consists of depositing the waste on the inclined slope of the trench (3: 1 slope), where they are scattered and compacted with the appropriate equipment, in layers, until forming a cell that will later be covered, at least once a day, with the material excavated of the trench, spreading it and compacting it on the waste.



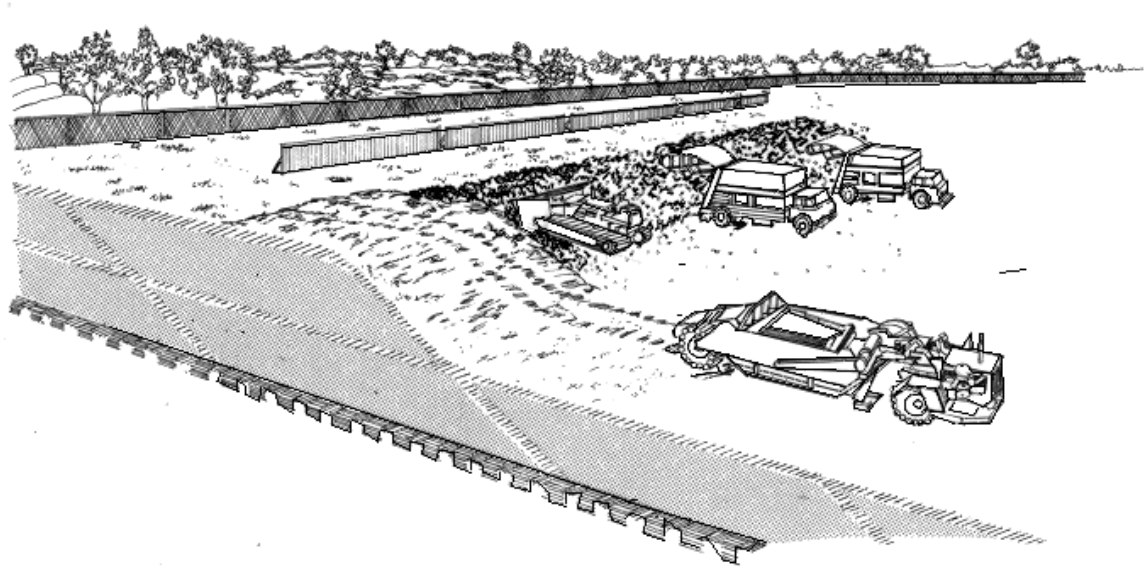
Source: Manual for the operation of landfills. SEDESOL. Mexico

Figure 9 Trench method

3) Area Method

This method can be used in any type of terrain available such as abandoned quarries, canyons, flat terrain, depressions and polluted ditches. A very important aspect is the proximity of the place where coverage material would be obtained, in order not to make the operation more expensive. The method is similar to that of trench and consists of depositing the waste on the inclined slope, are compacted in inclined layers to form the cell that is then covered with earth. The cells are initially constructed at one end of the area to be filled and

advanced to end at the other end.

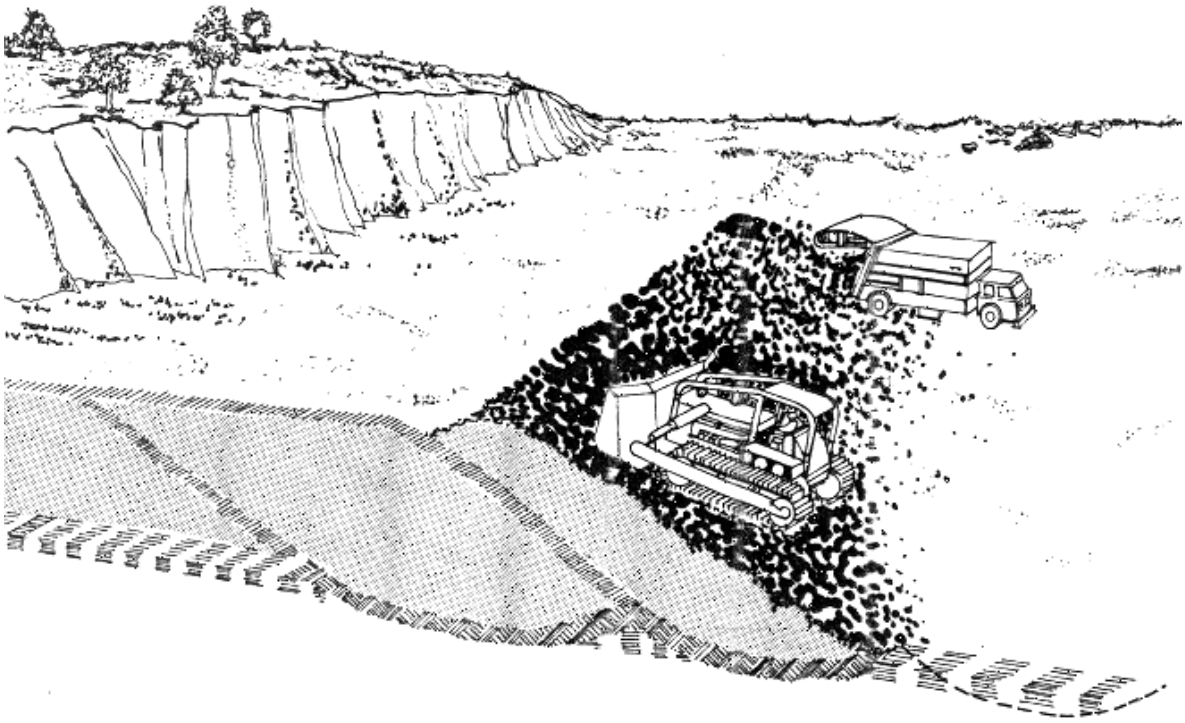


Source: Manual for the operation of landfills. SEDESOL. Mexico

Figure 10 Area Method

4) Combined Method

In some cases, when the geohydrological, topographic and physical conditions of the site chosen to carry out the landfill are appropriate, the two previous methods can be combined, for example, started with the trench method and then continued with the method of Area at the top. Another variation of the combined method is to start with an area method, by digging the cover material from the base of the ramp, forming a trench, which will also serve to be refilled. Combined methods are considered to be the most efficient because they can save the transport of cover material (as long as it is available on site) and increase the useful life of the site.



Source: Manual for the operation of landfills. SEDESOL. Mexico

Figure 11 Combined or mixed method

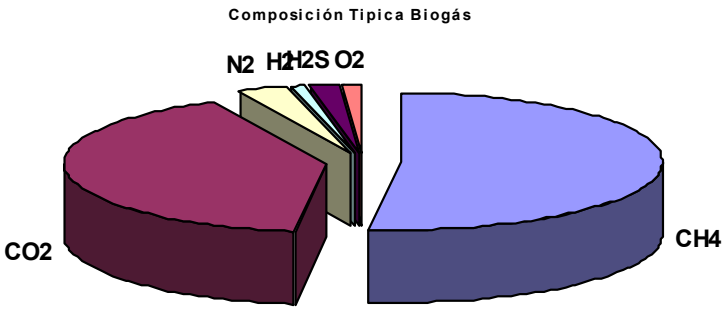
1.4.5 Reactions occurring in a landfill

For purposes of illustration and although in a very general way, it is considered of interest to present what happens in the mass of waste once deposited in the soil, so that operators are aware that a FDS is a living and dynamic entity, in Which produces biological, chemical and physical reactions, resulting in products, in gaseous and liquid form, whose effects on the environment and health can not be forgotten and, therefore, due attention must be given.

The most significant reactions occurring in a FDS are biological, involving microorganisms that decompose the organic matter present in the solid waste, resulting in the formation of gases and eventually liquids. The process of degradation begins in the presence of oxygen (aerobic conditions), producing mainly carbon dioxide (CO_2), but once all the oxygen is consumed, the process continues under anaerobic conditions (absence of oxygen) and at this stage Organic matter is fundamentally transformed into methane (CH_4), carbon dioxide and very small amounts of ammonia (NH_3) and hydrogen sulphide (H_2S).

Simultaneously with biological reactions, chemical reactions occur, among which the dissolution in leachates of biological conversion products and other compounds, particularly organic compounds, is significant, as these substances can be transported out of the landfill with the Leachate. Such organic compounds may then be incorporated into the atmosphere through the soil (when leaking) or through leachate treatment facilities. Other important chemical reactions are those between certain organic compounds and clay layers which alter the properties and structure of the same.

- In terms of physical changes in the landfill, the most important are associated with the diffusion of gases inside and outside the landfill, the movement of leachate in the landfill and subsoil and the settlements caused by the consolidation and decomposition of the deposited materials. The typical biogas composition is:
- Methane (CH4): 50% to 60%
- Carbon dioxide (CO2): 40% to 50%
- Organic Volatile Organic Compounds (VOCs): Traces
- Calorific value: 18.6 MJ / Nm3 or 4.450 kCal / Nm3
- Humidity Content: Saturated



Source: Presentation "Fundamentos del biogás", Ing. José Luis Dávila. SCS Engineers. Seminar "Reducing methane emissions in the waste sector" Global Methane Initiative. CNCCMDL. Santiago, May 2014

Figure 12 Typical biogas composition

Methane is a colorless, odorless and tasteless gas, lighter than air, relatively insoluble in water and highly explosive. Its lower explosion limit = 5% in air and

upper explosive limit = 15% in air[3].

Methane is a Greenhouse Gas because it absorbs terrestrial infrared radiation (heat) that would otherwise escape into space (characteristic of a GHG). Methane is a GHG, 21 times more potent by weight than CO2. Today there is 150% more methane than in the year 1750[4].

The movement of gases and emissions deserve particular attention, for example, when the biogas is trapped, the internal pressure can cause cracking of the cover and fissures, allowing water to penetrate through these cracks. The humidity generates a greater production of gas and consequently causes a greater cracking. At higher cracking, more likely biogas leakage, which carries traces of carcinogenic and teratogenic compounds that are incorporated into the environment.

In relation to the carcinogenic and teratogenic compounds, it is worth mentioning that several studies have been carried out in different places (Canada, USA, Germany, among others) demonstrating the linkage of these gases to various health disorders, such as congenital malformations, And above all, cancer. One such study in Montreal showed a statistically significant elevation of low birth weight in neonates compared to an unexposed reference population. Another conducted in NY showed a moderate but statistically significant elevation of risk of malformations in neonates when mothers resided near the landfill. In Germany a statistically significant increase in the number of leukemias was found in the Petershangen community, located 5 km southwest of the landfill. Another similar study shows a statistically significant increase in the number of leukemias in the community of Stadthagen, located 8 km southeast of the landfill.

On the other hand, and of great importance, is the fact that the biogas contains a high percentage of methane, reason why there are risks of explosion or combustion.

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[3] Same source as the graph presented.

[4] Idem

1) Advantages and Disadvantages of a Landfill [5]

a. Advantage

- Landfill, as one of the final disposal methods of municipal solid waste, is the most economical alternative; however, it is necessary to allocate sufficient financial and technical resources for planning, design, construction and operation. The most important advantages are:
- The initial capital investment is less than that required for the implementation of an incineration system.
- When material is available to cover solid waste at the same site, this condition is generally the most economical of the different options for final disposal.
- Landfill is a final method for the disposal of solid waste, which does not require additional operations, such as incineration, for disposal of final products.
- Land reclaimed previously considered as unproductive or marginal, transforming it into areas useful for the creation of parks, recreation and recreation areas, or simply green areas.
- It is a flexible method, since in case of increasing the amount of waste to dispose only very little equipment and personnel is required.
- The methane gas generated by the decomposition of the organic fraction contained in the solid waste can be attractive for its use as an unconventional energy source, depending on the characteristics of the site.

b. Disadvantages:

- The opposition of the population to the construction of a sanitary landfill is due to two fundamental aspects: the lack of knowledge about the landfill method and distrust of public servants in the locality.
- Requires large amount of ground, depending on capacity. This is especially important in places with low land availability.
- Ongoing supervision is required to maintain a high level of operations and ensure that there are no future failures.
- When there is no land near sources of solid waste generation, due to urban growth, the cost of transportation will be strongly affected.
- The relative proximity of landfills to urban areas can cause serious public complaint problems.

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[5] Manual para la operación de rellenos sanitarios – SEDESOL, México.

- There is a high risk that, especially in third world countries, due to the lack of economic resources for operation and maintenance, the landfill will be converted into an open pit.
- Contamination of nearby groundwater and surface water, as well as the generation of unpleasant odors and gases, may occur if proper control and safety measures are not taken.
- Differential settlements suffered by landfills with respect to time, prevent them from being used immediately once operations have been completed, having to wait a prudent time before giving it the intended use.

1.5 Stages of the Development of a Controlled FDS Project

The development process of a sanitary landfill and / or landfill project involves the following phases:

- Planning
  - ✓ Basic Design
  - ✓ Site Selection
- Detailed design
- Installation and Construction
- Operation
- Closing
- Post-closure use of the site

Every project, work or activity, prior to its implementation, must be properly planned and designed, so that it fulfills the objective for which it is created. This makes it easier to execute what has already been planned and on the other hand, there is a greater probability of success.

These stages and the development flow of a sanitary landfill project and / or controlled landfill are illustrated in the following figure:

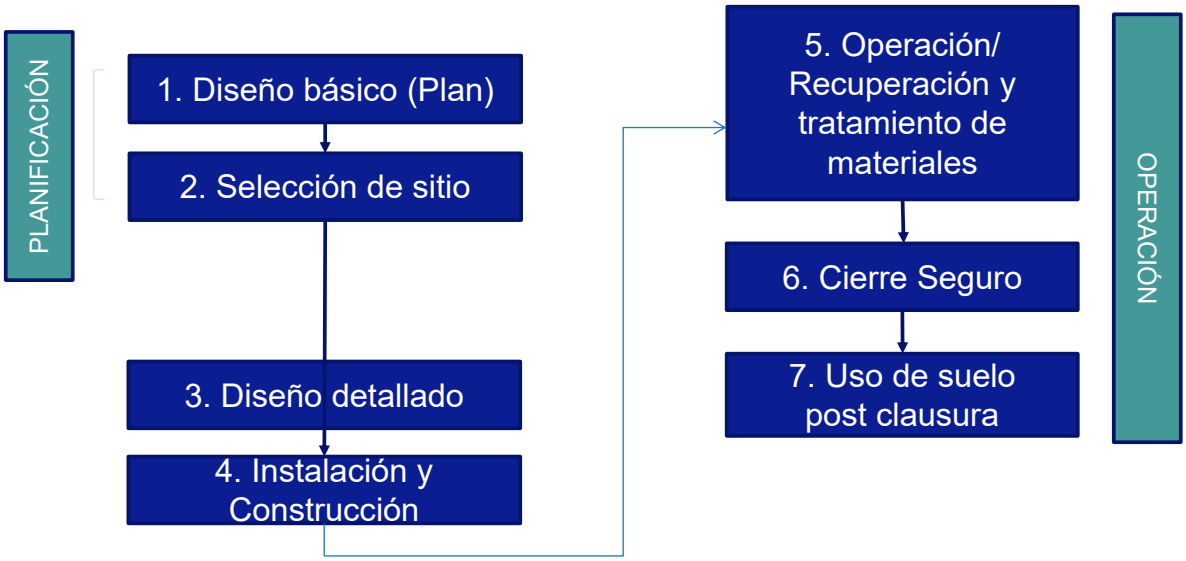


Figure 13 Flow of a FDS project

PART II

2 PLANNING

The planning stage covers basic design, site selection and detailed design.

2.1 Basic Design

The formulation of the basic design for a final disposal project includes the definition of the following items, among others:

- Design year: The target year must be established for a minimum of 10 years. It is recommended to consider more than 15 years.
- Planned waste disposal capacity (m3)
- Planned amount of waste disposal (t)
- Availability of the cover material
- Method of final disposal (cell, trench or mixed)
- Type (manual or mechanized / semiaerobic or anaerobic)
- Basic and complementary infrastructures
- Environmental monitoring
- FDS post-closure use plan

A phased development plan for an SDS should consider the interrelationship between the different infrastructures, the phased arrangement plans and the post-closure utilization plan of the selected site.

According to local conditions, it is of utmost importance to consider the joint Final Disposal with other municipalities, through the municipalities should consider joint management through the creation of municipal association and the convenience of a public-private partnership.

Already in the planning phase, it is advisable to start the process of developing public consensus, involving different stakeholders and maintaining a flow of information in a transparent and sincere manner, in order to consider different opinions and ensure acceptance of the project.

1) FDS Infrastructure Plan

Infrastructures in the FDS should be designed taking into consideration the factors of dead weight, live load, soil resistance capacity, water pressure, wind pressure, seismic conditions and temperature variations, among other things. In addition, facilities must be designed to operate effectively within their planned duration.

2) FDS equipment plan

The FDS equipment plan, ie the analysis of the necessary equipment and machinery (quantity, types, technical specifications, etc.) must be established at the planning stage.

3) Operation and maintenance plan

The success of the FDS will depend on proper operation and maintenance. Already in the planning stage, it is necessary to define the operational and maintenance aspects. It is important that this plan considers the need for a functional operation. A design of the different phases of FDS development periods should be designed.

4) Recovery plan and intermediate treatment

Given the environmental problems arising from the irrational use of natural resources and taking into account the difficulties and long process involved in the separation of solid waste at source, it is worth considering the recovery of materials in the FDS.

5) Health and safety measures plan

The FDS must also be designed and constructed to provide a safe and sanitary workplace. Based on the design and work plan in the landfill, a safety scheme must be elaborated according to the needs and possible accidents that could occur.

6) Closing or closing plan

From this stage one must consider the level of closure that will be given to the FDS. It is necessary to manage the site properly after cessation of operations and to manage the use of the land after closure, in order to protect public health and preserve the environment.

7) Management plan and post-closure use

The management and use that will be given to the FDS, once closed, should be planned in order to take into account the technical aspects required for the design of the future installation that will be developed according to the defined use.

2.2 Site Selection

In general terms, the selection of the location of the final disposal site will be made taking into account:

- Legal Restrictions
- Potential to accommodate planned quantity of waste
- Conditions in surrounding areas
- Topography and soil conditions
- Disaster safety
- Post-closure use of the site

The selection of the site must be studied step by step:

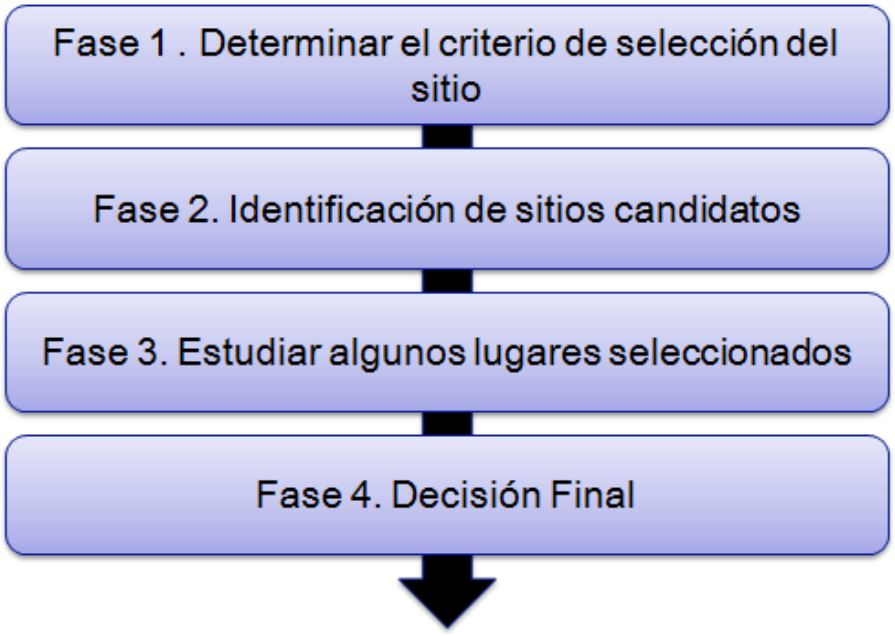


Figure 14 Phases for selecting the FDS

Phase 1. Site classification process

The selection of a suitable site for the location of a landfill / landfill depends on the final disposal site selection criteria. Much of this information can be obtained through a desk study that includes a compilation of all available information in archives, geological and topographic maps, meteorological data, and aerial photographs.

Phase 2. Identification of areas

At this stage a checklist is made of the possible areas removed from phase 1. This list can be used in the field and should help the technician to get a quick overview of the general situation of the site.

Phase 3. Site survey

After performing a comparative evaluation of the selected sites, a number of them (preferably between 2 and 5) should be considered favorable for conducting the deeper studies. In those sites that may be suitable for a landfill, special studies.

Phase 4. Final decision

The last phase of the benchmarking process is crucial before moving on to the design stage. Once all the information described above has been collected, the Ministry of Environment and Resources will decide which location will receive the highest priority.

2.2.1 FDS Selection Criteria

The selection of candidate sites for final disposal sites is a determining factor in any controlled landfill project, since it will condition their operation and exploitation, both from a technical and environmental point of view.

The criteria for selecting the site for a new landfill will depend fundamentally on three types of factors:

Technical / Physical Factors

- Transport distance to collection cores of solid waste
- Useful volume or capacity of the spill
- Access system for possible controlled landfill / sanitary landfill

- Availability of cover and sealing material
- Existence of infrastructures, water, electricity, telephone.
- Morphology
- Soil geotechnical characteristics
- Land cost
- Presence or absence of mineral resources and industrial rocks.
- Karstic soils and areas with highly permeable soil conditions that allow rapid water penetration or possible leaching to the next aquifer.

Environmental factors

1. Distance to inhabited nuclei.
2. Groundwater.
3. Surface water.
4. Climate: rainfall, temperatures, winds, evaporation, evapotranspiration.
5. Soils, types, uses.
6. Vegetation.
7. Fauna.
8. Geological hazards: floods, slope movement, erosion, seismicity.
9. Quality of the landscape.
10. Visual incidence.
11. Natural spaces or cultural and / or scientific interest.
12. National parks, nature protection areas and natural monuments; Areas with important flora and fauna.

Economic, political, legal and social factors

1. Discomfort to neighbors for traffic, dust, noise, etc.
2. Opposition of the community close to the landfill by actual or perceived dangers or 'NIMBY' syndrome (Not in my backyard).
3. Opposition of neighbors and nearby owners for fear of a devaluation of their property.
4. Existence of a regulatory plan of the city that limits the use of the ground.
5. Existence of political groups and parties and conservationists who oppose rightly or wrongly.
6. Historical, religious or cultural sites or heritages.
7. Acquisition price of land.

8. Compensation required.
9. Distance to waste generation areas (in relation to transport costs).
10. Topographical conditions (in relation to transport costs).
11. Accessibility to the site (in relation to the conditions of access roads).
12. Availability of cover material.
13. Availability of public services.

To determine the incidence of the factors mentioned above, the following three (3) steps:

Step 1: Study on the basic condition for the implementation of the new landfill / controlled dumping site.

Make a basic survey. The final disposal site should be located in places where the living environment of the inhabitants of the surrounding areas is not affected, does not interfere with the planning of the territorial order, direction opposite the population growth and does not contaminate the bodies of water Surface and underground areas identified for human consumption and supply.

Sites that produce environmental improvements after being abandoned and / or improving the natural contours for the final use of the site and sites whose soils have waterproof characteristics are preferable.

Step 2: Selection of proposed sites

To select the locations, the following aspects must be confirmed:

- The environmental legislation in force in the country.
- Overlapping of maps (cartographic, geological, land uses, natural protected areas, areas of water recharge and others that are considered necessary.
- Make the necessary visits to verify access conditions, proximity of urban populations, estimation of soil types, owners, etc., identifying up to 3 candidate sites.
- The execution of basic studies for the candidate sites, for example soil study (stratigraphy and field permeability), topographic survey and inventories of flora and fauna.
- Verification of the minimum distances to install sanitary landfills:
  - ✓ Airports and human settlements are as follows: 3,000 m (3,000 m) when

operating turbine engine airplanes and 1,500 m (1,500 m) when operating piston-powered airplanes. Of 1,500 meters, from the limit of the human settlements to serve. If this restriction is not fulfilled, it must be demonstrated that there will be no affectation to these population centers.

- ✓ Areas of marshes, streams, river channels and the like.
- ✓ Flood areas with return periods of 100 years
- ✓ A surface water bodies with continuous flow, must be at least 1,000 m (thousand meters).
- ✓ Of 100 meters to wells for extraction of drinking water (be they of domestic use, industrial, irrigation or livestock).
- ✓ Or 60 meters (60 meters) of an active geological fault including displacement over a period of one million years.

- If it is located in such a way that it fulfills the necessary conditions to prevent contamination of soil, groundwater or surface water and ensures the efficient collection of leachate.

On the other hand:

- Areas where differential settlements exist or can be generated that lead to faults or fractures of the terrain should be avoided.
- Assess land uses that compete with each other, environmental safety and cost efficiency.

<u>Step 3:</u> Evaluation of proposed sites and final selection.

Once the candidate sites have been debugged and their characteristics established, they are placed in a selection matrix, assigning values to the different characteristics (scale greater than the optimum characteristics and decreasing to the minimum permissible conditions).

To optimize the selection it is necessary to evaluate different location alternatives (at least 3), the following four conditions must be examined in an Integrated way for all proposed sites.

2.2.2 Required studies

Studies of the conditions of the site and its surroundings must be carried out, terms of hydrology, topography, geology, soil conditions, vegetation, traffic volumes and development.

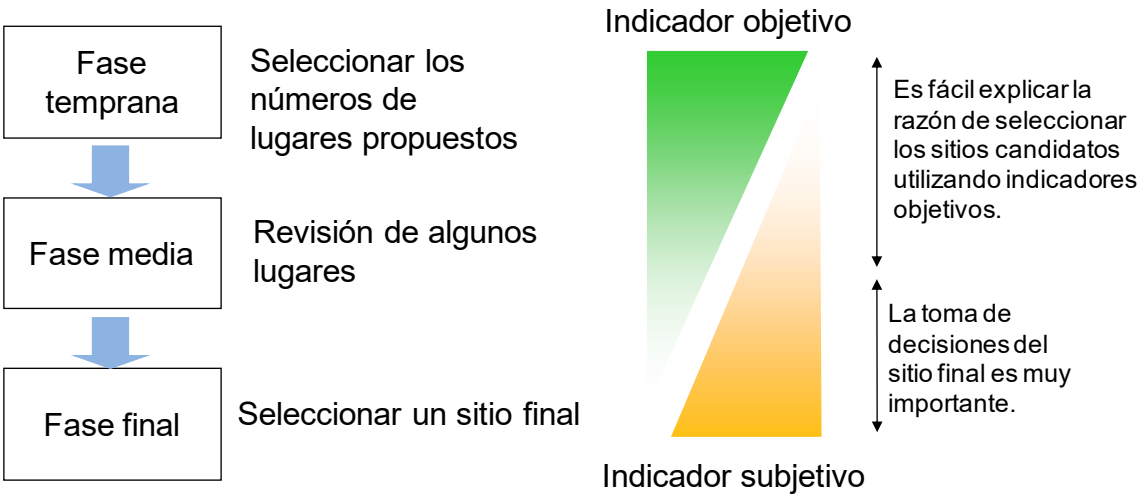
2.2.3 Early evaluation of environmental impacts

It is necessary to make an impact projection in advance of aspects such as water pollution, generation of odors and noise that would occur during the construction of the installation, its operation and post-closure.

2.2.4 Difficulties in FDS Selection: Addressing the NIMBY Problem (Not in my backyard)

It is necessary to understand that the consent of the residents and / or surrounding communities must be obtained for the construction and operation of the landfill, so that there must be transparency in the process from the early stages of planning.

The final decision should depend on the subjective indicator, which refers to obtaining the places without any mishap among the owners around the site.



Source: Expert Team - FOCIMIRS

Figure 15 Objective indicators Vs subjective

As a summary of important points to obtain public consensus, the following are recommended:

- Carry out key actions to obtain residents' consent: Disclosure of information and explanation to residents about landfill.
- Consider upgrading social infrastructures to the surrounding Communities as compensation for the changes that will be generated by the new infrastructure in their environment.
- Perform recommended activities to obtain the consent of the inhabitants: talks, trainings.

2.2.5 Detailed design

Once the location where the FDS is established and the basic design (macro design) has been defined, the detailed design (micro design) of the FDS must be followed, which should include:

- Detailed studies of topography, geotechnical and hydrological and others.
- Detailed design of complementary works such as fences, stands, workshops, roads and others.
- Hydraulic works of diversion and channeling of surface water and rain.
- Hydraulic collection, conduction, storage and treatment of leachate.

Photo 7 Construction of drains for the collection of leachate

- Capturing, conducting and burning works or treatment of biogas.
- Programs, works, water and gas monitoring wells.
- Determination of sites or lending banks for excavation of cover materials.
- Design of the backfill surface of the filler and its waterproofing either with clayey soil or with synthetic membranes.
- Design of the final surface, including its waterproofing and adaptation for planting plant cover.
- Design of the closing or sealing programs and the post-closure programs.
- Environment Effect investigation.
- Study of costs, both investment and operating, and financial analysis of income and expenses or the analysis of projected cash flow.
- Establishment of management policies such as decisions on whether the operation and construction will be municipal or private.
- Establishment of bidding rules, if applicable, or of the own management

program.

The detailed design must respond to the current legal framework and take into account a series of parameters / criteria, among which we must consider:

- Capacity required according to generation projection
- Useful life
- Type of waste to be disposed of. Composition and characteristics
- Topographic and hydrogeological conditions of the area
- Appropriate technology
- Body shape of waste, considering the type of waste (with or without biodegradable waste) and technical management (manual or mechanical).
- Method of operation (trench or trench, area, ramp or combined).
- Cell dimensions
- Waterproofing the bottom
- Runoff diversion system and collection of leachate.
- Gas collection and disposal system
- Analysis and stability control
- Environmental monitoring during the operation
- Closure and end use of disposal site

Before proceeding to the detailed design, the project will consider all minimum technical requirements () for the establishment and operation of a landfill, regardless of its type or size:

1. That there is a guarantee of stability of the ground and of the padding against landslides;
2. That there are internal access roads, balastadas or paved, passable at any time of the year, with information label;
3. That there is a peripheral fencing, that limits the terrain and prevents the entrance of people and animals, outside the landfill, with a restricted gate and entrance;
4. That there is preparation of the ground, with a waterproof base, sloping towards the drainage lines;
5. That there are peripheral channels for rainwater;
6. That there is drainage for leachates and chimneys, for gases and fumes;
7. That there are facilities to collect and treat or recirculate leachate;

8. That there is a booth, warehouse, sanitation and other basic infrastructure;
9. That there is sufficient staff, with adequate training and qualified supervision;
10. That there is daily coverage of waste with inert matter, with a minimum thickness of 15 cm;
11. There is a final coverage of the landfill, with a 60 cm thick cover layer, with an additional layer of 20 cm thick, capable of supporting vegetation, and with sufficient inclination to prevent the entry of rainwater into the landfill ;
12. That there is a design of the different phases of the periods of operation of the landfill site; Y
13. That there is a design of the final conFiguretion of the site, with its landscape treatment.

2.2.6 Capacity Required

In order to determine the required capacity of the site, it is first necessary to determine the volume that would occupy the mass of waste and then that which would occupy the mass of waste in the landfill, which are calculated by applying one of the following formulas:), Depending on the availability of the data:

$$\mathbf{Vwaste} = \mathbf{ppc} \times \mathbf{H} \times \mathbf{365} \times \frac{\mathbf{N}}{\mathbf{D}} \quad (1)^{6}$$

Where:

Vwaste**:** Volume of waste

Ppc: Daily production of waste per capita

H: Number of inhabitants of a city

N: Useful life span of the Landfill (years)

D: Density of waste

365 = Number of days per year (days)

$$\mathbf{Vwaste} = \frac{\mathbf{365 * Td}}{\mathbf{Pv}} \qquad \mathbf{(2)}$$

Where:

V = Annual volume in m³ (m3 / year)

365 = Number of days per year (days)

TD = Tons collected daily (t / day) * from waste flow

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[6] **Source: Design, Construction, Operation and Closing of Landfills. Ecuador 2002. Page 6**

PV = Volumetric weight or density of compacted waste in the landfill (t/m^3)

In formula 2, the total waste deposited will be the sum of the annual volume for each year of operation.

The landfill capacity should be the sum total of the volume of waste deposited plus the material covering (30% of the waste volume), as well:

$$\boldsymbol{Vlandfill = 1.3 \times Vwaste} \quad \textbf{(3)}$$

Where:

Vlandfill: Volume needed for the landfill

At the end the landfill capacity is determined by:

$$\textbf{Landfill Capacity} = \textbf{Vwaste} + \textbf{Vlandfill}$$

Equivalent to:

Total waste deposited (m^3)	+	Cover material (m^3)	=	Landfill Capacity (m^3)

The volume of waste is multiplied by the factor 1.3 to obtain the necessary volume of the landfill, considering that cover material is added. Shelf life should be more than 10 years; otherwise, the costs for the acquisition and preparation of the land are not justified. The optimum would be a useful life of more than 20 years. On the other hand, it is recommended to consider the demographic development when calculating waste production in subsequent years, as well as the increase in waste generation.

The density of waste varies according to their compaction state, as shown in Table 1.

It is important to mention that the amount of waste that would be deposited at a final disposal site, if previously separated and sorted, can be significantly reduced either at the source or at a recovery and sorting plant and then be utilized by composting and recycling. In this way, site life is increased and operating costs are reduced.

Table 1 Density of solid waste

Solid waste	Density
In the household container	105 - 210 kg/m^3
In the collector	350 - 630 kg/m^3
Compacted in manual landfilling	400 - 600 kg/m^3
Machinery compacted	600 - 810 kg/m^3

Source: Design, Construction, Operation and Closing of Landfills. Ecuador 2002. Page 6

From the required volume, the area required for the landfilling can be calculated, which depends on three important factors:

- Landfill volume
- Type of landfill (manual or with mechanized compaction)
- Leachate treatment technology

For a landfill with mechanized compaction, the required area is calculated with the following formula:

$$\mathbf{A}\text{waste} = \frac{\mathbf{V}\text{landfill}}{\mathbf{f}}$$

Where:

Awaste: Area that would occupy the mass of waste (ha)

Vlandfill: Volume needed for Landfill (m^3)

f: Factor Volume / Area = 10 m^3/m^2 (equivalent to 1,000,000 m^3/inhab)

Source: Design, Construction, Operation and Closing of Landfills. Ecuador 2002. Page 8.-

The volume / area factor of 10 m3 of waste / 1m2 of area results in a cell height of 10 m including the slopes, considering that the body of waste is seldom higher than 30 m and that the slope must have a slope of 18° or less.

In the case of manual landfills, a system of successively filled cells is generally designed, which must not have a height greater than 3 m, due to the low compaction. The required area is calculated as follows:

$$\boldsymbol{A = \frac{Vlandfill}{hcell}}$$

Source: Design, Construction, Operation and Closing of Landfills. Ecuador 2002. Page 8.-

2.2.7 Useful life

The useful life of the site depends on many variables, among which we mention the following:

- Available volume
- The amount of solid waste to be disposed of
- Method of operation

In order to determine the useful life, the projected volume of waste reception at the site (volume of municipal solid waste plus cover material) should be compared over the years, with the total accumulated volume that would be deposited in the projected cells, During the design stage within the final disposal area; Until finding a similar value, slightly higher or lower. This value corresponds to the life of the landfill in years.

The useful life of the final disposal site would be determined by the topography and dimensions of the soil, the amount of waste to be deposited, the height of the cells and the degree of compaction of the waste already deposited.

Once the useful life of the FDS has been determined, the project should be further detailed. For this it is important to determine the amount and height of the cells to be constructed. The height of the cells is determined by the type and quality of the compaction in the landfill to be constructed.

A cell size equivalent to the area required to receive wastes generated in a year, whose size is twice the width of the tractor, is recommended in order to facilitate the operation. In some cases it is necessary to consider the construction of an emergency cell, especially in areas where there is high rainfall.

2.2.8 Projection of per capita and total generation

The basic parameter for the design of all infrastructure concerning solid waste management, and therefore for a final disposal site, is the amount of waste to be treated in it, as well as its composition and characteristics (density, humidity, etc.). **Note:** See this more detailed topic in the Characterization Manual.

2.2.9 Type of waste. Composition and characteristics

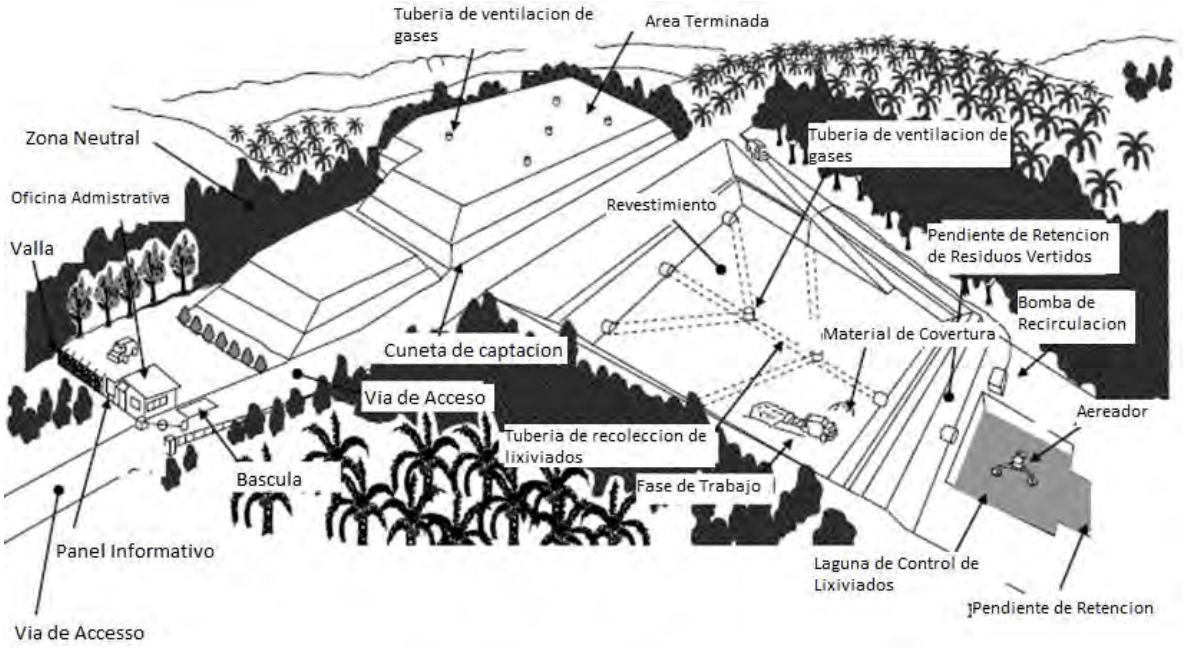
The type of waste, its composition and characteristics are important aspects in the design of the final disposal site. The design of a landfill for non-hazardous

(municipal) waste is not the same as for hazardous waste. In the latter case, additional protective measures, such as greater waterproofing of the bottom of the landfill, must be taken. Special cells are usually prepared for this type of waste within the final disposal site. **Note:** See this more detailed topic in the Characterization Manual.

2.2.10 Detailed design of infrastructures

The guidelines for the design of the infrastructures will focus basically on the following points:

- Overview
- Main installations: those necessary for the operation and use of the landfill, such as scale, waterproofing system, leachate collection and treatment systems, gas capture system, drainage systems, among others.
- Administrative facilities: those that, as indicated by its name, are intended to support management activities, such as administrative offices, booth and gate for access control, etc.
- Support facilities: those works complementary to the management and operation facilities of the landfill itself, such as the access route, perimeter fence, workshop, and installation for cleaning vehicles, fire prevention system, among others.
- Operation and maintenance:
- Estimation of costs (construction and operation):



Source: Technical Guide for the Design and Operation of a Landfill, JICA 2004.

Figure 16 General Scheme of a Landfill

It is highly advisable to consider infrastructures for the recovery and intermediate treatment of waste with commercial value.

2.2.11 Detailed design of equipment

This plan will indicate in detail all equipment, materials required to allow proper operation and maintenance of the FDS.

2.2.12 Detailed operation and maintenance design

The plan of operation allows to make more efficient the daily management of the sanitary landfill, clearly establishing the roles and responsibilities of those involved. The plan of operation is especially important for municipalities that share a sanitary landfill, for municipalities that want to privatize the management of the landfill or the collection and for landfills where several solid waste types are discharged.

The operation and maintenance plan should:

1. Definition of responsibilities and competencies
2. Establishment of the physical boundaries of the landfill and service areas
3. Establishment of working hours (solid waste discharge schedule, visiting hours)

4. Definition of institutions and legal entities that can enjoy the services of the sanitary landfill (nearby municipalities, communities, industries, hospitals (waste assimilable to RSD), etc.)
5. Definition of the type of waste that is accepted and where it is to be discharged: household waste, bulky debris, sweepings, markets, parks and gardens, construction waste, special waste, among others.
6. Registration of vehicles entering the FDS
7. Definition of discharge rates (for industrial waste or other municipalities, if applicable).
8. Define the rules for the discharge of waste on the site
9. Define the rules of behavior in the landfill (for example, no smoking, prohibited entry of children under 16, not enter barefoot, etc.)
10. Definition of the people and institutions that can discharge their waste individually. Prepare list.
11. Establish property rights over downloaded materials (this is especially important when there are recyclers in the site, when the landfill is handled by a private company, if the household classification and valuation of biodegradable and recyclable materials are carried out).
12. Establish responsibilities regarding risks and accidents caused by waste and its management.
13. Establish fines and penalties for persons and institutions that do not comply with the rules.

