CHAPTER 12 OPERATION AND MAINTENANCE MANUAL OF SANITARY LANDFILL (DRAFT)

12.1 INTRODUCTION

This manual stipulates the guidelines for application, operation and maintenance of sanitary landfill systems by explaining the components of the system, the required facilities for management of the site, such as weigh-bridge/truck scale and site office, and field operations. The contents also cover monitoring facilities that are indispensable for protection of the surrounding environment of the site.

The contents of this manual refer mainly to the *"Explanation of Design Guidelines of Solid Waste Final Disposal Site, May 1993,"* which was issued under the supervision of the Ministry of Health and Welfare, Japan. Therefore, some alterations will be required to suit the local conditions here in Kazakhstan.

12.2 COMPONENTS OF SANITARY LANDFILL SYSTEM

12.2.1 Management of Sanitary Landfill System

For the proper management of sanitary landfill systems, facilities for control of operations and monitoring, a site office, access roads and other administrative facilities should be constructed to involve the proper control of solid waste quality and quantity. Landfill operations involving landfill waste, layers and facilities should also be managed in a proper manner. Major management items of sanitary landfill systems are as shown in Table 12.2.1 below.

Table 12.2.1 Management Items of Sanitary Landfill System

	Management Items	Remarks
Sanitary Landfill System	Landfill Waste	Records of waste quality and quantity
	Landfill Work	Cover material, landfill plan, plan of safety and sanitary health
	Landfill Layer	Leachate and gas generation, ground settlement, etc.
	Facilities	Proper maintenance and repair of all facilities
	Others	Countermeasure for fire, disaster, etc.

12.2.2 Facilities for Sanitary Landfill System

Facilities required for sanitary landfill systems are classified into landfill control facilities and related facilities. Landfill control facilities should include incoming vehicles control facility, monitoring facility and site office, whose function is to record and control the quality and quantity of landfill waste as well as to monitor possible impacts. Related facilities, such as access roads, garage and workshop, are necessary for effective management and operation of the disposal site. Whenever necessary, depending on the local characteristics of the disposal site, noise insulation walls and

measures against insects and crows must also be considered. Main facilities of sanitary landfill system are shown in Table 12.2.2.

Table 12.2.2 Main Facilities of Sanitary Landfill System

Classification	Main Facilities
Landfill Control Facilities	Incoming vehicles control facility Monitoring facility Site office
Related Facilities	Access roads Others (Garage, Workshop, Vehicle washing facility, Littering prevention facility, Notice board, Gate, Fire prevention, Disaster prevention pond and other auxiliary facilities)

12.3 LANDFILL CONTROL FACILITIES

12.3.1 Incoming Vehicles Control Facility

1) Installation of Weigh-bridge (Truck Scale)

(1) Checking Landfill Waste

Landfill waste should be checked for smooth operations as well as to prevent land pollution due to inclusion of harmful substances. Therefore, the type, components, quality and quantity of the solid waste must be carefully checked before unloading the waste on the landfill area.

Landfill waste without passing through an intermediate treatment facility is usually checked by its outward appearance. Therefore, it would be convenient if a platform is built near the weigh-bridge so that the components on the truck can be inspected. When necessary, the solid waste should be firstly unloaded and then inspected. A place for inspection would thus be required.

(2) Classification of Weigh-bridges (Truck Scales)

In sanitary landfill systems, a weigh-bridge or truck scale should be constructed at the entrance to the landfill site to weigh and record the landfill waste. The weigh-bridge or truck scale weighs the truck loaded with the landfill waste before the truck goes into the landfill site. Weigh-bridges are generally classified into three (3) systems: mechanical system, load cell system and lever load cell system. The mechanical system has a scale face with a pendulum or digital indications. The load cell and lever load cell systems also have digital scales, but each of them has different measurement principles. The load cell weigh-bridge has recently become popular because the mechanism is simple and thus, easy to maintain.

2) Weigh-bridge Design

The following factors should be considered before selecting the weigh-bridge system.

(1) Number of Weigh-bridges to be installed

The total number of collection vehicles per day and maximum number of collection vehicles at peak delivery hours should be considered before deciding on the number of weigh-bridges to be installed. In particular, when the weigh-bridge is to be installed near public roads, the maximum number of collection vehicles at peak hours should be carefully surveyed at intervals of 15 to 30 minutes.

In an economical viewpoint, only one weigh-bridge is thought to be enough. However, additional number of weigh-bridges should be considered if excessive waiting time for measurement is predicted and a large number of vehicles have to wait and affect the traffic on the public road nearby.

(2) Maximum Weighing Capacity of Weigh-bridge

The maximum weighing capacity of the weigh-bridge should be set up several times more than the total weight of the collection vehicle so as to provide room for unusually heavy collection vehicles. In general, the maximum weighing capacity of 10 to 30 tons is usually used.

(3) Location of Weigh-bridge

The weigh-bridge must be placed at a strategic location where vehicles will pass through whenever entering and leaving the disposal site.

(4) Introduction of Automatic Weighing System

The automatic weighing system using a computer has an advantage in not only managing landfill waste to be carried in but also in reducing the time for making daily, monthly and annual reports. Data that should be put in the computer is presented in the following Tables 12.3.1 and 12.3.2.

(5) Necessity of Regular Inspection

When a weigh-bridge is used as a toll gate, regular inspection of the system should be made to ensure proper measurements.

3) Investigations of Solid Waste Quality

Besides checking to see if the solid waste meet the requirements set, the quality of solid waste should also be investigated. By knowing the quality of the landfill waste, the type of gas generated in the landfill, the leachate quality, and the amount of settlement due to compaction of the landfill layer can be understood. This is an important data not only for designing the usage of the completed landfill site but also for finding the future landfill sites. When samples of the solid waste are to be taken, a place of inspection to take the samples after the landfill waste is dumped should be prepared, if possible.

4) Analysis of Control Data

The data on the weights and results of the inspection of the waste should be analyzed on a regular basis for each type of solid waste and the site filled.

Usually, daily, monthly and annual reports are to be prepared. Time of deliveries should be clearly announced and strictly followed. The daily report should be turned in after one-day operation. On the first day of the month, the monthly report of the previous month should be submitted to a site manager while the monthly information are included in the annual reports.

5) Landfill Records

The landfill waste volume, quality, place, time of land-filling, solid waste type, etc., are all quite important data which should be recorded. The required input information and output record are shown in Tables 12.3.1 and 12.3.2.

Table 12.3.1 Input Information (Example)

Items
(1) Date
(2) Entry Time
(3) Departure Time
(4) Contractor's Name
(5) Driver's Name
(6) Vehicle Registration Number
(7) Waste Type
(8) Collection Points (Route)
(9) Gross Load
(10) Unloaded Weight
(11) Net Load

Table 12.3.2 Required Information for Management of Sanitary Landfill

Required Information
(1) Number of collection vehicle
(2) The total waste amount brought into the site
(3) Classification of waste type and each amount
(4) Classification of waste generation in each collection area
(5) Waste charge calculation and issuing of bill

Note: Daily report, monthly report and annual report should cover the above items (1) to (5).

12.3.2 Monitoring Facilities

1) Objective of Installation of Monitoring Facilities

Installation of monitoring facilities has the following three (3) objectives:

- Monitoring the landfill layers;
- Monitoring the environment; and
- Reflections on the future plans

Considerations of each item are described below.

(1) Monitoring the Landfill Layers

The landfill waste during the course or after a landfill operation should be checked to monitor changes in the solid waste component, trace and measure the amount of settlement in the landfill layers. The data obtained can be used for designing future leachate treatment plants, estimating the expected useful life of the site and considering a post closure plan for completed landfill site.

(2) Monitoring the Environment

The environment should be monitored during and after landfill operations to assess the environmental impacts or to equip the sanitary landfill system from points of environmental conservation and antipollution measures.

(3) Reflections on the Future Plans

The amount of data collected or analyzed will determine how well future projects can be planned. Therefore, it is important that data on solid waste component, leachate, underground water, gas, bad odors and other environmental qualities be regularly collected.

2) Implementation of Regular Monitoring

Following items should be monitored on a regular basis:

- Landfill layers;
- Leachate and discharged water;
- Groundwater;
- Gas;
- Bad odors; and
- Others

Considerations of each item are described below.

(1) Landfill Layers

The landfill waste will change with the years. Therefore, it is important that a certain specified landfill layer is sampled and analyzed, and its quality change recorded at regular intervals.

However, it would be very difficult to obtain a sample of a typical landfill waste since landfill waste is not homogeneous. As such, monitoring of the waste quality changes has to be taken on a macro basis. For example, landfill layers settle due to waste decomposition by gasification or leachate formation. If a plate can be placed in the layers to measure subsidence due to pressure or organic matter decomposition, changes of the landfill waste quality could be traced.

(2) Leachate and Discharged Water

As part of the management and maintenance of a sanitary landfill system, parameters and frequency of testing for the discharged water quality should be carefully examined. In terms of leachate monitoring, the testing should also be done for the water flowing into the leachate treatment facility. The amount of pollutants and harmful substances in the water flowing out of a landfill site, i.e., leachate, should be measured. In addition, the discharged water quality should also be monitored to prevent pollution of water in the areas where treated water is discharged. The proposed monitoring scheme is shown in Table 12.3.3.

Table 12.3.3 Proposed Monitoring Scheme for Leachate and Discharged Water

Sampling Place	Monitoring Parameters	Frequency
Leachate reservoir pond and discharged water	pH, CN, Pb, T-Hg, Cd, BOD, COD, SS, Color	1/month

(3) Groundwater

The groundwater in areas surrounding the sanitary landfill system should be monitored for the following reasons:

- To check whether or not the natural or artificial liner system in the site is effective; and
- If the natural or artificial liner system is not effective, to monitor the extent of impacts of pollutants discharged into the groundwater and the lives of inhabitants in the area.

Therefore, the monitoring facilities established should enable determination of the possible usage and the quality of groundwater in the areas around the sanitary landfill system. With these concepts in mind, the number, location and depth of monitoring wells required should be carefully decided.

Before considering the above, at least one well should be placed directly below the direction of the groundwater flow in the landfill. For monitoring, the amount of seepage should be surveyed before the pollutants in the water are dispersed into the groundwater.

In addition, the second monitoring well should be built downstream where the dispersion of pollutants has the highest possible and fastest effects. The monitoring wells should be as deep as possible but in reality, the depth of wells is usually set up

depending on the water table. The wells, in principle, should be more than 100 mm in diameter with a strainer at the water table.

The water quality inspection by monitoring wells can be divided into regular and routine inspection. Regular inspection includes inspections on the land-use in the neighboring areas. Routine inspection requires immediate detection of pollutant leakage. Therefore, instruments like pH meters or electric conductivity meters are usually prepared for measuring changes in the water quality at the groundwater collection and discharge facility or the monitoring wells located directly below the landfill site. It is recommended that the result of measurement be recorded on paper in the routine inspection. In the regular inspection, on the other hand, the water quality should be checked at the same time of each year at each monitoring well because groundwater quality varies from season to season. Figure 12.3.1 shows a typical groundwater monitoring well and Table 12.3.4 shows the proposed monitoring scheme of groundwater.