Photo 8 ASINORLU landfill schedule sign - El Salvador

2.2.13 Detailed plan for material recovery and intermediate treatment

In the vast majority of dumping sites in the country, the presence of the so-called Waste Pickers, segregators and recuperators of materials with commercial value is observed, who carry out this work in conditions of very little sanitation and, in many cases, impede the efficient and appropriate operation Of the landfill; Especially in places where there is a high generation and recovery activity is intense, as in large cities (Santiago and Santo Domingo).

Photo 9 Waste Pickers in recovery of materials in Duquesa -SDN

Photo 10 Rafey Waste Burn for Metal Recovery - Santiago

The ideal solution is the separation at the source by the citizens, the selective collection by the municipalities and then the treatment of the materials recovered in an intermediate treatment and / or recycling plant. However, much remains to be done in the Dominican Republic for this to be a common practice. Hence, it is necessary to look for alternatives that allow the recovery of usable materials and at the same time to dignify the important work that recoverers of waste in the open pit dumps. With the construction of landfills, many municipalities want to prohibit the work of these recuperators; however, experience has shown that it is perhaps not the best solution in our countries, given the conditions of poverty in which a large part of the population lives.

Una opción es la construcción, dentro o en terrenos aledaños al sitio de disposición final de una planta de recuperación de materiales -PRM, donde se lleve a cabo la clasificación, recuperación y tratamiento intermedio de los residuos con alto valor económico. Esta planta tendría las siguientes ventajas ecológicas, económicas y sociales:

- Reduction of the consumption of virgin raw material thanks to the subsequent recycling of secondary matter from the waste, contributing to reduce the overexploitation of natural resources.
- Composting with organic waste, with a consequent reduction in the amount of waste destined for final disposal, reducing, on the one hand, greenhouse gas emissions (responsible for climate change) and, on the other hand, ensuring the supply Continuous improvement of a soil improver or organic fertilizer of high quality (depending on the technique used).

- Increase in the life of the final disposal site.
- Decrease in disposal costs of the final disposal site, because fewer staff and equipment are required; which translates into a cost savings for the municipality.
- Creation of new sources of employment
- Improvement of hygienic labor conditions and income of existing segregators.
- Opening of new markets

Hence it is advisable to include in the cost budget of the final disposal site the construction of a manual or mechanized sorting plant combined with a simple composting plant, according to the possibilities of the municipality in question, and after an analysis cost-benefit. The investment required for an intermediate waste treatment plant depends on the volume to be handled, the extent of the treatment, the size and degree of mechanization. Such an investment would be justified on the basis of the extension of the useful life of the site, as well as the decrease in operating costs. It is also possible to contract the management service of the plant to recycling companies and obtain for the municipality a certain annual percentage on profits.

Waste sorting plants can be mechanized and manual. These plants generally consist mainly of a hopper or rotary drum where the waste is discharged, which fall into a perforated rotary drum and then pass to a conveyor belt where on each side there are people to select and classify the different materials, in the case Of manual plants. When it comes to mechanized or automated plants, for the selection and classification, optical, magnetic devices, separators by density or weight of materials are used, among others; In addition to human personnel, but in a much smaller proportion. For more information on PRMs, refer to the "Intermediate Treatment and Recycling Manual - FOCIMIRS".

Discharge on conveyor belt

Material selection belt

Receptacles for reception of classified materials

Receptacles for reception of classified materials

Intermediate treatment plant (compaction) of PET bottles in the Dump

Intermediate treatment plant (compaction) of PET bottles in the Dump

Photo 11 Waste sorting plant in the FDS of the municipality of Querétaro, Mexico.

In indirect-transfer transfer stations, where there is a pit intended for the storage of waste and then discharged to vehicles of larger capacity, it is also possible to install an infrastructure for the separation and classification of the same to be sold directly to The buyers of recyclable materials or transport them to the site of exploitation.

In the "Intermediate Treatment and Recycling Manual" you can find more extensive and specific information about the infrastructures and the different technologies available for the treatment of the different types of waste.

2.2.14 Detailed design of sanitary and safety measures

The safety plan is a continuous plan of action designed to regulate human behavior and the physical place of work in order to prevent accidents.

All measures to be taken to ensure the safety of the site and of the workers must be defined. Consequently, with this, the detailed design of required facilities and actions must be carried out.

The workplace should be made as safe as possible. However, employee safety programs are likely to have a greater impact on reducing accidents.

2.2.15 Detailed design of the closing or closing

It includes the definition of all the measures that will be taken to close or close the FDS, definition of the closure method, calculation of the volume of cover material, suitability of the land for the required end use, among other aspects.

The final coverage of the sanitary landfill is defined in the annex to the special MIDS (El Salvador) regulation and establishes "a layer of 60 cm thick covering material with an additional layer 20 cm thick capable of supporting vegetation and with sufficient inclination to prevent rainwater from entering the landfill.

2.2.16 Detailed design of the use and post-closure handling

It is necessary to define the details of the final use of the site and the post-closure management of the FDS: The environmental monitoring to be carried out, the analysis to be carried out and its frequency, maintenance of the facilities, personnel required, tools and materials, among other aspects.

2.3 Installation and Construction

2.3.1 Preparation of an environmental impact study - EIA

Before considering the installation of an FDS, an Environmental Impact Assessment (EIA) will be required to obtain the required environmental authorization.

A sanitary landfill / controlled landfill may fall into category A or B. The type of

study to be performed will depend on the category assigned by the Ministry of the Environment and Natural Resources, according to the established in the corresponding procedure.

Table 2 EIA Categories for a FDS

Actividad, trabajo o proyecto	categoría			
	A	B	C	D
Disposición de residuos solidos no-peligrosos para una ciudadanía de menos de 100,000 equivalente a la población		X		
Disposición de residuos solidos no-peligrosos para una población de mas de 100,000 equivalente	X			
Instalación de facultades para la gestión de residuos solidos no-peligrosos individuales			X	
Disposición y / o transporte de residuos peligrosos	X			

Source: Environmental Authorization Procedure, Ministry of the Environment and Natural Resources, RD.

According to the category, the size of the studies to be carried out will be defined, before proceeding to the detailed design of the FDS project.

2.3.2 Facilities and equipment for the FDS

A sanitary landfill / controlled landfill, in addition to the area specifically designed for waste disposal, requires a series of infrastructures and complementary works so that the final disposal site fulfills its function of protecting the environment and human health, avoiding the impacts Derived from an uncontrolled operation.

The facilities and equipment will be selected taking into account the conditions of the environment, waste conditions, local rules and regulations.

As noted above, an appropriate landfill must be provided with all facilities necessary for the whole system to function effectively.

Table 3 Installations of a landfill

Category	Details
Main Facilities	Structure of solid waste retention
	Groundwater drainage system
	Leak control work
	Rainwater harvesting system
	Leachate collection / treatment system

Category	Details
	Installing daily coverage
	Gas treatment equipment
Administrative Facilities	Vehicle Monitoring Office
	Installation of environmental monitoring
	Administration Building
	Balance
	Machinery management
Support Facilities Category Main Facilities	Access road
	Mechanical equipment
	Poster, door, fence
	Fire Prevention Equipment
	Disaster Prevention Team

Source: "Guidelines for the Formulation of an Integrated Solid Waste Management Plan (MIDS) for municipalities in El Salvador". February 2009.

Once the landfill has been conceptualized and the type of infrastructure to be implemented has been selected, it should be ensured that the following requirements are taken into account in its facilities::

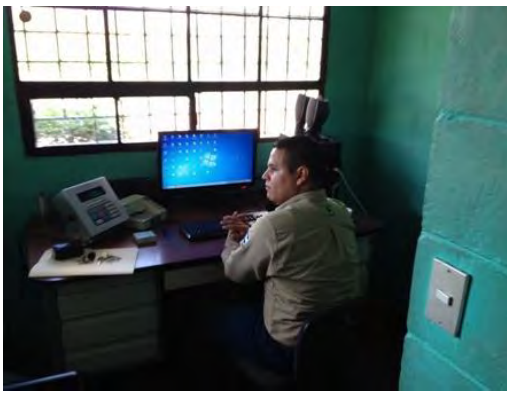
Table 4 Minimum technical requirements according to the type of landfill

Type of landfill	REQUIREMENTS
Manual	• Generation of solid waste less than 20 tons per day. • Service life over 10 years. • Minimum equipment for manual movement and compaction of waste, including personal protective equipment. • The disposal of waste in layers of 20 to 30 cm. • The landfill design, which will be part of an Integrated solid waste management project.
Combined or mixed	• Generation of solid waste more than 20 and less than 40 tons per day. • Any of the two types of landfill (manual or mechanized) or a combination of both may be used as required by the financial and environmental conditions of each case.
Mechanized	• Generation of solid waste more than 40 tons per day. • Service life over 10 years. • The final slopes should have a slope of not more than 30%. • Entrance area with balance, control house and parking. • One administrative and one office area. • Electricity, water and telephone service in the administrative and income areas. • Conditioning of the ground, with a waterproof floor base, with a maximum allowable coefficient of infiltration not exceeding 10-7 cm / s, of a minimum thickness of 50 cm. And compaction at 95%, and with a minimum slope of 3%, towards the lines of the drainage pipes. • A leachate drainage system, with additives for inspection and maintenance, which will lead these liquids to a treatment and final disposal system, with or without recirculation in the landfill. • A control of the groundwater, by drilling wells that are necessary, to detect the possible presence of contamination by the operation of the landfill. • Minimization of the emission of any volatile material. • A qualified, permanent supervision. • Disposal of waste in layers 60 cm thick. • A compaction of each layer, by a minimum of four passes with machinery of minimum weight of 15 tons. • An emission system for gases, with use or permanent evacuation. • An allocation of personnel that is sufficient for the volume of waste to be disposed of. • An internal operating regulation.

Source: "Guidelines for the Formulation of an Integrated Solid Waste Management Plan (MIDS) for municipalities in El Salvador". February 2009.

Pond of leachate with waterproofing and sprinklers to reduce bad odors in the Sanitary Landfill of ASINORLU, Santa Rosa de Lima, El Salvador.-

Scale for weighing of waste pick-up trucks at the Duquesa landfill, Santo Domingo, Dominican Republic



Electronic equipment for weight registration in the ASINORLU landfill, Santa Rosa de Lima, El Salvador.

Administrative offices and balance in the Punta Cana landfill, Higuey. Dominican rep.

Photo 12 Facilities and equipment for the SDF

2.3.3 Construction of the FDS

The construction of a sanitary landfill, must contemplate from the beginning the operational phases that are intended to develop from the zero year of the project until the end of its useful life.

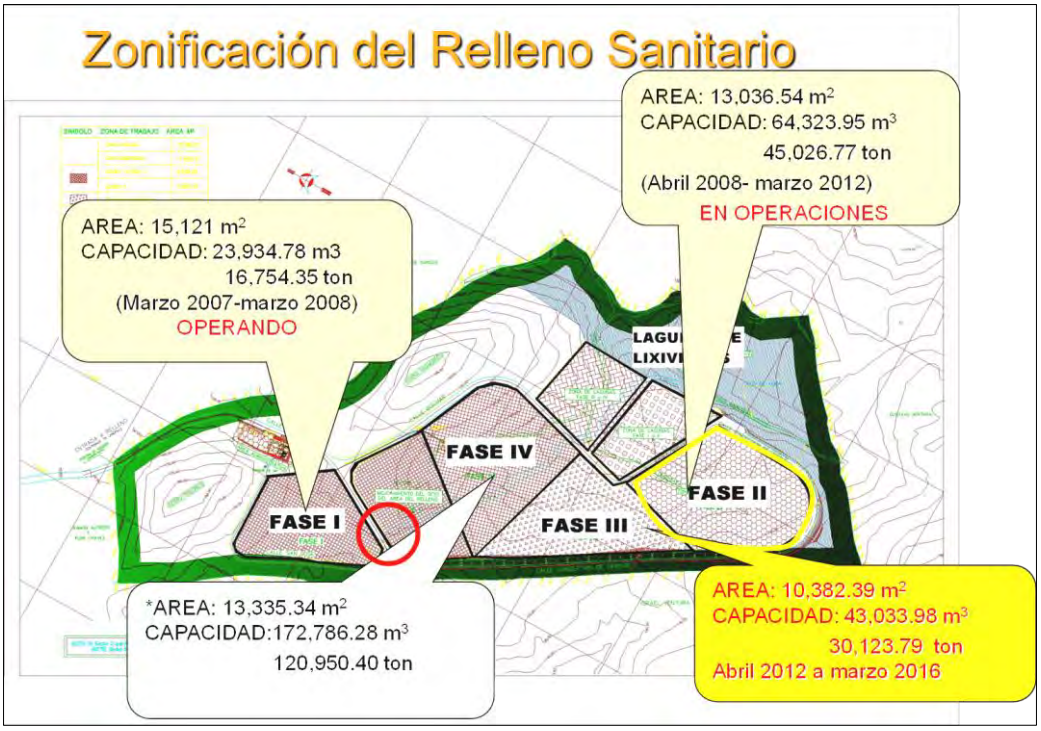


Figure 17 Zoning of the ASINORLU Sanitary Landfill, Santa Rosa de Lima, El Salvador

2.4 Operation

This stage will be developed extensively in part II of this manual. Here are some basics.

The operation stage basically covers:

- Management of waste reception
- Management of FDS

In order to manage the delivery of the waste it is necessary to comply with the requirements to prevent the inadequate reception of the waste and to keep a history of the quantities received in the final disposal.

In the stage of the management of the landfill, the landfill cells must be developed, the place of disposal must be chosen and the deposited waste compacted. To prepare the strip of landfill, a series of procedures must be carried out to allow the land to be able to receive the waste. These operations are as follows:

- Cleaning of the area: all obstacles that obstruct the passage of the collection vehicles to be poured and the operating equipment in the area used for storage must be eliminated.
- Adequacy of the land: prepare the deposit area with the desired geometry and adapt the surface to the degree of impermeability required by the regulations, depending on the type of waste to receive.
- Build access roads that allow the passage of collection vehicles at any time of the year.
- Perimetral fence to prevent access of animals and people.
- Register the waste collection vehicles that arrive at the final disposal.
- Deposit and compaction "in situ". This technique has as advantages the reduction of the volume of the waste and a smaller settlement of the FDS. It is necessary to realize the daily coverage with soil type clay, to avoid the dispersion by the wind of plastics and papers and the proliferation of rodents.

2.5 Closing or closing of the FDS

FDSs for municipal solid waste can generate environmental pollution and cause damage for a long time after it ceases operations. The degradation of the layers of waste takes a long time and in the meantime they continue to produce leachates and gases.

The physical closure consists of the necessary measures or facilities for the safe storage of the waste, their early stabilization and the prevention of environmental contamination.

Technical requirements for safe closures may include the construction of facilities, such as for leachate treatment, final coverage, continuous monitoring; Depending on the defined closing level. The maintenance of the facilities and the management of the FDS must continue even after operations have begun elsewhere.

The facilities necessary for the secure closure of the FDS should be planned, designed and implemented based on the following requirements:

- Reconforming the shape of the fill / slope and waste storage facilities.
- Final coverage
- Rainwater drainage

- Gas ventilation
- Leachate collection and recirculation
- Treatment of leachates
- Ground waterproofing for groundwater protection

The appropriate closure level should be assigned and applied for the prevention of pollution and environmental hazard. Relevant authorities should be responsible for determining the target closure level for each FDS.

2.5.1 Objectives of a secure closure

- Protect public health and the environment through proper management of landfill closures and post-closure land use.
- Prevention of environmental pollution and risks of inadequately closed landfills.

2.5.2 Closing levels and required parameters

Once the FDS has exhausted its useful life, the closing or closing process must begin. There are different levels, according to certain technical requirements, as indicated below. A series of appropriate steps must be taken, among which:

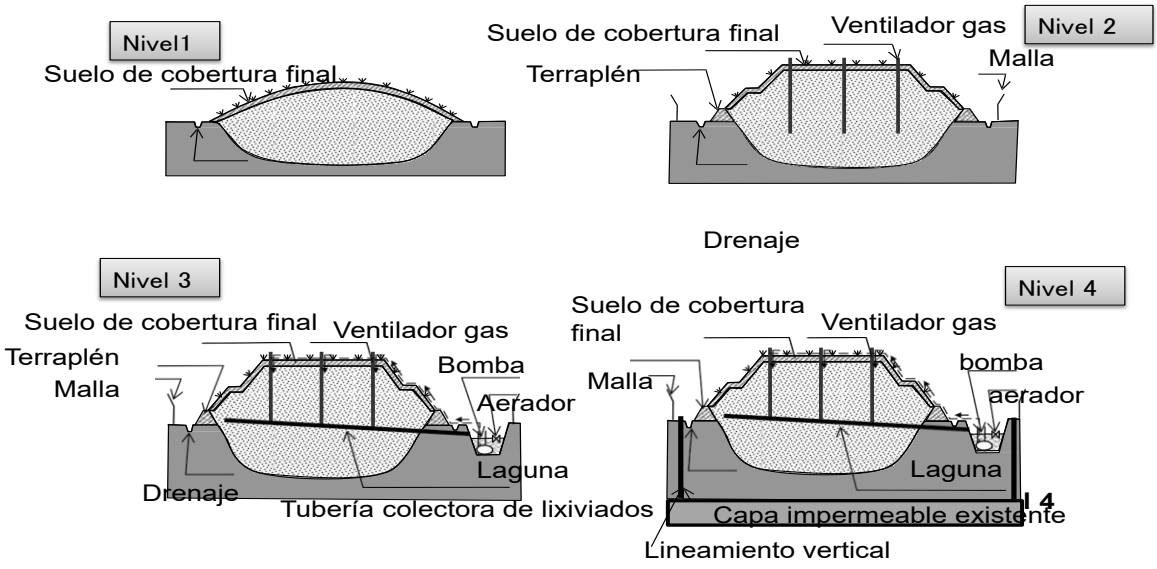
- Raise a fence to limit access by strangers who may continue to carry their MSW and prevent the entry of animals. Plus a biological fence of trees of great height and great consumption of water to avoid the bad smells.
- Placing a sign, sign or notices informing the public that the garbage dump is closed and indicating the location of the new site for the disposal of the MSW.
- Carry out a rodent and arthropod extermination program, for which the advice of the public health authorities is requested.
- Level and compact both the surface and slopes of the dump before discharging the cover soil. A slope of 180 degrees should be provided for waste landfills.
- In cases where there is no system for collecting or releasing gases, it will be equipped with perforated pipes for the release of gases.
- Place a system of rainwater collection, enabling gutters around the perimeter and on the slopes of the waste body.
- Remove heavy equipment, vehicles, scales, etc., as well as electric power, water services, as long as their handling or subsequent use does not require

these services. If there is a leachate treatment plant and gas collection pipes, it is advisable to keep them until it is necessary.

Town councils will adopt one of the following FDS closure systems:

- Place three layers of covering material (preferably clay soil) of 25 cm each and sow it in grams.
- Coverage with polyethylene geomembrane, plus 50 cm of cover material (preferably 25 cm clay soil and 25 cm of free soil) and sowing of grass to avoid runoff and collapse.

The final coverage of the appropriate landfill is "a layer of 30 cm thick covering material with an additional layer 100 cm thick capable of supporting vegetation and with sufficient inclination to prevent rainwater from entering the landfill"[7].



Source: "Guidelines for the Formulation of an Integrated Solid Waste Management Plan (MIDS) for municipalities in El Salvador". February 2009.

Figure 18 Levels of Safe Closure of Landfill

[7] **Guidelines for the Formulation of an Integrated Solid Waste Management Plan (MIDS) for municipalities in El Salvador ". February 2009.**

Table 5 Closing Levels and Required Parameters

Measurements	Secure Closing Level			
	C1	C2	C3	C4
Floor cover	++	+++	+++	+++
Rainwater drainage	+	++	+++	+++
Secure Storage	+	++	+++	+++
Ventilation of gases		++	+++	+++
Leached		+	+++	+++
Groundwater			++	+++
Early Stabilization		+	+++	+++
Post-closure measures		+	+++	+++
Monitoring	+	++	+++	+++
Landfill System			Semi-Aerobic System	

Notes: (1) +: Equipment / operated minimum, ++: fair, +++: fully equipped / operated
Notes: (2): While for C3 and C4, in line with the concept of semiaerobic landfill, aerobic landfill areas.
Source: "Guidelines for the Formulation of an Integrated Solid Waste Management Plan (MIDS) for municipalities in El Salvador". February 2009.

2.5.3 Management Post-closure

The management of the post-closure consists of the operation and maintenance of the closed FDS facilities, such as the leachate treatment plant, storm drains, final coverage; As well as the monitoring of environmental pollution and the stabilization of waste.

2.6 Use post-closure

The "post-closure use" of the FDS refers to the use of the land once it has been properly closed. It must be carefully analyzed, since in landfills / controlled landfills and open landfills, emissions and leachate production continue after closure, over a period of approximately 10 to 20 years, depending on the following factors:

- Amount of organic matter in the FDS
- Degree of compaction
- Weather conditions

Emissions are completed faster in small landfills and very hot areas. During this period there is also the danger of landslides and explosions, due to the generated methane gas. So the landfill area can not be used for urbanization or

agricultural use.

The decision of the final use to be given to the site must be defined based on the clear understanding of the operation of the FDS during its period of operation and closure; As well as taking into account the impacts it has had in the surroundings.

In general, the closed site is dedicated to communal activities; however, even in such a case, it is necessary to take measures to avoid any environmental impact for the surrounding communities and users of the site after its closure. The use of the proposed land must not endanger the lives of surrounding community members or users.

It is necessary to elaborate a design of the final conFiguretion of the site, with its landscape treatment.

The most recommended use for the ground of a closed landfill is:

- Natural protection area such as protective forest, parks, nurseries and green areas.
- Activities such as vermiculture.
- Recreation areas, excluding areas for smoking and cooking food.
- Sports facilities (courts, golf courses).

PART III

3 OPERATION OF A FINAL DISPOSAL SITE

Managing a controlled FDS is a very complex activity. Although the fundamental operation will consist in receiving and disposing of the waste properly, there are other additional complementary activities, which will contribute to the proper functioning of the FDS. On the other hand, certain activities, concerning the organization of the operation, must be carried out before the start of operations in the FDS, as indicated in the operation and maintenance plan.

- There is no good planning in the design, adequate facilities, without a subsequent operation of the FDS, which will allow:
- Better protection of the environment: drainage and treatment of leachate water, gas drainage by chimneys, waste cover.
- Better safety for workers: defined slopes, compaction of waste, less risk of landslides, less pollution in the workplace.
- Economic advantages for the municipality: With proper management of the landfill the land can be used to the maximum extent. Compaction of waste and planned construction extend the useful life of the landfill and allow a more prolonged use of the land.
- Less annoyance and pollution for potential citizens affected: Control of dust, odors, insects, etc.

3.1 Technical and human resources

3.1.1 Technical resources

The operation of the landfill requires specialized equipment whose selection is made taking into account fundamentally:

- Amount of waste
- Method of operation
- Working conditions for proper movement
- Compaction of solid waste
- Cover material

The basic functions of the equipment for a landfill fall into the following categories:

- Site preparation, including removal and removal.
- Compaction and waste management.
- Excavation, transportation and application of daily cover.
- Spreading and compaction of the final cover.
- Support functions.

Excavation, management and compaction of soils used as a waterproofing system or covering material are the aspects that must be considered when determining the functions of the equipment for the landfill.

The functions of the equipment related to solid waste are the push, spread or spread, compaction and cover.

Wheeled equipment is generally efficient for soil excavation in which sand, gravel, silty clays and clay silts predominate. While the equipment with chains or rails is recommended for work on sites that have problems of accessibility and materials difficult to handle. In another order, if the floors are to be moved at distances of less than 100 m, the loaders and bulldozers can serve perfectly for that purpose. For longer distances, other equipment must be used[8].

Heavy equipment specially designed for compaction is apparently more effective and efficient than light equipment specially designed for earthmoving. However, the weight can be significantly offset by increasing the number of passes of light equipment on the waste. The number of passes required to obtain sufficient compaction required also depends on the moisture content and composition of the wastes.

The equipment for the landfill must be resistant because the conditions for its use are very difficult. Radiators have a high frequency of saturation with particles, which damages them considerably and the body and the operative parts of the equipment can be damaged by the protruding or bulky waste. Tires, even those of rough use, can be punctured or cut, reducing their useful life.

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[8] MT Landfill Operation, SEDESOL. Mexico - 2002.

1) Machinery and equipment in a landfill with mechanized compaction

For the operation of a mechanized landfill, the following equipment is essentially needed:

a. Bulldozers or Track Tractors with Bulldozer

Function: Distribute and compact solid waste as well as site preparation, daily and final cover and general earthmoving work.

Characteristics: Bulldozers are equipped with metal tracks of specified variable widths, such as 457 mm, 508 mm, 559 mm and 610 mm. The caterpillars must be high enough to allow a good reduction of the size of the waste and to avoid possible landslides. The pressure discharged on the waste is obtained by distributing the weight of the machine on the contact surface.

The degree of compaction of the waste depends on the pressure exerted. Machines with crawlers are not very efficient in compaction of solid waste, due to their low pressure on the ground. For maximum efficiency of tracked machines, it is very important that they are equipped with suitable dozer blades.

b. Compactors with metal wheels

Function: Extended and compaction of solid waste.

Characteristics: The metal wheels generally have alternating inverted "V" shaped teeth that allow them to concentrate the weight on a smaller contact surface (compared to a crawler machine) and exerting a greater pressure on the solid waste.

Compactor tractors are tractors with caterpillars such as those used in civil construction, adapted to the conditions of the landfill. There are also compactors with special wheels that are specially built for compaction of waste. These compactors have the advantage of working very efficiently in the placement and compaction of the waste, they have the disadvantage that they can not be used flexibly for other jobs necessary in the landfill, since the special wheels are not suitable for work in normal soils.

Compactors are more versatile and faster than bulldozers. Compactors with steel wheels are equipped with blades controlled by a hydraulic system. The blade has an additional metal grille to increase its capacity.

The compacting equipment is the most important of all the equipment needed in

a landfill. It is the ideal equipment to compact, whenever purchase is possible.

It makes possible:

1. Move and spread the waste discharged by collecting trucks, compacting and covering them.
2. If the cover material is at the site of the landfill itself (ideal case), the compactor can also dig and bring the cover material.
3. Do soil preparation work (removal of vegetation, excavation, laying of the mineral layer, etc.) to open a new module of the landfill, opening of internal roads, etc.

Photo 13 Compactor Tractor

However, normally in our countries are used equipment that allow to do both functions, to spread and compact, but not with a high degree of compaction. This is the case of the common bulldozer or tractor used as an alternative to a compaction equipment, because it is more economical, not only because of the purchase price, but also because of the fuel consumption. This performs the same functions as the compactor, only the level of compaction is much lower. In fact, the bulldozer's own function is to spread waste.

Photo 14 Buldozer spreading waste in the rehabilitation of the FDS of Azua

Photo 15 Excavator

c. Wheel loader

Function: To excavate soft soil (eg low resistance soils), load the excavated material into trucks and pick-ups or to transport that material at distances of no greater than 50 or 60 m, for optimum efficiency.

Features: Tire loaders are generally equipped with diesel engines and four-wheel steering. The front axle is fixed and the rear axle can swing. The models vary in power, in a range between 65 HP and 375 HP. Bucket capacity ranges from 0.8 m3 to 6 m3. The most commonly used models are around 100 HP to 150 HP.

Photo 16 Wheel loader

On soft ground, a 130 HP machine with a bucket capacity for 1.91 m3 will be able to excavate and load a dump truck at a speed of about 160 m3 / hour of work. On hard ground, production decreases and this machine will probably need to be replaced by a more suitable one to do the excavation.

Tire loaders are also capable of efficiently performing work related to landfill operations.

d. Crawler Loaders

Function: These machines can perform functions similar to those of tire loaders. Crawler loaders are also recommended for excavating solid or hard ground. Its optimal distance for transport of materials should not exceed 30 m.

In emergencies, crawler loaders can be used for solid waste management (spread and compaction). They can also be used to shape and level the cell cover.

Characteristics: The bucket of this type of loaders, is operated easily and quickly by means of a hydraulic mechanism. You get better efficiency and flexibility in this equipment, when you have a multipurpose bucket. This type of bucket is adapted to different operations according to the position in which it operates.

The bucket has a stationary section and a moving section. The movement can be controlled by the operator with the same control system. Bucket can act as;

Loader, pusher, excavator or dredger.

The versatility of this type of equipment is required in the landfill especially when the availability of equipment is limited.

e. Crawler Excavators

Function: To excavate the soil and load transport vehicles, as well as to apply daily or primary coverage of solid waste (in the trench method). This equipment can also be used under certain premises in the earthmoving.

Features: The excavator is equipped with a diesel engine and a hydraulic system for the control of the load arms and the bucket. The time of the excavation cycle depends on the size of the equipment and the conditions of the site. Thus, when the excavation is more difficult or the trench deeper, the excavation procedure will be slow. The commercial literature available in the market of the different manufacturers indicates the calculation or the estimation of the time for the cycle, according to the equipment model and the particular conditions of each site (soil type and excavation depth). The excavation depth (measured from ground level) depends on the reach of the load arms**.**

f. Backhoe Loader

Its main function is to excavate the cover material. It is used for the manufacture of the retaining wall of a cell for waste disposal.

Photo 17 Excavation of cover material at Azua's Dumping Site

Photo 18 Construction with retaining wall excavator During the rehabilitation of Azua's FDS.

g. Dump truck:

Its function is to transport the covering material and carry materials from one side to another of the landfill.

Photo 19 Loading and transport of waste by truck turning in the FDS of Azua

h. Weight bridge

In medium and large fillers, a large scale needs to be installed like those used to weigh trucks. This balance registers the weight of each vehicle at the entrance and at the exit, the difference between both being the weight of the incoming waste. The registration can be done manually, using preset formats or you can perform the registration manually or through a computer.

Photo 20 ASINORLU Landfill with Computerized Weight Record at El Salvador Landfill - El Salvador.

In summary, the basic equipment required for the operation of a mechanized landfill consists of: compactor or bulldozer, backhoe and dump truck.

The scale is recommended, especially for medium and large. In smaller ones it is not so essential to establish a detailed control of the weight of the quantities of waste that are produced and collected, being sufficient to have a manual record of the quantity and the type of vehicle that enters.

When a new cell is to be prepared, a roller is required for compaction of impermeable soil. As its use is eventual, it is not indicated as part of the basic equipment of the FDS. Can be rented at the necessary time.

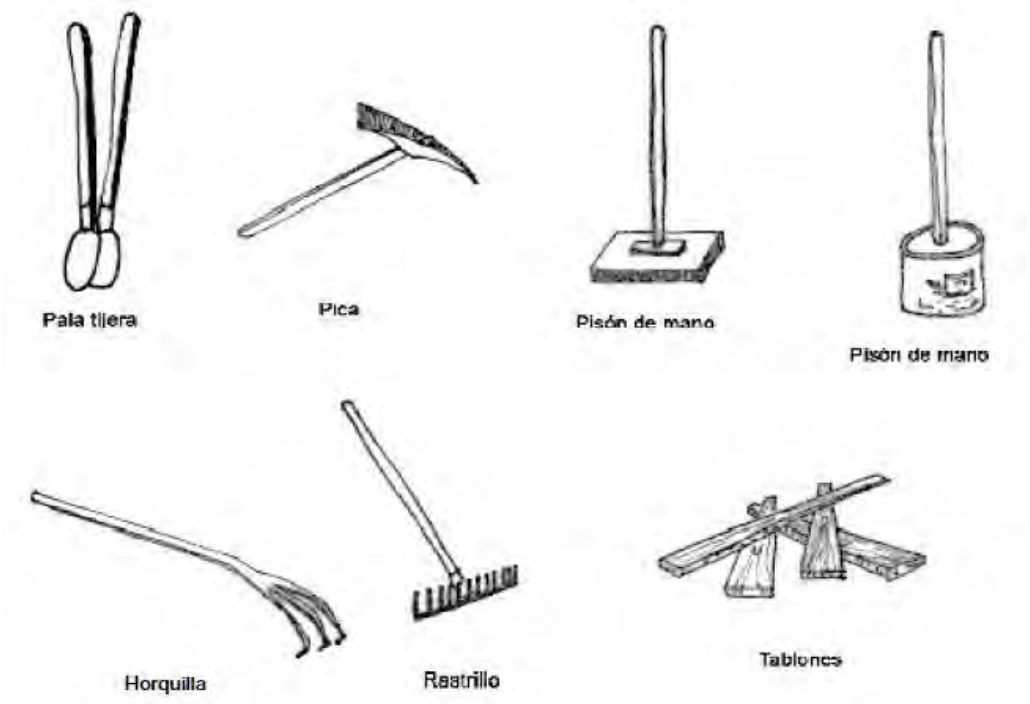
2) Tools and materials for the O & P of an FDS

a. Tools needed in a mechanized landfill

The necessary tools in the mechanized landfill are all those that are used for the construction and maintenance of gutters, drainage channels, chimneys, the afforestation and the treatment of the leached water.

b. Necessary tools in a manual landfill

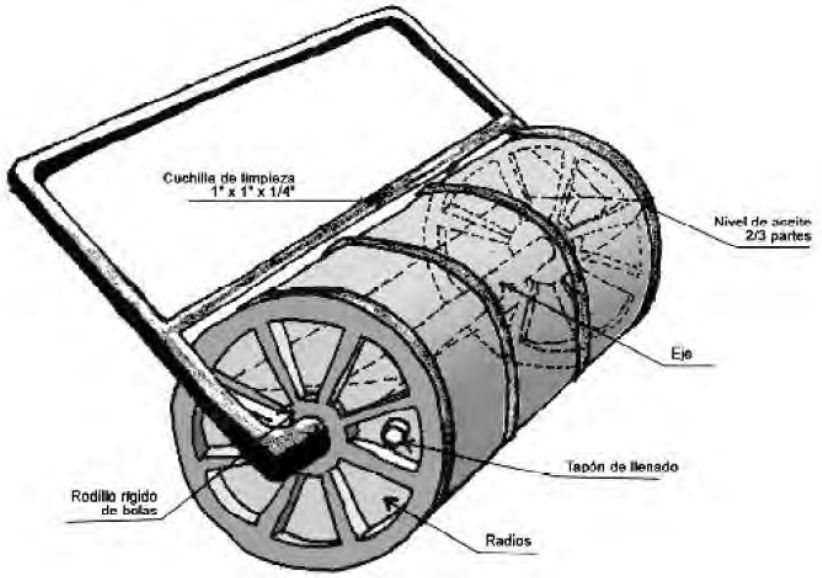
In the manual landfill, the necessary equipment consists of masonry tools, plus a manual roller compactor, as indicated in figure 19.



Source: Guide for the design, construction and operation of manual sanitary landfills - PAHO. 2002

Figure 19 Utensils for use in manual sanitary landfills.

For the construction of the roller, it is recommended to fill the barrel with stone, sand or concrete, in order to avoid that the blows in the ground dented. Table 6 shows the use of each tool or utensil used.



Source: Guide for the design, construction and operation of manual sanitary landfills - PAHO. 2002

Figure 20 Roller compactor packed 55 gallon barrel

Table 6 Function of tools

Utensil	Use
Shovel	- Loading, unloading and disposal of loose waste
Hoe	- Loading, unloading and placing cover material
Bar	- Digging
Peak	- Maintenance of the septic tank and pond of biological treatment (sediment excavation)
Hand Leveling	- Maintenance and construction of gutters
Hairpin or devil	
Machete	- Loosen the ground
Hammer	- Arborization works
Mountain range	- Maintenance of ditches and drainage channels
Rake	
Wheelbarrow	- Loosen the ground for excavations
Hand Roller	- Arborization works

Source: Design, construction, operation and closure of municipal sanitary landfills. Ecuador. 2002.

The number of these tools depends on the number of workers.

c. Materials needed for the O & M FDS

The following materials are needed for the operation and maintenance of landfill:

Construction of gas fireplaces:

- ✓ PVC pipes or perforated tanks
- ✓ Metal mesh
- ✓ Gravel or stone ball
- ✓ Sticks
- ✓ Nails

Any tree growing in the area can be used to make sticks with a diameter of 5 - 7 cm. It is recommended to plant eucalyptus around the landfill, as this serves to absorb a certain amount of leached water, grows quickly and produces a suitable wood to make the sticks.

Preparation of new cells and daily cover:

- ✓ Cover material, clayey

Both for the preparation of new cells and for the coverage of the waste layer or daily strip, clay soil is required, which ensures a sufficient waterproofing against the infiltration of leachate in the bottom and against the infiltration of rainwater, in the cover Daily. An approximate amount of 25 - 30% of the total amount of waste to be deposited daily.

Personal Protective Equipment -PPE

Basic materials for the protection of workers in the landfill, including the driver of the tractor in the case of a landfill with mechanized compaction, are:

- ✓ Uniform (2 overalls per year)
- ✓ Gloves (must be renewed 2 or 3 times per year or more, depending on use)
- ✓ Boots

The best solution would be to provide them with safety boots with toe and steel reinforced sole as used in heavy industry and some construction sites. These boots are quite expensive, but they endure for many years. They protect the worker against sharps such as broken glass, metals or syringes. If you cannot get this type of boots, at least you have to provide rubber boots to the workers.

- ✓ Mask to protect against dust (DO NOT protect against filler gas).
- ✓ Hats, sun hats or coats, depending on the weather.

3.1.2 Staff required

The quantity and qualification of personnel required for the operation of a FDS depends on multiple factors, among which:

- Size (surface) of the landfill
- Daily amount of waste deposited
- Availability of coverage material (how far from the FDS)
- Type of landfill (manual or machined)
- Type of waste handled / number of active cells (if it is only municipal, it is enough with a cell. If they are also received dangerous, then they would have another or other cells and possibly the nature of the RS will require more personnel to handle them than waste Common)
- Existing environmental legislation (degree of exigency of the environmental standards)

- Working days and duration of the working day in the FDS (if you work from Monday to Friday and also on Saturdays and Sundays, a single shift or more)

The following table presents the requirements, in quantity and qualification, according to the type of landfill.

Table 7 Requirements depending of Lanfill Type.

Calificación y tareas del personal	Relleno mecanizado	RS mecanizado	Relleno manual
	Personal necesario para relleno pequeño o mediano	Personal necesario para relleno grande	Personal necesario para relleno pequeño o mediano
Jefe del relleno (ingeniero civil, ingeniero mecánico o tecnólogo ambiental) (1)	0.5 - 1	1	0.5 – 1
Ayudante del jefe del relleno (tecnólogo)	0	1	0
Técnico de laboratorio o químico	0	1	0
Responsable de la balanza	1	2	0
Chofer de tractor compactador	1 – 2	3	0
Chofer de camión u otra maquinaria necesaria dentro del relleno	1 – 2	2 – 3	0
Maestro o técnico para reparaciones de vehículos	0	1	0
Obrero para reparaciones de vehículos	1	1	0
Obreros de relleno con las tareas siguientes:	2 – 3	3 – 6	2 – 8 (ver Cuadro 32)
. Construcción de chimeneas			
. Limpieza de canales de drenaje y cunetas			
. Mantenimiento de la planta de tratamiento de las aguas lixiviadas			
Guardia con tareas siguientes:	1	2	1
. Presencia continua sobre el relleno			
. Prohibir el ingreso de personas no autorizadas			
. Prohibir y controlar que no ingresen animales sobre el relleno			
. Registro en la balanza			
. Avisar el lugar de descarga a los recolectores			
(1) Segun necesidad podria trabajar medio tiempo.			

Source: Design, construction, operation and closure of municipal sanitary landfills. Ecuador. 2002.

It could be considered that the basic staff of a FDS is formed, at least by:

- Manager / FDS Manager (for joint landfill)
- Operation Manager (would also work as a manager for non-joint FDS)
- Administrative Assistant
- Vigilante
- Weight Operator (if scale is available)
- Operators of heavy equipment in cell (bulldozer, excavator)
- Dump truck operator
- Front of charge
- Carrier (s)

3.2 Basic operations

3.2.1 Surveillance and access control

Despite being a municipal facility, a controlled FDS is not a place of open access. To ensure access control, the FDS will be properly fenced in at its perimeter, with access and exit control. It will also be duly identified with a sign / poster, which will indicate the schedule and types of waste accepted.

The personnel responsible for control and surveillance:

- Establish monitoring and control of the entrances and exits of unauthorized persons to the facilities.
- Particularly monitor the weighing system of the collection vehicles, if applicable.
- Constantly monitor that there are no fires in the landfill.
- Supervise the good condition of the internal roads and access to the FDS.
- It will control to the maximum the type of incoming solid waste, in order to avoid the entrance to the site not allowed / prohibited waste.

It is recommended to plant eucalyptus around the landfill, as this serves to absorb certain amount of leached water, grows quickly and produces a suitable wood to make the sticks.