Table 12.3.4 Proposed Monitoring Scheme for Groundwater

Sampling Points	Monitoring Parameters	Frequency
Monitoring Well	pH, CN, Pb, T-Hg, Cd, BOD, COD, SS, Color	1/month

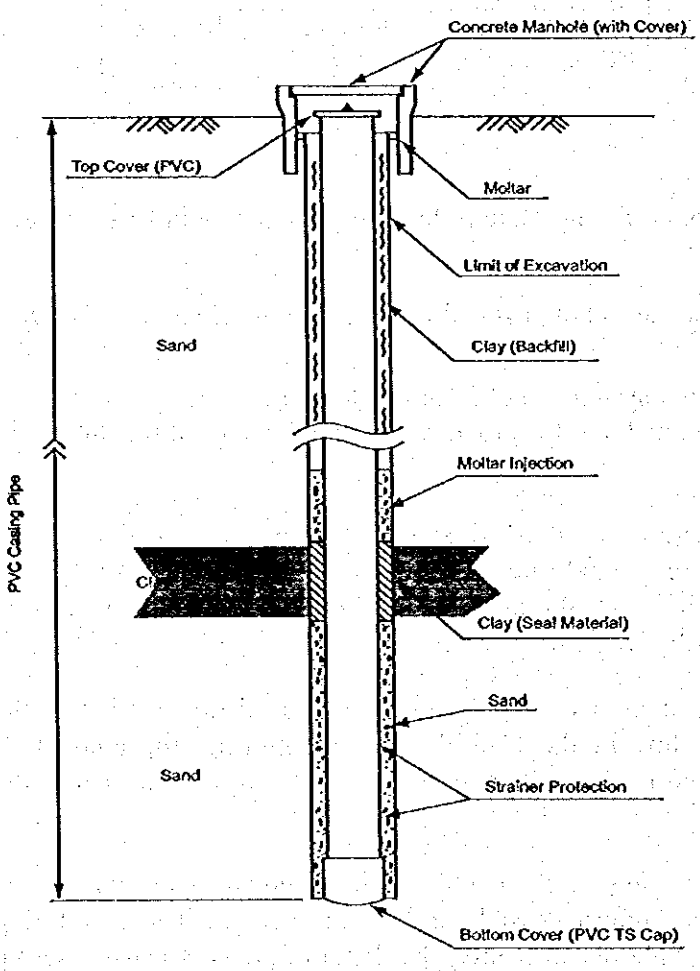


Figure 12.3.1 Typical Groundwater Monitoring Well

(4) Gas

When waste with organic substances is buried in a landfill site, monitoring of generated gas will help to determine the decomposition condition of the landfill waste. Even in a landfill that is used for filling mainly of incombustible waste, it is recommendable that composition of the waste carried in is also monitored since the waste may include many organic substances.

Generated gas can be monitored by using gas-venting facilities in the landfill. Monitoring parameters and frequency for gas should be determined flexibly depending on age of the landfill and characteristics of generated gas. In other words, the monitoring should be carried out much more frequently when gas generation actively occurs; however, monitoring frequencies can be reduced during stable periods. Table 12.3.5 below shows the monitoring scheme for gas.

Table 12.3.5 Proposed Monitoring Scheme for Gas

Sampling Point	Monitoring Parameters	Frequency
Gas outlet pipe	Temperature and humidity of original air, Temperature and volume of gas, Composition analysis (CH_4, CO_2, CO_2 and O_2)	1/month

(5) Bad Odors

Monitoring points and times for bad odors should be decided taking into consideration the living conditions in the surrounding area as well as the weather conditions. Monitoring of bad odors is usually conducted once a day in every 6 months at 2 or 3 places on the landfill site boundaries.

There are two (2) methods for measurement of bad odors: instrument method and sensory test method. The instrument method measures eight (8) parameters, namely, ammonia, thiorumethane, hydrogen sulfide, methyl sulfide, triethylamine, acute aldehyde, styrene and methyl disulfide by using instrument. The sensory test method is carried out in comparison with three test bags by the sense of smell. However, the method should be selected after considering the solid waste quality and the local conditions.

(6) Others

Besides the above-stated items, other impacts on the environment like noise, vibrations, fauna and flora should also be considered, if necessary.

12.3.3 Site Office

The sanitary landfill system should be systematically operated to protect the environment, promote safety of the facilities and improve the cost effectiveness. In this sense, inspection and weighing of the landfill waste, checking of landfill progress and conditions, securing of cover soil materials, and operation, maintenance and monitoring of leachate treatment facilities should be carried out in a proper manner. The site office, so as to accomplish this, should be equipped with management office, test laboratory

and analytical room, worker's rest room, locker room, showers, a room for boiling water, canteen, toilets and conference room, if possible. Ventilation, telecommunication, and other utilities should also be considered. In any case, the type of facility or room required at a site will depend on the scale of the landfill site, management policies, and the number of employees and managers at the site.

The site office should be placed in a convenient position to enable easy control of landfill waste or landfill operation itself.

12.4 Related Facilities

12.4.1 Access Roads

The access roads or approach roads to the landfill site can be divided into two parts: public roads and roads leading from the public roads up to the disposal site.

Surveys on the use of existing public roads should be made to comprehend the characteristics of the locality. The road width and structure should be checked to ensure that it is suitable for collection vehicles to transport solid waste through the road. When a public road is also used as a route for transporting solid waste, road signs to indicate this dual purpose must also be erected. The junction should be designed so as not to obstruct the flow of present traffic. Usually, most of the roads leading from the public roads up to the final disposal site are newly built ones.

The access roads should be designed carefully in consideration of their route, alignment, width and structures to fit these features to the site requirements for the landfill area. In particular, if the approach roads are to become public roads in future, special considerations are required. They must be built in such that no problem occurs when solid waste is accidentally dropped onto the road and repairs are to be made on the approach road itself. All other necessary measures should be considered to prevent accidents from happening.

12.4.2 Others

1) Garage/Workshop

Garages, petrol station, warehouses, and workshop for machine inspection and maintenance should be installed, if possible. Landfill sites are usually located in a suburb of a city, so that it is difficult to carry out the preventive maintenance work on a daily basis. It is thus recommendable to provide these facilities against machine troubles and failures. Tools and equipment for minor repairs and the minimum level of spare parts such as oil filters, tire tubes and fan belts should be stored in the warehouse.

2) Vehicle Washing Facility

To prevent the collection vehicles from carrying dirt onto the public roads, a vehicle washing facility should be installed on the existing site roads. The facility should be located near the exit of the site.

3) Littering Prevention Facility (Buffer Zone)

To prevent solid waste from littering or flowing out of the landfill site, cover soil should be provided as soon as possible. However, the amount of cover soil is not always necessarily enough because of geological conditions in the region. In this case, a littering prevention facility or buffer zone must be installed. Littering prevention fences should be about 3 or 4 times as high as the height of perimeter fencing that is built on the site boundary. Additionally, for protection against strong winds or seasonal winds, trees may be planted around the site.

If the waste is composed mainly of ash that is easily dispersed, water should be sprayed on the waste to prevent dust from rising. Considerations should be taken against excessive watering because excessive watering will make handling of the waste worse.

There is a limit, in some cases, to prevent waste dispersion only by structure and height of fence. Therefore, it would be more effective if the waste is divided into dispersible and non-dispersible waste when delivered into the landfill site. Accordingly, the dispersible waste will be dumped into a depression area that is designated for the exclusive use of this type of waste.

Fences are constructed for preventing not only trespassing on the site and littering the waste, but also exposing the unsightly site. The fences must be strong against the wind but from an economical point of view, a height of less than 3 m would be sufficient. In a landfill site where there are many naturally vegetated trees such as mountainous area, for example, these trees may also have the same function as a fence or buffer zone.

4) Notice Board/Gate

A notice board should be built at the entrance of the site to indicate clearly the purpose of the landfill site. The items to be clearly marked on the board should be as shown in the following Figure 12.4.1, a typical design of the notice board.

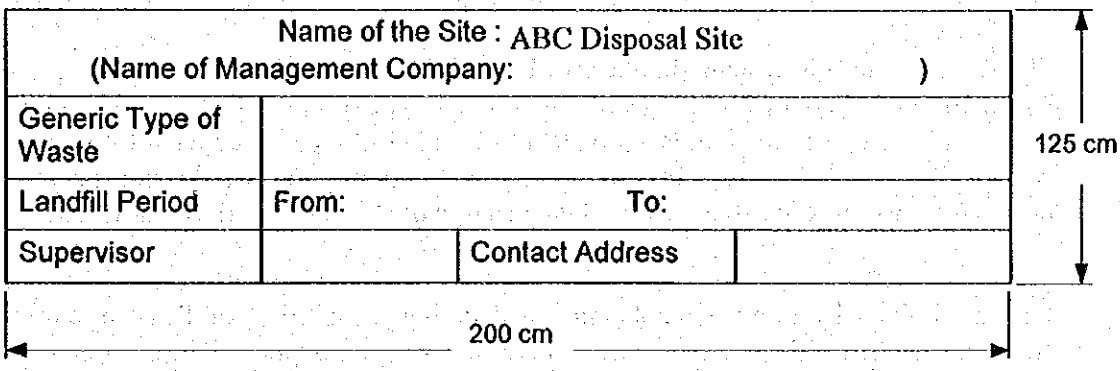


Figure 12.4.1 Example of Notice Board

In addition, a gate should be built at all entrances and exits of the landfill site. At the end of the daily work, the gate should be closed and locked to prevent entrance to the site by someone especially at night.

5) Fire Prevention Facility

Fire at the sanitary landfill system usually results from the generation of combustible gas like methane due to decomposition of food waste or other substances containing organic matter. Firstly, to prevent the outbreak of fire, it is advisable that daily cover soil work is carried out. When gas leakage occurs on the landfilling area through cracks or holes on the ground, glass pieces in the waste may sometimes act as tiny lenses to focus solar energy and thus causing fires. Secondly, generated gases should be removed as fast as possible by means of gas vents. Release of the gas into the atmosphere would prevent explosions, and withering of trees around the site would stop.

It is extremely difficult to extinguish a fire that breaks out in the gas vent facility. If water is poured into the gas venting pipes, a very dangerous subterranean explosion may occur. Special attention should be taken in this case. Fire extinguishers, water and sand for extinguishing fires should be made fully available. In the sanitary landfill system, it would be better if the cover soil itself is fireproof. Stockpiles of cover soil should be made available, so that fires could be extinguished by covering the soil and stopping the supply of oxygen for the fire. Also, dump trucks, dozer shovels and other heavy equipment should be ready for use in the site when necessary.

When inflammable fuel for machine and equipment or insecticides are used in the site, they should be handled in accordance with the rules on handling of dangerous substances.

The most important thing to prevent fires is extinguishing of fires at the initial stage. Therefore, daily routine inspection of the site is important.

6) Disaster Prevention Pond

Since leachate control facilities for runoff overflow are to be installed in the sanitary landfill system, the design concept of a disaster prevention pond is different from that of the pond in a residential area development project. Rainwater in a landfill site is temporarily stored in the leachate control facility, such as the leachate retention pond.

The sanitary landfill system should also have the function of a flood control facility. Especially in a plain area, the rainwater in a trench type of landfilling has to be pumped out. In this case, the area that is equivalent to the landfill area is deducted from the total watershed area. Consequently, a disaster prevention pond would not always be necessary since the landfill area would take charge of storing peak flooding water.

When final or intermediate cover soil is effective in removing surface runoff that will then be drained by rainwater collection and drainage facilities, outflow of rainwater from the landfill site will increase. Therefore, the importance of rainwater control facility at the landfill site will be the greatest when landfilling is completed.