Figure 21 Access Control Gate to Azua's dumping site (MANCOM)

The living enclosure is very important, since in many places there is no natural barrier. It is recommended to plant a live enclosure 30 - 50 m wide, using bushes at the edges and taller trees at the center. With the enclosure alive, you can deflect the winds and reduce considerably the annoyance caused by bad odors in the surroundings.

3.2.2 Registration of waste admission and weighing

Upon entering the final disposal site, the registration of incoming vehicles will be

carried out, taking at least the following information:

- Origin (name of municipality, company, person)
- Date and time of entry
- Vehicle license plate
- Type of vehicle (large / small compactor truck, dump truck, fixed bed truck, etc. It is advisable to also record the capacity or volume, in m3, especially if weighing equipment is not available.
- Quantity and type of waste

In order to determine the quantity, if there is a balance, the weight of the loaded vehicle and the weight of the empty vehicle (tare) will be recorded, according to the corresponding format used by the weighing system. In case of no balance, the municipality must first take the measures (length, width and height) of the trucks and estimate the amount of waste they contain, based on the criteria established by the Ministry of Environment in the national system of the database.

Register who brings what type and how much, will allow to establish responsibilities, in case of non-compliance or accident, as well as control the amount of waste entering the FDS and establish the corresponding payment.

3.2.3 Inspection of the load

Trucks should be inspected regularly. It is important to verify if the nature of the waste that is brought in corresponds to the information supplied and recorded in the register. Such inspection is usually performed at random. For that, it is enough to carry out the visual inspection of the discharge and to open some covers.

The inspection is performed with the objective of detecting prohibited waste (not accepted in the FDS), either because they are considered hazardous by current and applicable national legislation or because they present risks to the operation, such as combustible waste (tires, waste containing oils or Minerals).

It is important to train staff to identify suspicious waste. If there is a suspicion that disallowed wastes (e.g., hazardous industrial wastes in a dumping site, where this is not accepted), a sample can be sent to a laboratory. In landfills where recyclers work they can also coordinate with them to communicate their

observations (for example: "we have found used syringes and blood piles in the harvester load that came at xx hours").

In the case of hazardous and prohibited waste, they must be separated from common solid waste, in order to:

- Reduce risk of personal injury
- Reduce risk of fire / explosion
- Reduce potential pollution to the environment.

Potentially hazardous loads:

- Wood
- Wires
- Metal drums
- Chemical containers without identification
- Medical waste
- Pressurized cylinders
- Dead animals
- Others

The hazardous waste found must be segregated and stored until adequate disposal can be given. In temporary storage of hazardous waste, the following must be taken into account:

- Safe location
- Protected from inclement weather
- Adequate ventilation
- Storage area with spill containment
- Have areas where they can be separated according to their chemical nature.
- Have security and emergency response equipment.

3.2.4 Dumping

A specific waste disposal space, known as the rollover area, should be designated, which should be located near the dumping area. Once the vehicles arrive at the overturning area, the FDS's operative personnel give the relevant indications to the drivers of the same, using signals, for their proper parking, in such a way that the discharge of the waste is carried out in the established place and in the shortest possible time.

The overturning area may be made of land fill, gravel, crushed asphalt, concrete or clay. It is very important to guarantee access to the rollover area, so the required maintenance should be given.

The unloading must be carried out at a short distance from the working front, avoiding that the collecting and transfer vehicles interfere with the activities of the heavy machinery. Once unloaded, waste is hauled to the front of work in operation.

1) Method and placement of waste: Construction of the work front

The working front, dumping area or daily strip of landfill must be previously identified, by cuttings that will set the limits of the same. These limits will be indicated to operators of heavy equipment and drivers of vehicles. It is necessary to zonify the land available for the landfill. Plan waste disposal, taking into account the amount to be deposited per day and the cell does not exceed one year of use.

It is recommended that the working front be kept as narrow as possible and that a minimum separation of 3 meters between adjacent vehicles be allowed for the transit of heavy machinery. The Ecuador manual referred to above indicates 1.5 m as the minimum lateral distance between vehicles. It is also important to maintain a minimum distance between the back and front of two vehicles. Parkers or coordinators have the responsibility to ensure that the indicated conditions are maintained.

Photo 21 Waste disposal at ASINORLU landfill - El Salvador

Different methods of unloading and placing of the solid waste in the landfill can

be applied, depending on the shape and topography of the land, as well as the type of sanitary landfill, manual or a landfill with mechanized compaction. However, there are basically two methods for placing the waste: build from above / top or bottom (bottom).

In the **construction from the bottom** (bottom) are pushed the waste uphill, from the bottom of the slope towards the top. It eliminates the "cascade" effect of waste, the equipment must work more and the wear is greater. However, it allows vertical or sloped layers and this provides greater compaction when using a bulldozer.

Building from the top allows you to create horizontal layers. The waste is pushed downhill, so there is less wear and tear on the machines. The potential of the "cascade" effect of waste is increased. Much easier for bulldozers, although it provides less compaction if this equipment is used. However, by this method it is difficult to control the slopes compared to the construction from the bottom and can create more waste like plastic sheeting, sheets of paper, etc.

During discharge, it is required to have waste control, as all loads have the potential to create litter. For your control, loose, permanent or movable garbage fences, suitably placed, at the required height and regularly maintained.

Photo 22 Fixed and mobile fences for small garbage control

"Good" waste and "bad" waste could be identified in a landfill. "Good" waste is homogenous, easy to handle and represents

Little threat to the team. In contrast, "bad guys" are bulky, difficult to level and usually do not compact well. The former are placed on the outside and closest to the work front; the second, under the "good".

Photo 23 "Good" and "bad" waste

Bulky waste including electrical appliances, furniture, tree trunks, etc. should be handled as follows:

- Be available in an area separate from the main work area.
- Download at the foot of slope and compact other debris around them.
- Compact voluminous objects on firm ground, to increase compaction.
- Reclaim and resell scrap.

Apart from the person who indicates the place of discharge, only the personnel responsible for the discharge should be found in the shooting area. People working on the padding should wear safety clothing (vivid colors, boots and gloves).

3.2.5 Spreading and compaction of waste

Compaction could be considered as the most important aspect in the operation of a landfill. Compacting is simply increasing the density of the deposited waste, i.e. having more, less volume.

The benefits of compaction are:

- Optimizes landfill use by allowing more waste to be placed in less space
- Extends the life of the FDS by increasing the volume that can be received
- If the waste is compacted, less soil is required to cover daily

- Reduces FDS settlement
- Prevents rodent burrows
- Prevents leachate leaks from the slopes

It is essential to compact the waste in an optimal way to extend the useful life of the landfill and minimize environmental impacts. The following measures help to achieve this objective:

✓ It is recommended to divide the cell into daily stripes. The area of a strip is calculated by considering the amount of garbage being buried, the density of the compacted waste and the thickness of the desired layer. Consider the following example: Calculate the area of a daily strip for an amount of 30 Ton / day, whose density once compacted will be 500 kg / m3, with a thickness of 30 cm.

✓ Recall that:

Density = Weight / volume, where

Volume = Weight / density = 30,000 kg / 500 kg / m^3

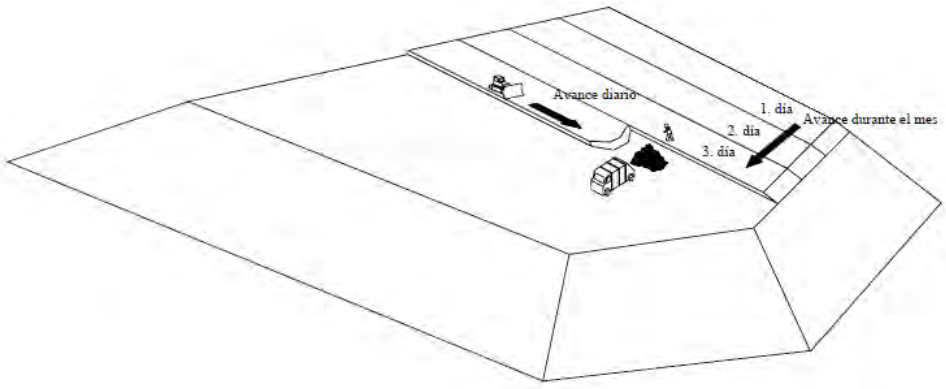
Volume = 60 m^3

On the other hand,

✓ Volume = Area x height (in this case the thickness), where:

✓ Area = Volume / Height = 60 m3 / 0.3 m = 200 m^2

The strip should have an area of 200 m^2. It is preferable to make narrow and long strips to minimize the number of turns and turns of the tractor. In this case, a strip of: 5m x 40m or 6m x 33m.



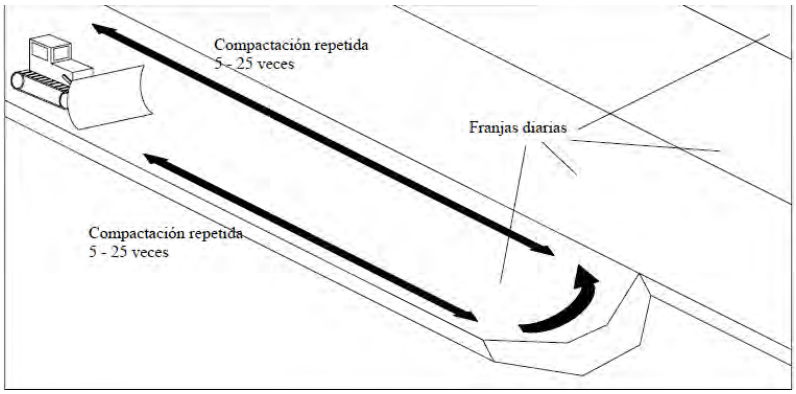
Source: Design, construction, operation and closure of municipal sanitary landfills. Ecuador.2002

Figure 22 Division of the work front in daily slots

- Place the waste evenly. It is important that personnel who have the function of indicating the places of unloading organize them in such a way that the mounds of discharged waste are distributed homogeneously on the area of the daily strip. This precaution also minimizes the work and consequently the costs of the compacting equipment.

Photo 24 Spreading and compaction of waste with bulldozers in the FDS of Azua

- To pass between 5 and 25 times over a layer of waste as seen in figure 23. If it is passed 25 times, the compaction achieves a density 20% -30% greater than that achieved with 5 passes. It is recommended to spend 20 times on the waste. The experiences of the Municipality of Loja in Ecuador have shown that it takes 2 - 3 hours to compost 54 tons of waste with 20 passes (with a Caterpillar D6D bulldozer). In landfills with better equipment, more waste could be compacted at the same time[9].

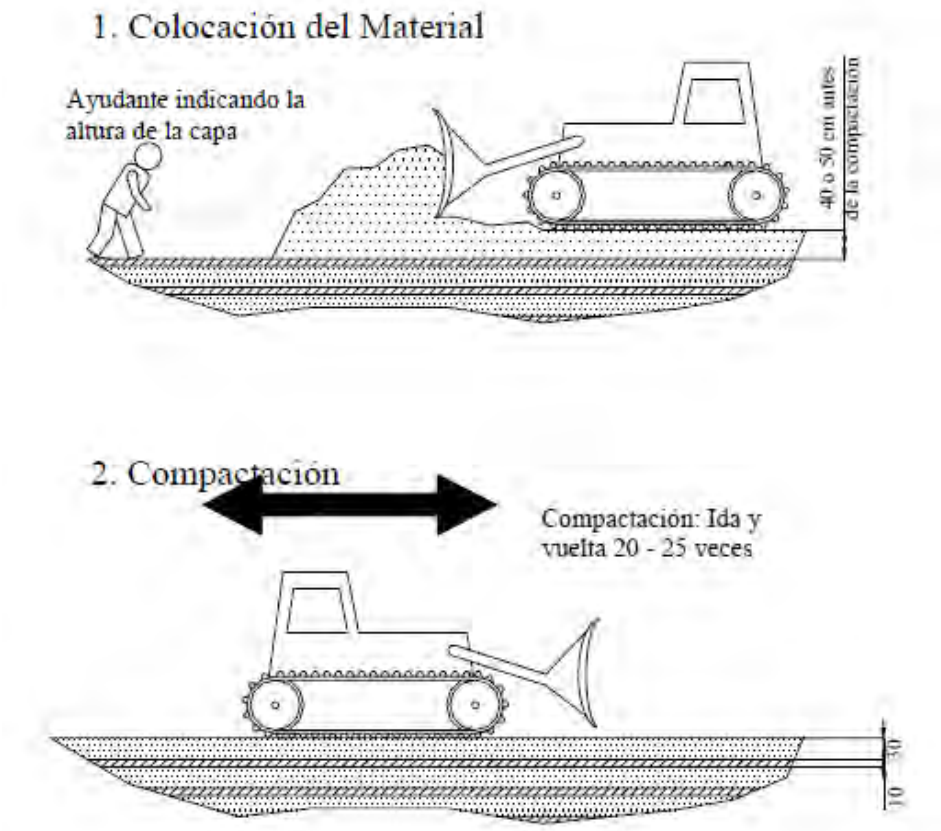


Source: Design, construction, operation and closure of municipal sanitary landfills. Ecuador. 2002

Figure 23 Repeated compaction for density increase

[9] Design, construction, operation and closure of municipal sanitary landfills. Ecuador.2002

- Lay thin layers of waste, as they are compacted more easily. If a compaction equipment is used properly, the ideal thickness is between 30 and 60 cm. In the case of bulldozers, the best compaction (0.81 t / m3) is achieved if the waste are placed in thin layers with a thickness of less than 30 cm. The tractor operator can determine the thickness of the layer by descending to make a visual control, or his assistant can place a stake with measures to visualize the current measurements.



Source: Design, construction, operation and closure of municipal sanitary landfills. Ecuador. 2002

Figure 24 Compaction with high number of passes

1) Compaction in a manual sanitary landfill

The waste is discharged as close as possible to the place where it will be filled; which must be indicated to the driver of the collecting vehicle. The workers place the waste in thin layers, with a maximum thickness of 30 cm. Horizontal layers or inclined layers can be constructed which are supported by a natural slope or layers previously constructed. If it is made in inclined layers, the maximum slope will be 1: 3. The placement system is shown in the following graph:

a. Horizontal layers

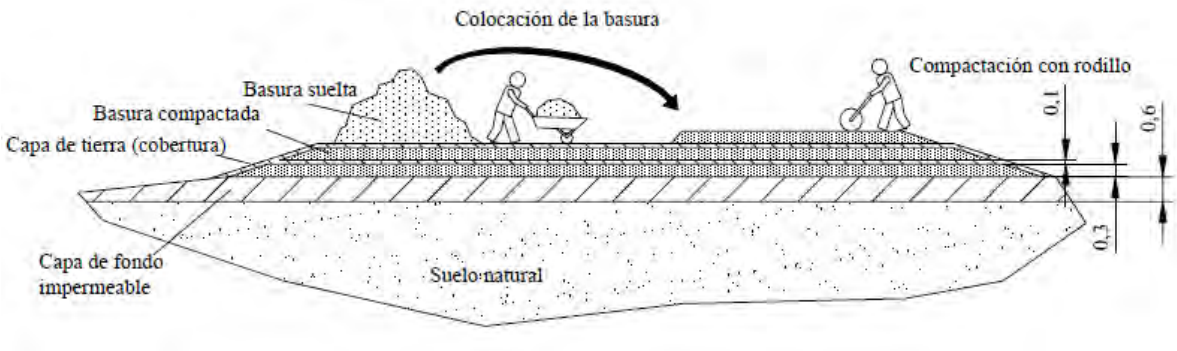


Figure 25 Manual placement and compacting of garbage

b. Inclined layers

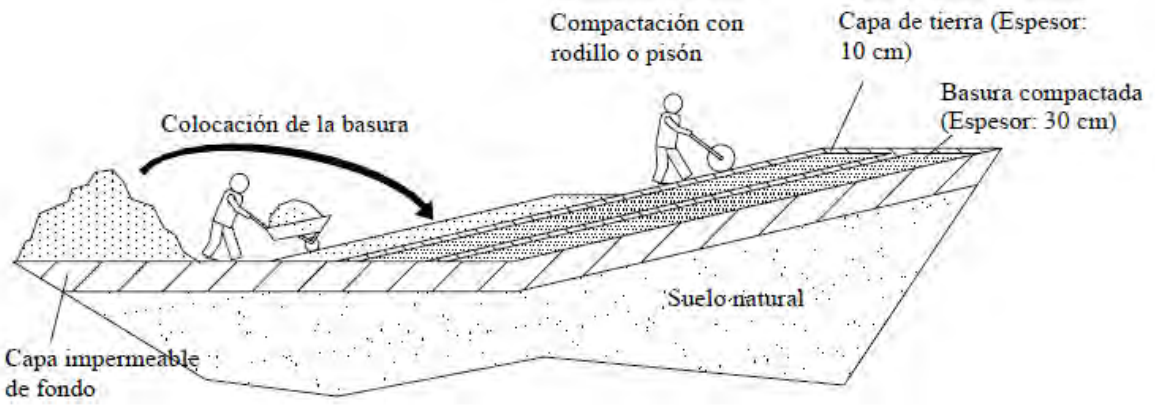


Figure 26 Layers and compaction

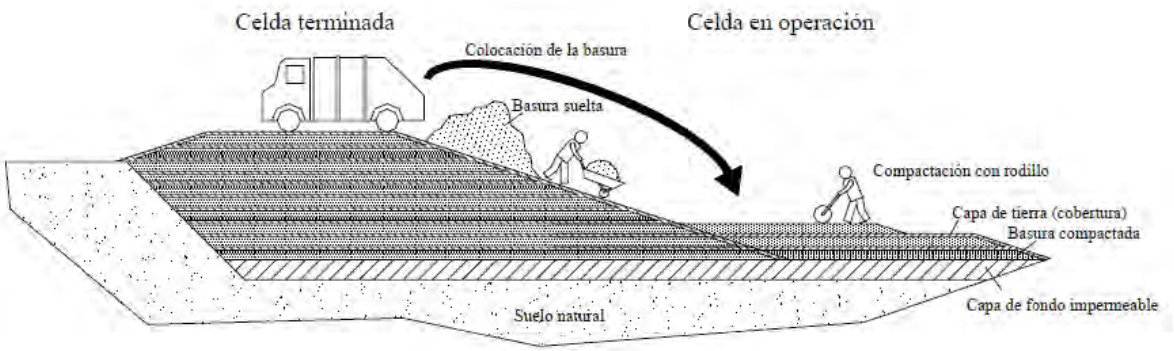
Source: Design, construction, operation and closure of municipal sanitary landfills. Ecuador. 2002.

The layers should be prepared daily and compacted at the end of the day. Then cover with soil or other suitable material to protect the landfill against rodents, insects and other animals (hens, stray dogs etc.) and prevent the dispersion of volatile materials, dust and odors. It is very important that no waste is exposed.

In very precipitous regions, excavation or daily transport of the cover material can be problematic. As the earth becomes saturated with moisture, it weighs more and is stickier than in the dry season. In such a case, it is recommended to store a sufficient amount of cover material in the same landfill. If possible, this earth is stored on an already finished cell. With this, the transport distance to the currently operated cell would be minimal, and the weight of the accumulated soil would help to further compact the finished cell, at the same time as the leachate

generation.

In a manual sanitary landfill, the compaction of the deposited waste and the cover material is carried out with hand drums and rollers. To compact the slopes, the use of the ram is more advisable; while for horizontal surfaces it is better to use the hand roller. Figure 27 shows how manual compaction of the daily layer should be done. In order to improve the compaction of the cells, it is also possible to arrange for the collecting vehicles to pass over the cells. For that, a good manual compaction has already been done previously. Keep in mind that this work should not be carried out in the rainy season, since there is danger that vehicles will collapse if the terrain is too loose. The transit of the vehicles on the waste can be facilitated by putting plates and sticks on the cell, as shown in figure 27.



Source: Design, construction, operation and closure of municipal sanitary landfills. Ecuador. 2002.

Figure 27 Transit of vehicle on the finished cell.

The transit of the collecting vehicles on the finished cells contributes with their weight to significantly increase the density of the cell and, consequently, to minimize the amount of leachate.

2) Factors affecting compaction

From the above, it can be deduced that, among the factors that influence compaction:

a. Type and characteristics of equipment or machinery

The heavier the equipment, the better the compaction as it puts more pressure on the ground. Although the bulldozer has the function of compacting the waste, the compactors, specially designed equipment for this purpose, are obviously manufactured with specific characteristics to achieve a higher degree of

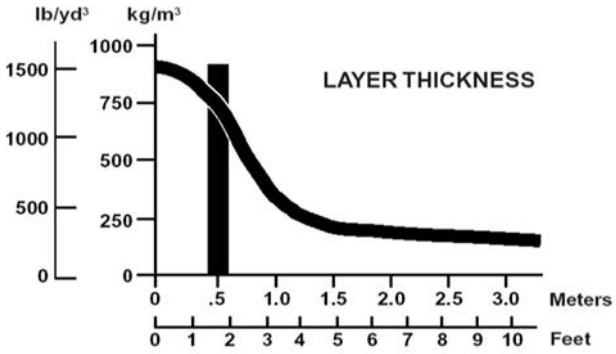
compaction.

b. Composition and moisture of the solid waste dumped

There are waste more easily compacted. For example, tree branches are difficult to pack, as are bulky waste (mattresses, refrigerators, washing machines, etc.); Not so the remains of food.

c. The thickness of the waste layer

At higher thickness / thickness, less compaction.



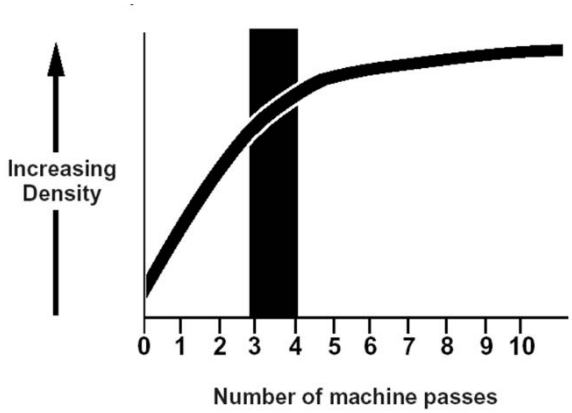
Source: Presentation "Biogas Basics". Ing. Marcos Elizondo, WCA Waste Corporation. Seminar "Reducing methane emissions in the waste sector" Global Methane Initiative. CNCCMDL. Santiago, May 2014

Figure 28 Importance of load thickness

d. The number of times the equipment passes over the waste layer

With a bulldozer, the greater number of passes, the greater the compaction (increase in the density of the deposited waste). However, a balance must be struck between the desired compaction and the fuel consumption, because the more it compacts, the higher the costs. The final decision will depend on which of the two factors is most limiting in the operation.

When using compaction equipment as such, it must pass over the waste at least 3 or 4 times to achieve adequate compaction, as can be seen in Figure 29. On the other hand, from four (4), the increase in density is not significant, as can be observed.



Source: Presentation "Biogas Basics". Ing. Marcos Elizondo, WCA Waste Corporation. Seminar "Reducing methane emissions in the waste sector" Global Methane Initiative. CNCCMDL. Santiago, May 2014

Figure 29 Importance of number of passes

e. Working front slope / inclination

Upwards, the compaction factor is lower than in a horizontal plane and is in turn smaller, than sloping down. Ideally, the waste is pushed downhill, as it increases the potential of the "cascade" effect of the waste, forming thinner layers. However, when bulldozers are used, there is less compaction.

Photo 25 Inclined upwardly

Photo 26 Flat Compaction

3.2.6 Intermediate coverage

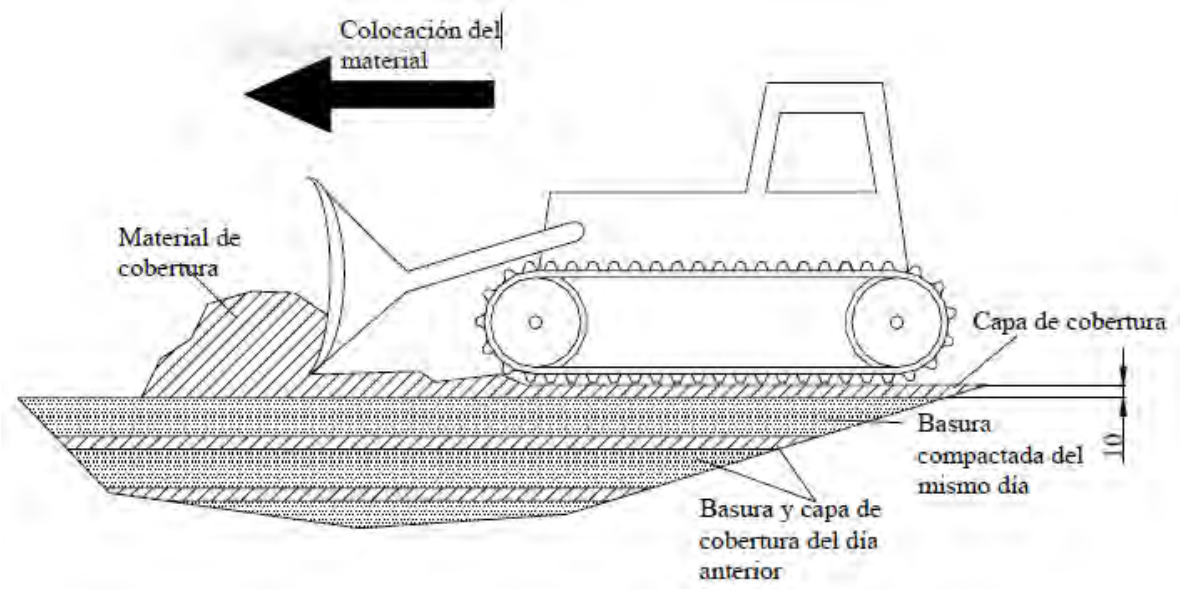
Coverage is defined as the action of coating solid wastes with soil or other suitable material, after they have been paired and compacted, into the already formed area.

In a landfill there are two types of coverage: intermediate and final. The intermediate coverage is the one that is realized during the operation of the FDS, whereas the final one, is executed at the time of its closing or closing. The intermediate cover is also called daily because it must be placed, as the name implies, continuously and before 24 hours after the deposit of the waste[10].

The objectives of the coverage are:

- Provide fire protection
- Promoting rainwater runoff
- Reduce rainwater infiltration
- Improve biogas generation (creates anaerobic conditions faster)
- Reduce odors
- Provide vector control
- Control access to waste pickers
- Check loose waste
- Provide immediate benefits essential to the proper operation of the site

[10] However, given the financial constraints of most municipalities in the country, and considering that the cycle of the fly is 72 hours, the Ministry of Environment and Natural Resources has established at least acceptable that the intermediate coverage is made At least 3 times a week.



Source: Design, construction, operation and closure of municipal sanitary landfills. Ecuador. 2002

Figure 30 Application of intermediate coverage

The successive application of a layer of soil on a layer of waste is called a "sandwich method", where the bread would represent the soil.

The availability of the cover material at the site where the landfill is located is a key aspect in site selection in order to reduce costs during operation.

The material for the coverage of the day will be emptied by turning at the point closest to the cell of the corresponding day, to which the transport vehicles can access. The loader or tractor will be responsible for pushing and spreading it over the entire surface to be covered.

Photo 27 Emptying the cover material

Photo 28 Coverage

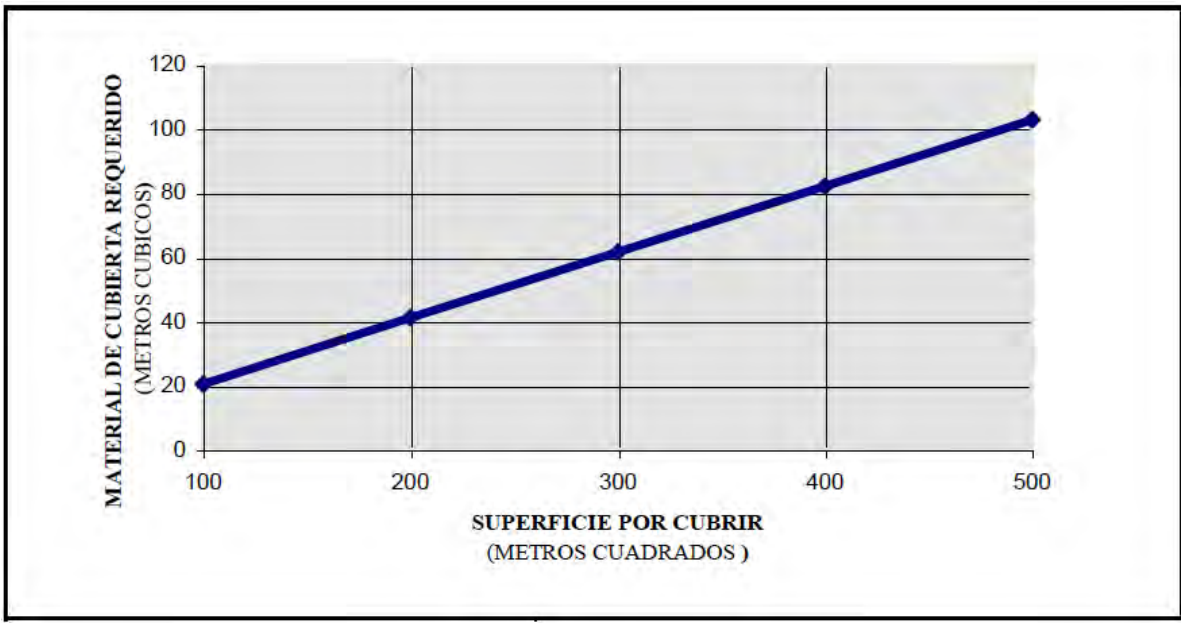
1) Coverage method and material

The deposited waste will be covered forming a continuous and uniform layer. Ideally, the thickness of the daily covering of material should be at least 30 cm with the already compacted material, equivalent to a thickness of approximately 35 centimeters of loose material. However, experiments carried out in countries similar to the DR, such as El Salvador, show that a minimum of 15 cm can be applied, as well as in slopes. An already compacted 15-20 cm thickness is suitable.

On the other hand, it is found in the literature that the required amount of cover material should be between 1/4 and 1/3 (25 to 33%) of the buried waste layer. Taking into account the percentages indicated, if 50 m3 / day of waste is buried, 13 - 15 m3 of soil would be used for daily coverage, in which case the lower value of the range is below 15 cm.

It is worth noting that the thickness will also depend on the type of soil from which the cover material comes. On the other hand, it should be noted that regardless of the thickness of the applied layer, the final state of the intermediate cover should be visually verified to confirm that the thickness of the cover layer obtained fulfills its function: odor control, The presence of insects, rodents and birds, of unexposed waste and a sufficiently homogeneous surface to allow easy drainage of rainwater.

The following graph shows the relationship between the surface to be covered and the required volume of cover material.



Source: MT Landfill operation. SEDESOL - Page 75

Figure 31 Area to be covered Vs Volume of cover material

The roofing material on the slopes may still have a smaller thickness, provided that it meets the criteria indicated above.

The surface of the cell will be formed with a slope of 2 to 3%, preferably, to facilitate drainage in case of rain. However, it is also acceptable for 1 to 2%[11].

2) Cover material

The materials recommended to serve as daily cover are, depending on their availability in the area: earth, caliche, clay, fine granzote, compost, among others. It is very important that the source of the material is close to the site.

In the case of manual sanitary landfills, where there is difficulty in obtaining coverage material, tarpaulins can be used, which are placed at the end of the day and removed the next day to continue the operation. This allows the intermediate cover to be made with a lower frequency.

The covering material can be obtained from the site of the landfill, if the landfill is made in the form of a trench, as the excavated material serves as a daily cover and can even be used as final cover.

In case the manual landfill is constructed by the area method, there are different

[11] Design, construction, operation and closure of municipal sanitary landfills. Ecuador.2002.

possibilities of supplying the covering material:

- If biodegradable waste is produced by producing humus, the coarse fraction of the compost can be used to cover the waste.
- If the landfill is built on sloping ground, you can level the slope and use leftover soil.

The surplus land of excavations inside the city, can be hosted in the landfill. Construction and demolition waste can also be used mixed with soil for daily coverage purposes.

3.2.7 Recommended operating practices [12]

The following is a series of recommendations to achieve an effective landfill operation:

- No provision should be made when a supervisor is not present. The site must be closed when there is not sufficient staff to provide the service.
- Keep the smallest possible width on the working front.
- Maintain a separation of **2.5** to **3.0 m** between compaction equipment and pick-up or transfer vehicles.
- All waste received in the landfill must be sanitary disposed and should not exceed a period of 48 hours after entry.
- The waste must be worked immediately after being deposited in the work front and not allowed to accumulate in mounds or that only the waste is formed one to two times per day.
- To ensure maximum utilization of the landfill capacity, the waste must be emptied at the base of the disposal cell or ramp and worked at the same level. This "bottom of discharge" reduces the possibilities of spreading of papers due to the wind, allows maximum compaction and improves the control of the waste. Another advantage is that when the debris is deposited in a small area, the amount of cover material used is also smaller.
- Waste should be spread on the surface of the working front in layers of between 30 and 90 cm.
- Waste should never be deposited at the front of those areas where excavation maneuvers are being carried out.

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[12] Taken from MT Landfill Operation - SEDESOL, Mexico.

- The waste strewn in the working front must be compacted according to the compaction requirements established in the executive project and in accordance with the operation plan (generally with a minimum of four passes is sufficient if compaction is performed with wheel tractors Metal or chain).
- The wastes are efficiently managed if they are scattered on a 3: 1 slope, using tracked machinery; but excellent results can be obtained on flat surfaces, if you work with equipment with sprockets. Using a slope with a certain slope, it is favored the saving of cover material, as well as a shorter time in the spread and compacted of the waste. However, excessive slope slopes (slopes greater than 3: 1), result in lower compaction
- Once a quantity of cover material has been loaded by the earthmoving equipment, it must not be discharged anywhere until the place where it is laid is defined.
- The covering material must be moistened sufficiently to achieve adequate compaction, in addition to controlling the drag of the material by the effect of the wind. However, care must be taken to meter the water necessary to achieve the proposed objective; but great care must be taken not to add excess water because of problems of clogging and / or run-off that affect the properties of the material cover resulting in operational problems.
- It is advisable to remove any accumulation of rainwater on the filled surfaces, within a period of 72 hours, after identifying that problem.
- When high intensity rains are present on the working front, the accumulated water must be pumped to rainwater or off-site water channels before proceeding to discharge solid waste.
- All depressions that appear on the surfaces already worked, must be filled as soon as possible, to avoid the accumulation of water and in this way to minimize the possibility of infiltration of water towards the lower strata.
- The acceleration of the degradation of the waste deposited in the landfill, by the addition of microorganisms or enzymes with specific action, only makes sense, if there is a well-defined plan that establishes the location of the area designated for this program, composition of the Additives, method, amount and frequency of application, as well as the required safety measures.
- If special or industrial waste is received for any reason (even if it is not dangerous), waste of municipal origin must be disposed of separately. There

should be no joint arrangement.

3.2.8 Precautions for rainy season[13]

During the rainy season, there are major problems in the operation of the landfill, especially manual, such as:

- It is difficult to pass the collecting vehicles above the already formed cells and can present obstructions, due to the low density reached with manual compaction.
- Difficult to extract and transport the covering material and hard work of shaping the cells. These factors lead to lower performance on the part of operators.
- It is only possible to unload the garbage and the covering material on the terrace, thus delaying the formation and compaction of the cells. If adequate measures are not taken in time, the scattered waste and the presence of carrion birds will deteriorate the appearance of the landfill.
- Higher production of leachate.

Therefore, it is necessary to take the following forecasts:

- Partially or totally cover the surface of the landfill with a palm roof, plastic or other material in the area.
- Reserve some areas in places less affected by the rains, with accesses conserved to operate in the worst conditions (emergency zones).
- Build an artificial road or path using logs or small construction debris (debris).
- Program the earth movement for the dry periods, both for the extraction of the cover material and for the opening of trenches, leaving only the burial of the waste for the rainy season.
- As a matter of course, the cells should be covered with plastic material in order to prevent rainwater from seeping through the waste.
- Reservation of areas and construction in height of the cells for the operation during periods of rains.
- Maintain narrow work areas, supporting the cells on the slope of the terrain and overlapping three or more cells near the internal road so that the advance is more vertical than horizontal.

---

[13] **Guide for the design, construction and operation of manual sanitary landfills - PAHO. 2002**

For one or more days a week, reinforce labor with an extra crew of two or three workers, in order to keep the landfill in good condition as long as the adverse factors persist.

3.2.9 Steps and recommendations for the construction of the cell[14]

A cell is constructed by compacting waste on a slope in successive layers of the same thickness. The waste are deposited at the foot of the work front and pushed on the slope. Appropriate steps for constructing the cell are described below:

- Download the solid waste over the area that will form the corresponding work front of the day.
- Use leveling piles to control the height of the cell and give the proper slope to facilitate drainage by gravity. The level of the top surface of the cell should be between 2 and 5 percent, while the cell height is commonly about 2.4 to 3.5 m.
- Spread the solid waste on the working front in layers of 0.30 to 0.60 m thick.
- Compact the solid waste with between 3 and 5 passes on the slope.
- Once compacted the waste of the day, the material for the daily cover is discharged on them.
- Spread and compact the covering material, maintaining a minimum thickness of 15 cm. Depending on the type of floor from where the roofing material comes from, it may require a greater thickness.

Typically the dimensions of the cell are in the design planes of the filler. However, if for some reason the dimensions of the cell are not known or need to be modified in a popup, some useful recommendations are as follows:

- The width of the working front depends on the number of vehicles transporting waste to the operating area and the amount of equipment available for scattering and compaction. For safety reasons, the width of the working front should not be reduced to less than three times the width of the dozer blade of the equipment used and should not exceed 45 m, since with larger dimensions it becomes very difficult to handle, Unless there is a large amount of equipment available and its operation is strictly supervised.
- As for the height suitable for the cells there is no rule, however, some

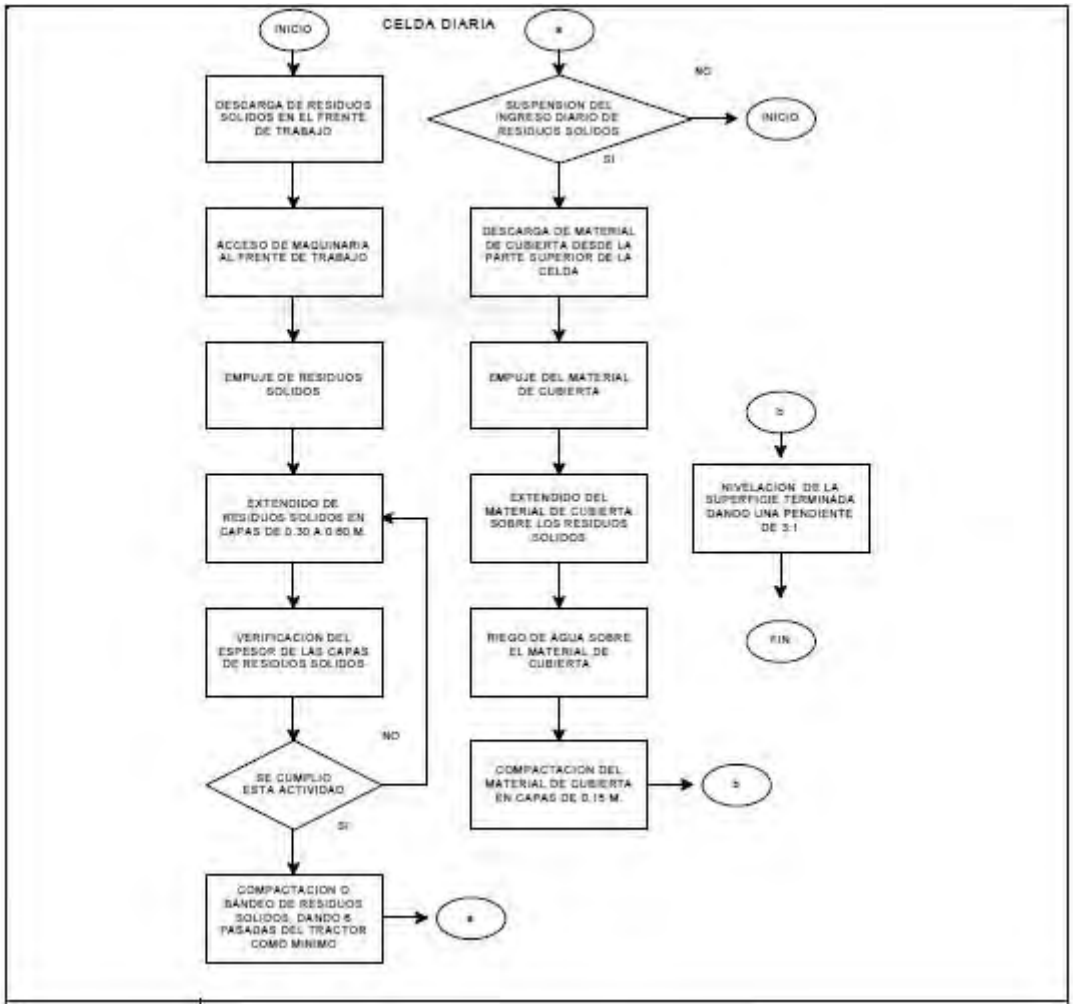
[14] Taken from MT Landfill Operation - SEDESOL, Mexico.

designers prefer 2.5 m. Or less, presumably because this height will not cause severe settling problems.