The disaster prevention pond should be designed in consideration of the following items:

- Watershed area;
- Landfill area;
- Layout of rainwater collection and drainage facility;

- Development area other than landfill area; and
- Flow capacity of the downstream river.

12.5 SAFETY MEASURES

The landfill site should be fenced off to prevent trespassing on the site because most parts of the site are dangerous places. The fencing off is also to prevent other people from dumping their own waste illegally especially in the nighttime. Net fences or barbwire fences are usually used for enclosing the sanitary landfill system, while corrugated plates are used to fence off the area from public roads or residential areas. These fences could be easily damaged and therefore, it will be important for them to be inspected and maintained regularly. Since the area to be controlled is usually large, name of landfill site and supervisor, address and contact telephone number should be indicated clearly on signboards put up at several strategic locations. In addition, signboards showing *"UNAUTHORIZED ENTRY FORBIDDEN"*, for example, should be installed.

Inspection and maintenance of landfill site, dangerous places in particular, should also be carried out to prevent waste pickers or children from climbing over the fences and entering the enclosed area. The following measures to deal with dangerous places should be carefully considered:

- Dangerous substances or insecticides should be placed in a warehouse under lock and key;
- Leachate treatment facilities and the leachate control pond should be fenced off, and the entrance/exit to them be properly locked up;
- Manholes should have heavy lids;
- Gas venting facilities should be fenced off with barbwires and a sign showing "DANGER" be placed on the fence;
- Landfill equipment should be kept in a designated place and a buffer area should be established if necessary;
- Sand and gravel used for cover soil should be piled to a safe height so that they will not collapse; and
- Depending on the progress of landfilling, surface drainage should be elaborately performed since potholes are easily formed and water is easily collected.

Corrugated plate fences should also be regularly inspected since heavy rains and winds easily damage them. Lighting during nights is also important for safety and prevention of illegal dumping. Light bulbs and power line should be regularly inspected. Security guards should always be stationed during nights and holidays, if necessary.

12.6 LANDFILL OPERATION

12.6.1 Types of Landfill Operation

Landfill operation means the whole series of work that includes delivery of solid waste into the landfill area, spreading, mixing and covering soil and all related temporary work. Types of operation are given in Table 12.6.1, and, in short, the operation comprises landfill work, cover soil work, site road work and slope adjustment work.

Table 12.6.1 Types of Landfill Operation

	Major Work	Items to be considered
Landfill Operation	Landfill Work	- Landfill method - Order of landfilling - Spreading and compaction - Separate landfilling
	Cover Soil Work	- Daily cover - Intermediate cover - Final cover - Selection of cover material - Application of cover material - Control of cover soil
	Site Road Work	- Main roads - Branch roads
	Slope Adjustment Work	- Safety slope - Types of adjustment (tree-planting, grass, etc.)

The primary function of the sanitary landfill system is to promote stabilization of solid waste placed on the landfill area so as not to cause environmental problems. Simultaneously, it is also important that effective and economic solid waste disposal within a limited landfill area be considered. Therefore, the following matters should be considered comprehensively before proceeding with the landfill operation:

- Surrounding environment;
- Natural conditions, such as geography of the landfill site and meteorological condition;
- Types and amounts of solid waste generated per day; and
- Financial and technical capability of the management organization.

The close relationship between composition of the landfill operation and the required function of the sanitary landfill system is shown in Table 12.6.2. Landfill work should not only depend on intuition and experiences of a supervisor of the work, but decisions on the work should also be made based on results of appropriate surveys on the technical and economic aspects. That is to say, supervisors or managers of the landfill site should understand fully about the function required for the sanitary landfill system described in Table 12.6.2.

If much attention is paid to efficiency of the landfill work, careful considerations should go to landfill method and period, spreading and compaction of landfill waste, and the thickness of the landfill waste and cover soil. If stabilization of the landfill waste is to be given priority, the landfill method, selection of cover soil material and compaction method that will not hinder the process of landfill waste stabilization should be considered. In addition, if necessary, separate landfilling depending on types of solid waste should be introduced. On the other hand, when leachate and gas quality or

quantity is of great importance, the order of landfilling and cover soil work should be considered.

Table 12.6.2 Relationship between Composition of the Landfill Operation and the Required Function of the Sanitary Landfill System

Landfill Operation / Required Function	Landfill Work				Cover Soil Work				Site Road Work		Others
	Landfill Method	Order of Landfilling	Spreading /Compaction	Separate Landfilling	Selection of Cover Material	Daily Cover	Intermediate Cover	Final Cover	Main Roads	Branch Roads	Slope Adjustment Work
Efficiency of landfill work	A		A			A	A	A	A	A	A
Stabilization of waste	A	B	A	A	A	B	B	B			
Leachate quality		B	B	B	A	B	B	B			
Leachate volume		B	B	B	A	A	A	A			
Gas quality			B	B	A	B	B	A			
Settlement	B		A	B	B	B	B	B			
Prevention of littering waste			A		B	A					
Physical characteristics	A		A	A	B	B	A	A			
Post-closure land use	A	B	A	A	B	B	B	A			A
Workability	A	B	A	B	A	A	A		A	A	A
Cost effectiveness	A	B	A	A	A	B	B	B	B	B	B
Maintenance		B	A	A					A	A	
Disaster prevention		B	B		B	A	B	B			A

Note: A – Close relation, B – Some relation

12.6.2 Landfill Work

The method and order of landfill should be carefully selected in the following order:

(1) Secure the required landfill volume;

(2) Promote stabilization of the landfill;

(3) Create a physically strong foundation for post-closure land use; and

(4) Improve efficiency of the landfill work.

In particular, enhancement of post-closure land use will require consideration of separate landfill methods for each type of solid waste. Additionally, data on the amounts and types of landfill waste, and changes of landfill area should be recorded for future reference or maintenance of the landfill site.

1) Landfill Method

(1) Area Method/Cell Method

The area method should be introduced when the original ground is unsuitable for excavation of trenches. Earth dike with a height of one lift (2-3m) should be firstly constructed to get the support for compaction. The waste should be unloaded at the toe of the earth dike, and spread and compacted on the slope of the dike in a series of layers that vary in depth from 30 cm to 60 cm. The recommended slope of these layers is 1 to 3. The area method is illustrated in Figure 12.6.1. The width of the working face should be as narrow as possible to confine the waste to the smallest possible area, but it should also be wide enough to give necessary maneuverability to bulldozers.

At the end of each day's operation, a 15-cm to 30-cm layer of cover soil should be placed over that daily-completed fill. This daily-completed fill including the cover soil is called a cell. However, in the case of a large landfill site where the amount of solid waste disposed is more than 200 tons per day, two or more cells should be constructed each day. To avoid the decrease of structural stability, a smaller cell would be better. The waste should be unloaded at the top of the last cell, spread and compacted. When all the area is covered by one layer of cells, it is called a lift. One more lift can be constructed on top of the preceding lift whenever it does not surpass the final topography set by the design.

If a small amount of usable cover soil is available at the landfill site, the ramp variation of the area method is used as shown in Figure 12.6.2. In this method solid wastes are placed and compacted as described for the area method and are partially or wholly covered with earth scrapped from the bottom of the ramp.

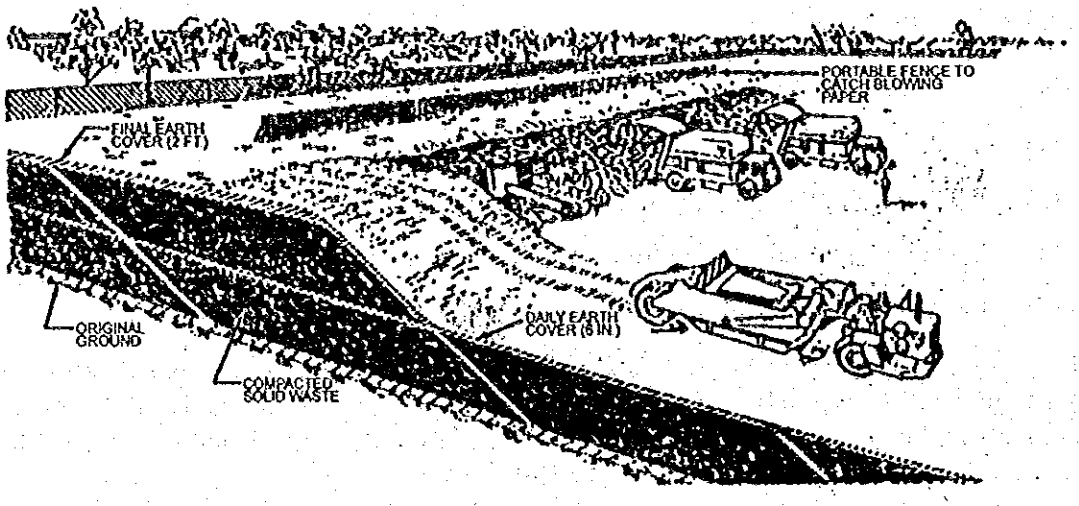


Figure 12.6.1 Area Method

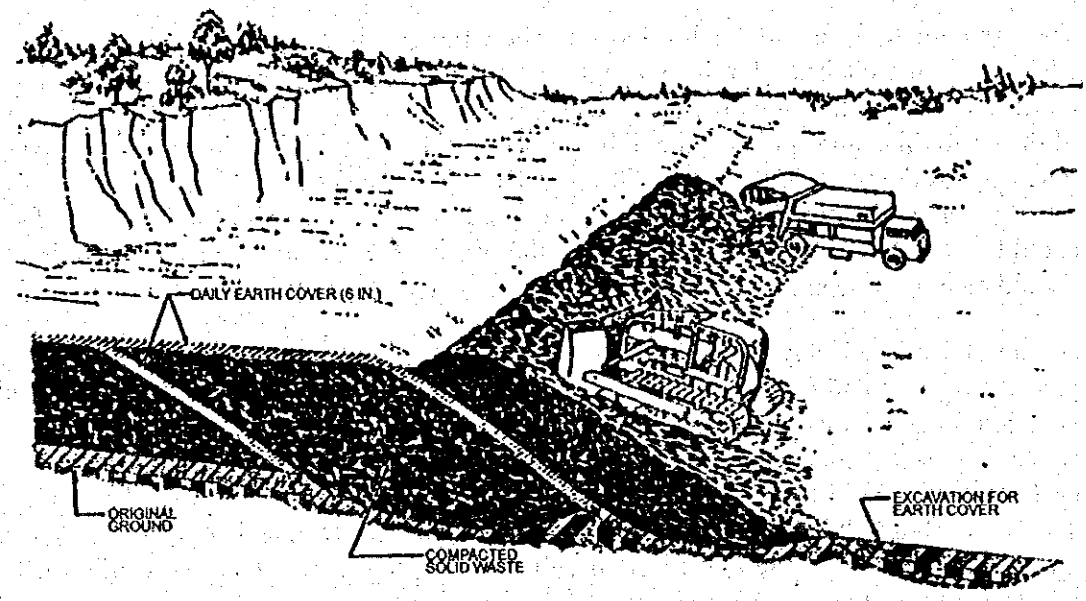


Figure 12.6.2 Progressive Slope or Ramp Method

(2) Trench Method

This method is suited for a place where the original ground is relatively level and the water table is not near the surface. In this case, the excavation of trenches give on-site cover soil as well as support for compaction. Solid waste is placed in trenches varying from 30 to 120 m in length, 1 to 2 m in depth and 5 to 8 m in width. To start the process, a portion of the trench is dug and the earth is stockpiled to form an embankment behind the first trench. Waste is then placed in the trench, spread into thin layers of from 30 to 60cm with the slope of 1 to 3 and compacted. As described for the area method, cover soil is placed near the completed fill at the end of each day's operation. Cover soil is obtained by excavating an adjacent trench or continuing the trench that is being filled.