- The recommended density for solid waste from a finished cell is greater than 600 kg / m3.

1) Flow of daily operation in a landfill

The following figure summarizes the daily operation of a landfill. The term daily cell refers to the strip where daily waste are placed inside the cell itself. In some other literature we talk about daily cell to refer to what in another is indicated as the daily strip.



Source: MT Landfill operation. SEDESOL - Page 77.

Figure 32 Flow Diagram of Daily Operation at a Landfill

3.3 Complementary or supportive operations

Support functions during the operation phase include:

- Extension and maintenance of the roads to the landfill work front.
- Fire prevention and control.
- Supervision and inspection.

3.3.1 Extension and maintenance of roads

During the operation of the site, the roads are deteriorated by the transit of the pickup trucks, so that their regular conditioning is necessary. Generally the extension and the maintenance of roads can be realized during the phase of operation by means of the equipment used for the spreading and compaction (bulldozer, for example).

3.3.2 Fire prevention and control

Fires generate safety problems, reduce air quality (health), cause discomfort and property damage. In landfills, fires can be difficult to locate because they are sometimes generated inside the cells and the smoke takes the route that allows it to exit more easily and not to the direct surface over its location.

1) Types of fires

Fires in a landfill are of 2 types: surface and underground.

(1) Superficial **(2) Underground**

Photo 29 Types of fires

Surface fires may be caused by sources outside the site (e.g., waste coming in with high temperatures on the inside or already lit) or by site sources (machinery, someone smoking in the waste mass, recyclers, Waste Pickers).

Underground fires are produced by the infiltration of air into the waste mass and the presence of fire below the surface. They are difficult to extinguish, so it becomes necessary to know how to identify the signs of an underground fire.

2) Identification of underground fires

The presence on the site of the following conditions indicates the existence of underground fires.

- Sudden cavities and subsidence
- Cracks
- Ventilation holes

Photo 30 Identification of underground fires.

3) Measures for the prevention and control of fires

Fires can be controlled as follows:

- Effective compaction of waste to reduce voids and restrict access routes to air.
- Daily coverage of waste.

- Adequate compaction of the covering material.
- If the fire appears, try to quell the combustion by preventing the access of the air (oxygen) to the burned area, which can usually be achieved by covering the area with sufficient earth. Water is not recommended.

Among the prevention measures are:

Monitoring the internal temperature of the landfill: The normal temperature of a landfill is less than 55 degrees Celsius. Higher temperatures are signs of an abnormal situation.

Monitoring of the composition of the biogas: If the concentration of oxygen is greater than 1%, indicates that the air is not being stopped. Better cover and compact.

A fire prevention and contingency team must be formed and trained. The team will be designated within the workforce, which in its entirety must be trained in the subject.

3.3.3 Supervision and inspection

Supervision and inspection in a landfill are activities to ensure that the operation is carried out in an optimal manner and consequently avoid economic, social, technical and / or environmental problems. If the landfill does not carry out good supervision and proper maintenance, there is a risk that it will be converted from an open pit with its drawbacks.

Supervision should be understood as the action of observing a particular job, in order for it to be performed correctly. On the other hand, the inspection is the observation action to confirm that a certain work was performed properly, once completed.

The activities within the supervision are:

- Check that the operating hours are respected. If not respected, determine areas of discharge to prevent it from being done in inappropriate places.
- Make random visits to the place where the access control is carried out, verifying that it is carried out properly, in order to ensure that only authorized trucks and persons have access.
- Check that the required and defined data in the format are entered in the input

and output register.

- Supervise the control of solid waste entering the site, to ensure that no industrial or hazardous waste is received, making random visits to the access area and observing the entry and exit records.
- Check the operation and operation of the truck scale in a random manner, checking the correct adjustment of the scale at a known reference weight.
- Pay particular attention to the weighing procedure of the collection vehicles and the cover material in order to detect possible errors.
- Check that vehicles, when arriving at the maneuvering yard, are oriented to unload as close as possible to the work front; and that the yard is organized and clean.
- Verify that the orientation of the traffic and unloading, in the patio of operations, is the most adequate to avoid wasted time.
- Verify that tools, equipment and equipment for the protection of workers are well maintained.
- Check that the working front is in operative conditions at all times, even when heavy rains occur.
- Ensure that the drainage on the working front is immediate and is led to the drainage system.
- In case of night operation, observe that the front is illuminated.
- Check that the cells to be built each day, are identified by stakes that will set the limits of the same. These limits shall be indicated to the operators of the tractors.
- Ensure that the debris and cover material are properly compacted.
- If it is required, for the payment of the equipment, to see that a record of effective machine hours is carried out.
- Observe that the trucks do not throw waste in their transit through the landfill, but in the work front.
- Monitor that the operators carry out the cleaning of their units in the designated area, within the same cell, so as not to delay the discharge.
- Verify the execution of the program of the use of the machinery, the landfill of cells and the design of operating fronts, based on the number of vehicles in a given time.
- See that the transit zone is continuously watered with treated water, to reduce

tolls.

- Observe the potholes.
- Submit a complete report, with conclusions, of all observations made during a given period of time.

Inspection activities are:

- Constantly monitor that there are no fires at the landfill, should they occur, the area should be considered as an emergency and the fire will have to be controlled and killed immediately by sand or cover material.
- Verify that the area of passage of vehicles is as firm as possible to prevent them from clogging and obstructing access to the work front.
- Observe the good condition of the internal roads and access to the landfill, verifying that cleaning and maintenance is carried out.
- Verify that the size, distribution, shape of the cells and roofing material correspond to what is indicated in the project and the specifications, making leveling in the access roads, the natural floor, and the finished cells.
- Note that there are no cracks in the cells.
- Check that the access roads, maneuvering yard, storm drainage networks and finished surface of the landfill are maintained in good operating condition.
- Check that the scale purchased is as suitable as possible to the site conditions and that its installation conforms to the recommendations of the manufacturer and the engineers.

3.4 Environmental monitoring and control operations

The first part of this Manual explained the basic concepts associated with the Final Disposal of solid waste, among which the environmental impacts of an open pit disposal and the products resulting from the decomposition of waste were addressed: biogas and Leachate.

3.4.1 Management and control of biogas using

As indicated in Part I, methane is a highly explosive, greenhouse gas fuel, which together with CO_2 is the major component of biogas.

Various types of systems can be used to control the emissions and migration of biogas (active and passive systems), depending on the amount that is generated. Such control may consist of:

- Its venting into the atmosphere
- Combustion in burners or burners
- Incineration
- Recovery as an alternate source of energy

These options allow:

- Minimize potential environmental impacts
- Track your off-site migration
- Control odors
- Comply with legislation

The migration of biogas to uncontrolled areas during the landfill operation can be detected as follows:

- Perceiving its characteristic odor.
- Checking cracks or cracks in the coverage using an exposure meter.
- Observing fires or vapors between the cells, as well as in surrounding areas.
- Sampling site where biogas migration is suspected

Burners and vents are simple tube installations placed within the solid waste layer to allow the biogas to vent to the atmosphere.

1) Biogas capture systems

Capture systems are installed to capture biogas in a sanitary landfill.

The elements of a biogas capture system are:

- Biogas capture points
- Vertical extraction wells
- Horizontal collectors
- Connections to existing venting wells, leachate system cleaning pipes, etc.
- Wells and monitoring equipment
- Network of interconnected pipelines
- Condensate management
- Biogas suction / combustion station (torch, motor, etc.)

The most common method used to capture biogas is the installation of vertical extraction wells. They are installed in existing or operational disposal areas. The ideal depth of the waste is> 10 meters. They are installed 2 meters above the

base of the landfill. There are also horizontal wells.

Photo 31 Vertical extraction wells

Photo 32 Horizontal extraction wells.

Biogas monitoring wells are structures that are constructed mainly in the areas surrounding the site, in order to evaluate and detect the biogas accumulated in three layers of the soil.

The use of biogas as fuel depends on the concentration of methane present. The options of use of biogas are:

Medium Calorific Fuel: Used directly or with little treatment for commercial, institutional and industrial use to supply water heaters, ovens, aggregate dryers, waste incinerators and greenhouses. Typically it contains 50% methane. It is also used as a fuel in the leachate evaporation, reducing treatment costs.

Fuel of High Calorific Power. Biogas is purified at levels of 92 to 99 percent methane, removing carbon dioxide. Final use as Natural Gas or Compressed Natural Gas.

Electric power generation: Used as fuel for internal combustion generators and

turbines for power generation and then supplied to the grid. Each megawatt generated requires 615 m3 / h of biogas. Which is equivalent annually to: sowing 4,900 hectares of trees or eliminating CO2 emissions of 9,000 cars; preventing the use of 99,000 barrels of oil, or preventing the use of 200 coal wagons; provide electricity to 650 homes?

It is also used as fuel for domestic use, fuel for vehicles and in the production of methanol.

In all cases a certain degree of processing is required before the biogas can be used. Companies that install biogas recovery systems indicate that for a project to be economically viable on a large scale, the following conditions must be met:

- The landfill must contain at least 1'000,000 tons. The higher the organic content is the better.
- The site must be in operation or have been closed for five years.
- The thickness of the layers of solid waste must be at least 12 m.
- The covering material must be impermeable to reduce the movement of biogas.

2) Quality of Biogas for Use

Biogas concentrations fluctuate between 50-55% for methane and 45-50% for carbon dioxide. This amounts to an energy value of biogas between 4.5 and 5.0 kilocalories per m3. The gases with this energy value are called medium quality gases. The contaminants present in the biogas can cause corrosion, abrasion and excessive wear of the combustion chambers.

Biogas can be treated to remove the impurities and improve it until obtaining 9 kilocalories per m^3.

3.4.2 Leachate management

When the water passes through the mass of waste, it removes some of the solids. This water and what it contains is called leachate. The leachate is unpleasant in appearance, usually has a bad odor and can contaminate groundwater and surface water. Contains organic and inorganic matter. Some of these materials are toxic to humans and animals. This means that the leachate must be kept away from lakes and streams, as well as groundwater that people can consume.

Photo 33 Leachate outbreak

La Amount of leachate production can be prevented:

- Keeping fluids out of the waste mass
- Keeping rainwater out of the filler

The cost of preventing leachate generation is less than the cost of treating leachate. In order to avoid / minimize the infiltration of rainwater into the waste mass and become leachate, the following measures can be applied:

- Improve water runoff controls in areas around the work front.
- Keep the intermediate and final cover
- Avoid waterlogging on waste
- Keep the plant cover (finished cell)
- Repair erosion

Legislation (in developed countries) requires leachates that have been generated to be collected and processed for disposal. This requirement resulted in the requirement of two or more layers of waterproofing at the bottom of the fills. A waterproof double layer system also requires a leak detection system. A filler designed and constructed with a waterproof double layer has a very low probability that the leachate can escape, but there is always the risk.

Technologies for the treatment of leachates can be broadly classified into two categories: biological and physicochemical. The cost of treatment is high. The

selection of the treatment process depends on the final characterization of the leachate and the requirements of the environmental regulations. There are several leachate treatment options. Disposal options fall into any of the following four categories:

- Direct discharge to a water receiving body.
- Discharge to a public treatment plant.
- Recirculation to the landfill.
- Application or treatment on soil.

1) Leachate Recirculation

The treatment of leachates can be complemented by the recirculation of that leached back into the landfill cells. This technique also has the benefit of accelerating the stabilization of the organic materials present. The use of recirculation does not eliminate the final need for treatment. Eventually, excess leachate will have to be removed and treated.

Three different types of leachate recirculation systems can be used: spray irrigation, surface flow and injection irrigation. In most of our countries, the treatment-disposal method is the accumulation in a pond and its recirculation in the landfill mass.

Photo 34 Recirculation of leachate in the waste mass

3.4.3 Management and control of storm water

The Rainwater:

- May become leachate.
- It causes difficulties in the operation of the equipment
- Increases landfill operation costs.

The objective of storm water management and control is to prevent the flow of rainwater to the site from surrounding areas and reduce the amount of leachate generated within the landfill. Drainage and drainage of surface water / runoff is required. Different measures are used for the control of rainwater.

- Trenches
- Earth walls
- Earrings / Leveling
- Sewers
- Erosion control
- Vegetable cover

Photo 35 Stormwater Sewer in a Landfill

Photo 36 Retention of rainwater in a landfill

3.4.4 Control of immediate visible environmental impacts

Immediate visible impact control refers to the control of dust, odors, noise, insects, rodents and birds.

1) Dust

Within the control measures for powders,

- Roads: On passable roads throughout the year (asphalted) only give permanent maintenance. On unpaved roads, moisten the soil. Calcium chloride in the proportion of 220 to 450 grams per square meter can also be applied to the soil previously moistened with water (more than 30% moisture).
- Landslide activities: there are no specific controls to regulate this activity to reduce potential off-site impacts.
- Storage, spreading, compaction and waste cover: Wet work areas to reduce impact to the exterior of the site during eddies or strong winds
- Wind: Acts on the final deck and in apparently finished areas. For its control it is recommended to plant trees that serve as a barrier, in order to reduce its speed (also reduces the visibility of the site).

2) Smells

The odors are usually seasonal in nature and can be controlled through:

- The placement of a cover on those waste that have reached an advanced state of decomposition; if they require special handling, it is recommended to unload and cover them immediately. The control plan in the work areas will depend on the direction of the wind. Finally, it is possible to use chemicals to

mask odors in special cases. However, this method is very expensive and not always the most effective.

- Adequate biogas venting.
- Collection, minimization and treatment of leachate.

3) Noise

Noise can be controlled through:

- Proper handling of the operating phases to create a buffer zone or barrier between the source and the receiver.
- Proper maintenance of the equipment.
- Regulate hours of operation in such a way as to be compatible with adjacent land uses.
- Appropriate distances.

4) Insects and rodents

Insects basically include flies and mosquitoes, but not only these. Potential insect problems are mainly the transmission of disease, poor image and discomfort to nearby residents. Insect control can be performed by:

- The timely coverage of the waste, to put out of reach the food, shelter and areas for reproduction.
- Application of insecticidal solutions, on the waste discharged at the work front.

As for rodents:

- The timely coverage of the waste, to put out of reach the food, shelter and areas for reproduction.
- Application of pesticides on waste discharged at the work front.

5) Birds

Seagulls often use landfills as a food source. Their presence constitutes a risk to aircraft flying in the airspace of the landfill and a source of pollution to surface waters.

Bird control is very difficult. Some of these could belong to protected or endangered species and therefore require special permits if an elimination program is to be established.

A successful method in bird control is the use of raised ropes over the landfill,

which cause interference in the radar system of seagulls and other birds. Other methods for bird control that have been used with varying degrees of success are listed below:

- Timely coverage of waste.
- Noise emission systems.
- Use of poisons and baits.
- Emission of recordings with sounds of birds in danger situation.

3.4.5 Environmental monitoring

Monitoring systems are used to identify possible impacts of the landfill into the environment. For this reason it is very important to give it the necessary maintenance.

1) Monitoring of groundwater

One of the potential hazards of greater magnitude that can be derived from a final disposal site is leakage and migration of leachate to groundwater bodies.

In each landfill it is necessary to control the contamination of the leached water and the impact on the quality of the groundwater. It is recommended to carry out the analysis in three different places, drilling with a hole to the level of the first water table. It is also possible to open monitoring wells during landfill construction. Depending on the character of the landfill, this type of analysis should be performed between 1 and 4 times per year during the landfill operation and 1 time per year during the first 5 years after the landfill is closed. Sampling must be performed at least 2V per year, according to Dominican regulations. The reference standard is "Groundwater Quality and Underground Discharge".

The purpose of groundwater monitoring is to:

- Check that the coating system and / or waterproofing layer of the disposal site is working properly (there are no leachate leaks).
- Verify the degree of propagation of the harmful substances contained in the leachate flow into the groundwater.
- Check the degree of contamination of the environment in case of failure in the coating system and / or waterproofing layer.

There are some cases where groundwater analysis is not necessary[15]:

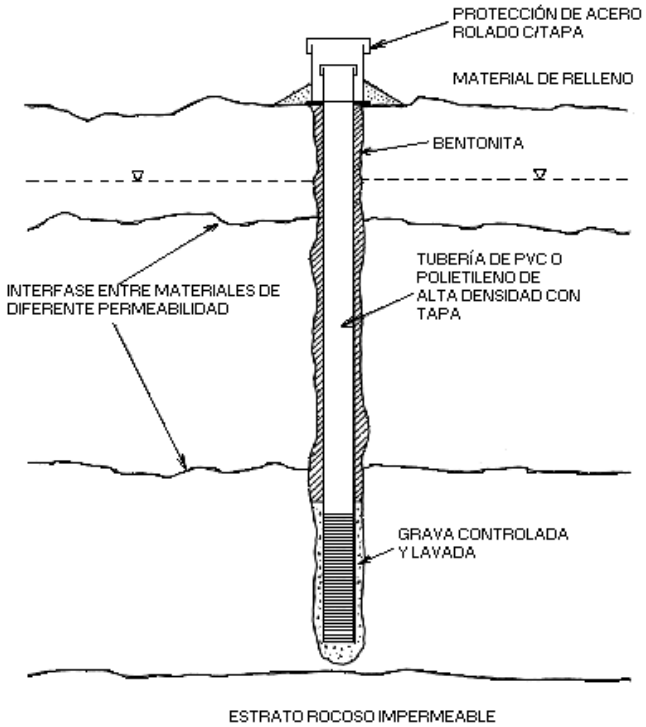
- Sites where the first water table is very low (more than 40 m under the bottom layer of the filler).
- Sites with a waterproof geological barrier
- Arid regions with less than 300 mm annual rainfall
- Small and very small landfills where no hazardous wastes of industrial origin are disposed.

It is recommended that the groundwater analysis be thoroughly analyzed in the following situations[16]:

- Fills with a very high water table (3 m or less under the bottom layer of the landfill).
- If there is a water catchment (for irrigation or drinking water supply) in the same basin of the landfill and at the lowest level of the landfill.
- Large and very large landfills
- Landfill near districts where water is supplied by wells (here you can take tests from the nearest wells, in order to lower costs)
- Medium and large landfills with poorly constructed waterproof bottom layer.
- Landfills built on sandy soil or other highly permeable soil

[15] Design, construction, operation and closure of manual sanitary landfills. Ecuador, 2002. Page 105

[16] Design, construction, operation and closure of manual sanitary landfills. Ecuador, 2002. Page 105



Source: MT Landfill Operation. SEDESOL, Mexico.

Figure 33 Scheme of a well for monitoring groundwater

2) Surface water monitoring

The surrounding surface waters could also be affected by leachates, so monitoring surface water quality should be a routine component when leachate is known or suspected to be impacting surrounding surface waters or when there is some concern about the quality of groundwater. The cost could be very high for small and medium municipalities. It is recommended to carry out analyzes in spite of the cost, in the following cases:

- The landfill is in a protected area. It is worth mentioning that in RD is prohibited the installation of landfills in protected areas.
- The treated waters are discharged into a very susceptible medium (river with very low flow, river inhabited by endemic aquatic species, susceptible aquatic ecosystems, etc.)
- The middle receiver serves for the supply of drinking water or for irrigation
- The landfill also receives hazardous wastes of industrial origin.

3) Air monitoring

It is important to evaluate air quality during half-yearly measurements during the

first two years of decommissioning and then with an annual measurement will suffice. During the transport of the waste to the FDS, on unpaved roads, the necessary measures will be taken to minimize the generation of dust and the negative impacts derived from nearby populations.

4) Monitoring of settlements and landslides

With the passage of time solid wastes undergo transformations due to microbial activity, decomposing into gases and leachate. This process favors differential settlements and subsidence, causing destabilization of the terrain.

Differential settlements cause depressions on the surface of the land, where water accumulates, leading to the entrance of the same and to the generation of leachate. For this reason, monitoring is necessary. This situation should be avoided, leveling the ground for good drainage.

3.5 Administration and cost control

Finally, it should not be forgotten that all operations involving the proper functioning of FDS could not be performed efficiently and effectively without good management and control of the costs involved. Effective coordination of all the activities and the staff performing them is an extremely important task. On the other hand, controlling the costs of landfill management is a task that requires careful monitoring in order to ensure the financial sustainability of the operation over time.

As an example, aspects of the administrative management of the Municipal association of ASINORLU in El Salvador[17].

[17] Taken from the presentation made by Hugo Guerrero, manager of ASINORLU, members of the FOCIMIRS team, during the visit of June 2014.

Table 8 Aspects of the administrative management of ASINORLU

EL RELLENO SANITARIO DE ASINORLU Aspectos Financieros	
Costo por Tonelada dispuestas	• $28 - $ 35 dólares a no socios (fracción de ton) • $23 dólares a municipalidades ASINORLU • $ 17 dólares a Santa Rosa de Lima (CM)
Costo Ton/tratada para ASINORLU	• $ 18.75 cada tonelada (Dic. 2013)
Legalidad de Cobro	• Contrato anual con municipalidades no socias • Acuerdo de Junta Directiva por pago de servicios y sostenibilidad
Custodia de Fondos	• Depósitos y remesas a cuentas de ASINORLU en sistema financiero local
Manejo de fondos	• Chequeras con firmas A, B, y C autorizadas , manejadas por el Presidente, el tesorero y eventualmente un director de la JD respectivamente
Auditorias Financieras	• Corte de Cuentas de la República • Auditorias Interna Municipal • Auditoria de cooperación externa

Table 9 Control of environmental monitoring

EL RELLENO SANITARIO DE ASINORLU	
MANEJO DE LIXIVIADOS	• 2304 M³ (Máximos en invierno , hasta 904 m ³en época seca), aplicando recirculación para captura de sólidos suspendidos , laguna de lixiviación y evaporación natural
COBERTURA	• 60 cm aproximados de espesor de desechos en celdas diarias • 15 cm de material de cobertura diario**
PUNTOS DE MONITOREO DE AGUAS SUPERFICIALES Y SUBTERRANEAS	• 6 Puntos ubicados en el sitio y registrados en el Ministerio de Medio Ambiente y Recursos Naturales
INSPETORIA AMBIENTAL	• 2 veces al mes por el MARN
INSPECTORIA SANITARIA	• 1 vez al mes MSPAS
INFORME DE OPERACIONES	• 1 Informe anual al MARN por el titular del proyecto; elaborado por la UTI

CONCLUSIONS

In the country in each municipal or district jurisdiction there is a land dedicated to the uncontrolled deposit of solid waste generated, affecting the health of surrounding populations, degrading environmental quality and deteriorating resources. In contrast to an uncontrolled or semi controlled dump, a sanitary landfill or controlled landfill protects public health and the environment.

As it has been observed throughout this Manual, there are many complex steps that must be followed for a correct selection of the place and planning of a FDS, as well as for a proper design, construction and operation of the same. They need specialized technical resources and abundant financial resources. Of both, there are major shortcomings in the municipalities.

The initial and operational costs of a landfill are high in all parts of the world, so it is very difficult for a particular municipality to carry out such a project, except in exceptional cases. Even in developed countries, alternatives have been sought that allow municipalities to fulfill one of their main attributes: the management of solid waste from generation to safe disposal. One of them has been the creation of special funds by the central state for the construction of such infrastructures, under the premise of the intermunicipal association, better known here as "municipal association" and with the participation of the private sector.

This is a great opportunity for alliance between the central government, local authorities and private companies to provide the country with the facilities required to end the more than 350 existing landfills in the Dominican Republic.

REFFERENCE

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Ministerio de Medio Ambiente y Recursos Naturales

JICA

OPERATIONAL TRAINING AT FINAL DISPOSAL SITE (FDS)

FOCIMIRS
Fortalecimiento de la Capacidad Institucional en el Manejo Integral de los Residuos Sólidos

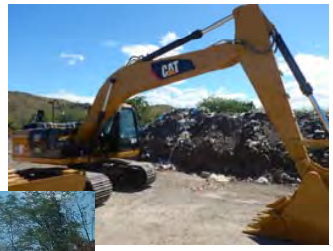
May 2017

1. Introduction

- ✓ **MANCOM was established to implement sustainable Solid Waste Management.**
- ✓ **Under these conditions, JICA decided to grant an additional Support, especially for monitoring MANCOM. This consisted of :**
  1) Donation of equipment
  2) Operational Training for the current landfill.

1. Introduction

DONATED EQUIPMENT



2. Objectives of the Operation training

- During the Operation Training -

- ➢ **Obtain knowledge** on the management of a Landfill.
- ➢ **Implement and experience** on-site activities by the MANCOM staff.

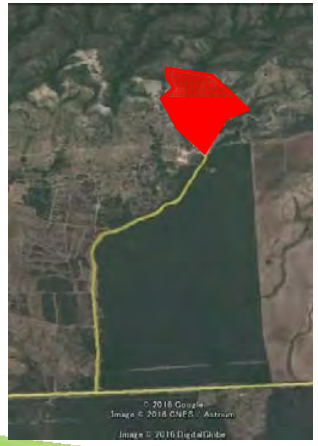
- After the Operation Training-

- ➢ **Continue** managing the landfill.
- ➢ **Share** knowledge and experience with other Municipal Associations and Municipslities.

3. Training Plan for the Operation of the FDS

1) CHECK current conditions.
2) LEARN technical aspects.
3) IMPLEMENT operation (with JET)
   - ✓ Construction of landfill cell.
   - ✓ Receiving of transferring waste.
   - ✓ Landfilling waste.
4) IMPLEMENT the operation (by MANCOM)
5) SHARE knowledge and experience.

4. Conditions found (1)



- ✓ There is an access road with an approximate distance of 1.8 km between the national road and the entrance of the dumping site.
- ✓ Waste is dumped all the way in.

4. Conditions found (2)

- ✓ The landfill area belongs to a protected area comprised of: the National Park and Forest Reserve.
- ✓ Most of the landfill is scattered in the National Park area.
- ✓ The southern half spreads in the area of the Forest Reserve.
- ✓ The selected training area was the National Park (Not the Forest Reserve).

4. Conditions found (3)

- ✓ Some of the land is owned by the **Government** and others are private.

↓

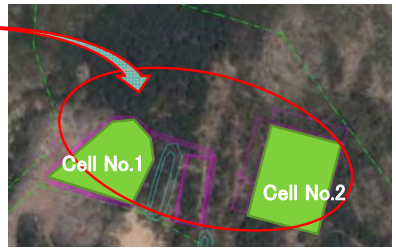
The area for training should be the area that belongs to the Government.

4. Conditions found (4)

- ✓ Scattered waste was found throughout the area.
- ✓ The estimated volume of waste deposited is approximately 50,000 m3.

FOCIMIRS

4. Conditions Found (5)



Cell #1 It was completed during operation training by the JICA Expert Team.

Cell #2 It is being built by MANCOM.

4. Conditions Found (6)

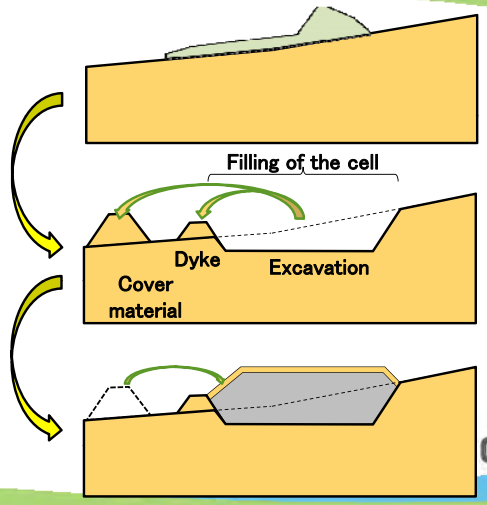
Image of the Operation

CASE-1

①Actual condition.

②Start of landfilling operation.

③End of landfilling operation.



5. Training on site (1)

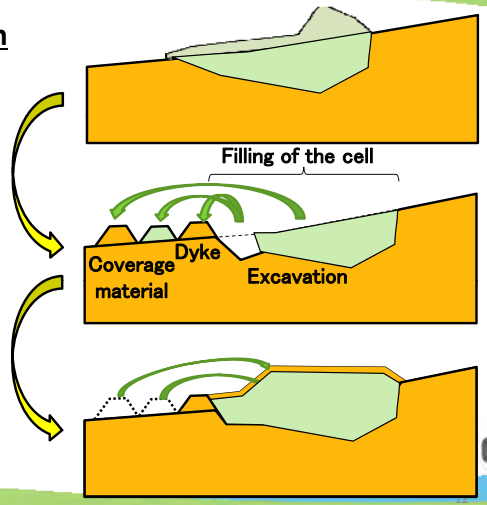
Image of the operation

CASE-2

①Actual condition.

②Start of landfilling operation.

③End of landfilling operation.



@AmbienteRD

5. Training on site (2)

@AmbienteRD

5. Training on site (3)

He passed:

1) Preparing a road around the cell and cutting trees.

@AmbienteRD

5. Training on site (4)

1) Preparing a road around the cell and cutting trees.
2) Building Dyke -1

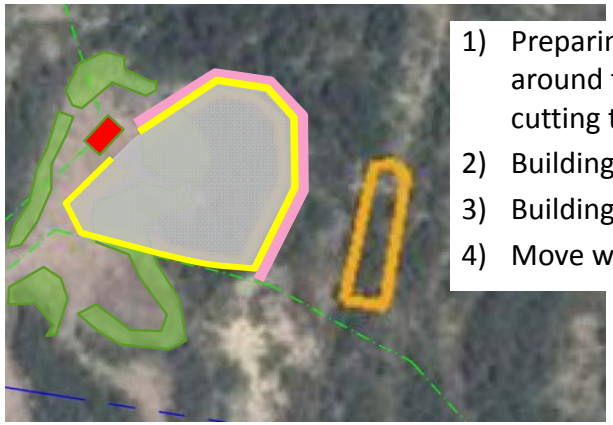
@AmbienteRD

5. Training on site (5)

1) Preparing a road around the cell and cutting trees.
2) Building Dyke -1
3) Building Dyke -2

@AmbienteRD

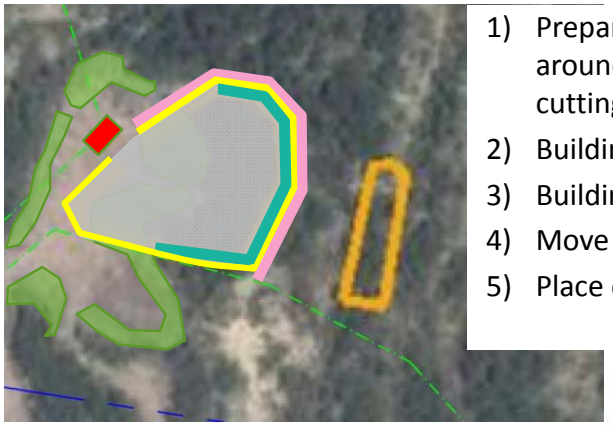
5. Training on site (6)



1) Preparing a road around the cell and cutting trees.
2) Building Dyke -1
3) Building Dyke -2
4) Move waste

@AmbienteRD

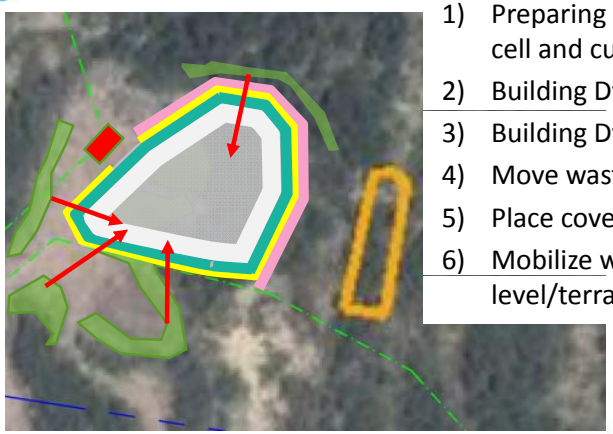
5. Training on site (7)



1) Preparing a road around the cell and cutting trees.
2) Building Dyke -1
3) Building Dyke -2
4) Move waste
5) Place cover material

@AmbienteRD

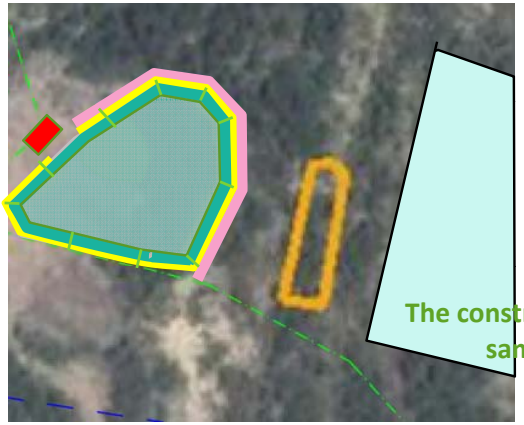
5. Training on site (8)



1) Preparing a road around the cell and cutting trees.
2) Building Dyke -1
3) Building Dyke -2
4) Move waste
5) Place cover material.
6) Mobilize waste to a second level/terrace.

@AmbienteRD

5. Training on site (9)



Once what was previously shown is done:

1) Drainage installation and cover material
2) Construction of Cell #2.

The construction process is the same as in Cell #1

6. Photographic record (1)

Photos taken during operational training

6. Photographic record (2)

6. Photographic record (3)

6. Photographic record (4)

6. Photographic record (5)

6. Photographic record(6)

Photos taken after operational training

6. Photographic record (7)

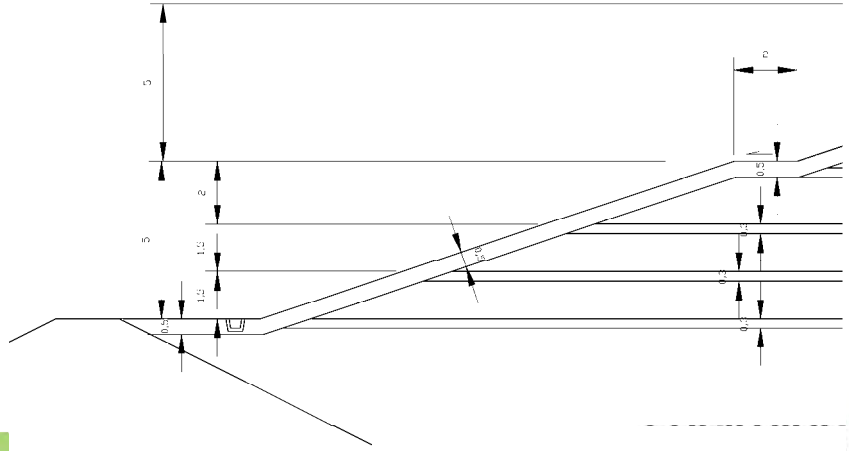
6. Photographic record (8)

6. Photographic record (9)

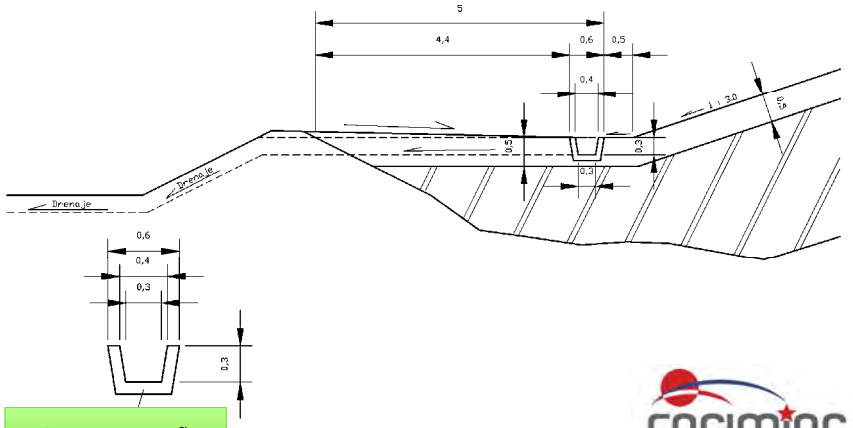
7. Typical Drawings (1)

Typical Drawings

7. Typical Drawings (2)
Slope and cover soil

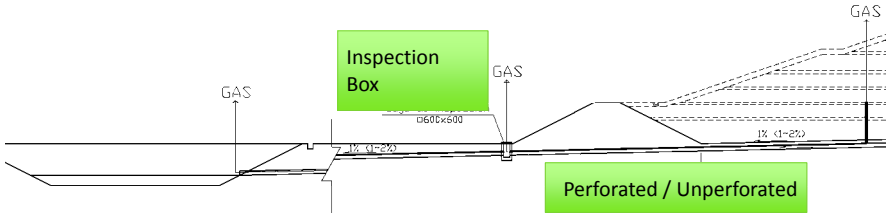


7. Typical Drawings (3)
Drainage

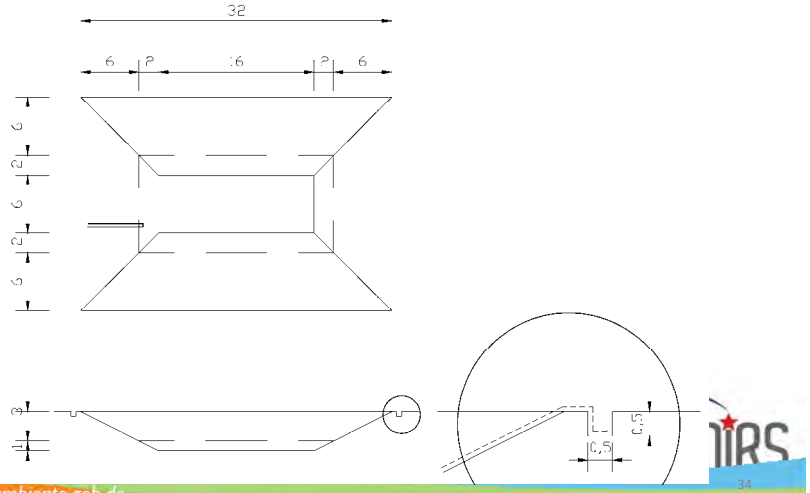


Drainage, cement floor

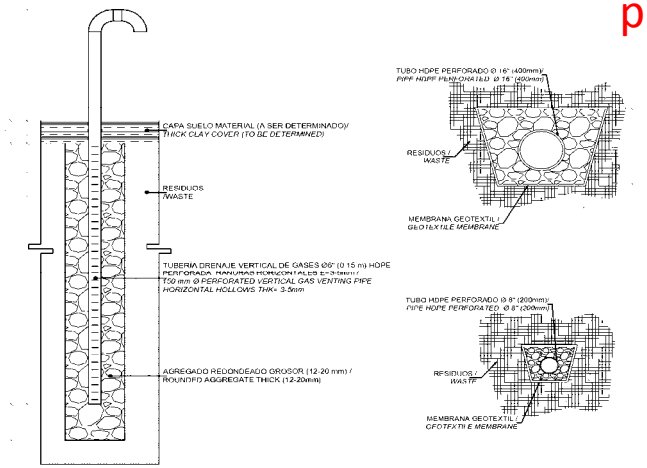
7. Typical Drawings (4)
Leachate and Discharge System



7. Typical Drawings (5)
Leachate pond



7. Typical Drawings (6)
Leachate discharge pipe and ventilation pipeline



END

Project For Institutional Capacity Development On Nation-Wide Solid Waste Management In Dominican Republic

Manual for Environmental Education/ Awareness and Development of Public Consensus for the Integrated Solid Waste Management

May 2017

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INTRODUCTION

The problems caused by the inadequate management of municipal solid waste reach a wide range of areas: (health, urban development and soil use, air quality, water quality, education and culture, climate change) and affect different means: air, water and soil/subsoil quality, landscape, among others.

Even though "waste" has been traditionally identified, as one of the problems of the country, the citizen participation in the solid waste management is very limited. In general, the population considers that the municipal authorities as responsible of collecting "solving this problem". Unfortunately, Dominicans often litter everywhere. This reality goes beyond the socioeconomic levels of the population and it seen in poor neighborhoods as well as in rich neighborhoods. Seeing a citizen littering from a luxury vehicle is as common as seeing a citizen displaying the same behavior from a public transportation vehicle. As a country, we used to see "waste" on the streets as something normal. On the other hand, the tourist that visit point out the big amount of solid waste on the streets as a weakness of the country. The inadequate management of solid waste could endanger the achievement of the goals of the National Development Strategy 2030: 10,000,000 tourist per year.

On the other hand, without wanting to justify this situation, it cannot be expected for attitudes and/or changes of behavior in a population that has suffered a deficient service for years and that has not been the objectives of permanent campaigns of sensitization and awareness on the good handling of solid waste by the correspondent authorities.

Currently, the environmental issues are the most important concerns of humanity. The boom, it has had in recent years, is related with the increase of a number of issues at different scales, which affect society increasingly. There is clear evidence of the environmental situation of the earth, the situation is getting worse; and for the first time in history, human beings have the possibility of destroying the planet. Disregarding the perspective or individual priority, all of us have a common responsibility: ensuring the protection and conservation of our natural resources and the environment. When it comes to the environment, we should "Think Globally, Act Locally and Change Personally"

It could be said that an important part of the success of an urban ISWM plan depends

on a population that is aware of its responsibilities, taking into account that within said population is where the first stage of the process start. Waste generation and handling inside the house and subsequent presentation in the public road for collection. From there the importance of developing permanent dissemination, awareness and environmental education programs focusing on this topic, in order to develop attitude and values on the population that become responsible behaviors regarding solid waste management.

As it can be seen throughout this whole document, the complete management of solid waste is framed within the concept of and need of sustainable development. The primary objective of this manual is precisely to sensitize and create awareness, developing a sense of responsibility and inciting support from the municipals so that together with the corresponding authorities adequate plans for the management of waste can be implemented along with specific waste reduction and recycling programs. To attain genuine participation from the population in the collection of waste is one of the greatest challenges of this country's municipalities.

The manual is divided into three parts. The first deals with fundamental concepts.

PART I

1 ENVIRONMENTAL EDUCATION FOR THE ISWM: GENERALITIES

1.1 Environmental Education

1.1.1 Concept

The origins of environmental education go back to World War II (1939-1945), since the countries affected were the first to decide to implement a plan for the education, protection and conservation of natural resources, following damage to the environment. Tage Erlander was the first Minister of Sweden to recommend to the Economic and Social Council of the United Nations (UN) to include in the agenda the status of the environment and habitat

At the end of the 60s, the UNESCO makes an effort of including the environmental topic as an educational resource. The concept takes strength in the “Conference of the United Nations for the Environment”, Stockholm 1972, highlighting its importance for the change in the development models. This conference created the "United Nations Environment Program" (UNEP), which encourages and supports cooperation on environmental issues. The "World Environment Day" was also established and the "International Environmental Education Program" (IEPP) was created, which is interdisciplinary in nature, encompassing formal and non-formal education, based on characteristics defined in Principle 19 of the Stockholm Declaration. It is under the leadership of UNEP and the United Nations Educational, Scientific and Cultural Organization (UNESCO).

The purpose and objectives of the environmental education where established in the “Letter of Belgrade”, raised in the “International Seminar on Environmental Education”, Belgrade 1975. In that moment, the environmental education was oriented to reaching worldwide consensus on the environment and its problems and develop in the persons “knowledge, aptitudes, attitude, motivations and necessary desire to work individually and collectively in the search of solutions to the current problems and prevent the ones that may appear in the future”.

In general terms, the education can be defined as the process through which it is

influenced on the human being, developing knowledge, abilities, competencies, aptitudes and values, that are then translated in a changed of behavior. In the other hand, it has always been said that "the education is the basis of the development of the cities". This being so, the environmental education will be related with a permanent education action focused on creating conscience on the global reality of the planet and the environmental deterioration caused by a socioeconomic development that has not respected the harmony needed that must exist in the interaction among the human being and its environment.

The law 64-00 defines the environmental education as: "A permanent process of the citizen formation, formal and informal, for making consensus and the development of principles, concepts, attitudes and skill facing the protection and the sustainable use of the natural resources and environment".

1.1.2 Importance

The public education and consensus is extremely important in the ISWM due to the following:

- The waste flow starts with the generation, manipulation, temporary storage and presentation at source by the population.
- The implementation of the system and the achievement of the objectives of the ISWM strongly depends on the behavior of the citizens as waste generators.
- The efficiency of the ISWM depends on the way that the population manages the waste after its generation.
- The recovery of the costs depend on the payments made by the population.
- The active participation and consensus of the population in the management of solid wastes is important in all aspects of the ISWM. The awareness is a key factor, especially for the following components of the ISWM:
- Keep clean the public places like sidewalks, streets, parks, markets, etc.
- Promotion of the 3Rs (reduction, reuse and recycling).
- Efficiency in the collection services.
- Payment for the ISWM services, particularly because of the increase on the costs, due to the implementation of the proper management of the wastes in the final disposal site, with the objective of protecting the health of the population and keep the environment and natural resources.

1.1.3 Objective and benefits of the education and public consensus

The ultimate objective of the education and public consensus is to obtain a change in the attitude and behavior of the persons. The education process and the awareness contributes the following benefits:

1) Develop conscience: The first step for the public consensus is awareness (awake the interest and worry) in regards to the cleanness and environmental problems, as well as the conservation and the sustainable use of the natural resources.
2) Provide knowledge: To understand the reason of the harm to the conditions of cleaning and hygiene and the deterioration of the environment and natural resources in general. The knowledge includes responsibilities and duties of the citizens, which usually are integrated in the current legislations, like the laws, regulations and municipal ordinances.
3) Change attitudes: Based on the increase of the environmental conscience and the development of knowledge, a change of attitude or behavior must be followed.
4) Develop abilities: These are necessary to solve specific problems, achieve objectives and encourage the change in the behavior, as well as fight the problems of the solid waste management. The abilities must include those that are necessary for the formulation and implementation of the action plans of the community's organizations.
5) Provide Capacities for Monitoring/Evaluating: Capacities of the community organizations to give follow up, control and evaluate the activities, programs and plans of ISWM.
6) Commit to the participation: It is required, the active participation and awareness of the citizenship so that the ISWM is sustainable.

1.1.4 Contributions and Characteristics[1]

1) The environmental education allows:

- Learn to think and live on another way, transforming the intervention form on the biosphere.

[1] Basically taken, even though with some inclusions and//or modifications, from the **Manual for the community awareness and environmental education- Integrated Solid Waste Management. INTI. Argentina.**

- Create own environmental standards and principles, affirming it and justifying it.
- Strengthening the link with nature, through the observation, the information and the compensation of it.
- Develop the sense of membership and responsibility regarding the planet earth.
- Appreciate the diversity, both biodiversity as the cultural diversity.
- Encourage a complex and integrative vision.
- Learn to establish systematic relations.
- Recognize the multiple reactions among the economic, social and environmental area.
- Exercise the problem resolution.
- Set out questions as: "Which is the future of our planet and of its inhabitants?", "In what world do we want to live?", "What world do we want to leave for our descendants?"

2) Characteristics

The environmental education is:

- **Policy:** Promote the debate on the model of current development and its limits.
- **Social:** Study the relations of the society with the nature and to its own interior, which cause environmental impacts.
- **Questioner:** Tries to look for the causes of the events, achieving the routes of the problems, which assume as opportunities of change and improvement.
- **Community:** Part of the problems raised in the community and it is inserted in it for the joint search of solutions.
- **Ethic:** Seeks to develop principles, attitudes and behaviors that allow to reach the necessary sustainable development.
- **Interdisciplinary:** Relates the environmental, social and economic aspects, studying the interactions that establish themselves among the same.
- **For the citizens' practice:** Encourages the participation, the debate and the dialog to achieve common decisions facing the resolution of conflicts.
- **For the entire life:** It is an uninterrupted learning process.

3) Role of the Environmental Education in the ISWM

The education in general, plays an important role in the lives of the persons, since through this we can accomplish changes in those that receive it. In the environmental sense, the education brings large contributions to the ISWM, taking into account the need of change in the behavior of the population in general, in order to achieve the

desired objectives, through the implementation of projects and concrete programs related to the 3Rs.

One of the objectives of the environmental education in the ISWM is disseminate and share the knowledge on the different environmental problems related to the bad solid waste management, emphasizing on the damages to the natural resources, the environment and therefore to human health.

The environmental education plays an important role on the changes of attitudes and habits to the consumption of a good, product or service and manage appropriately the resulting wastes, contributing to having cleaner cities and towns.

The environmental education makes easier:

- The development of the sense of co-responsibility.
- The promotion of the 3Rs culture.
- Favoring a responsible consumption.
- Assuming the care and the protection of the environment.
- Forming changing agents.

1.2 Integrated Solid Waste Management –ISWM–

1.2.1 History remarks

The Creator placed in the availability of the human being, all nature and their precious resources, in order for them to use it and that way satisfy their different needs; establishing like this, a mutual interdependent relation. The evolution of human beings through the history can be understood by the study of the wastes resulting from their activities in the different stages of their development.

From their origin and until part of the Neolithic period, the human race was nomadic (did not have a specific place to live), they made small groups and dedicated to hunting, fishing and collecting to satisfy their basic needs. We can say that the impacts on their environment where insignificant, since on one side, the materials used where natural, and on the other, the generation was limited and the disposal of waste was not in a specific place, therefore the nature was able to easily degrade the waste produced.

In the same time period, the economy of the human society developed from gathering, hunting and fishing to the agriculture and livestock, which caused the sedentary lifestyle contrary to the nomadic lifestyle. The agriculture and domestication of animals

required the settlement in specific places. This fact changed their relation with their surrounding environment. The human being discovered that he could modify he's surrounding for his benefit and reach a better wellbeing.

The agriculture development produced an economic and demographic explosion, which served as a base for the urbanization process by the creation of the first organized society. Nevertheless, a big progress was achieved. For a long time the available technology did not allow the intensive exploitation of the natural resources. Accordingly, in general the impact on the environment was limited and the wastes generated did not cause any problem since the human activities consisted in the natural cycles and its sub products once absorbed by the ecosystems. Nevertheless, some problems came up when the lack of planning in the waste collection in the incipient urban cores caused plague and diseases, causing a terrible impact on the population.

The scientific and technological advances of the end of the XVIII century found its application in the so called Industrial Revolution, new industrial activities raised and the commercial development. A true demographic and economic explosion was caused, which manifests the urban development with no precedent, which led to a significant increase in the amount of waste and significant changes in its composition as a result of the new mode of production and life. With the rise of economic development, problems have been increasing, posing major challenges worldwide. This reality has demanded the definition of legal instruments to limit the impacts derived to health and the environment.

At the beginning of the 70s, in the framework of the appearance of the Brundtland report, titled "Our Common Future", where the concept "Sustainable Development" appears for the first time, the growing public concern on the deterioration/reduction of the natural resources caused a change in the focus of the solid waste management; establishing the precedent of what after the beginning of the 90s will be known as the ISWM, which stood out by its focus on the sustainability of the natural resources. The essential aspects of this proposal were concentrated on:

- Minimizing the generation.
- Maximizing the reuse and recycling.
- Using environmentally appropriate treatment, elimination and final disposal technologies that include energy recovery.

As people develop, it is necessary to create laws, norms and policies that include provisions to regulate life in society, so that citizens can enjoy their rights.

The most important legal provisions that have been established in the country, before Law 64-00, issued in August 2000, are presented in chronological order below:

- Criminal code of 1867, Chap. II, Art. 471 establishes sanctions for the ones that dump waste in public places.
- Law 4984, police law, of 1911, Articles 29, 43 and 44, provides among all, the prohibition of burning wastes within settlements.
- Law 675 of 1944, on urbanization, adornment and constructions, Articles 32 and 35, prohibit placing debris in the public roads.
- Law 241 of 1968, on the legal regimen of vehicles transit, Art. 130 that prohibits placing in public roads different types of wastes.
- Law 218 of 1984 that prohibits the introduction of basically any type of waste to the country.
- Law 83 of 1989 that prohibits placing construction waste, debris and waste on the streets, avenues, among others.
- Law 120-99, that prohibits dumping solid wastes of any nature on the streets, sidewalks, parks, paths, beaches, rivers, oceans and any other public place.
- By August 2000, Law 64-00, in Chapter VI, article 106, 107 and 108, confirms the operation of the systems of collection, treatment, transportation and final disposal of non-hazardous wastes by the municipal city halls; prohibits placing, throwing and finally disposing solid wastes in unauthorized places and establish the establishment of the classification of solid wastes in public institutions.

General Law of Health (Law 42 of March the 8th, 2001) defines, in its article 46, that the Ministry of Public Health (in coordination with competent authorities) will elaborate the official norms that regulate the final disposal and handling of solid waste, as long as their use, collection, treatment, deposit, reconversion, industrialization, transport, storage, elimination or final disposal is dangerous for the health of the population. In relation to this disposition, Regulation 126-09 on waste generated by health centers and related.

When it comes to Law 176-07, Art. 19 (m), it confirms the competency of the municipalities in the services of cleaning and public adornment, collection, treatment and final disposal of solid waste.

From 2003 to 2014, 10 legal instruments related to SWM were created, to know:

- Standard for the Environmental Management of Domestic and Municipal Solid Waste.
- Radioactive Waste Rule
- Standard for the comprehensive management of infectious waste (management, segregation, transitional storage, transportation, treatment and final disposal)
- Environmental standards for non-metallic mining operations
- Regulations for the management of hazardous chemical substances and wastes in the Dominican Republic
- Regulations for the Transport of Hazardous Substances and Materials
- Regulation of environmental use and management of agrochemicals and their solid waste in horticultural production.
- Environmental regulations for the use, handling, transport and disposal of polychlorinated biphenyls (PCBs)
- Regulation for the environmental management of pig farms
- Environmental Technical Regulation for the Management of Scrap Metal in the Metal Sector

In 2014-2015, they were issued:

- National Policy for the Comprehensive Management of Municipal Solid. Waste.
- Procedure for the Recovery of Recyclable Multimaterials with Commercial Value.
- Regulations for the management of acid-lead batteries.

In October 2016, the draft "Comprehensive Solid Waste Management and Co-Processing Law was introduced for the first reading in the Chamber of Deputies, and its discussion was postponed.

1.2.2 Concept and Importance of the ISWM

In a genuine attempt on satisfying its needs, the human being has indiscriminately used the natural resources and for a long time has made an uncontrolled disposal of the inevitable solid wastes resulting from their activities, causing negative impacts in all elements that form the natural and built environment. Causing on one side the gradual decrease in the availability of such resources and, on the other, the contamination of these (air, soil and water). This gave place to the degradation of the environment in general and, as consequence, a reduction of the life quality of the population and

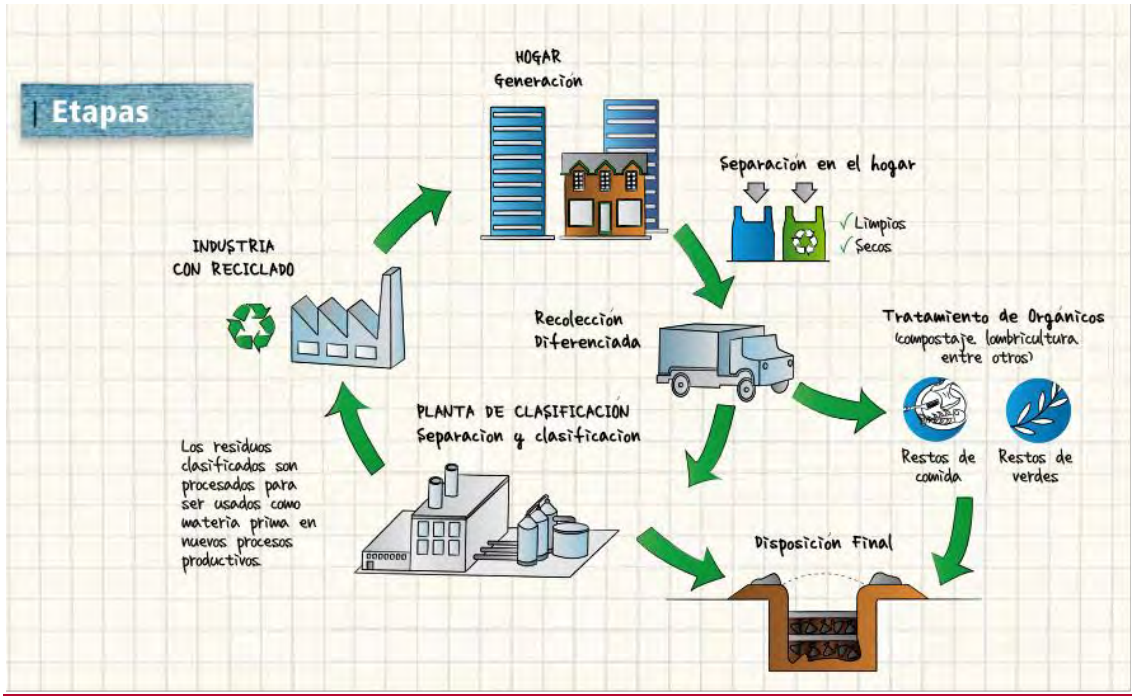
important effects on the human health.

Worldwide, the population growth, the economic development, the increasing urbanization process, the changes in the lifestyles, among other factors; leaded to a significant increase on the demand of goods and services. The generation of wastes is inherent to all human activities and the amount produced is corresponding to the development level of the countries and to the number of its inhabitants. Being so, by not changing the current production and consumption, we cannot expect another situation but the progressive increase of wastes and a higher complexity in their composition, since the satisfaction of all their needs and even desires, it is the reason of the individual human activity and of the society in its conjunction.

In nature, contrary to what happens in society, there is no waste accumulation. Actually, a waste, will appear as a rupture of the natural cycle of the material. This type of cycle is that is called **closed cycle**, where all the material used returns to the starting point after completing the purpose for which it was created. Nevertheless, the human society does not benefit the closed cycle, when they turn all resources they use to live and grow into waste.

The concept of "integrated waste management" results as a response for reestablishing the broken equilibrium. It is a new idea where the wastes are no longer seen as wastes with no value, but as resources, secondary material usable in the production of new goods or services for the satisfaction of needs.

It is in this context where it has sense and encourages the concept and vision of integrated waste management, taking into account that it pretends to give a more appropriate solution to wastes in all of its stages, in the economic, social and environmental point of view. Stating the rational use of the natural resources, the potential reuse and the urgent need of recovery/valorization of the materials found in wastes. With the objective of maintaining the balance and contribute to the environmental sustainability of the planet, the societies have thrown themselves in the search of new technologies for recovery, recycling and valorization of waste.



Source: Manual for the community awareness and environmental education- Integrated Solid Waste Management. INTI. Argentina

Figure 1 Waste management stages under the vision of integrated management

The importance of the ISWM precisely consists in its interest of imitating the natural processes, which are developed in cycles and therefore, do not produce wastes. What happens is that the materials are reabsorbed in the nature, transforming into the same element or into new elements. The ISWM includes the recycling concept, where the wastes are reintroduced into the productive cycle that originated them, to then obtain the same good or to a different industrial process for the manufacture of a new product; contributing like this to developing a sound cycle of the materials.

In the last decade, significant progress was produced in all aspects of waste management and, particularly, in the technologies development for its treatment, being for their incorporation of the sound cycle of the materials, for the use of the energy they have. The use of the wastes is an imperative need worldwide and the recycling advances at accelerated steps, by which the wastes have started to be considered as "the resource of the XXI century".

On the other hand, the ISWM demands an appropriate and secure final disposal, at a long term, for the human being and the environment, of that waste that under any circumstances cannot be recovered/valorized.

Among the objectives of the ISWM, we can mention:

- Reduce the generation.
- Favor the reuse and recycling, reducing the amount of wastes destined to a final disposal.
- Protect the human health.
- Improve the life quality of the population.
- Care and protect the environment.
- Preserve and promote the rational use of the natural resources.

1.2.3 Hierarchy in the ISWM

The principles that rule the integrated wastes management are articulated following a priority order, which goes from the prevention/minimization/reduction that allows to avoid/minimize/reduce the amount of waste that are produced, until its harmless final disposal.

In an order of importance, its priorities are:

- Prevention/Reduction
- Reuse
- Recycling
- Recovery of the organic material
- Energy recovery
- Final Disposal

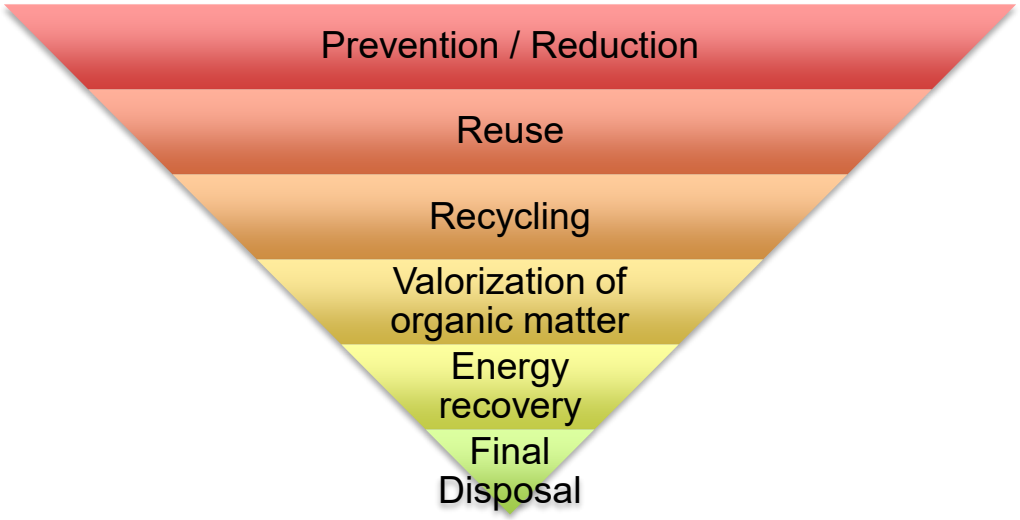


Figure 2 Hierarchy in SWM

This hierarchy is presented in the "Solid Waste and Coprocessing Integrated Waste

Management Bill", which is currently presented in the national congress, as follows:

Figure 3 Proposed hierarchy for solid waste management in DR

EfW/WtE: **E**nergy **f**rom **W**aste/**W**aste **t**o **E**nergy.

Which means harnessing the warmth of solid waste to turn them into energy.

How can we apply this hierarchy to our daily life?

Below are a few examples.

- Preferring products at a large unit, instead of many small individual units: a '1 liter container', instead of 5 of '200 milliliters containers'.
- Opting for the purchase of products with reusable and/or recyclable containers and/or packages, such as "refill containers", meaning, that they can be refilled.
- Making a rational use of the plastic bags that we use in the supermarket for the groceries and products we buy, for example, using their capacity as much as possible, either in weight or volume.
- Use reusable bags, made of cloth or plastic, for our groceries and products.

1.3 Solid Waste and Climate Change

Climate Change is a term that has gradually become relevant within the Dominican population. Because of its effects, it is important for us to know what we are referring to when we talk about a phenomenon that is so important worldwide.

"Climate change" is a change of weather blamed on, directly or indirectly, on the human activity that alters the composition of the atmosphere and that adds up to the natural variability of the weather observed, comparable during time periods. (Framework Convention of the United Nations on Climate Change).

Because of **"adverse effects of climate change"** we understand that changes in the environment or in the biota resulting from climate change that has significant negative effects on the composition, recovery capacity or on the productivity of the natural ecosystems, or on the role of the socioeconomic systems or on the health and welfare of humans. (United Nations Framework Convention on Climate Change).

- Methane gas (CH4) is the major component of biogas produced at the FDS. After carbon dioxide (CO2), methane is the greenhouse effect gas (GEI) with greater presence in the atmosphere. Even though methane is found in a minor proportion in the atmosphere, its contribution to global warming is 21-23 times greater than that of CO2. This is why it is important to properly mange biogas generated in the dumping sites.
- The Dominican Republic is the eight most vulnerable country in the world before climate change as a part of the Caribbean, which is the second most vulnerable region in the world when it comes to this phenomena. This means that we will have higher

temperatures and more droughts, but at the same time more storms, cyclones, floods, among other changes.

- Actually, we could say that climate change is a reality in the country. According to a study[2], the increase of Enriquillo's lake waters is a consequence of climate change because this happened due to the increase of rain out of the rainy season. In the same order, Ozama and Isabela rivers frequently cause floods more often than before.

2 CITIZEN PARTICIPATION

2.1 The 3rs: Culture towards a Society Focused on Reduction and Harnessing

To the years 1960s, the international scientific community starts to alerts the world on big problems of the planet: poverty, lack of biodiversity and deterioration of the environment. It starts to witness the physical inevitable interrelations among the human activities and nature. More awareness was raised on the environment, the biosphere in which we live, results to be a complex, dynamic, synergy and ever uncertain system; having a mutual interdependence among the natural ecosystem, requiring like that a mutual adaption of both. At present there is no doubt that the entire earth is connected and that the entire biosphere brakes when any of its components is altered.

The reduction in the generation of wastes and its harmfulness it's a need, both from the point of view of the sustainable development as from the financial part. The same contributes, as a part of the economy of resources and the limitation of damages, and by another part, the reduction of the costs of the management.

The citizen participation constitutes an essential part of the ISWM, in order to achieve the objectives and goals that must be established in each one of the stages. A change in the thinking and behavior are imposed. The citizens, companies and public and private institutions require adapting its activities of consumption, production and service.

The implementation of the 3Rs demands the construction of a co-responsibility process among the government, as a ruling and regulatory body; the private sector, as a producer and provider of goods and services; and the citizenship in general as a consumer.

[2] Dominican Institute for Integrated Development –IDDI. Study of the Capacities of Adaptation to Climate Change in Rural and Urban Communities in the Dominican Republic, Final Report. Nov 2010

2.2 Roles of the Key Actors Involved

Article 11 of the aforementioned bill, establishes the responsibilities inherent to solid waste management. We quote: "the responsibility to ensure the adequate management of solid waste is inter-institutional" and must be carried out by:

1) **The Ministry of Environment and Natural Resources**. It is the governing authority of environmental management in the country, and of waste management in particular, so it establishes the guidelines of national policy on management criteria, quality goals and coverage of public cleaning services, minimization, Recovery of packaging and packaging, as well as of reuse in general.

2) **The Ministry of Public Health**: In addition to the functions already established, it will exercise the following on waste:

   a) Manage records related to waste management in the country, in accordance with the criteria determined by the regulations of this law;

   b) Propose the declaration of sanitary emergency for the inadequate management of waste in the national territory and coordinate with municipalities, as well as with other competent authorities and entities, the provision of exceptional services to overcome such situation;

   c) To monitor, in coordination with the Ministry of Environment and Natural Resources, the sanitary quality of the system of management, collection, transportation and final disposal of waste generated by the health system, in accordance with the regulations and technical provisions issued by both institutions.

3) **The Ministry of Public Works and Communications**. It is in charge of transporting hazardous waste, and is responsible for regulating, authorizing and supervising the use of roads for the transportation of hazardous waste.

4) **City councils**: They are responsible for the management of domestic solid waste, special waste and urban solids of small generators; Of the public cleaning and the environmental quality of its jurisdiction.

5) **Collecting and marketing companies, foundations and recycling associations**: They are responsible for the provision of the services and activities for which they have been authorized.

6) **Non-municipal waste generators**: They are responsible for the management of the waste they generate or own, until their reuse or appropriate final disposal.

7) **Municipal waste generators**: They are responsible for the management of waste generated or possessed, until delivery to the corresponding waste services, under the terms and conditions to be established.

8) **Waste producers**: Producers, manufacturers, importers or distributors of waste listed as priority producers, subject to the special waste management regime under the extended liability modality, are responsible for the product throughout its entire life cycle, including the post-industrial and post-consumer phases. The corresponding regulation will establish the conditions and forms to apply the rules of extended responsibility of the producer.

2.2.1 Ministry of environment and natural resources

Ministry Of Environment And Natural Resources will be the authority for application in 'solid waste matters', with the power to direct, monitor, evaluate, control and coordinate with the sectoral and municipal authorities the proper application of this law, and it has to:

1) Elaborate the National Program for the Prevention, ISWM, and rehabilitation of contaminated sites;
2) Formulate, conduct and evaluate public policies on solid waste;
3) Issue and, if appropriate, adapt according to this law, the regulations, norms and other provisions to regulate the integral management of hazardous wastes and the mining-metallurgical industry, their classification, to prevent contamination of soils and to carry out Its remediation when it occurs;
4) Issue regulations, standards and other provisions to regulate the ISWM of the mining-metallurgical industry that correspond to its competence in accordance with this law and the Mining Law of the Dominican Republic, No.146;
5) Issue the environmental performance standards that should prevail in the ISWM and special waste management;
6) Issue the standards that establish the criteria to determine the waste that is subject to management plans, which must include the lists of these and specify the procedures to be followed in the establishment of the same;
7) Regulate and control hazardous waste from large and small generators, when the municipalities do not control the latter;
8) Issue the declaration of remediation or
9) Environmental Rehabilitation of Contaminated or Degraded Sites;
10) Regulate the environmental aspects related to the transportation of hazardous waste solid and special handling waste within its competence;
11) Authorize and approve plans for hazardous waste management and special management;
12) Authorize and dictate solid waste management plans for large generators;
13) Regulate and control special handling and solid waste from large generators;

14) Issue, if appropriate, certificates, permits, licenses of managers, social companies or segregators and basic recyclers as appropriate; As well as plans of environmental management in the matter of infrastructure and operation of the sites for the management of waste;

15) Design, implement, evaluate and monitor the management tools that correspond to it in accordance with the attributed competence;

16) To verify the compliance with the regulations in the subject of its competence and to impose the corrective, security measures and sanctions that correspond, if applicable;

17) The other attributions that are established in this law, the norms, regulations and other legal systems that are applicable.

In regards of the recovery of recyclable materials, the "Procedure for the recovery of multimaterials with commercial value", indicates as functions of the Ministry of Environment and Natural Resources:

a) Issue the normative for the regulation of the processes involved in the different modalities of the recovery and in general in the recycling chain.

b) Coordinate with the key stakeholders for the encouragement and sustainability of the recovery/recycling, worldwide and locally, in order to ensure the good function of the markets of the materials and the private companies that will participate in the management.

c) The establishing of incentives to promote the recycling, nationwide.

d) Create a platform for the data and information collection on the management of solid wastes and the recovery/recycling of materials.

e) Watch for equity, providing criteria that allows the establishment of fair relations between the different involved stakeholders.

f) Developing joint actions with all key actors in the recycling chain (municipalities and/or municipal associations, companies, social stakeholders, NGOs, etc.), facing outwards toward the environmental education and the awareness of the population, in order to stimulate the recycling culture.

g) Take the necessary measures to induce the payment and incorporation of the costs of the recovery of environments polluted by wastes, to the ones responsible of such contamination.

h) Exercise the competencies for supervising, controlling and sanctioning, in the faithful fulfillment of its supervising and controlling roles in the matter of wastes.

i) Stimulate the industrial reconverting processes linked to the implantation of clean technologies and to the development of activities of in-contaminating, recycling and the reuse of waste.

2.2.2 Local Governments

Article 9 of the aforementioned bill grants municipalities the following powers:

1) To issue the corresponding regulations, ordinances and administrative dispositions, so that in their respective jurisdictions the provisions of the present order are fulfilled;

2) To be in charge of the integral solid waste management functions of its competence, which consist of the collection, transfer, treatment, and final disposal;

3) To formulate, by itself or in coordination with the Ministry of Environment and Natural Resources, and with the participation of representatives of the different social sectors, the municipal programs for the prevention and integral management of solid wastes, which should observe the Established in the corresponding National Plan for the Prevention and Integral Management of Solid Waste;

4) Issue the regulations and other administrative provisions of general observance within their respective jurisdictions, in order to comply with the provisions of this law and the legal provisions issued by the Ministry of Environment and Natural Resources;

5) Control solid waste;

6) Provide, by itself or through managers, the public service of integral management of solid waste, observing the provisions in the other laws and regulations in force;

7) Grant the authorizations and concessions of one or more of the activities that comprise the provision of solid waste management services;

8) Establish and keep up to date the registration of large generators of household and small solid waste;

9) Verify compliance with legal provisions on solid urban waste and impose applicable sanctions and safety measures;

10) Participate in the control of hazardous waste generated or handled by micro generators, as well as impose the sanctions that may arise, in accordance with the applicable regulations and what establishes the agreements that are signed with the other government entities, in accordance with What is established in this law;

11) To assist in the prevention of contamination of soils with hazardous materials and wastes and their remediation;

12) To charge solid waste management services and allocate revenues to the operation and to strengthen them;

13) Design, implement, evaluate and monitor the management tools that correspond to it in accordance with the attributed competence;

14) Apply sanctions for non-compliance with this law, the regulations deriving therefrom, as well as its municipal regulations, regarding solid and hazardous

residues of domestic origin, small generators of special management and solid waste residues, within its competence;

Paragraph. - The municipal waste management programs, and in particular the final disposal projects, will be submitted by the municipalities and the Ministry of Environment and Natural Resources for their environmental assessment, in accordance with what is established by law and regulations, As well as by the standards that develop them.

Regarding the recovery of recyclable materials, the "Procedure for the recovery of multimaterials with commercial value", indicates as functions of municipalities:

a) Issue ordinances to make waste separation at the source of generation mandatory, so recovering and recycling them becomes an easier task.

b) Establish alliances and provide additional assistance (i.e., provide land and/or municipal establishments, tax exemptions, etc.) for the installation in their respective territories of projects, equipment and infrastructure (clean points, transference stations, material recovery plants, –MRP etc.); that allow the recovery multi-materials with commercial value for its intermediate treatment and/or recycling.

c) Execute, promote and/or support pilot projects of separation at the source and selective collection of waste, with the participation of informal segregators, popularly known as "Buzos".

d) Establish mechanisms and incentives to promote the recovery of the multi-materials through the different modes that exist.

e) Monitor and control the sources of generation with the objective of verifying the fulfillment of the municipal provisions, related to recovery and recycling.

f) Supervise the clean points in order to ensure its proper implementation.

g) Establish incentives per ton of recovered waste that avoided its final disposal at the FDS.

h) Execute permanent programs of environmental education, focused on ISWM.

i) Organize public actions that allow the education and y raise of awareness of the community around the established clean points, at the same time, encourage the population to massively recover the multi-materials.

j) In the final disposal sites, improving the work conditions of the waste segregators through the construction of infrastructure for the recovery of materials, provide equipment for their personal protection, carry out vaccination campaigns regularly, in coordination with Ministry of Public Health (SESPAS by its Spanish acronym); among other measures.

k) Promote/ease the organization of the micro-companies/coops of the informal segregators, in order to formalize and humanize such an important activity.

l) Demand that the actors involved, within the framework of their jurisdiction, the recording and delivery of statistics related to the amount of multi-materials recovered.

m) Keep and send statistics related to the amount of multi-materials recovered by MARENA through its provincial directions.

n) Keep records of the socioeconomic benefits related to the implementation of the recovery systems in the municipalities, such as collection and transportation cost reduction, collection of the amount of waste destined to the FDS, among others.

o) Establish sanctions and mechanisms for their application when the provisions in regards of recovery and recycling are ignored.

The said procedure also points out specific functions for the private sector and general citizenship, as indicated below.

2.2.3 Private sector

1) Producers, importers and distributors

a) Organize individually or collectively the Deposit, Reimbursement and Return System (SDDR, by its Spanish acronym) for the recovery of wastes or products that turn to wastes at the end of its lifespan, which have the multi-materials to recover; being able to use a symbol to differentiate these, if necessary.

b) Establish management and finance systems for the recovery of multi-materials of products that turn to waste at the end of their lifespan and/or of the wastes resulting from the consumption activities.

c) Instruct mechanisms and incentives to generate inverse logistics process, in order to ease/ promote the recovery of such products or wastes, which have different materials with commercial values, among which we highlight the multi-materials pointed out previously, to know: plastics in its different types, paper, carton, metals and glass.

d) Develop campaigns of citizen information to ensure the active participation of the consumers, pursuing the objective of achieving the success of the systems and mechanisms proposed for the recovery.

e) Execute, among its publicity description, awareness campaigns and dissemination to all population, with the objective of promoting the recovery and that way contribute to the protection of the environment.

f) Establish alliances with the corresponding instances for the location, in strategic places, of clean points to ease the consumers of the deposit of products at the end of their lifespan and/or from the wastes resulting from the consumption. The strategic

places can be defined following different points of view: a) Due to the massive consumption of determined products (for example, consumption of different types of beverages such as: grocery stores, drinks stores, discotheques, schools, colleges, hospitals, bus stops, public transportation waiting areas, sports stadiums, sports and recreational clubs, schools specialized in sports, etc.); b) by the geographical location (for example, intersections of large avenues); c) by the nature of the place to be visited frequently by the population (supermarkets, grocery stores, malls, churches, hospitals, bus stops, public transportation waiting areas, etc.).

g) Promoting the use of reusable containers.

h) Promoting the use of containers which's components can be incorporated to the recycling chain.

i) Send to the city halls, the corresponding statistics regarding the amount of recovered multi-materials, through the mechanisms to establish.

2) Business entities (commences, hotels, restaurants, etc.)

a) Constitute itself as partners in the recycling process by the segregation at source of the recyclable multi-materials with commercial value, creating clean point[3]

b) Contribute to the environmental education and the citizen awareness in regards to the recovery and recycling, by placing signs referring to this in their facilities and/or electronically or any other means.

C) Share information and encourage the consensus on the recovery and recycling through their business associations.

3) Intermediaries

a) Provide the environmental authorization required for the performance of the activities of aggregation, purchase and sale of recovered multi-materials.

b) Participate and promote actions tending to incentivizing the recovery and recycling.

c) Establish strategic alliances with other stakeholders of the recycling chain.

d) Send statistics related to the amount of multi-materials recovered, indicating the precedence, to the city hall of its jurisdiction.

4) End users (industries of intermediate treatment, recyclers and exporting companies)

a) Be provided of the corresponding environmental authorization.

b) Join in the recycling chain, by the purchase of the recovered materials for the specific purposes.

c) Develop dissemination and environmental education actions to the general public to

[3] In this process, the term "clean point" means all infrastructures, equipment, storage, container, etc., that allows the recovery of the recyclable multi-materials with commercial value. The term includes aggregation centers.

contribute to the awareness on recycling, emphasizing the socioeconomic and environmental benefits obtained, due to the separation at source of the recyclable material, by all the stakeholders involved

2.2.4 Citizenship in general

1) Segregators

a) Collaborate in the community collection of recyclable multi-materials, previously segregated in the generation source.

b) Formalize its activity, if required.

c) Participate in the activities programmed by the municipal authority regarding the recovery, as well as in education and training activities.

d) Integrate to the regular organized vaccination programs by the municipal authorities in coordination with public health.

2) NGOs, schools, community group (neighboring boards, clubs, etc.)

a) Establish clean points in its facilities.

b) Link the community with the stakeholders of the recycling chain.

c) Assume an important role in the awareness process, environmental education, and development of consensus and organization of the communities for the implementation of the mechanisms to recover the multi-materials.

3) The citizens, as co-responsible in the integrated wastes management, segregate the wastes in the generation source, according to the established in this procedure and/or the particular municipal provisions.

2.3 Responsible Consumption

The prevention/reduction of the waste starts with the manufacturer, who determines the product's characteristics, such as lifespan, the lack of harmful makeup and the possibilities of its reutilization and recycling, among other things. Afterwards, the consumer, through purchasing power and consumption mode, also exerts influence in the generating of such waste and in the possibility that they come back to the productive cycle.

Taking into account the environmental decline at a global level; given that the care and protection of the planet is the responsibility of all, and that in the framework of sustainable development in the last few years the concept of responsible consumption has increased -which implies rational use of resources and productive efficiency at the same time that promotes changes in habit consumption-, responding to real needs, and considering the environmental conservation and social equality. The selection of a

product cannot be done based alone on price and quality criteria.

The responsible consumption is **a reflective consumption**, which takes into account not only consuming less, but also informing ourselves and investigating, to choose goods with less environmental impact. Be it because of the material used in its manufacturing or by the amount of waste that its use generates; by the conditions of its manufacturing process (among other aspects). It also involves demanding the governments apply public policies that limit the generation of waste in the productive and postconsumer chain. These policies must also encourage the companies, in order for them to use environmentally friendly production technologies, biodegradable packaging and containers, and in the least possible quantity.

It's a type of **consumption that promotes the development of a critical attitude** when it comes to buying, because it questions the environmental impact caused during the whole manufacturing of the product (ecological footprint analysis), and during the product's life cycle, assigning value to the processes of transportation, distribution, use, and waste it leaves. For this, systems of tracking are established, which allow us to know the location and complete trajectory all through the product's productive cycle until its final destination. On another vein, it's **an ethical consumption**, in the sense that it takes into account the social conditions in which the product was manufactured (respect of human rights, for example) and the type of business that it looks to favor (fair trade).

2.4 Separation at the Source or Origin

Within the trash, all waste is mixed, which is not good for anything other than throwing it out. For the waste generated through different human activities to be repurposed/revalued, meaning that the resources/material contained within them can be of use, their separation, and in many cases classification according to its chemical/physical characteristics, is indispensable. From there the importance of sorting, which can be done from the moment of generation or later on at an industrial level at a separation and classification plant.

The separation at the source refers to the manipulation of the waste from the moment when they are generated until their temporary storage for collection. Meaning until they are placed in the public space. It constitutes the first citizen step to guarantee an integrated municipal solid waste management. The sorting can entail as many factions as material present in the waste. Thus, in some countries, the citizens separate paper

and carton, plastics, metal, glass, food and garden waste, electronic waste (unusable cell phones), special household waste (batteries, paint buckets, expired medication), etc. For this, different types of containers and bins are used, in which people deposit their waste in the measure that they are generated, to later be object of selective or differentiated pick-up. Thus the different materials do not mix.