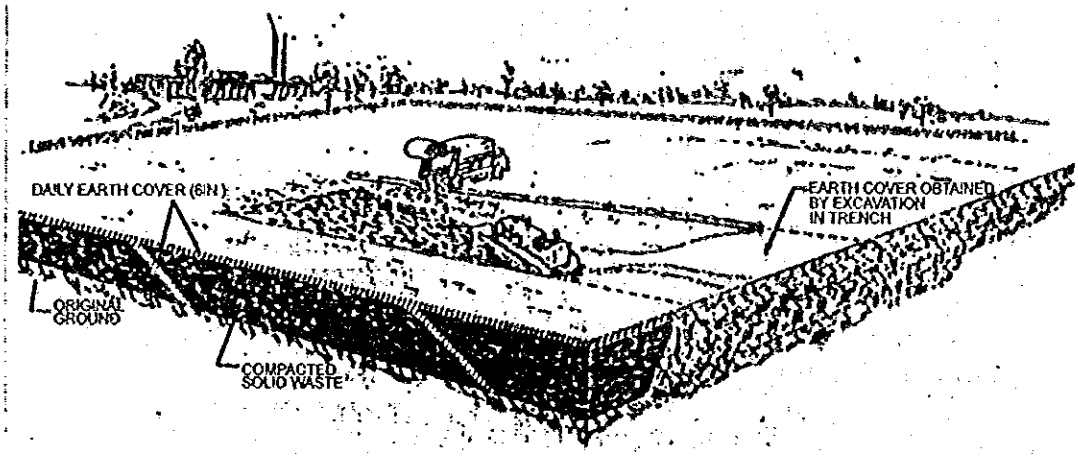


Figure 12.6.3 Trench Method

2) Cell Construction

(1) Sandwich Method

This method is shown in Figure 12.6.4 below. Solid waste is laid horizontally covering soil layer by turns. This method is usually used to landfill in a narrow valley. When a wide area is to be filled-up, the cell method as shown in Figure 12.6.5 is applied.

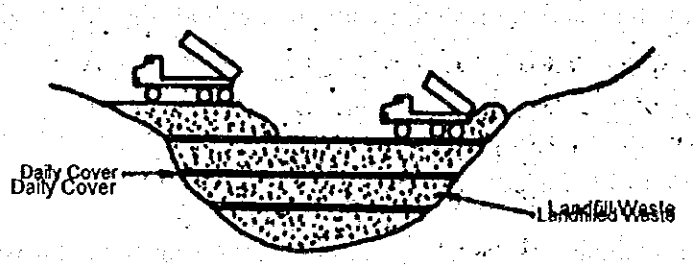


Figure 12.6.4 Sandwich Method

(2) Cell Method

This method, as shown in Figure 12.6.5, is widely used for the landfill method of sanitary landfill systems nowadays. This has a cell of solid waste topped with a layer of cover soil. The size of each cell is determined by the amount of solid waste filled per day. Since each cell is thought to be an independent landfill area, it acts as a fire-breaker. Each cell also prevents the waste from being scattered, the emission of bad odors and breeding of harmful vectors. The disadvantage of this method is that the cell hampers gas generation and water flow within the landfill.

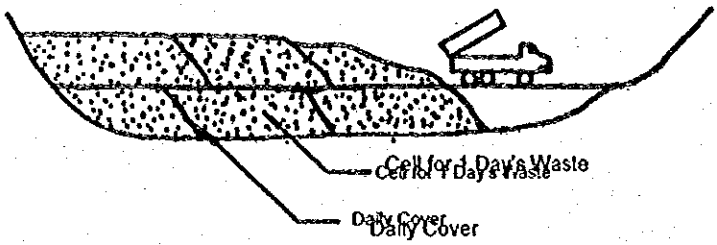


Figure 12.6.5 Cell Method

3) Order of Landfilling

There are two (2) orders in terms of landfilling, namely:

- Landfill starts from the upstream to the downstream; and
- Landfill starts from the downstream to the upstream.

In the former method, easy access to the landfill area via the filled-up area is possible. During the early stages of landfilling, rainwater absorbed into the inner landfill layers are easily discharged. However, it is difficult to remove the rainwater from the unfilled areas. Rainwater on liners on the bottom of the landfill will result in slipping of the landfill layer as well. Sometimes the liners may even be damaged.

On the other hand, the latter method overcomes the above-said difficulties in the former method. Therefore, if the order of landfilling is decided, geography of the area, rainfall pattern, leachate treatment method and rainwater treatment method should be given sufficient consideration.

4) Spreading and Compaction

(1) Methods of Spreading and Compaction

Figure 12.6.6 depicts two (2) methods of spreading and compaction for the solid waste dumped from the collection vehicles: *"Push Down"* or *"Push Up"* the waste on a slope by bulldozer or a loader.

Figure 12.6.6 Spreading/Compaction Method

"Mounting Up" method that is applied for *"Push Up"* method is shown in Figure 12.6.7. This method is used when a cell on a plain ground is made.