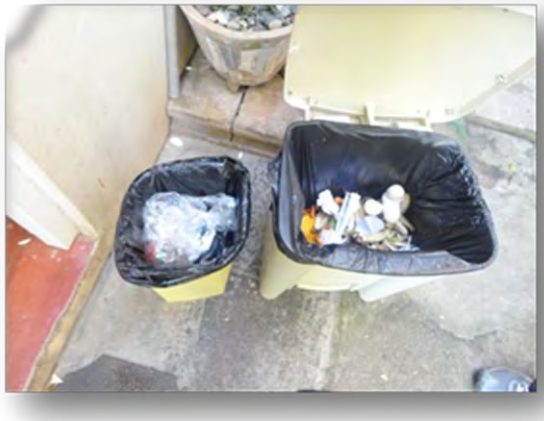


Photo 1 Separation of solid waste in houses of San José de las Matas

In our country, the Ministry of Environment and Natural Resources, together with other civic institutions, initially promotes the separation in the origin of only two categories: commercial recyclables and The Rest, under the understanding that on first instance, the educational level and the socioeconomic conditions of the majority of our country's population does not allow for further separation. Among the commercial recyclable waste are papers, carton, plastics, metals and glass, which must be separated from the rest of the garbage. The Policy for the Integrated Municipal Solid Waste Management contemplates the segregation of special household waste.

Photo 2 Separation of solid waste in houses of San José de las Matas.

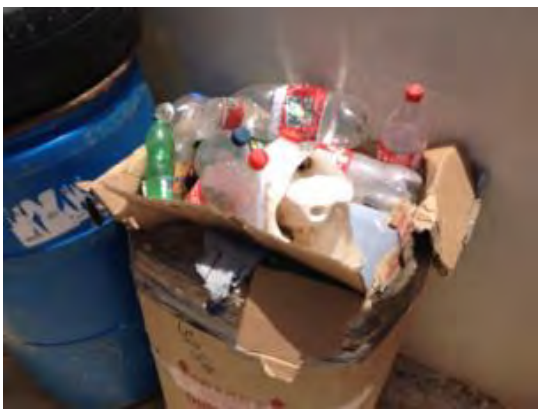


Photo 3 Separation of solid waste in houses of San José de las Matas

A broad information, sensitization, education, awareness effort is required, given that the separation of waste at the source requires some sacrifice and commitment with the citizenry, with the end goal of facilitating the recycling or energy revaluing process of the waste, as well as avoiding treating that the hazardous waste in the same manner as the non-hazardous waste.

2.5 Home Composting

The composting is the process through which the organic material decomposes or degrades, transforming into another element called "compost", a natural product that according to its physical/chemical properties, can be utilized as manure or fertilizer; bringing large benefits to the land and crops. It is a technique of stabilization or biodegradable organic waste treatment.

The composting process can be accelerated and the quality of the resulting product can be improved through the use of a domesticated species of worm. This process is called **Vermicomposting**. The resulting product of this process is called Humus (vermicompost), which is a bioregulator and corrector of physiochemical characteristics of the ground as well as an organic fertilizer.

The following diagram draws up the decomposition process in aerobic conditions (meaning, in the presence of oxygen) that organic matter experiences under certain humidity, temperature, presence of carbon, nitrogen and other nutrients. The temperature delays or accelerates the decomposition process. At a higher temperature, higher speed of decomposition and vice versa.

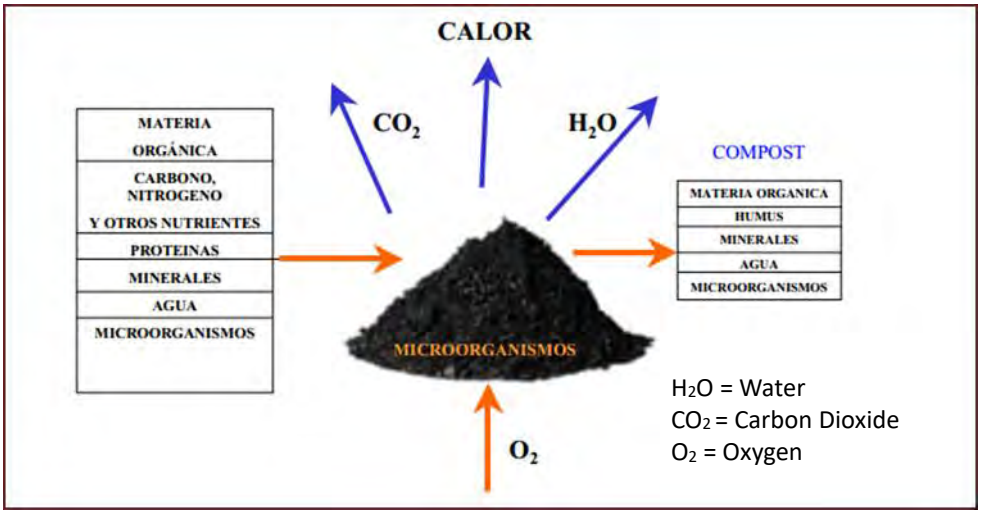
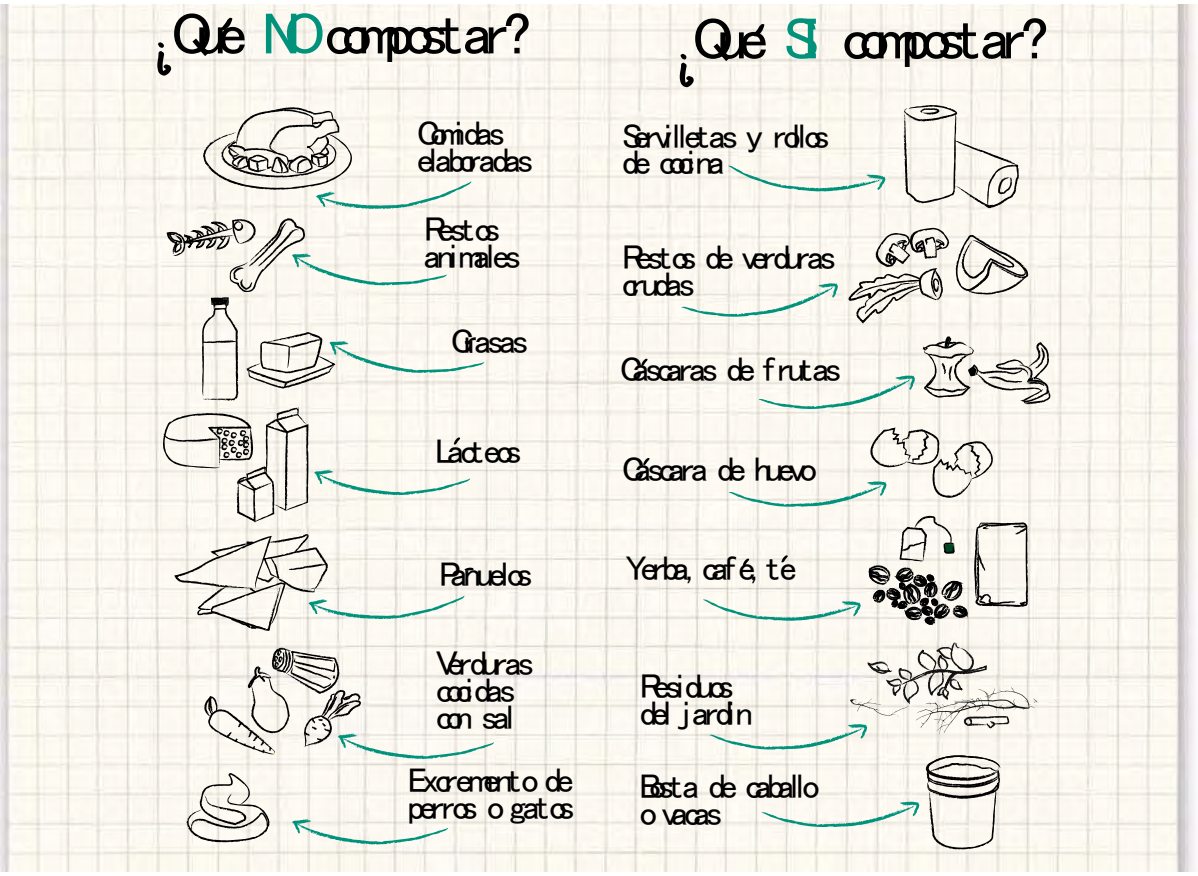


Figure 4 COMPOSTABLE WASTE

This breakdown process can take place at an industrial or household level. The technique can be done at any house, because in reality it does not require any special infrastructure. It can be done on any pile on the ground or in a special composter, which can be purchased or be made by ourselves, taking into account that the same allows the removal of the compost for easy aeration (air ventilation), elimination of excess water and facilitate remoistening, in case it's needed.



Source: Manual for the community awareness and environmental education - Integrated Solid Waste Management. INTI. Argentina

Figure 5 COMPOSTABLE WASTE

HOW TO COMPOST

- Place the compostable waste on a pile, or compost heap. At the base of the pile or compost heap, build a bed or base of twigs, hay or any other material that will allow for ventilation. The oxygen is fundamental for the microorganisms to effectively decompose the organic matter.
- If possible, cover with hay, grass or newspapers, especially during the first month.
- During the first month, remove and mix every week. During the second and third months, mix every two weeks, and then just once a month until it reaches maturity. Removing and mixing allows the required oxygen for the process to permeate.

- It's important that the humidity is kept between 40-60% during the entire process. This can be determined experimentally through the so called "croquette method", which consists of collecting a small portion of sample with the hand (latex gloves can be used as to not stain our hands, for example) and squeeze it, making a sort of small croquette with the hands. The following situations can occur: (1) when squeezing the sample, this one starts dripping, meaning that there is excess moisture. (2) After squeezing the sample, when you open the hand, this one stays wet, but not dripping. This would be the ideal situation, because the humidity would be correct. (3) After opening the hand after squeezing, this one is dry and the croquette falls apart. This indicates a lack of water.
- The humidity level depends of the proportion of dry and humid waste (normally 3 parts to 1, respectively), of the meteorological conditions, and the location of the compost heap in relation to whether the material is receiving direct heat from the sun.
- The compost pile is mature, or ready to be used when it presents a dark brown or black color, you cannot make apart one waste from the other, the mix smells like forestry and it does not emit any heat.

Table 1 Problems that can come up (causes and possible solutions) in the compost

Problem	Cause	Solution
Bad smell	Lack of ventilation (Excess moisture and/or Nitrogen, little mixture) Small pieces of waste	Incorporate brown material (dry leaves, sawdust, chip, dry grass) large pieces: branches, cardboard. Ensure that there is good drainage and mix the compost.
Slow decomposition	Lack/excess of carbon rich material	Add dry or brown materials to incorporate green materials, bung is preferable, as appropriate.
Flies and/or rodents	Presence of meat, dairy or elaborated foods	Remove the waste, cover with cardboard and close the composter.
Ants	Citric excess	Retire the material and cover the composter-.

Source: Manual for the community awareness and environmental education - Integrated Solid Waste Management. INTI. Argentina

Composting was a common practice in China from the year 2000 before Christ. In the San José de Las Matas municipality, household composting is a common practice, whose

roots lay in the implementation of the Basura Cero project.

Photo 4 Manufacture of composter and finished composter in the municipality of San José de Las Matas.

Photo 5 Manufacture of composter and finished composter in the municipality of San José de Las Matas.

In our country the organic matter content of the waste represents the majority – average of 58% of the household waste in the Great Santo Domingo, according to the last study done in 2011[4]. At a national level, this value should be higher, given that this waste increases in the rural population. Which is why composting represents a big opportunity of the valuation of the organic waste, which is returned to the soil in the shape of humus for plants and crops.

Benefits of composting

- Reducing of the amount of waste deposited in the dumps, with the consequent reduction of the potential derived environmental impact, contamination of waterways and soil by waste water, contamination of the air by biogas emissions, bad odors, development of disease vectors associated with the mismanagement of solid waste, etc.
- Decrease of the consumption of fertilizer of chemical origin, contributing to the conservation of the natural quality of the soil.
- The reusing of organic matter, which rejoins the natural cycle.

2.6 Illegal Dumping

What is dumping?

[4] ISWM Master Plan of the Great Santo Domingo. JICA-BID. 2013

According to the Norm for the Environmental Management of Non Hazardous Solid Waste, dumping is the disposal of solid waste on a space with determined conditions. Depending on such conditions, negative impacts to the environment could take place, risking the health of the people and cause environmental decay.

What does illegal mean?

It is any act contrary to the norms in force, established in a country, nation or territory. The norm covers: ordinances, decrees, treaties and international covenants signed by the country, etc.

What is illegal dumping?

When it comes to solid waste, we refer to the action of dumping and disposal of solid waste (garbage) properly in places not established or allowed by the competent authority, whether it is done by particulars or by the municipalities, according to what is established by articles 106 and 107 of the 64-00 law on the Environment and Natural resources.

The constitution of the Republic recognizes as principal objective of the state, the effective protection of the rights of people, as well as the preservation and protection of the environment for the benefit of the present and future generations, achieving an adequate and sustainable management of Human resources; as well as inhabiting a healthy environment, ecologically balanced and adequate for the development and preservation of the different forms of life, the landscape and the nature.

In this sense and taking into account the provisions from Law 64-00 on the Environment and Natural Resources, as regulatory framework, establishes sections for each moral and legal person before the exercise of actions that negatively impact natural resources and the environment and, as a result of this, the quality of life of the Dominican people.

Sanctions and fines applicable

When it comes to the administrative sanctions, art 167 of the Law 64-00 establishes, that Ministry Of Environment And Natural Resources is entitled to apply the following measures:

1) Fine from (½) minimum wages to (3,000) minimum wages in force when the infraction took place, proportional to the economic dimension of the physical

person or legal responsible for the damage and the magnitude of such damage.

2) Limitation or restriction of the activities that caused the damage or risk to the environment or, if it is the case, their subjection to the same modes and procedures that make said prejudice or risk disappear. See also, numerals 3 and 4, and paragraphs 1 and 2 of the same article.

Art.169 establishes that without prejudice of the sanctions pointed out by the Law, whoever damages the environment or natural resources will have an objective responsibility for the damages that could be cause, in conformity with the current law and the complementary provisions, likewise the offender will have to repair the damage caused with his own money, of doing so is possible and pay up according to the law".

2.7 Public Consensus to Solve NIMBY Problem

2.7.1 NIMBY Problem

To guarantee the success of an ISWM, it's essential to count on the active and conscious participation of the population, considering that the process initiates precisely with the control and management of the generation and temporary storage, both functions dependent on each citizen.

The ISWM requires the installation of specific facilities, according to the type of treatment that it's decided on for its valorization, as well as its final disposition. If the citizens of a certain community were to be asked their opinion about the need of counting with this type of installation, it's likely that the answer would be 100% positive. However, if they were to be asked their willingness to accept that the same would be located in their immediate surroundings, the most likely is that their answer would be 100% negative.

The NIMBY ("Not in My Back Yard") syndrome refers to the citizen's reactions when without opposing the activities per se, they organize against the risks that they perceive said installations, that are perceived as dangerous, would bring upon their immediate surroundings due to certain activities or facilities that are perceived to be dangerous or because of the externalities (Direct derived consequences).

The solid waste management infrastructures are frequent objects of the previously mentioned syndrome. It must be recognized that these facilities bring a direct impact to the population and environment: bad odors, development of disease transmitting vectors, presence of air particles in the nearing areas, biogas and waste water

production, among others. Hence, an adequate control of these negative effects, with the goal of guaranteeing the health and well-being of the population as well as the protection of the natural resources, is necessary. Because of this, it's understandable that the population would feel threatened when they learn the intention of installing some or other type of facility in their near surroundings; specially if we take into account that in our country, to this date, there does not exist any previous experience with a 100% correct handling of said infrastructure. It must be recognized that the experience with the installation of the few controlled dumps/sanitary landfills operated in the Dominican Republic until the date has not been satisfactory, making clear that only through a careful design, followed by an adequate operation, through the use of technology appropriate for our surroundings and social/cultural condition of our municipalities and regions; that we will be able to give an adequate response to the appropriate disposal of the non-recyclable solid waste

When it comes to placing sanitary landfills/controlled dumps, transfer stations, selection/classification facilities, solid waste incinerators, among others; the experience, not only in our country but at a world level shows that achieving the involved population's acceptance is one of the most difficult aspects; It has happened before that the location of a facility in a place that technically fulfills all the conditions has been discarded over strong opposition from the communities.

2.7.2 Public Consensus: Solution to the NIMBY problem?

The reality is that a strong opposition exists by the population of the installation, close to their community, of any type of solid waste management infrastructure. To overcome the obstacles it is essential to establish mechanisms of participation and consensus development.

Developing public consensus is extremely important, presenting the positive externalities advantages for the community and/or adopting compensatory measures for the affected populations.

Among the positive externalities that might be pointed out in the area: improvement of the access ways, generation of gas/electricity for household and industrial consumption, employment generation, creation of green spaces as a product of the buffering zones and later closing of the site, among others. Incentives to the municipality where the facility would be located could also be considered, such as lower payment of the service. In the same way, lower service tariffs for the citizens could be considered. Schools, health center, recreation

areas, etc. could be built or be equipped as compensatory measures, with the goal of improving the quality of life of the aforementioned population.

It's necessary to promote dialogue and consensus to avoid, eliminate or minimize the conflicts. This can only be achieved through a joint work methodology that achieves a genuine involvement of the community members in their own environmental management. Starting from this approach, the new currents suggest subordinating the purely technical and economic aspects and focusing on wider subjects, that take everything into account; life, in its physical, psychological and social dimensions. Therefore, the location of a solid waste management infrastructure, like a sanitary landfill, for example, cannot be selected considering only objective criteria/indicators.

The methodology to develop to achieve the public consensus would have as an objective increasing the participation levels of the community members in the solution of their environmental problems. Specifically, in the relation to the waste management. The same must come from a sincere and transparent approach to the community from the initial stages of the project, where the potential developing sites are identified.

It's pressing to involve and wind the trust of the community as the starting step towards the acceptance of a project of such nature. A first step could include meetings with organized community group representatives (neighborhood associations, cultural association, sports leagues, etc.); with the goal of informing and explaining the project so that later they can transmit it to the community. It is also important to incite the support of key players that play an influential role in the chain of solid waste management and the health and education authorities, among others. The formation of a "Committee for an Integrated Solid Waste Management" could also be considered beforehand, integrated by key community members, whose responsibility would be jointly participating along the municipal authorities, in the search of an integrated and sustainable solution to the solid waste problem.

Another important aspect would be the exchange of experiences with communities that have lived through similar experiences and where the implementation of the project has been successful (if any).

2.7.3 Criteria for building consensus among the inhabitants

- Provide clear information and consistent explanations to the community.
- Consider key negotiators among the inhabitants.

- Clearly designate the contact and decision maker persons.
- Organize an internal framework to win the information warfare.
- Clear up of the reach of the project, to be revised with public participation.
- Win trust though sincere and transparent communication.

It's important to answer all the questions and comments of the inhabitants' right from the announcement of the definitive site. The questions of the inhabitants cover a wide range of topics, not only those of construction, but also of the operation of the landfill. Therefore, the decision-making team must be established, with who will have the responsibility of handling the landfill's affairs during the construction phase as well as during the operation.

Table 2 Check list for Consensus Building among the Residents and stake holders

Phase	Main questions and opinions by the residents
Basic plan for waste treatment (Master plan of integrated solid waste management)	(1) Are the targets for waste reduction and recycling clear? (2) Is the facility excessive capacity? (3) Why is this facility necessary? (4) What is the relevance with other facilities? (5) Should the location be decentralize to avoid concentration of the load to one area?
Site selection	(1) Who decided the final site? (2) How was this final site decided? (3) What is the reason for making the final call for this location? (4) Are the past troubles with the residents around the site unsettled? (if there were such troubles) (5) Should the site be selected based on the environmental survey? (6) How will the surrounding area be developed after construction of this facility? (7) Should the residents be participated in site selection? (8) Should information be announced at an earlier stage?
EIA (Environmental Impact assessment)	(1) What are the impacts to the surrounding environment? (2) How about smell? (3) How about water pollution? (rivers, lakes, groundwater, etc.) (4) How about air pollution? (NOx, Sox, dust, HCI, Dioxin, etc. if planned for incinerator) (5) How about noise problem and vibration problem? (6) How about impact due to waste collection trucks? (increase of traffic jam, smell, noise problem) (7) How about flies and birds problem? (if planned for landfill) (8) Will countermeasures be taken against above impacts?

Phase	Main questions and opinions by the residents
	(9) How will the environmental monitoring be implemented?
Correspondence with the residents	(1) Is the setting target residents around the site appropriate? (Aren't the opinions being considered only from few residents?) (2) What are the benefits for the local residents, such as development of new roads, employment of local people, compensatory facilities? (3) Who is the person in charge of public communication for the residents? (4) How will the opinions or requests from the residents be reflected?
Construction / operation of the facility	(1) Will the agreement on pollution prevention be concluded with the residents? (2) How will the environmental monitoring results be announced? (3) If a problem occurred through the monitoring results, what will the countermeasure be?

Source: JICA project team

2.7.4 Structure for the development of Public Consensus

It's the municipality's obligation to provide all the steps and exhaust all the resources to make sure that the community is taken into account and is informed in a clear and transparent manner when it comes to the project that is in the cards. If the project is developed by a private entity, the municipal authority will follow the promoter in the process, given that by law it is its obligation to manage the solid waste in its locality. It is highly advisable to form a structure that would be responsible of the whole process of development of community consensus. A structure proposal is show in the following figure. The decision taking team has whole responsibility, from the construction until the landfill's operation.

Figure 6 Scheme of the parts involved with municipal consensus

What is the role to be exercised by the Ministry of Environment and Natural Resources?

Basically, to serve as technical support for the municipality and ensure the community is properly informed. It is not the responsibility of the Ministry to develop public consensus in the communities, this is the competence of the City Halls. However, once the environmental impact study corresponding to the aforementioned project is presented, the law mandates the performance of public visits, with the mandatory participation of Ministry representatives.

2.7.5 Some steps for the development of the public consensus relative to the installation of a final disposal site.

Prior to the development of any process of public consensus, it is important to highlight that the selection of a final disposal site responds mainly to the technical and legal criteria, in order to protect the health of the population and natural resources. The selection process of a FDS covers three basic stages:

1) Identification of the potential sites.
2) Evaluation of the identified sites.
3) Selection of the definite site.

It is highly recommended to involve the community, from the initial stage, when the location alternatives are being identified.

In fact, principle 10 of the Rio Declaration ratifies the need for citizen participation in

environmental issues, by establishing:

"The best way to deal with environmental issues is with the participation of all interested citizens, at the appropriate level. At the national level, everyone should have adequate access to environmental information available to public authorities, including information on hazardous materials and activities in their communities, as well as the opportunity to participate in the processes of decision-making. States should facilitate and promote awareness and participation of the population by making information available to all. Effective access to judicial and administrative procedures, including compensation for damages and relevant remedies, should be provided.

At the United Nations Conference on Sustainable Development (Rio + 20) held in Rio de Janeiro in June 2012, the Declaration on the Implementation of Principle 10 of the Rio Declaration on Environment and Development was signed. Latin America and the Caribbean. In the Declaration, the signatory countries committed themselves to advancing a regional agreement that facilitates the full implementation of the rights of access to information, participation and justice in environmental matters with the support of the Economic Commission for Latin America and the Caribbean Caribbean (ECLAC) as technical secretariat. Between 2012 and 2014, four meetings of the focal points of the signatory countries and fourteen working group meetings were held. In November 2014, the countries began the negotiation phase of the regional agreement, creating a Negotiating Committee with a view to concluding its work no later than December 2016.

2.8 Citizen Participation In Iswm Projects: Sanchez, Samaná Experience

The municipality of Sánchez is one of the three model municipalities selected by the project "Strengthening of Institutional Capacity in Solid Waste Management" - FOCIMIRS, to elaborate its ISWM plans and execute a pilot project that includes one of its Components. In this sense, the municipality decided to implement the separation of solid waste at the source and selective collection.

In the different social strata of the municipality there was no proper management of waste, nor actions focused on a culture or education based on the practice of waste reduction and / or classification, both in schools and households. After the characterization of the waste in the municipality, it was determined to develop the separation of waste in the source and selective collection, as one of the components of

the ISWM, which must be elaborated and executed from 2015 until 2031.

For the implementation of the pilot project, three sectors were selected (Play Abajo, The Rieles and Hoja Ancha) of the three social statuses (high, medium and low), in order to separate the waste and perform the scheduled collection during eight months.

Photo 6 Meeting at Municipality

Photo 7 Delivery of materials to Sanchez' municipality

In addition, the delivery of materials (caps, T-Shirt, garbage cans, containers, calendars, bags for purchases), for the work of separation of waste in 400 homes.

It began with the presentation of the project to the key stakeholders of the municipality, Presidents of the Neighbor Boards, Directors and teachers of different schools and colleges, among others. The trained team was trained to develop the activities.

Figure 7 Map with the location of sectors within Sanchez' Pilot Project

After explaining the importance of the project on the separation of solid household waste, the community members were emphasized that, although the ISWM plan will be a great solution and hope for environmental rehabilitation for Sánchez, it is the responsibility of the mayor to comply with the municipalities are directly responsible for the success of the project, through a committed conscience and dedicated to being an example for the rest of the municipality.

Weekly weighting of solid waste

Location of the containers in strategic points

Meeting with the general population

Waste segregation

Photo 8 Activity of pilot project in Sanchez

<u>Difficulties in the implementation of P.P.</u>

- ✓ Budgetary limitations of the execution of the activities.
- ✓ Official inexistency of UGAM in the City Hall.
- ✓ The link between recycling companies and the community.

While it is true that as in every process there are small or great difficulties to overcome, without being this the exception, during eight months of execution of the P.P. We have noticed with irrefutable evidence that, little by little, Sanchez is acquiring among its citizens the change and the will of the good habit of separation of waste, reuse and reduction of them. Every day more people are interested in this project, even residents of other sectors that are not inside the PP they ask when this precious activity will reach to their neighborhoods.

Photo 9 Multiple activities developed in the Municipality of Sanchez

2.9 Good Practices for Environmental Education In ISWM In the D.R.

In the country, since many years ago, efforts for the raising of awareness of the citizenry on better SWM have been implemented. It is important to point out some important initiatives that have been developed when it comes to education and the diffusion of good environmental practices:

- **SABAMAR project (2002-2006)**, which objective was the establishment effective mechanisms for the collection and disposal domestic solid waste in zones that are difficult to access in the National District, through 3 complementary activities: creation of micro-companies of waste, sensitization of the users and strengthening of the capacity of the Institutional Urban SWM.
- In 2004, with the financing of BID, through MINERD and the Technical German Cooperation, didactic guides on environmental education related to solid waste were made. These were directed to teachers and were revised in 2013.
- In 2008 the RED GIRESOL DOMINICANA y the CCN were established for the ISWM –CCN-GIRESOL, through the triangular cooperation of Germany, Mexico and the Dominican Republic. Said network organized the training of "1st Generation of Environmental Promoters for ISWM". Later, in 2009, the training of instructors took place in Mexico, who later would be responsible of the training of the "2nd Generation of Environmental Promoters for ISWM", carried in 2010. In 2011 the inter-institutional agreement of cooperation is signed between the organizations that conformed CCN-GIRESOL, which, to date, is still in force and is formed by MARENA, MSP, MINERD, MEPyD, LMD, FEDOMU and the National Network of Companies that Support Environmental Protection –ECORED, the formation of the 3rd generation of environmental promoters was focused on the sanitization of dumping sites, under the sponsorship of GIZ.

- In 2010, CEDAF started an educational program in schools, called “I recycle”, with the sponsorship of the Dominican Popular Bank. Afterwards, in 2013, the program was renamed, “I recycle with Clean Points”, because it won't be limited to the educational part, because it also proposed the creation of Clean points. At the end of 2013 there were about 100 clean points located in schools of the Great Santo Domingo, Santiago, La Vega and Moca. The 3Rs programs of CEDAF, sponsored by the private sector, they have reached more than 700 educational centers, according to the reports provided by the institutions.
- In the year 2010, the city hall of San José de Las Matas started the implementation of the “Basura Cero” program, with the support of GIZ, in three specific neighborhoods: Ojo de Agua, Los Jardines and Ensanche Las Palmas. The development of this project implied a strong component of training and community sensitization. The change of habits of the population was the most difficult part. In this sense, a group of promoters was trained to communicate with the households, who follow-up and supervise systematically. The schools widely supported the process.
- In 2011, CEDAF under the auspice of ARS Universal and SERIGRAF and with the support of MARENA and MINERD, published the 3Rs Guide: REDUCE – REUSE – RECYCLE, a research document on 3Rs.
- ECORED, with the support of the Inter-American Development Bank through the MIF, since 2013 has initiated projects for classification and selective collection with formalization of informal segregators (divers) in the municipalities of Santo Domingo Este, Samaná and SPM, which include awareness and involvement of community members in the sector where they are carried out.
- In April, 2013 the first “National Recycling Week” sponsored by MARENA, with the support of CCN-GIRESOL and other organizations of the civic society, with the objective education the general population on the SW problem and promoting the recycling culture. In said week, the “Classifying, you contribute” campaign, sponsored by ECORED, was launched, this one was diffused by the media with the support of LMD. The national week of recycling is an initiative of permanent nature, around May the 17th, declaring it as “World Recycling Day” or “International Recycling Day”.

Projects on SWM and activities on environmental and sanitary education have been developed, these were supported by the local offices of organisms and international agencies for cooperation and development (BM, JICA, GIZ, UNICEF, UNDP, USAID, UE, AECI), NGOs (CIECA, IDDI, CEUR/PUCMM, CEDAF, CEDECO, Centro Juan

Montalvo), The city halls and institutions related to them, such as LMD and FEDOMU; Companies, associations and micro-companies within the communities FUCOSAGUACIGUA, FUNDSAZURZA, ESCOBA), among other institutions and organizations. Traditionally, environmental education programs have been developed by MARENA and MINERD.

PART II

3 PLANNING OF THE ENVIRONMENTAL EDUCATION AND AWARENESS PROCESS

3.1 Creation Of A Team Responsible For The Environmental Education Process

Even though Law 64-00 in Environment and Natural Resources and Law 176-07 on the National districts and The Municipalities assigns the environmental education responsibility to UGAM, we understand that in order to ensure the adequate planning and execution of the Environmental Education and raising of awareness process, it is necessary that each city hall creates an operative structure that links all the instances relating directly or indirectly with SWM and community participation. To develop projects, programs or plans, it is necessary to rely on an organizational structure or a work team responsible of planning and executing all the activities/actions, efficiently and effectively, but above all, sustainable through time.

Not all the city halls rely on the organizational structure, for this reason we cannot establish a unique structure. Each city hall will have to create said structure according to the structural and functional units related to their own topics. Below you will find the possible instances that could be part of the organizational structure of the team proposed for such an essential activity:

- The Environmental Management Unit –UGAM
- Department/ Urban Sanitization Unit
- Department/Community Participation Unit
- Department/Social Development Unit
- Department/Health and Gender Unit
- Department/Public Relations and Communication Unit

3.2 Investigtion and Assesment of the Current Situation Of ISWM

The first step for the planning of the Environmental Education process is to evaluate the current conditions of SWM in the community in question. The necessary information on the current situation and problem on the solid waste management must be collected for its subsequent analysis, through the development of different activities,

as field investigations, surveys, workshops, discussions with groups of interest and key stakeholders, discussion meeting, etc.

The activities of public consensus must cover all the sectors and groups of the society in the target area, in the urban and rural area. In the other hand, the topics cannot be limited only to topics related to the waste management, but must also include general aspects on the environment in order to push changes to the behavior desired.

3.2.1 Current Situation in the Local Communities

In order to be able to formulate an efficient ISWM plan, it is essential to know and understand completely the reality of the SWM in all of its aspects, especially in those that are critical. Below are the essential aspects to consider.

- Current SWM problems and its causes.
- Identification of institutions and organization related to the SWM.
- Compression level to the public on Solid Waste Management (preservation of the environment).
- Compliment of the persons on the rules regarding placing the wastes for its collection.
- Activities of the segregators.
- Level of satisfaction of the existing services of cleaning, collection and transportation.
- Level of awareness of the population in regards to SWM.
- Partnership among the civil societies, businesses and the government.
- Willingness of the persons to pay for the cleaning, collection and transportation services.

While the collection of information, it is convenient to identify key stakeholders that can assume the consensus activities for the communities in the future.

Each municipality has different characteristics, but a lot of similarities when it comes to the management of solid waste. Likewise, groups of people who behave differently can be found. The class society constitutes a hierarchical division based mainly on the different levels of income, wealth and access to material resources. It is something basic for the city hall to know how the municipality is structured. Generally, there is a classification of three types of social classes: High, medium and low.

However, sometimes, they are divided in a different way, likewise, it is necessary to know how many of each group there are in each municipality in order to ease the teaching process, because different learning tools and information diffusion strategies

can be used for each group.

3.2.2 Current situation of educational centers

Public and private schools constitute spaces of great importance, because kids and young people transfer their knowledge and their good practices to their families. This is why it is important to consider them for the public EE and awareness process.

The current situation of the schools in regards to the environmental education and SWM must be known and understood as exactly as possible, through the appropriate tools such as workshops, focal group discussions, surveys, field inspections, etc. The following points must be included:

- The number of schools that has environmental education and environmental management activities, comprehension and interest of the teachers, didactic materials, methods, etc.
- Current public education on the SWM and other environmental matters, including the target groups, methods, providers and environmental education, didactic materials.
- Possibilities of collaboration among the different schools and local communities.

3.2.3 Evaluation of the situation found

It is necessary to analyze each problem, identify their causes, the impacts associated and the ones in charge. Likewise, the possible solutions to the problems pointed out must be identified, taking into account the parts interested in all the phases of the necessary activities to solve the problems. By interested parts we mean the people, institutions and organizations interested on the development or on the result of the plan. It is advisable to present the results as a matrix where the problems, causes, impacts, responsible parts, possible solutions and interested parts are shown.

3.3 Definition of Priority Issues and Objectives of the Environmental Education Plan

Not all the problems have the same level of importance. On the other hand, it is not possible to face all the problems at the same time. After an analysis of the current situation of EE and citizen participation, intervention priorities must be established. Below you will find some selection criteria for the selection of priority issues:

- Level problem.
- Geographical scale of the problem.

- Urgency to solve the problem.
- Technical capacity to handle the problem.
- Financial capacity to handle the problem.
- Availability of human resources for the realization of activities.
- Impact expected after solving the problem.

After identifying priorities, we must define the general(s) objective(s) to achieve when it comes to each priority problem identified.

3.4 Elaboration of the Environmental Education and Information Diffusion General Plan for the Community

Based on the analysis and evaluation of the results found and the establishment of priorities, strategies, actions and appropriate measures for increasing public awareness on ISWM will be implemented, taking into account the local conditions and the available resources. The sequence to be followed will be as follows:

- Define GENERAL OBJECTIVES, which means, results to be achieved. They must be evaluable /verifiable and have a defined duration.
- Elaborate an ACTION PLAN, to identify means for reaching objectives (tasks, activities, resources, responsibilities)
- CONTROL the fulfillment of the objectives by determining measurable indicators.
- EVALUATE the achieved results.

The needs of environmental change will be the objectives of the plan. The ways of achieving them will be formulated as “action strategies” and through “activities” and “resources” the “strategies” will be implemented.

The strategies refer to measures/actions to reach objectives and determine the fronts where action must be taken. The design of a strategy must be based on the following elements: (a) its reach, (b) target demographic (c) contents, (d) writing of a work plan e) selection of the media.

It is necessary to define the action plans, which specify with more detail the measures/actions to be executed.

It is necessary to plan the monitoring for the execution of the planned activities, in order to ensure the results expected and the achievement of objectives.

3.5 Elaboration of Action Plans

The steps to follow for the elaboration of an action plan are the following:

1. Defining specific objectives.
2. Define activities to reach the indicated objectives.
3. Assign roles and deadlines.
4. Specify the required resources for each task: work team y necessary means.
5. Determine the control indicators for each task
6. Create the budget for each task.

PART III

4 IMPLEMENTATION OF THE ENVIRONMENTAL EDUCATION AND INFORMATION DIFFUSION PLAN

4.1 Capacity of the Team Responsible for Execution

4.1.1 Process of Environmental Education

After conforming the team responsible for the process of EE, the next step for its training. Must be elaborating a basic program of training and the topics to be covered, environmental issues and ISWM must not be the only topics to be covered, techniques and tools related to and effective transference of knowledge

Training is a tool crucial to improve the attitude, knowledge, abilities and behavior of the people. Therefore, it is essential the people responsible for environmental education are trained on the solid waste management topics, knowing that they will teach different social groups.

It is advisable to request the support of certain institutions, such as MSP, LMD, FEDOMU, MARENA, MINERD, among others, which take into account technicians trained on the topic that can support the development of a training program.

The people responsible of promoting the participation of the citizenry must interact in the following way:

- Respecting the initiatives and aspirations of the citizens and communities co-responsible of ISWM.
- Learning of/with the citizens instead of teaching them.
- Motivating, collaborating and cooperating with the citizens instead of supervising, inspecting and ordering.

4.2 Interinstitutional Coordination and Aliances for Environmental Education on ISWM

To carry out the implementation of the component of environmental education in the Municipalities when it comes to ISWM, it is necessary to have the participation of the institutions that, one way or another influence the lives of the members of the community when it comes to enjoying a healthy and free of pollution environment. This

implies that the municipal authorities have the responsibility of coordinating joint actions with institutions, such as MARENA, MSP, MINERD, National Police, AMET, MITUR; among others, and their local or provincial representations.

On the other hand, the commitment of the other key actors is required, such as the community groups (community councils, clubs, associations, ecologic groups, etc.), NGOs linked to the protection of the environment and/or ISWM, business association, etc. Churches an important role to develop, because of their influence. It is necessary to make them a part of the process and create alliances.

To achieve the planned objectives, it is very important to integrate all the social sectors, joining efforts to fulfill the objectives of ISWM. In this sense, it would be advisable for the municipal authorities to take responsibility for the creation of a coordinating entity (committee, commission, council, etc.) for the support the actions planned, it will count on the participation of representatives and the key actors mentioned before.

To achieve the participation and commitment of said governing entity with ISWM, a basic formation on the problem with current SWM and the benefits of ISWM as a solution must be developed.

The collective activities help solve problems that could come up as SWM is carried out, at the same time that it contributes to the change of individual behavior. The community organizations take initiative and exercise primary roles to promote the raising of public awareness. In that sense, the municipality or municipal community must coordinate between the municipal services and ISWM and the activities of the community organizations and support the activities of the communities.

4.3 Activities to Develop in the Environmental Education Process

1) Meetings of periodic coordination with the actors involved

These coordination must be focused on activities for the achievement of the objectives established in the plan. It is very important, to define and identify the direct person or entity responsible for the activities.

2) Training workshops

Before starting any EE plan it is important for the team in charge, on the city hall's behalf, to receive an adequate training to exercise the previously established labor, both in terms of knowledge of the SW problem and when it comes to the ISWM literature, as well as on concepts, methods, methods, resources and strategies of diffusion and

communication of information. Said training must be focused on specific points, such as:

a) General knowledge on solid waste.
b) Stages of SWM and complementary aspects.
c) Impact of inadequate management.
d) Specific orientations on the purpose of the implementation of the plan within the community.
e) Aspects relative to the follow-up and monitoring of the plan.

Points to be taken into account in the workshops:

- Purpose.
- Number of people to be trained. Time established.
- Identification of topics.
- Selection of topics to be exposed in each workshop.
- Identify the type of instrument and/or material used for the development.
- Location of the places where the capacities will be developed.
- Schedules of the workshops.
- Among others.

3) House-to-house sensitization

The habit of nor properly managing solid waste, has turned into a custom in our country. The direct personal contact established through the exercise house-to-house visits conforms an excellent means to sensitize the community on the need to change such practices and motivation to participate in the new management model that we are trying to implement. The sensitization house to house is a valuable resource to be used in order to achieve the change of attitude and behavior needed.

This strategy presents a disadvantage that requires a lot of time, human resources and even financial resources (e.g., food for the collaborators). Taking that into account it would be necessary to evaluate the reality of each municipality. However, it is possible to incorporate the students of the public and private, as well as young who belong to community groups and even voluntaries on their own account. On the other hand, sponsorships could be sought for among the businesses and companies within the municipality.

During the carrying out of these visits, educational material in regards of ISWM could

be provided.

4) Points to be considered for the house-to-house sensitization

- Contact the community councils at the neighborhoods involved in order to join their support for this activity.
- Preparatory Meeting to identify the neighborhoods where the activity will be carried out, define the content of the basic information to be handled by all the people responsible of the visits and allocate them by neighborhood.
- It is important that the people in charge of the visits are properly identified. If they use caps or t-shirts, it is recommended to avoid colors related to political parties, especially if such parties are easily recognized by the general public.
- During the realization, it is important to design a coordinator to help the people who will carry out this activity if any inconvenience comes up.

5) Community Meetings

It is important to carry put meetings with the community, which could be done periodically in order to learn about what happens through the implementation of the activities and plan the next steps to be followed. They can also be done in a extraordinary fashion, if deemed necessary, according to the special circumstances that come up.

It is recommended that the municipal team identifies key personnel and/or community leaders that could serve as direct links to inform about activities to be developed on the management of SW. Said people would be responsible of the diffusion of information, motivating the active participation of the project.

Before each meeting, the following is recommended:

- Taking into account the number of participants. Meetings with a small amount of personnel are easier to handle and could obtain better results.
- It is necessary for the dates and times chosen for the meetings to be convenient for of those that will have to participate, so it can be ensured that more people will participate. It is convenient to establish some mechanism to remind the participants about said meetings (e.g., word of mouth, through the community councils).
- In each meeting, we must be prepared to hear about possible conflicts that could come up and for the different ideas exposed by the participants.

6) Cleaning days

"Actions are stronger than words". Cleaning days allow to involve the community with the cleaning and beautification of their neighborhoods. They are a means of practical sensitization. Teach with example. Could serve as framework to teach the community that keeping the environment clean is not an exclusive responsibility of the city hall and encouraging A change of behavior.

It would be advisable, during the carrying out of the cleaning day, for a municipal authority to be present.

Solid Waste collected during the cleaning day, must be classified for its subsequent harnessing. In this case, it is necessary to coordinate the place with the intermediary agents, so at the end of the cleaning day they can be taken to a clean point.

Before carrying out the cleaning day

- After identifying the neighborhoods where the cleaning days were carried out, days before its elaboration, a periphery vehicle could be used to inform them about the cleaning day.
- Carry out a survey in the neighborhood in order to find out how the collection service works on the city hall's behalf.
- Carry out an inspection of the neighborhood, in charge of the coordinator committee of the project, (at least a week before), in order to know the magnitude of the waste to be collected and prepared for such end.
- Prepare a list of the required resources (bags, gloves, shovels, wheelbarrow, etc.)
- Invite the local media.
- Coordinate with the community council the possibility of monitoring the target areas for the cleaning, in order to avoid for them to turn into improvised micro-dumping sites.
- The cleaning day could end with a playful activity, alluding communal activities.

7) Talks

The first talks will be directed towards the different key actors, already identified in the community. Afterwards, different orientation talks will be carried out with members of the community on the adequate SWM and its benefits when it comes to the protection of human health and the environment.

8) Recycling Fairs/Workshops for the elaboration of crafts based on discarded recovered materials

Another way of motivating and/or involve the community is through the implementation of recycling fairs and workshops of craft elaboration. These allow for the members of the community to be able to take advantage of those materials that are considered by them as "Garbage", i.e., without value. But once transformed into a craft, can be used by them or provide them with economic benefit. The workshops can be designed for trainers or for mere members of the community. Housewives, and the young student population are good target demographics.

9) Recommendations

- Contact crafters of the community or from outside the community.
- Train students or members of associations, the potential to become crafters and trainers of such art.
- Having a stock of recyclable materials to be used in the crafting workshops, requesting the collaboration of the community.
- Elaborate a list of materials required and request a contribution from the participants.
- Elaborate a results verification list, with a before and after of the implementation of said workshops.

10) Separation at the source and household compost programs

The pilot programs of separation at the source for the recovery of recyclable materials and compost at schools, universities, public institutions, etc., are excellent means to motivate and raise awareness when it comes to ISWM.

11) Garage sale

These are an excellent way to promote the 3Rs, while they allow the acquisition at low prices of articles not being used by the owners.

12) Contests, acknowledgement and incentives

How can the community participate in the achievement of the objectives of ISWM?

1) Participating in talks, workshops and cleaning days sponsored by the city halls.
2) With the decrease of waste at the source through the responsible of products with a lower amount of packaging or that are elaborated through production modes that friendly with the environment.
3) When consuming products elaborated through clean production models or under

strict environmental protection norms.

4) Separating the waste generated at the source, which allow their incorporation as raw matter in the production chain, contributing to the rational use of natural resources.
5) Respecting collection days.
6) Storing the waste adequately and in the place designated until the day established for their collection.
7) Paying the tariff for the collection service.
8) Collaborating with the city hall at the moment of choosing an FDS, achieving consensus by supporting favorable alternatives for both.

It is fair to stimulate and reward the good participation of the community in the ISWM. The carrying out of contests, the delivery of acknowledgements and the establishment of incentives to the users of the service are excellent means to acknowledge good practices and promoting the cooperation of all the actors involved. Incentives, such as a discount on the tariff or the delivery of bonuses for shopping at local businesses could contribute to promoting the active participation of the general population.

4.4 Diffusion of Information to the Community

An important part of the responsibility of Urban SWM rests on a population that is aware of its responsibilities, taking into account that it is precisely within the population where the first stage of the whole process starts: the generation and handling within the household and its later presentation in the public road for its collection.

The education and active participation of the population is necessary for an informed citizenship to accept an ISWM that is sustainable. Achieving the responsible participation of the population requires the development and implementation of an adequate strategy of diffusion that takes into account the cultural backgrounds of the country and specific places, in order to encourage/improve the cooperation of the community and ensuring the sustainability of the system. Said strategy must take into account not only the aspects directly related to SWM, but also others of global nature related with the environmental problem in general. In this way, environmental education, information divulgation and public participation go together.

Divulgation is the action of spreading information, i.e., spreading, promote or publish something to place within the general population's reach. Therefore it is associated with

the task of communication. Previous to this action, it is necessary to know what will be divulgated or informed, to whom (target audience), how (means/method), where and for what (objective).

In this case, the objective is achieving sensitization/awareness among the community on the adequate solid waste management from the standpoint of the 3Rs and harnessing of discarded materials. Once the reality f the community is known, carious points must be verified:

- The identification of the key institutions involved (Community council, community, schools, churches, community organizations and other groups of interest).
- The identification of the actors to where the information will be taken.
- Identification of the coordinating team with key actors and involved sectors.
- Amount of inhabitants that live in the area where the information will be taken to.
- Amount of households.
- Solid Waste Collection behavior on the authorities' behalf.

To provide the information required and achieve the desired impact on the population, all means, methods and communication strategies necessary can be used.

- House-to-house visits / Personal contacts.
- Meetings with the community.
- Delivery of flyers, handouts, sheets or informative bulletins.
- Installation of signs, posters and billboards in public places.
- Landline/call center.
- Internet.
- Videos/documentaries.
- Mass media.
- Campaigns.
- Others.

4.5 Resources and Means/Methods for the Diffusion and Communication

The selection of the means and methods to be used for the divulgation and communication of the information required towards the community depends on different factors. First, the availability of financial resources assigned to the budget and of human resources (When it comes to amount and availability) must be taken into

account. It is also necessary to consider the nature of the activity, program or project that wants to be implemented.

There is a wide variety of means (Printed or not) that can be used for the communication with members of the community, each of them with their advantages and disadvantages, which must be analyzed before the light of reality, both on behalf of the community as on behalf of the city hall. These stand out:

1) Home-to-home visits (Personal contact)

These allow direct contact with the community, which increases the possibility of them understanding the message better and of raising awareness.

2) Community meetings

In this case, it is important to establish a connection with the leaders of the community councils, who would be collaborators in the announcement and coordination of the meetings. It is important to define who will be the intermediary with the City Hall. The Community Councils represent a great level of support when it comes to the activities related to ISWM.

The meetings, depending on its objective, could be done with the participation of the community (by neighborhood) or with the representatives of the directors of the community councils of the different sectors of the municipality. It is necessary to create ties of trust and of mutual respect, in order to establish good relations with the leaders if the community and other key actors. This requires time and sincere and honest actions on behalf of the authorities, avoiding manipulation.

3) Delivery of flyers, brochures, fact sheets, bulletins

a. Flyers

This is a simple way of promoting and spreading a concrete piece of information on an activity. This is generally printed on one half of a sheet of paper, whether it is just on one side or on both. They contain brief and specific information. They must be didactic, easy to read and preferably with graphic representations (images and illustrations). The size of the font must allow clear and reading of the message. The message must be direct and intelligible.

The can be delivered in the visits hoe-to-home, in the meetings with the community or during the collection. They allow to reach a great amount of people, however, their impact is short term.

The amount to be printed is determined by the number of residents in the target area.

b. Brochures

A brochure is a printed document with small amount of pages used to divulgate information or to advertise something. It can be delivered directly or via mail. It has an informative end. It must be a summary with the main points of the technical, informative message, where the problem has to be described, as well as the solution proposal.

It is used to ensure the longevity if the information in a talk or can be handed in before meetings, workshops and conferences.

In the case of the promotion/sensitization of ISWM, brochures elaborated by other institutions can be used, likewise, the city hall can create their own didactic material. However, it must be considered that the cost of elaboration and printing. Financing by third parties can be managed.

c. Sheets or newsletters

The sheets and bulletins are an excellent means to keep the community informed, as well as the personnel of the city hall on the advance of the activities and projects of the municipality, indicating the achievements reached. On top of that, generally, the bulletins contain articles to encourage public raise of awareness.

4) Placing signs and billboards on the public road

Signs and billboards are a notice placed in a public place to spread information. They contain a visual message that can include text, images and other graphic resources. They should be easy to read and have contrast of colors (dark and clear colors), with the objective of achieving a strong visual impact. The letters must not have glitter on them or high relief. Depending on whether it is designed to be seen by passers-by or from vehicles, the size is different and adequate to the end.

When it comes to the location, the signs or billboards must be placed on visible places, so they can be seen any resident or driver, depending on whether they will be seen by the target audience or not.

In a nutshell, the message must be:

- Shocking, so it attracts the eyes of the residents.
- Simple and easy to understand at first glance.
- With brief and direct text related to the image.

- With bright and contrasting colors so it stands out.

5) Landline (call center)

The enabling of a landline, so the community can receive answers to their needs is an option to be considered by the municipal authorities. Some City Halls of the country can count on this service. This is the case of the ADN and Moca. This can also serve as a channel for the reception of complaints by the users.

6) Internet (Webpage, social media)

According to the reality and needs proper to the municipalities and taking into account the reach and facilities offered by the internet, the use of this resource can be considered for the diffusion of information and the raising of awareness among the residents.

The creation of an e-mail and a website, as well as the use of social media (twitter, facebook, instagram, etc.) are low cost means that represent a more efficient use of time. These are powerful tools, mainly if reaching the youngest demographics is desired.

7) Production of videos/documentaries

Videos and documentaries are excellent, practical and dynamic didactic tools to display problems, promote solutions, encourage the cooperation of the communities, encourage good practices, call for reflection and cause changes of attitude and behavior when it comes to the adequate management of solid waste. We must recognize that they have a very high cost. However, it is always possible to manage their financing, because of this it is an option that cannot be discarded beforehand.

8) Use of Mass Media (Radio, TV, newspapers and Magazines)

The mass media, mainly television and radio are excellent means to raise awareness among the citizenry, taking into account that they use basic communication elements such as word, silence, music and sound. Their biggest disadvantage is their high cost. Obtaining the collaboration or the support of these means is key to spread information related to ISWM.

9) Campaigns

These are normally spread through a motto or slogan, which is a short phrase (as much as six words) containing a clear message, direct and understandable, so that it can be easily memorized by the target audience. The slogan must summarize the objective of the campaign. The mottos or slogans are a means to raise awareness, so they do not have to be associated to any campaign.

10) Other means and divulgation methods

- The design of the **collection bill** of the service can have a space destined to serve as means of commercial or educational information.
- **The carrying out of contests/Acknowledgements** between different sectors of the community supports the collaboration of the communities, translating into changes if behavior.
- **The billboards** are usually very effective media, due to their great visual impact. It can be placed in educational centers, businesses, public spaces, health centers, public and private institutions, etc. Their elaboration can be object of litigation.
- **Painting of murals** is an excellent means to recover and make spaces more beautiful, while a message is communicated. They can contain written information. This technique of divulgation is trending in the country.
- **Operations/Cleaning days** communicate a message to the residents. Its impact is short term.
- **The visits to SWM installations**, such as transference stations, intermediate treatment facilities and final disposal sites, mainly destined to school groups, allow that the ones involved know what happens with "garbage" once the trucks collects it, making the environmental impacts of an inadequate SWM evident.

4.6 Monitoring and Evaluation

Completing the cycle of continuous improvement, it is necessary to monitor and evaluate the activities of communication of educational information, as well as of de simple communication of the message, with the objective of knowing and value the effectiveness of the content and the divulgation methods used, before the success of the ISWM objectives.

With the established frequency, the level of divulgation and satisfaction regards of the service will have to be monitored. The personnel responsible will have to verify if there are critical/ problematic points or complains from the population.

- Satisfaction and knowledge acquisition survey.
- The monitoring will be done mainly through surveys of satisfaction and acquisition of knowledge. In the community meetings complaints from the community can also be heard. Below you will find an example of the monitoring sheet:

Table 3 Monitoring sheet of citizen perception

Hoja de Monitoreo

Información y Comunicación con la Comunidad

Area de Monitoreo: .....

Nombre (entrevistado/a): .....

Fecha :..... Encuestador: .....

No.	Cuestionario	Si	S/R	No
1	¿Conoce usted la frecuencia del nuevo servicio de recolección?			
2	¿Ha recibido usted una información previa y explicación antes del comienzo del nuevo servicio de recolección"?			
3	¿Por qué medio se enteró de la infomación?			
	a. Volantes	☐		
	b. Carteles/Letreros	☐		
	c. Reuniones en la comunidad / de vecinos	☐		
	d. Encuestas	☐		
	e. Otros (mencionar):	☐		
4	¿Está usted cumpliendo con la información suministrada (cómo sacar la basura, frecuencia y horario de recolección)?			
5	¿Está usted satisfecho con el "Proyecto de Mejoramiento del servicio de Recolección"?			

Source: Manual for the diffusion of the information to the Community - ADN 2005

Call Center for the reception of complaints

The phone is an appropriate means to receive the complaints of the users. The same landline can be used to inform and cover the needs of the clients, as well as for receiving complaints.

The monitoring system established must cover activities that allow the control of illegal dumping. Billboards and signs allusive to this bad practice must be established, indicating the correspondent sanctions. The places where this action is carried out must be identified and monitoring must be carried out more frequently in the beginning, this monitoring will be decreased as the change of behavior is confirmed.

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ANNEXES

Project For Institutional Capacity Development On Nation-Wide Solid Waste Management In Dominican Republic

Manual for Financial Management of the Integrated Solid Waste Management

May 2017

NIPPON KOEI LAC
NIPPON KOEI

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INTRODUCTION

Since the municipalities must have enough capacity to control the performance of all of its activities in the solid waste management, it is necessary for the municipalities to implement a financial management system, with a focus of achieving a higher efficiency and effectiveness in the services offered to the population.

In this sense, the Ministry of Environment and Natural Resources started the “The Project for Strengthening the Institutional Capacity of Nation-Wide Solid Waste Management in the Dominican Republic (FOCIMiRS)” in January, 2014, with the support of the Japanese people through the Japanese International Cooperation Agency (JICA), which will have a duration of three years.

During the project discussions, the need of preparing supporting materials was identified, these serve as support to the municipalities for the preparation of their ISWM plans. That is why the elaboration of manuals that cover all the stages for the waste management was contemplated as well as other very important aspects to ensure the sustainable integrated management of solid waste.

That is how the ‘‘Manual for the Financial Management of the Municipal Solid Waste Nationwide in the Dominican Republic” was born, with the objective of providing the municipalities with a tool that allows the preparation, previous estimate and cost analysis of management, as well as the income analysis. With which they will be able to elaborate the required budget for the execution of a quality service. This manual describes the steps to be followed for the establishment of an accounting system for ISWM.

OBJECTIVE OF THE MANUAL

Provide a tool, so the municipalities can develop the capacity to elaborate an accounting system for ISWM, this system has to allow the understanding of the financial condition of each municipality. The accounting system of each municipality can be developed with the cooperation of MARENA and its provincial offices.

1 LEGAL FRAMEWORK

The following are the legislations related to the financial management of ISWM:

1.1 Norm for the Environmental Management of Non Hazardous Solid Waste (NA-RS-001-03)

Point 3, “On principles”, paragraph 3.9 indicates: “The strengthening of municipal finances is essential for a satisfactory management of waste. To ensure the financing of the service, tariff and municipal collection systems could be established. The tariff systems must incorporate a differentiation system when it comes to income, type of productive activity or amount generated, depending on the case. The mode of collection will be established by each municipality.”

1.2 Policy for the Integrated Municipal Solid Waste Management (ISWM).

Point 5, on ‘‘General Guidelines of the Municipal Solid Waste Management Policy’’, course of action 5.4 establishes, in paragraph 5.4.3 (a) that ‘‘the municipalities are supposed to design and apply a tariff system and a fee collection system for the users of the community. For the development of these activities, the municipalities are entitled to subscribe contracts or covenants with private or public institutions.

- 5.4.3 (c) about “Define specific roles and institutional mechanisms” it is stated that: “At a municipal level: to access the resources of the central government, the municipalities will represent their ISWM plan through MARENA. The availability of funds, and eventual subsidy, granted by the central government, will be subject to the achievement of the goals set in the plans, as well as the disposition and commitment to push and ease the formation of municipal communities”.

1.3 Law # 176-07 on Nacional Distrit and the Municipalities

- Article 211 on ‘‘Forms of Management’’ establishes that ‘‘The municipal services may be managed as any of the following ways’’:
  - ✓ Direct Management: a) Management done by the municipal entity; b)

Autonomous Municipal Organism; c) Municipal Public Company; d) Municipal Commercial Society, its social capital belongs to the municipality or to one of its public entities.

- ✓ Indirect management: a) Concession or delegation; b) Unilateral Management; c) Lease; d) Commercial Society and legally constituted coops, its social capital belongs, partially, to the municipality; e) Consortium.

- Article 216, on ‘‘Construction projects’’, indicates: ‘‘Construction projects must have blueprints, a development budget, a memory that includes a detailed correlation and an approximate assessment of the value of the land, as well as the constructions that have to be used and both the technical and economic conditions. Paragraph. The Municipalities will follow the standards and parameters established by the different sectors of public administration when it comes to construction projects’’.
- Article 217 on “Cooperation between Organisms, Government Entities and Institutions and External professionals” points out that: “When the municipalities lack the technical personnel for the development of plans and construction projects or the installation of services, they may request the technical cooperation of organisms, government entities and institutions and the civic society or proceed to hire external professionals”.
- Article 218 on “Construction plans and Municipal Services” establishes: “The works covered by the plans and construction projects and municipal services, if required, will annex the public utility declaration and the occupation need of the lands and buildings they include due to its expropriation”.
- Article 219 on “Intermunicipal works states: “When a work concerns 2 or more municipalities, said work could be done through an agreement between the concerned municipalities”.
- Article 220 on ‘‘Hiring Capacity’’ indicates: “The municipalities will have the capacity to arrange contracts for the acquisition of goods and services as long as they are not against public interest, the legal system in force and the principles of good administration. Paragraph. - The procurement system, concessions, award of contracts and procurement of goods and services of municipal administration will be subject to the principles of publicity, transparency, equal opportunities for interested parties and bidders, promoting

competition, and accountability of municipal officials in charge".

1.4 Law # 340-06, on procurement and contracting of goods, Services, Works and Concessions with modification of the law 449-06

Define as the faculty that the State provides to individuals, natural and legal people, so they can, on their own and at their own risk, build, install, improve, add, conserve, restore, produce, operate or manage a public construction work, good or service under the supervision of the conceding public entity, with or without occupation of public goods.

Furthermore, the special norms for the procurement and granting of goods.

2 ACCOUNTING SYSTEM FOR SOLID WASTE MANAGEMENT

The accounting systems are developed exclusively for maintaining order and transparency in a specific area, this is why it is important to implement this system at the Municipality, when it comes to waste management.

The implementation of an accounting system will allow the understanding of the municipal financial situation when it comes to solid waste management, the cost estimation required and the identification of the means for ensuring the funds needed for the execution budget of the ISWM plan.

For the development of an accounting system for the management of solid waste it is necessary that the municipalities install a data base, which will allow the storage of large amounts of data that will be grouped or structured in an organized fashion, so it can be found and used easily.

The FOCIMiRS project contemplates the creation of a database, which will allow for the collected data to be sent from the municipalities to the provincial directions and then to MARENA. This information will be the base of the calculations of the established indicators for the analysis and evaluation of the progress of the ISWM system established nationwide. Figure 4.1 illustrates the flow of information.

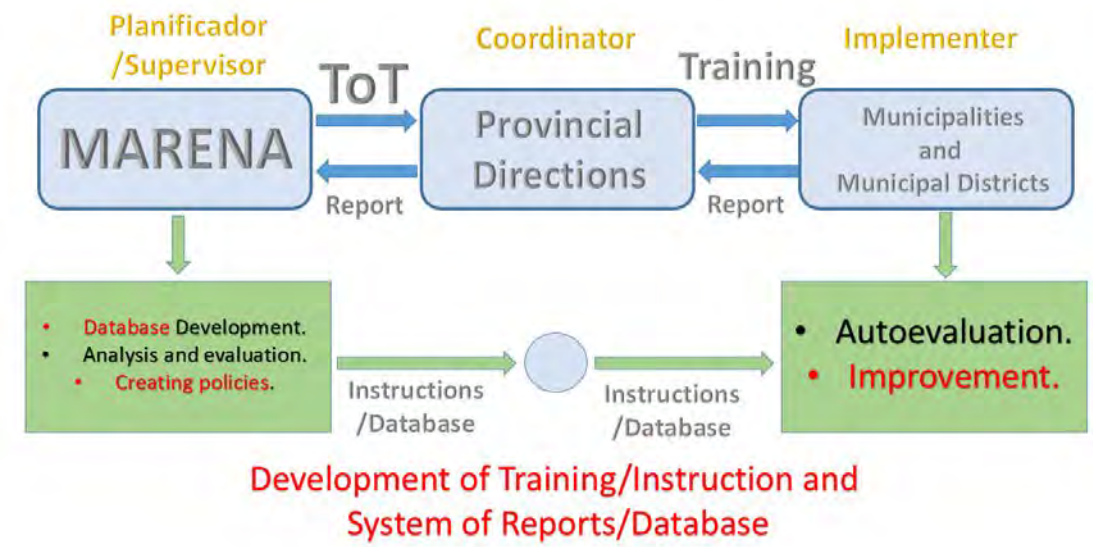

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Figure 1 Flow of information of the data base for the ISWM at the municipalities

2.1 Cost related to ISWM

2.1.1 Direct Costs

These are the costs that the municipality has to pay for in order to provide ISWM services, which include: personnel, services, materials and supplies consumed, consumption of active assets and intangible goods and financial expenses.

2.1.2 Indirect costs

It refers to other costs incurred by the municipality when it comes to ISWM, these can be related to the allocation of personnel in a way proportional to the amount of time needed to carry out an activity.

2.2 Accounting System for ISWM

It is necessary to implement an accounting system for the integral management of solid waste. There are 3 steps for the Development of the plan, explained as follows:

2.2.1 Step 1: Information gathering

Develop formats, gather and register the data related to the different operations and aspects related to the management of solid waste. The formats for registering data must be simple and easy to fill in (As much as possible). What is

done must be registered and what is registered must be done.

The following formats are based on the practices of Japan. These formats can be modified through practice and the needs displayed by the municipality.

Table 1 Solid Waste Management Income Format

#.	Item		Income (RD$)
1.	Funds from central Government's Budget		
	1.1	Funds from the Ministry of Treasury	
	1.2	LMD's Budget (If it applies).	
	1.3	Other Government Institutions' budget (Specify if they exist).	
2.	Funds from the Municipality's Budget		
	2.1	Annual Budget of the Municipality.	
	2.2		
3.	Solid Waste collection fee collection		
	3.1	Collection fee.	
	3.2	Collection fee for companies, institutions, etc.	
	3.3	Collection fee of other waste generators (If they exist).	
	3.4		
4.	Donors' subsidy, NGOs and/or specific projects (is they exist).		
5.	Others (specify).		
Total			

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This table presents an example of the solid waste management income format, indicating all the possible municipal income.

Table 2 Solid Waste Mangement Cost Format

#	Item				Cost (RD$)
1.	Initial Costs				
	1.1	Construction, rehabilitation and demolition cost.			
		1.1.1	Collection and transportation facilities.		
		1.1.2	Intermediate treatment and recycling facilities.		
		1.1.3	Final disposal facilities.		
		1.1.4	Other facilities.		
	1.2	Survey cost for facilities (F/S, EIA, etc.).			
	1.3	Contribution cost (in the case of a multi-municipal investment for facilities).			
	Subtotal				
2.	Operational Costs				
	2.1	Personal Costs.			
		2.1.1	Mangament and administrative personnel		
		2.1.2	Technical and field personnel.		
			2.1.2.1	Responsible of collection and transportation.	
			2.1.2.2	Reasonable of intermediate treatment and recycling.	
			2.1.2.3	Responsible of final disposal.	
	2.2	Operation and maintenance cost.			
		2.2.1	Collection and transportation's opration and maintenance.		
		2.2.2	Intermediate treatment and recycling's operation and maintenance.		
		2.2.3	Operation and maintenance of final disposal.		
	2.3	Vehicle purchase cost.			
	2.4	Subcontract cost (*outsourcing*).			
		2.4.1	Outsourced collection and transportation.		
		2.4.2	Outsourcing of intermediate treatment and recycling.		
		2.4.3	Final Disposal's Outsourcing.		
		2.4.4	Other subcontracts.		
	2.5	Contribution cost. (In the case of multi-municipal operation and maintenance).			
	2.6	Satisfaction survey cost, environmental education (excepting F/S, EIA, etc. for facilitites).			
	Subtotal				
3.	Others (Specify)				
Total					

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In table 3.2, an example of solid waste cost registration format is presented, it indicates infrastructure construction investment as well as the operation and maintenance cost.

In table 3.3, the Japanese solid waste management costs and trends are shown.

Table 3 The Solid Waste Management costs and trends in Japan

				2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total population(1,000person)				127,007	127,299	127,507	127,606	127,712	127,781	127,487	127,530	127,429	127,302
Revenue	Total			**2,120,033**	**1,975,963**	**1,750,387**	**1,709,196**	**1,683,421**	**1,862,653**	**1,859,902**	**1,823,476**	**1,832,021**	**1,838,976**
	General finances			1,497,631	1,480,046	1,411,268	1,353,531	1,357,926	1,350,754	1,345,236	1,343,986	1,340,785	1,352,056
	Specific revenue sources	National treasury disbursement		131,508	53,354	37,276	50,178	31,033	56,650	46,752	37,099	47,880	50,662
		Prefecture disbursement		9,410	7,971	6,072	8,448	5,462	5,406	5,370	5,068	6,651	8,632
		fees and commission		131,418	136,731	144,119	152,860	166,229	231,113	234,965	235,077	230,928	231,862
		Municipal bonds		292,861	235,627	91,539	76,539	61,551	125,949	107,184	85,012	99,293	82,206
		Other		57,205	62,234	60,113	67,640	61,220	92,781	120,395	117,234	106,484	113,558
		Sub-total		**622,402**	**495,917**	**339,119**	**355,665**	**325,495**	**511,899**	**514,666**	**479,490**	**491,236**	**486,920**
Expenditures	Solid waste management expenses			**2,602,866**	**2,395,621**	**1,960,037**	**1,934,330**	**1,902,500**	**1,836,474**	**1,856,771**	**1,815,073**	**1,813,551**	**1,837,438**
	Construction costs	Construction costs	Collection vehicle facility	–	–	–	–	–	26,182	3,130	1,873	3,037	1,539
			Intermediate treatment facility	861,391	654,322	260,994	214,516	207,294	164,470	177,530	153,068	173,406	151,144
			Final disposal site	79,370	80,074	62,110	71,692	62,040	42,114	23,966	17,096	10,356	24,031
			Other	17,907	23,874	12,844	12,117	10,276	7,302	4,777	4,230	5,071	8,483
			Survey	10,229	7,484	6,104	3,450	2,796	4,277	3,188	3,430	3,356	3,769
			Sub-total	**968,897**	**765,754**	**342,052**	**301,775**	**282,406**	**218,163**	**209,461**	**177,824**	**192,189**	**187,427**
			Union dues (Reference)	54,481	54,381	37,009	38,136	31,318	24,852	24,967	27,357	24,848	20,810
	Maintenance costs, etc.	Personnel expenses		610,407	588,769	561,777	550,043	534,988	522,187	519,282	495,676	473,014	488,464
		Treatment costs	Collection & transportation	81,568	79,309	77,212	78,861	75,538	67,048	71,687	65,967	63,975	64,792
			Intermediate treatment	263,008	269,099	277,061	283,153	277,656	277,683	284,230	285,512	273,069	268,864
			Final disposal	40,569	42,994	36,770	36,140	28,825	29,817	31,756	34,624	33,288	36,714
		Vehicle purchase		11,749	11,902	10,105	7,702	8,016	7,329	5,933	6,792	7,959	4,855
		Commission expenses	Collection & transportation	–	–	–	–	268,980	277,128	279,929	292,206	300,504	300,959
			Intermediate treatment	–	–	–	–	238,779	254,516	264,068	279,650	287,098	294,342
			Final disposal	–	–	–	–	47,949	48,543	52,948	46,911	44,140	43,036
			Other	–	–	–	–	29,053	22,999	25,167	21,386	21,393	22,766
			outsourcing expenses	488,225	504,265	529,341	545,482	584,761	603,186	622,112	640,152	653,134	661,102
		Other		50,929	45,193	43,950	43,210	–	–	–	–	–	–
		Research study		–	–	–	–	3,918	1,575	1,222	1,426	1,167	1,173
		Sub-total		**1,546,455**	**1,541,531**	**1,536,216**	**1,544,591**	**1,513,702**	**1,508,825**	**1,536,222**	**1,530,149**	**1,505,606**	**1,525,964**
		Union dues (Reference)		271,315	277,943	285,904	272,923	250,682	241,279	243,117	247,728	249,676	234,946
	Other			87,514	88,336	81,769	87,964	106,392	109,486	111,088	107,100	115,756	124,047
Solid waste management business expenses per capita(JPN/capita/year)				20,500	18,800	15,400	15,200	14,900	14,600	14,600	14,200	14,300	14,400

Source: Japanese Solid Waste Management, 2010 Fiscal year edition, Ministry of Environment, Secretary of Solid Waste Management and Recycling Department.

Fictional Example: Cost Structure

The municipality of CANDAMANDAPIA serves a population of 150, 000 people and offers the following services, related to the ISWM:

- Mixed collection: There are 25 trucks for this.
- Segregated collection: which is provided through a truck, which rented monthly for providing the collection service in the defined routes, as well as through the special containers (big volume) which are found in different sectors.
- Recovery Center of valuable materials: The municipality has just signed for the

treatment of waste from the selective collection.

- Collection of hospital waste: Acquired a pickup truck, which has a modified bed for the transportation of hospital waste. We do not have exclusive personnel for this labor, this service is provided by paying the personnel for overtime.
- Program of volunteers: It has a volunteer program, mainly to provide talks on the importance of solid waste management.

The municipality has done a breakdown of the costs that that they will have to pay for in order to provide a solid waste collection service, on the following way:

Table 4 Structure model of expenditure planning

Concept	Annual Amount RD$
1. Personnel	
1.1 Direct Personnel	**7,930,000**
Includes the salary and the social loads of 25 drivers and 60 employees that work in collection crews. (Occasional activities).	
1.2 Direct Personnel	**585,000**
50% of the salary and loads related to the Environmental Manager and an Assistant (Which in their position profile have ISWM responsibilities assigned to them).	
2. Services	
2.1 Office renting	**300,000**
An office adjoining to the municipality is rented, where the personnel, they shower and deposit tools there (such as brooms) and ISWM informative material.	
2.2 Truck renting	**336,000**
The municipality rents a truck every month for its segregated collection program.	
2.3 Rent for communication equipment	**180,000**
Service of ‘‘floats (work cellphones)’’ for the communication of the work crews.	
2.4 Basic service of electricity	**18,000**
The electricity category is included within the recovery of recycling and office adjoining the Municipality.	
2.5 Information services	**200,000**
The edition and printing of posters, literature, ads, among others, allusive to the integral management program of solid waste.	
2.6 Professional Services	**250,000**
Consultation Contract for determining the composition of the waste generated at the municipality, information needed for implementing the programs.	
2.7 Insurance and other obligations	**600,000**
Collector trucks insurance	
2.8 Training	**150,000**
The delivery of material on ISWM and recycling training to the officials is expected to happen.	

Concept	Annual Amount RD$
2.9 Maintenance and repairs	**1,000,000**
It is contemplated that the amount budgeted for the preventive maintenance of the trucks, as well as corrective maintenance.	
2.10 Maintenance and repair of infrastructure	**500,000**
The place where the trucks are stored require some improvements, which have been planned for next year.	
2.11 Payment final disposal at the FDS (tipping fee)	**12,420,000**
Corresponds to the amount that the municipality pays for to the FDS where the waste is taken to. (If the FDS is managed by the municipality itself, the management cost is included).	
3. Materials and Supplies	
3.1 Combustibles, lubricantes y productos químicos	**750,000**
Pago por combustible para los camiones que prestan el servicio de GIRS. Productos de limpieza de camiones y para desinfección.	
3.2 Materiales de uso en la construcción y mantenimiento	**100,000**
Aunque el centro de recuperación es alquilado será necesario comprar materiales para adecuarlo al nuevo uso.	
3.3 Útiles y materiales diversos	**150,000**
Uniforms	
Shirts for volunteers	
Office supplies and materials	
Supplies and materials for personal protection and safety	
Tools and cleaning matearias|	
4. Consumption of fixed assests and intangible assets	
4.1 Depreciation of cars and trucks	**12,500,000**
It includes depreciation of trucks used for mixed collection.	
4.2 Depreciation of buildings	**2,000,000**
Recovery center and campus adjacent to City Hall(Municipality)	
4.3 Depreciation of furniture	**1,000,000**
Depreciation of special containers for separate separation.	
5. Financial expenses. loans	**100,000**
6. Other expenses	**40,000**
Freedom of movement (plate / magazine) vehicles of ISWM,	
SUB TOTAL	**41,109,000**
Contingencies / administrative costs (10%)	**4,110,900**
TOTAL	**45,219,900**

Based on the cost estimation manual for municipal SWM of the CYMA program. San José Costa Rica, 2012.

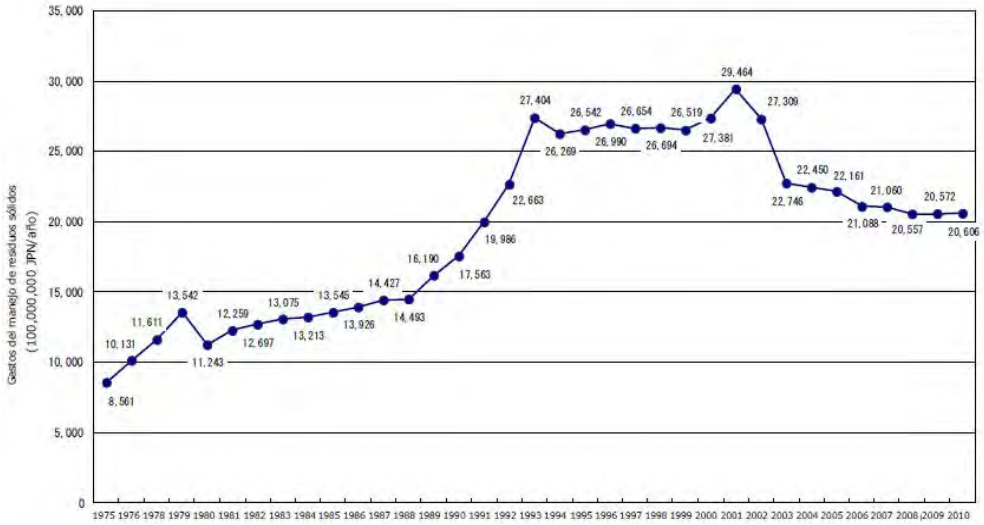
Note: This total amount will be used to define tariffs.

For many years, municipalities have defined their costs for ISWM based on executed costs, but not taking into account what really should be executed. For example, they enter the cost of having repaired a truck, without a preventive

maintenance program for trucks. This causes a vicious circle due to the fact that without preventive maintenance, the damage to the vehicle is higher and therefore more pricy. For this and other reasons, municipalities should define a plan for next year and conduct a comprehensive budget for the activities related to the ISWM service.

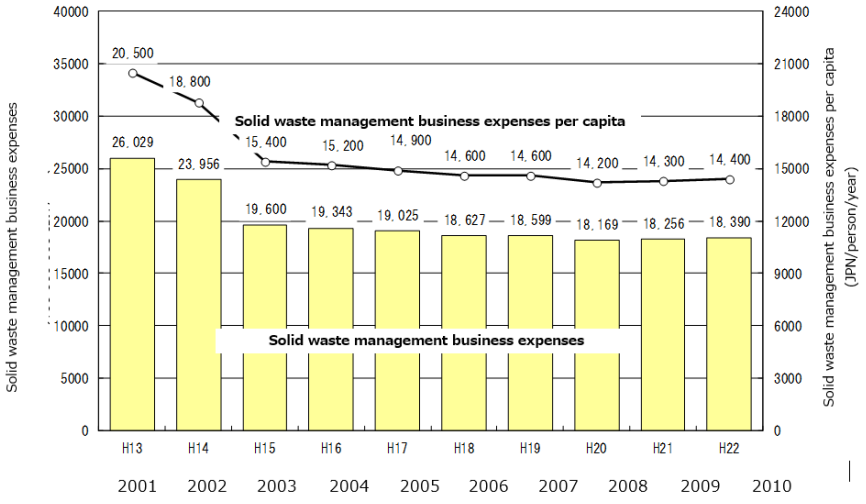
2.2.2 Step 2: Data analysis and evaluation

Once you have registered the information, processing it is necessary to proceed to the analysis and evaluation of the data obtained. The resulting data can be presented as graphs for better understanding and visualization of trends in the management of solid waste. Figures 3.2 and 3.3 show the trends in the costs of solid waste management in Japan in national currency, from 1975 to 2010.



Source: Solid Waste Management of Japan, 2010 fiscal year edition, March 2012, Ministry of Environment Minister's Secretariat Waste Management and Recycling Department Waste Management Division.

Figure 2 Trends in the expenditure in the solid waste management in Japan until the year 2010



Source: Solid Waste Management of Japan, 2010 fiscal year edition, March 2012, Ministry of Environment Minister's Secretariat Waste Management and Recycling Department Waste Management Division.

Figure 3 Trends in the expenditure in the solid waste management in Japan until the year 2010.

Assess management involves systematically measure, on a continuous basis in time, the objectives achieved by administrative units or units executing the institutional programs, compare what was done with what was initially programmed to provide information for the adoption of the most appropriate decisions at the right time.The ISWM evaluation is uses for:

- Providing feedback to the current budget cycle.
- Analyzing the variations detected by the control and determine their causes.
- Analyzing budget execution.

1) Performance indicators

The Indicators give us the ability to assess the performance of a system as a whole. The following are ISWM performance indicators.

a. Efficiency in the Collection & Transportation

The efficiency in the Collection & Transportation shows a relation among the financial resources used and the amount of waste collected. This indicator is defined by the following formula.

$$\textbf{\textit{Collection \& Transportation Efficiency}} = \frac{Collection\ \ cost\ \ (RD\$)}{Collected\ \ waste\ \ (t)}$$

b. Efficiency in the Final Disposal

The efficiency in the Final Disposal refers to the money spent by the amount of solid waste disposed in the FDS. It reflects the cost/ton disposed in a controlled/sanitary landfill. This indicator is defined by the following formula.

$$\textbf{\textit{Final Disposal Efficiency}} = \frac{Disposal\ \ cost\ \ (RD\$)}{Disposed\ \ waste\ \ (t)}$$

c. Overall ISWM Efficiency

The Overall Efficiency of the ISWM shows information on the global cost of the solid waste management in the municipality, these being submitted to intermediate treatment, recycling or disposed in the FDS. This indicator is defined by the following formula.

$$\textbf{\textit{Overall SWM Efficiency}} = \frac{SWM\ \ cost\ \ (RD\$)}{Discharged\ \ waste\ \ (t)}$$

These indicators allow the identification of which municipalities show a higher or lower efficiency level. By making comparisons among municipalities, it is important to take into account the size of the municipality, the population density (person/km^2), economic level (GDP), among other factors.

Example:

Calculate the efficiency of collection and transportation, disposal efficiency and overall efficiency of the collection service in the municipality of CANDAMANDAPIA which gathers around 160 ton / day, of which 140 ton / day are placed in the final disposal site.

Calculation of efficiency of collection and transportation:

To determine the cost of collection, associated costs are considered: personnel, communications equipment, vehicle insurance, vehicle maintenance, supplies / materials, vehicle depreciation,

Table 5 Planning structure model of collection and transport expenses*

Item	Cost (RD$)
1.1 Direct Personnel	7,930,000
2.1 Office rent	300,000
2.2 Truck rent	336,000
2.3 Telecommunication equipment rent	180,000
2.7 Insurances and other obligations	600,000
2.9 Maintenance and reparations	1,000,000
2.10 Maintenance and infrastructure reparation	500,000
3.1 Fuels, lubricants and chemicals	750,000
Uniforms, supplies and security and cleaning materials**	100,000
4.1 Depreciation of cars and trucks	12,500,000
Total cost of collection and transportation	23,656,000

* They must consider all costs related to the collection and transportation.
** Amount corresponding these items, out of the RD$150,000.00 assigned to "Supplies and diver materials".

$$\textit{Collection and Transportation efficiency} = \frac{RD\$23{,}696{,}000/year}{365\ \ days/year * 160\ \ ton}$$

$$= \boldsymbol{RD\$405.75/ton}$$

Final Disposal efficiency calculation

$$\textbf{\textit{Final Disposal Efficiency}} = \frac{RD\$12{,}420{,}000/\text{año}}{365\ \ \text{days/year} * 140\ \ ton}$$

$$= \boldsymbol{243.05\ RD\$/ton}$$

Overall efficiency calculation

$$\textit{ISWM general efficiency} = \frac{RD\$45{,}219{,}900}{365\frac{days}{year} * 160ton}$$

$$= \boldsymbol{RD\$774.31/ton}$$

2) ISWM autonomy indicator

The autonomy indicator indicates whether the municipality may or may not cover the costs of ISWM alone, without relying on external funding. These indicators are shown below:

a. Coverage per tariff

The coverage per tariff is the rate of income for waste collection fee collection in relation to the total cost of ISWM. This income comes from the tariffs that the

ISWM service users pay to the municipal authorities:

$$\textbf{Coverage/tariff} = \frac{Income\ \ per\ \ tariff\ \ (RD\$)}{ISWM\ \ total\ \ coverage\ \ (RD\$)} \quad (\mathbf{4})$$

a. Coverage of the Municipality

The coverage of the Municipality is the rate of the total cost of the ISWM by the engineers of the municipality, due to concepts different to the tariffs related to ISWM, e.g., use of public space, advertising, municipal permits, among others. This indicator is defined through the following formula:

$$\textit{Municipal Coverage} = \frac{Total\ \ cost\ \ of\ \ ISWM\ \ (RD\$)}{Municipality's\ \ income\ \ (RD\$)} \quad (\mathbf{5})$$

These indicators allow us to identify which municipalities show a higher degree of economic autonomy, comparing the costs and incomes of each one of them, taking into account the size of the municipality, the density of the population (person/km^2), economical level (GDP), etc.

Example: Per year, the municipality of CANDAMANDAPIA gets incomes from the national budget, public space use, advertising, municipal permits, among others, which were equal to RD$ 170,000,000 for completing all the activities related to municipal management. Of this amount, only RD$ 6, 503,450 correspond to the payment of tariffs by the users of the collection and transportation service.

- Calculation of coverage per tariff:

$$\textit{Coverage/tariff} = \frac{6{,}503{,}450\ \ (RD\$)}{45{,}219{,}900\ \ (RD\$)}$$

$$= 0.143$$

This means that for every RD $ 1.00 spent on the MIRS, charging for fee only covers about 14 cents.

- Municipal coverage calculation:

$$\textit{Coverage of the municipality} = \frac{45{,}219{,}900\ \ (RD\$)}{163{,}496{,}550\ \ \ (RD\$)}$$

$$= 0.276$$

This means that for every RD $ 1.00 received by the council, almost 27 cents are spent on

the management of solid waste.

2.2.3 Step 3: Take action

Following the circle of continuous improvement, based on the results obtained, taking measures to improve quality, efficiency and effectiveness of the services offered by the municipality.

In this phase the accompaniment of budget execution is done through the verification of partial results that are obtained in a period of programming of budget execution, as well as its analysis at the end of this period. The objective of this evaluation is determining the behavior of the elements of the ISWM in order to detect the deviations in the execution, and if it is necessary, apply the corrective measures timely.

2.3 Benefits of an accoutning system

There are many benefits associated to the development of an accounting System for ISWM, the following are some of them:

2.3.1 For the Municipalities and Municipal districts

- Understanding the financial reality of ISWM.
- Understanding the level of Development (and compare it to other municipalities).
- Identify the causes of problems and find solutions to achieve the improvement of said problems.
- Improve processes.
- Design new services.
- Take decisions on how the determined service will be provided.
- Define the sustainability of the services.

2.3.2 For the Ministry of Environment and Natural Resources

- Understanding the municipality’s current financial situation;
- Identify the socioeconomic category of the municipalities of the country: Low, medium and high.
- Develop policies and normative for improvement.

3 MEASURES TO IMPROVE THE FINANCIAL SUSTAINABILITY OF ISWM

3.1 Measures that do not require additional budget

Understanding the financial reality of the municipality is the first step, before the improvement of the System. A series of measures that can improve the efficiency of solid waste management when it comes to the current capacity, without the need of using additional resources:

1. Adequately allocate the ISWM personnel.
2. Establish a route and a Schedule for solid waste collection minimum and logical[1].
3. Operation with minimum solid waste management criteria established by the Ministry of Environment and Natural Resources[2].
4. Examine an adequate allocation of Budget between the service areas of the municipality.

3.2 Establish and collect a collection fee for the services

3.2.1 Establish Tariffs

The tariff is the cost structure that allows the calculation of the real value of the different activities of urban cleaning service. In all the cases, it is necessary to consider, in a realistic fashion, the grade of delinquency.

When establishing the tariffs of the cleaning rates, the municipalities must pay special attention to the following points:

- The unit rate must be determined based on the precise analysis of the costs of the operation and maintenance services.
- Public consensus on responsibility must be achieved.

The municipalities have to make the real cost of the service transparent in order to establish the appropriate tariff and communicate it to the citizens, while carrying out activities for the increasing of public awareness.

Even though global studies on the willingness to pay (WTP) of the citizens do not

[1] Refer to the collection and transportation manuals.

[2] Refer to the final disposal manuals.

exist, when it comes to the cleaning service, what can be assured is that most of the times the tariff is very low in relation to the costs and some municipalities do not even collect a fee for this service.

On the other hand, the payment capacity of the users of the ISWM services are related to the financial possibility to pay for the service received, which must be studied cautiously. According to Alejandro Jáureagui there must be an adequate margin for covering the needs of urgent payments that must be incurred, generally above 1% of the income or household expenditure. The Integral Solid Waste Management Plan of the Great Santo Domingo (2011) revealed that its implementation affects the household income by less than 2%.

Taking into account that the cleaning service is the municipality's responsibility, they must try as hard as possible to collect the collection fee from the contributors, in order to operate the services under healthy financial conditions. The municipalities must establish a tariff in accordance with the payment capacity while the permanent efforts are carried out in order to increase the willingness to pay.

- If the correct tariffs are being applied while taking into account their fee collection capacity, but the municipalities still face financial difficulties related to the ISWM services, said difficulties must be solved using the funds received from the government or other institutions. It must be pointed out that the increase on the cleaning rate requires utmost care because an unjustified increase of said rate, would trigger discomfort among the users of the service. If the municipality need to increase the increase the tariff, the next points must be considered:
- The review of the tariffs must be based on the analysis of the costs of the operation and maintenance services:
- The establishment of the tariff must be transparent for the population and the authorities must assume the complete responsibility for it.

Due to the fact that the payment capacity depends on household income, the municipalities must know objectively the income of the beneficiaries and the tariff system could be established based on the levels of household income. It is recommended to encourage the crossed subsidy, where richer families pay more and poorer families pay less, so that operation costs and maintenance can

be covered completely by the collection of rates.

The rate for established businesses, except small or family businesses, can be established based on a complete recovery of the costs. The rates for these establishments can be collected according to the amount of generated waste and disposed by them. It is recommended to do periodic studies on the amount of solid waste disposed for each entity in order to establish an appropriate tariff for each establishment, as well as adequately reflecting the efforts for the reduction of their solid waste.

Before increasing the tariff, the municipalities must try hard in order to reduce the costs, through the rational use of Resources in each of the procedures for ISWM.

3.2.2 Types of tariff

Different types of rates can be set, according to different criteria that can be applied, which must be selected, based on the current financial situation of the ISWM, the characteristics of the population in question, among other factors.

In the figures below, tariffs are based on the amount of waste generated. Starting with the figure on the left, the fee to be payed is fixed, regardless of the amount generated by the user, whether high or low, the same is paid. In the middle figure, the rate is variable and the user pays for the quantity generated, so that as more is generated more is paid. Finally, in the right figure, the rate is fixed to a certain amount (to be defined by the municipality) and then varies (increases) in proportion to the increase in generation.

✓ **Types of tariff**

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Figure 4 Types of tariff, based on the generation

The objectives of the establishment and collection of the tariffs by service are:

- Encourage the cooperation / responsibility to ISWM.
- Ensure the financial sustainability of the ISWM.
- Incentive the 3Rs culture (Reduce, Reuse and Recycle): "Pay as you generate".

To increase the rate of collection of fees for the service of ISWM, municipalities must make every effort to implement the following measures:

- Inform taxpayers of the costs for the provision of ISWM.
- Update the log of real property (land and buildings), if rates are related to such goods.
- Land registry and registration of taxpayers.
- Report statements regularly to taxpayers who have accumulated debts.
- Imposition of fines or surcharges to taxpayers who do not pay or are late in paying the service.

1) Tariff calculation method

a. Calculation of monthly tariff for the total recovery without subsidy

Based on this calculation, families will pay the real cost of the service, regardless of their economic situation. The average monthly tariff will be:

$$Trt = \frac{Cat}{12\ Fcs}$$

[3]*Where:*

Trt= Family monthly tariff for the total recovery (RD$/fam-month).

Cat= Total annual cost of the service, (RD$/year).

Fcs= Number of families with the service in the population.

b. Calculation of monthly tariff according to their generation:

$$Tmf = \frac{30\ (ppci)\ (Cut)\ (N)}{1.000}$$

Where:

Tmf= Family monthly tariff for the social stratum I (RD$/month-family).

Ppci=Per capita production in the socioeconomic stratum I (kg/inhab./day).

Cut= Total unit cost (RD$/t).

N= Average number of persons per family (inhab. /family)

30 and 1.000 = Dimensional parameters. 30 refers to the days/month and 1,000 is the conversion of kilograms to tons.

Example: Calculate the tariff of the CANDAMANDAPIA municipality which has a production per capita of 0.80 kg/hab/day, assuming that the municipality has registered 30, 000 households with an average of 5 people per households, based on the cost calculated annually.

- Monthly tariff calculation for the total recovery without subsidy:

$$\textbf{\textit{Trt}} = \frac{Cat}{12\ \ FCS} = \frac{45{,}219{,}900\ \ (RD\$)}{12 * 30{,}000\ \ viv.}$$

$$= 125.62\ \ RD\$/household$$

[3] Jaramillo, Jorge. Guide for the Design, Construction and Operation of Manual Landfills. University of Antioquia, Colombia. 2002. Pag. 224.

- Calculation of tariff based on generation:

$$\mathbf{T}mf = \frac{30\ (ppci)(Cut)(N)}{1000}$$

$$= \frac{(30\ \ day/mon)(0.80\ \ kg/person/day)(774.31\ \ RD\$/ton)(5person)}{1000\ \ kg/ton}$$

$$= 92.21\ RD\$/month$$

3.2.3 Collecting tariffs

1) Importance of the tariff collection for the service

The bottom philosophy of the basic theory in the collection of tariffs is essentially based on:

- The application of the Polluter Pays Principle (PPP), taking into account that the “garbage” pollutes.
- The Affordability –to-Pay (ATP), based on the socioeconomic category of the user.

In the other hand, the objectives of the establishment and collection of the tariffs by service are:

- Encourage the cooperation / responsibility to ISWM.
- Ensure the financial sustainability of the ISWM.
- Incentive the 3Rs culture (Reduce, Reuse and Recycle): “Pay as you generate”

3.2.4 Methods of collection

There are different methods of collecting the tariffs, as shown below:

- Separate invoice, meaning, the waste is billed by itself, not with any other service.
- Together with other services invoice (electricity, water, etc.)
- Predetermined container/bag size. This system is applied in Japan, where they use different bag sized for the handing over of waste to the collection service. They can be of 30, 40, 50, etc. litter, depending on the municipality.

Municipalities can pick the method that best guarantees the collection of the service fee and that it can be applied to the community.

In the Dominican Republic, the usual is for fixed tariffs to be established, which depend on the social stratum of the user, as shown in figure 5. In the other hand, normally it's the collection by separate invoice, in the cases where waste is charged for. In many municipalities the costs of the SWM service are covered by the city halls, meaning that the population is not charged.

Figure 5 Fixed tariff by social stratum

4 PUBLIC SECTOR PROJECTS

Public sector projects are owned by the state, used and funded by citizens at any level in the government; while projects in the private sector are owned by corporations, associations and individuals. Public sector projects aim to provide services to citizens seeking public welfare and not earning profit. Some examples from the public sector are: hospitals, parks, schools, roads, landfills, among others.

Before the conception of a project for the public sector an analysis of financial performance should be made, which is the first step in evaluating a project, as it should study the feasibility of the project from the point of view of its financial results. Therefore, the benefits and costs of the project are calculated in monetary terms, at current market prices. This allows to put alternatives in hierarchical order of profitability or efficiency.

The point of view of the analysis in the public sector should be determined before the calculations of costs, benefits and losses are made, and before proposing and carrying out the assessment. There are different points of view for

any situation, and different perspectives can alter the classification of cash flow.

There are significant differences in the characteristics of the projects undertaken by the public and private sectors.

Table 6 Differences between public and private projects

Characteristics	Public sector	Private Sector
Magnitude of the investment	Bigger	Some are big; most of them are medium size or small.
Lifespan estimation	Longer (30-50 or more years)	Shorter (2-25 years)
Estimated annual flow of cash	Without profit; costs are estimated, benefits and losses	Income contributes to profit; costs are estimated.
Financing	Tax, payment of rights, bonuses, funds of particulars.	Acciones, bonos, préstamos, propietarios individuales.
Interest rate	Lower.	Higher, based on the cost of cash in the market.
Selection criteria for alternatives	Criteria Multiples.	Mainly based on the performance rate.
Evaluation environment	Influenced by policies.	Mainly economical.

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4.1 Formulation of a ISWM project

For the formulation of a project of the ISWM plan, its sizing and cost analysis must be performed, which comprises the following tasks:

- Estimate and project the services demanded by beneficiaries.
- Know the current supply and restrictions on services currently provided.
- Know the size of the deficit in the provision of goods or services that the ISWM plan will provide.
- Determine the total and incremental costs of each alternative solution.

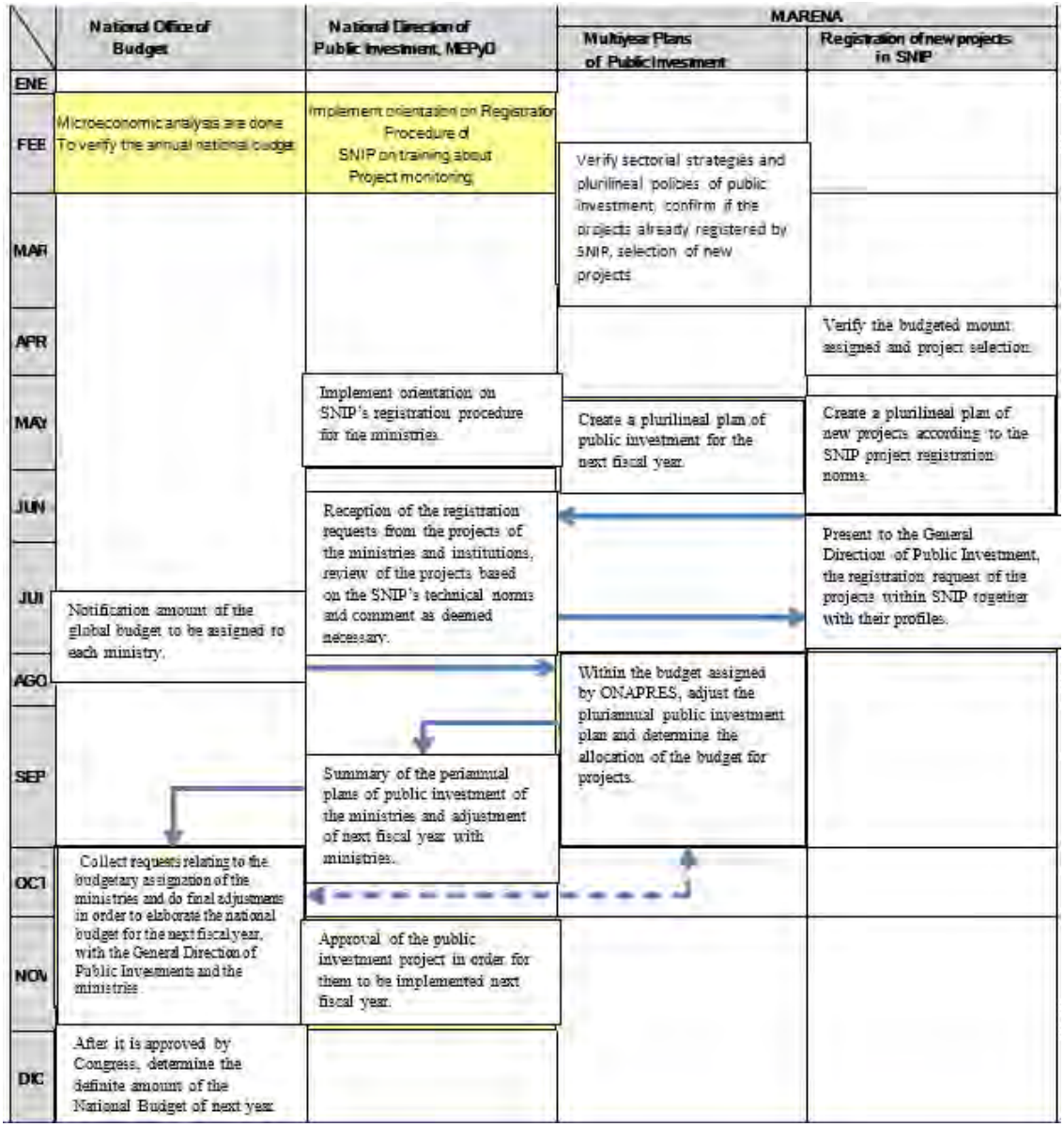
4.2 Opt for fund from the National Public Investment System (SNIP, by its Spanish acronym)

In the Dominican Republic there is an instrument through which municipalities can obtain financial resources for the improvement of SWM. This is SNIP (National Public Investment System). The access to the funds of this system is based on the following laws and/or amendments:

- Law No. 176-07 of the 17th of July of 2007, of the National District and Municipalities.
- Law No. 341-09 of the 26th of November of 2009, which introduces amendments to the Law 176-07 of the 17th of July, 2007, of the National Districts and Municipalities.
- Law 166-03 of the Allocation of Resources to City Halls.
- Organic Law No. 423-06 of the Budget for the Public Sector.
- Law No. 340-06 on Purchases and Contractions of Goods, Services, Works and Concessions.
- Law No. 170-07 that institute the Municipal Participative System.
- Law No. 498-06 that creates the National Planning and Public Investment System.
- Law No. 496-06 that creates the Secretariat of State of Economy, Planning and Development (SEEPYD).
- Decree No. 493-07 that approves the Application Regulation for the Law 498-06.

4.2.1 SNIP application flow

SNIP application flow is as the table 5 below. For the municipalities to get funds from SNIP, they should fulfill the established procedure. However, there is no project for SWM through the SNIP, it is a challenging approach.



Elaborated by the JICA expert team of the Project FOCIMiRS.
Source: "Methodological Guideline for the Formulation and Evaluation of Public Investment Projects", MEPyD, June 2013.

Figure 6 SNIP application flow

4.2.2 Steps for a Project to enter SNIP

1) Step 1: Formulate the SWM projects4

The first step is to elaborate a survey of the Project, which has different levels, according to the profundity of it:

[4] The "General Methodological Guideline for the Formulation and Evaluation of Public Investment Projects" shows the instructions to follow for the preparation of the study at a "Basic Profile and Executive Summary" level, as well as the content itself. This guidelines is found on the annex 1.

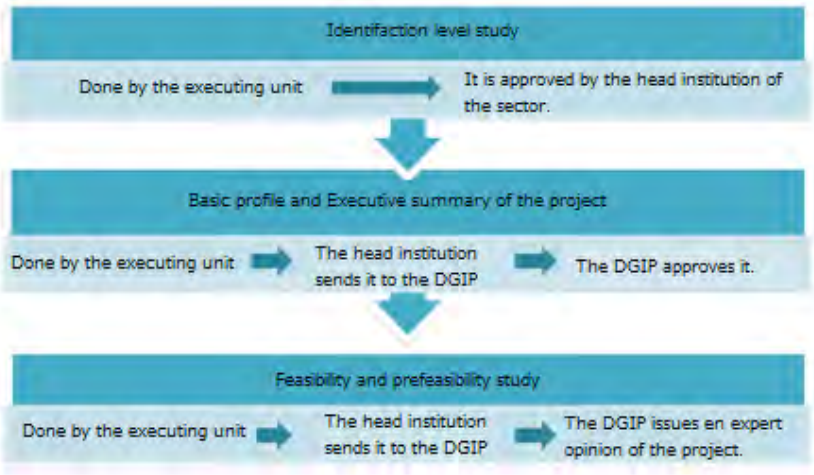
1) Survey at an Identification level.
2) Basic profile and Executive summary of the Project.
3) Profile.
4) Prefeasibility.
5) Feasibility.

2) Step 2: Submit to SNIP

Figure No. 8 illustrates the procedure to follow for the presentation of the projects to be implemented under SNIP. In order for a project to be implemented, conveniently, it must reach a minimum profile level and then, if it is the case, a prefeasibility and feasibility.

As we can see on the diagram, the implementing unit of the Project, in this case municipalities/municipal associations, elaborates a level of “Identification” and presents it to the main sectorial institution or Ministry of the sector, who according to the sectorial priorities, determines if it can take the survey to a superior level of Basic Profile, minimum requirement requested by SNIP to assign a code and process for the inclusion in the investment budget in the Republic.

In the case of projects on the management of MSW, the main institution of the sector is the Ministry of Environment and Natural Resources, by which the municipality or municipal Association must present it before the Ministry, for its approval. In the case of approving, the implementing unit must prepare the “Basic Profile and Executive Summary of the Project”, which will be presented to the Ministry of Environment that then sends it to the General Direction of Public Investment (DGIP, by its Spanish acronym).



Source: Methodological Guideline for the Formulation and Evaluation of Public Investment Projects.

Figure 7 Flow of the pre-investment phase of a project

3) Step 3: Wait on technical opinion from the DGIP

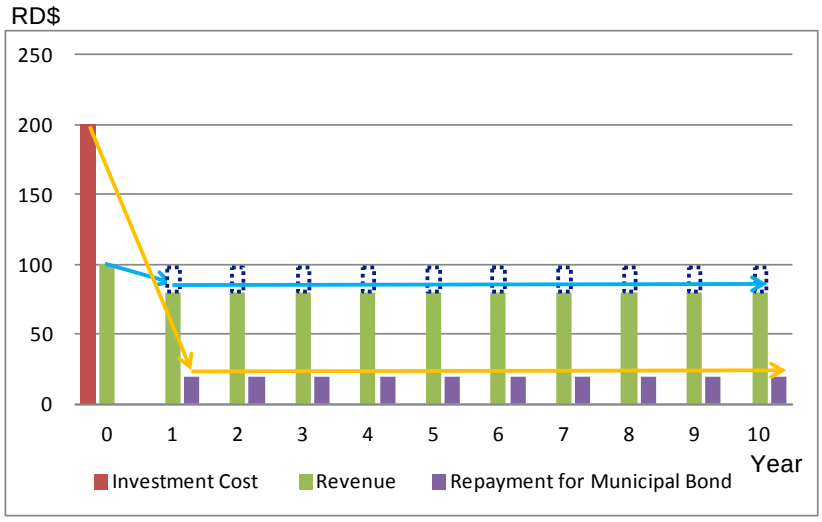
In general terms, the approval of the funding of the project will depend on the financial evaluation and/or the socioeconomic analysis. The financial evaluation considers the analysis of the profitability of the investment, meaning that the profitability of the resources that make the project or the return on capital is evaluated. By its part, the socioeconomic analysis promotes a valorization further than the solely financial indicators, including economic and social criteria that allow to measure the benefits to the society.[5]

4.3 Request loans

A loan is a long term debt. In principle, the local governments must cover the annual expenses by annual income. Nevertheless, the construction of certain public infrastructures as a controlled/sanitary landfill require a huge investment and its lifespan will extend for many years.

Therefore, the municipality could consider a loan for the development of long term infrastructures. This modality allows a shared cost among the generations (users), since the infrastructure will benefit the current generation as well as future generations.

[5] For more information on financial evaluation, see point 4.3 of the Guideline



Elaboración por el equipo de expertos de JICA del proyecto FOCIMIRS.

Figure 8 Amortization of capital.

Example:

The president of the Dominican Republic is considering a loan for the allocation of US $ 15, 000,000 for the construction of a landfill, specifying the following: waterproofed cells with geomembranes, leachate and gas collection system, separation center, perimeter fence, scale, and administrative office. The loan is covered to 10 years and will generate an estimated of $ 1, 500,000 worth of savings annually in costs related to the disposal (less expenditure on operation and maintenance of the FDS for recovered materials that do not go to final disposal site). The loan will be taken at a rate of 6% per annum for the project.

Costs of annual operation and maintenance (O & M) are estimated to be US $ 500,000 from the municipal budget and US $ 1, 500,000 were generated in sales of recovered materials and charge for service fee. Determine whether the project is justified in economic terms.

Solution:

The annual value is used as equivalent unit base, the annual uniform value is calculated for *n* years of a present value in the 0 year when the rate of interest is *i*, according to the following formula:

$$\boldsymbol{A} = P * \left[\frac{i(1+i)^{\mathrm{n}}}{(1+i)^{\mathrm{n}}-1}\right] \quad (\mathbf{8})$$

Note: In the financial engineering book by the Publisher McGrew Hill literature on how to work with an annual and present value.

Where:

A= Annual value

P=Present value

i=Interest rate

n= Years

$$A = 15{,}000{,}000 * \left[\frac{0.06(1+0.06)\text{^}10}{(1+0.06)\text{^}10-1} = 15{,}000{,}000 * \left[\frac{0.1074508618}{0.7908476965} = \ 2{,}038{,}005\right.\right.$$

Annual value of investment cost: US$ 2, 038,005

Annual Value of benefit: US$ 1, 500,000

Annual value of the O and M cost: US$ 500,000

Annual value of VM and TSA: US$ 1, 500,000

$$\frac{\mathbf{B}}{\mathbf{C}} = \frac{\text{Annual value of benefit}}{\text{Annual value of costs}}$$

$\frac{\mathbf{B}}{\mathbf{C}} = \frac{1{,}500{,}000+1{,}500{,}000}{2{,}038{,}005+\ 500{,}000} = 1.18 > 1$ The project is economically justified.

5 PUBLIC PRIVATE PARTNERSHIP

5.1 What is a Public Private Partnership (PPP in Spanish)?

PPP is an instrument through which government authorities allow any natural person or legal entity to design, plan, finance and implement, within a specified period, the construction, development, maintenance and operation, or only the holding of a infrastructure work for the provision of a public service, granting the right to the Contracting Company to receive the corresponding economic compensation by charging users of the work and public services provided by a tariff defined in the contract, or through contributions rate and / or guarantees granted by the State to allow the recovery of their investment and maintenance of the infrastructure and provision of services in the satisfactory levels contractually committed. They are vitally important where governments face aging infrastructure and requires more efficient services, a partnership with the private sector could be useful in promoting a new solution.

PPPs combine the activities and resources of both sectors in new ways by sharing risks and responsibilities. This allows governments to benefit from the specialties of the private sector, and then allows them to focus on policy, planning and regulation by the delegation of operations day-by-day.

To achieve a successful partnership, a careful analysis of long-term development, the distribution of objectives and risks are essential. In addition, the legal framework should adequately support this model of service delivery and to be regularly monitored and the results and services provided.

A well-written PPP arrangement can be informed both about the country's laws and international best practices to clearly delineate risks and responsibilities.

5.2 Benefits and Risks of Public private Partnership (PPP)

5.2.1 Benefits

The economic crisis of 2008, also called the Great Recession was the global economic crisis that began in 2008, and was originated in the United States. Among the main factors attributed as causes of the crisis are failures in economic regulation, the large number of crimes committed by banks, the improvement in prices of raw materials due to greater demand for them and a

competitive global market, the overvaluation of the product.

This has brought renewed interest on PPPs, both developed and developing. Facing limitations of public resources, while recognizing the importance of infrastructure investment to help develop its economy, governments are increasingly relying on the private sector as an additional source of alternative funding.

Table 7 Benefits of the Public Private Partnership

Benefits for the Municipality	Benefits for the Private Sector
- Because the private sector contributes to the initial investment and working capital, the City will be benefited by the municipal budget savings; - The private sector involvement in issues of solid waste management at the municipal level; - Benefits to be obtained from the administrative and technological expertise to provide the private sector; etc.	- Securing the market without competition for the duration of the contract or concession; - Projecting image of social responsibility to its customers; - Incursion in the development of the waste recovery market; etc.

Made by FOCIMiRS's JICA Expert Team.

5.2.2 Risks

Risks define the combination of the probability of occurrence of one or more events and their negative consequences. These are susceptible to various factors, among which are the threat and vulnerability that can occur at any stage of the association.

In a public-private partnership in the management of solid waste risks can be:

Table 8 Public Private Partnert Risks

Risks for the municipality	Risks for the private sector
- Discontinuance of Service; - Low performance in service quality; - Contractual breaches; etc.	- Termination of the contract for reasons of political interest; - Inability to obtain profits during the contract period; - Uncertainty for contractual or conventional renewal; etc.
Shared risk	
- Obsolescence of service or venture because of sharp market fluctuations or technological innovations.	

Made by FOCIMIRS's JICA Expert Team.

6 PUBLIC PRIVATE PARTNERSHIP'S OPTIONS

There is a wide variety of Public Private Partnership (PPP) options, which can be implemented to make maximum use of the scheme of private sector involvement. The optimal plan for private sector involvement will be selected by the type of PPP.

All contracts for the development of a Public Private Partnership activity should be made taking into account the provisions of Law No. 340-06, on procurement and contracting with modification of Law 449-06 and its implementing regulations.

6.1 Types of PPP

6.1.1 Authorization (Private Subscription)

The authorization or private subscription at any stage of the solid waste management allows qualified providers authorized by the municipal council and the Ministry of Environment and Natural Resources private services, to implement the management of solid waste in a specific area.

This mode allows waste generators to contract with private providers / individual services. The authorities give authorization (license) to private companies and encourage competition among themselves to provide services solid waste management. The license is used to ensure that an authorized service provider operates in accordance with the operational standards, and can be withdrawn if the service provider's performance is poor.

6.1.2 Service Contract

Service contracts are a finite term to provide solid waste services and must comply with Law No. 340-06 on procurement and contracting with modification of Law 449-06, especially in Chapter II of special rules granted for hiring of goods, works and services.

Hiring solid waste management services, such as collection and transportation of waste and operation of a landfill or controlled dumping site can be done by an external contract to a private operator for a specified period of time.

When it comes to contract services of equipment and machines. Collection vehicles are basically owned by external private company and, payment

guaranteed by the authorities to providers of services is defined in the contract document. While the authority is responsible for the management, the service provider must support operational risks.

6.1.3 Management Contract

The management contract is a contract commissioning a specific service solid waste management under private management for a period of time, for which a management fee is paid to the management contractor. The management fee can be paid according to contractor performance.

6.1.4 Rental contract

The lease allows the private operator full control over the provision of a specific solid waste management service in exchange for the use of fixed assets whose ownership and responsibility lies with the authorities. Under an improved lease, while partial improvements of the leased premises are the responsibility of the private operator, increased investment remain the responsibility of the authorities.

6.1.5 Concession

For all concession processes conditions set in Law No. 340-06 must be met, taking into account quality and price, and being subject to suspension and termination thereof.

A concession agreement stipulates the rights and duties of granted dealer, who retains ownership of major assets.

The concession agreement transfers responsibility for a capital investment and operation and maintenance to private concessionaires. While fixed assets remain the property of the authority, the licensee may pay a fee to use them.

In case of services of solid waste management, concession contracts include the management and construction of large-scale installations, such as a landfill, controlled dumping site and intermediate treatment facilities. In this case the authority must pay a fee or service fee to use these facilities.

An example of concession is the case of the operation by a private company at Duquesa Dumping Site where waste of the Great Santo Domingo and the National District are dumped.

6.1.6 Construct-Operate-Transfer (COT) and its variations contracts

The contract Contruct-Operate-Transfer (COT) and its variations are similar to granting options and are primarily sustainable large scale investments in facilities such as landfills.

During a long period of time, preferably 30 years, depending on the size of the investment, which has to be repaid.

A COT operator provides a wide range of services for the management of solid waste in exchange of the service costs guaranteed by the contract, although the operator accepts the risk of designing, building and operating the facilities in standards agreed services in exchange of a guaranteed flow of money.

6.1.7 Complete Privatization

Full privatization is an almost radical way of private sector involvement, in which existing assets and operations services for solid waste management are sold to the private sector, in some cases with a limited term license.

The Dominican Republic has as an example, the privatization of the sugar industry of the State Sugar Council (CEA) for the private sector.

6.2 Comparison of the possible PPP options

Tab 8-1, shows a variety of possible options by comparing PPP procession of assets, operations and maintenance, private equity, commercial risks and contract duration.

Table 9 Comparison of the possible PPP options

Option	Asset Owner	Operation and maintenance	Capital investment	Commercial risks	Contract period
Service contract	Public	Private and Public	Public	Public	1-2 years
Franchise	Public	Private and Public	Public	Public	1-5 years
Management Contract	Public	Private	Public	Public	3-5 years
Lease contract	Public	Private	Public	Public and Private	8-15 years

Option	Asset Owner	Operation and maintenance	Capital investment	Commercial risks	Contract period
Concession	Public	Private	Private	Private	25-30 years
CTO and its variations	Public and Private	Private	Private	Private	20-30 years
Complete privatization	Private or Private and Public	Private	Private	Private	Undefined

Fuente: Public-Private Association Manual, Ministry of finance, Singapore, 2004

Of the possible options mentioned above, COT options related to PPP have a wide range of variation and can be applied in different ways, at different stages and service facilities for the management of solid waste.

Table 8-2 shows the Build-Operate-Transfer (BOT) options compared to PPP related to possession of assets, operations and maintenance, private equity, commercial risks and contract duration.

Table 10 Comparison of options for Construct-Transfer-Operate (CTO) and its variants

Options for COT	Official Name
DC (DB)	(Design-Build)
COT (BOT)	(Build-Operate-Transfer)
CTO (BTO)	(Build-Transfer-Operate)
CPOT (BOOT)	(Build-Own-Operate-Transfer)
CPO (BOO)	(Build-Own-Operate)
DCO (DBO)	(Design-Build-Operate)
DCFO (DBFO)	(Design-Build-Finance-Operate)
AROT (LROT)	(Lease-Renovate-Operate-Transfer)
CATM (BLTM)	(Build-Lease-Transfer-Maintain)

Source: Ministry of Finance, Singapore, 2004

7 OPTIMAL PPP SELCTION CRITERIA

Clear criteria should be used to select the best and optimal choice for private sector participation in the provision of services of solid waste management.

However, in applying these criteria, the specific conditions of the present site should be taken into account.

The choice of the optimal participation initiative of the private sector is one of the most crucial before formulating the organizational and legal content decisions.

A wide range of experiences indicate that a copy of the approaches that have been successful in other countries tend to fail when not properly adapted to the local situation and specific site.The PPP selection criteria to be considered are:

- Benefits
- Costs
- Sustainability
- Eficiency
- Normative
- Competency and efficiency
- Access to Capital Investment
- Responsibility and transparency
- Risks and sustainability
- Equity
- Transparency
- Institutionality
- Importance of the project

7.1 PPP modes

While there have been a number of successful experiences in the private sector in major cities of developed countries, there has also been a considerable amount of failures, especially in terms of long-term sustainability.

The private sector in the field of services of solid waste management has been under a wide range of options. **"Private Sector Participation in Municipal Solid Waste Management, Part I: Executive Overview by the World Bank"** cites a variety of major international experiences of private sector participation

as follows:

- Supply of vehicles or heavy equipment: Leased by the owners of the equipment.
- Pre-collection of household solid waste: For franchise.
- Pre-collection of household solid waste: For service contract.
- Collection of general municipal waste of whole neighborhoods: For service contract or franchise or management contract.
- Sweep streets and open spaces: For service contract.
- **Repair of municipal solid waste equipment:** By contract of service depending on the needs.
- Repair of municipal solid waste equipment: By contract of long-term services.
- **Waste-to-compost:** For service contract or concession.
- Operation of a transfer station and the system of long distance carrying: For service contract or concession.
- **Operation of a disposal site:** For service contract or concession.
- **Collection of taxes on solid waste:** For the franchise bill collection agents, water authority, or the utility company**.**

However, it is not advisable to directly apply these international experiences to other countries, and the specific conditions of each country or specific sites should be taken into account.

8 PROCEDURE FOR THE ELABORATION OF PPP PROJECTS

For a public-private partnership, a procedure between the two parties regarding the project must be followed:

- Identification of a common interest
- Design partnership
- Functioning of the association
- Monitoring and Evaluation
- Completion or below
- Etc.

It should be pointed out that at the national congress there is a **"Public-private partnership in infrastructure for the provision of public services bill"** attempting to pass, so that at present there is no legal technical procedure in the Dominican Republic for the implementation of public-private partnership projects.

Internationally there are various models and procedures for the preparation of investment public-private partnership projects, as expressed in the following table.

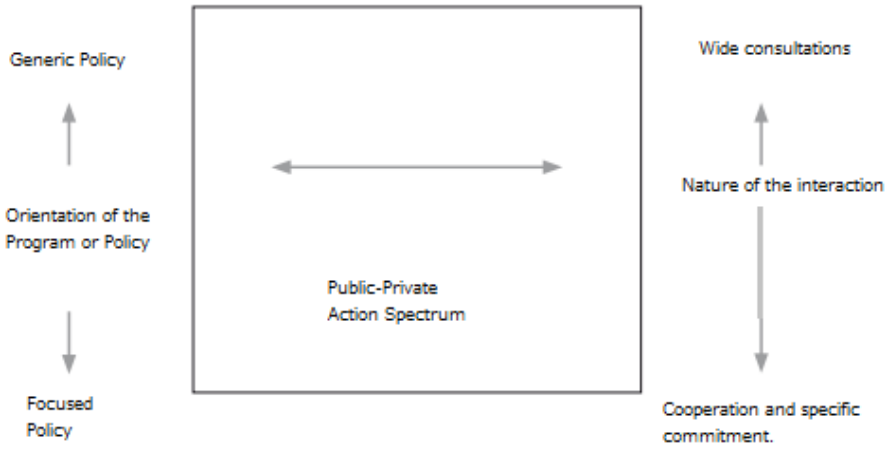
Table 11 Nature of Public Private Partnership when it comes to the Implementation Strategies

Country	Type of partnership	Participants	Means of interaction
Australia	Hybrid (Formal and structured; informal/tactic)	Business sector and academic world.	The private sector participates effectively and fulfills operative functions in the directorates of the public organizations, supporting the research and development and innovation. Informal contacts predominate in other areas.
Spain	Hybrid (Formal and structured; informal/tactic)	Business sector and academic world.	Formal in the area of promotion of exportations through the recent participation in the directorate of the Spanish Institute of Foreign Commerce (ICEX) and informal with guilds and in the area of innovation.
Finland	Formal and structured	Business sector and academic world.	Participation in directorates of execution organisms with operative responsibilities.
Ireland	Formal and structured	Business sector and academic world.	Participation in directorates of execution organisms with operative responsibilities.
Malaysia	Hybrid (Formal and structured; informal/tactic)	Business sector and academic world.	Participation in directorates of execution organisms with operative responsibilities.
New Zealand	Formal and structured	Business sector and, sometimes, unions.	Participation in directorates of execution organisms with operative responsibilities.
Czech Republic	Formal and structured	Business sector, academic world and certain follow	Participation in the directorate of Czech Invest (As advisor only) and in follow-up committees of programs. The council of I and D guides the

Country	Type of partnership	Participants	Means of interaction
		up committees, including unions and non-governmental organizations.	innovation strategy.
Korea	Formal structured and informal/tactic	Business sector and academic world.	For the innovation there is the national council of science and technology.
Singapore	Formal and structured	Business sector and academic world.	Participation in directorates of execution organisms (As advisor only) and councils.
Sweden	Informal/tactic	Business sector and academic world.	

Source: Update on the base of the Economical Commission of Latin America and the Caribbean, **CEPAL**, La transformación productiva 20 años después. Viejos problemas, nuevas oportunidades LC/G.2367 (SES.32/3), Santiago de Chile, 2008.

CEPAL, created programs and policies and nature of the public-private participation, from which the following policy or program life cycle chart originates, based on T. Cutler, ‘‘Public and private sector partnership for innovation and economic development: The Australian experience’’,



Source: Update on the base of the Economical Commission of Latin America and the Caribbean, **CEPAL**, La transformación productiva 20 años después. Viejos problemas, nuevas oportunidades LC/G.2367 (SES.32/3), Santiago de Chile, 2008.

Figure 9 Chart of the public private spectrum

At one end of the left axis is the generic or horizontal policy in which incentives can be targeted to any actor. At the other extreme is the selective policy, aimed at developing a new sector or a specific activity.

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