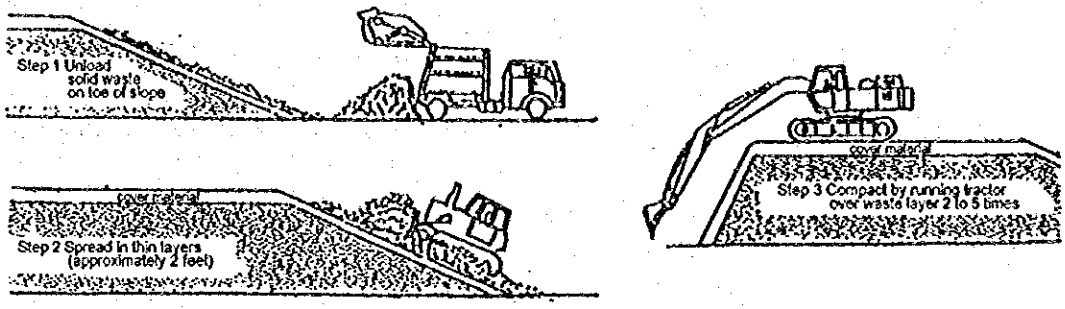


Figure 12.6.7 Mounting Up Method

In the case of pushing the solid waste down the slope, it is difficult to spread the waste into a uniform thickness. The bottom part of the slope tends to be thicker. Mixing and compaction is also difficult. On the other hand, it is easier to make uniform landfill layers when pushed up on the slope. Compaction is also easier.

Therefore, when the compaction layer has to be established as soon as possible, the *"Push Up"* method is preferable. Even so, choosing which method is better depends on the following considerations:

- Types and composition of solid waste;
- Topographical condition; and
- Equipment for landfilling.

The spreading and compaction of the solid waste delivered will affect largely the capacity of landfill, stabilization of landfill layer, post-closure land use, and environmental conservation. It is therefore important that when spreading and compacting solid waste, the component and shape of the waste, landfill type, landfill method, order of land-filling and types of machines used are to be considered together with the following items:

a. The spreading is not too thick. For example, normal thickness is about 30 to 50 cm when normal spreading and compaction machine is used.
b. The landfill layer should be made as uniform as possible and, if necessary, the solid waste be pushed up on a slope when spreading and compaction of the waste is made. A slope gradient of about 1 to 3 (about 20 degrees) is normally recommended.
c. The thickness of each layer should be determined after considerations are given to the component and type of waste, and the post-closure land use plan. At any rate, each layer should be generally less than 3 m thick. When the site is to be used immediately after closing or used for multi-purposes rather than sports ground and a park, the layers should be about 2 m thick.

The typical operation of spreading and compaction is shown in Figures 12.6.8 and 12.6.9.

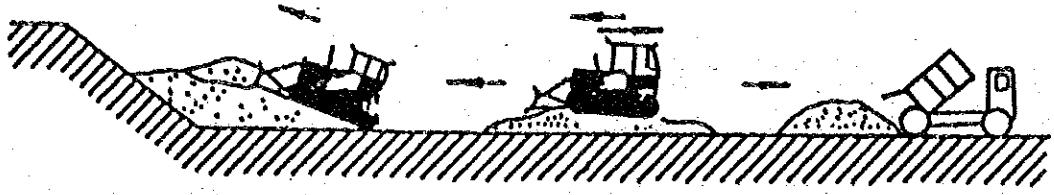


Figure 12.6.8 Operation of Spreading/Compaction

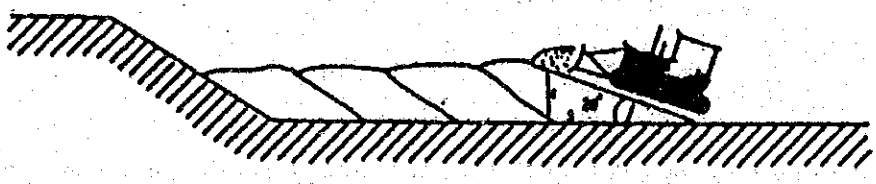


Figure 12.6.9 Pushing Up and Compacting the Waste Simultaneously

(2) Landfill Equipment

a. Selection of Landfill Equipment

Landfill equipment should be selected after considerations are given to the topographical features and size of the site, landfill method, and types of solid waste disposed in the sanitary landfill system. Landfill equipment can be classified into the following, depending on their functions:

(i) Equipment to spread and compact a landfill layer of uniform thickness;
(ii) Equipment for excavation and covering soil; and
(iii) Other equipment required for smooth landfill operation.

Tractors such as crawler tractors and wheel tractors are usually used in (i) and (ii). The crawler tractors is called a bulldozer or tractor shovel depending on the type of arm attached to the tractor like for instance, buckets or blades. These tractors have different purposes.

In this manner, different equipment has different characteristics and therefore has to be properly selected according to its usage.

Besides this, equipment relevant to (iii), such as water tankers, disinfecting trucks and fire-fighting trucks, may also be required on large-scale landfill sites.

b. Number of Equipment Required

The required number of equipment in a landfill project depends on the following:

- Daily amount of waste disposed at the landfill;
- Amount of waste delivered at peak times;

- Size of the sanitary landfill system;
- Efficiency of landfill equipment;
- Operation hours per day;
- Maintenance and repair; and
- Economical aspect.

c. Notes on the Use of Landfill Equipment

Most of the landfill equipment used is equipment for construction purposes. For this reason, the equipment sometimes breaks down in a different manner as compared to equipment in other construction sites. These failures, for example, result from corrosive gases, such as hydrogen sulfide or ammonium salts, which are produced during the decomposition process.

Furthermore, wear and tear in caterpillars due to wires or metal parts or even clogging of the mesh of radiator due to dusts or dirt also usually occurs. It is thus always advisable that spare parts be made available in good condition.

5) Separate Landfilling

Separate landfilling is a method in which the landfill site is divided into small sections and filled with different types of solid waste. This is different from the section landfill method in which the unfilled site is distinguished from the filled site in order to reduce the amount of leachate generated.

There are very few examples of separate landfilling; however, they have several advantages as follows:

- Ease of foundation management;
- Usable land after closure; and
- Ease of leachate monitoring.

On the other hand, the following disadvantages may arise.

- Increase of landfill cost;
- Decrease of landfill volume; and
- Increase of number of landfill equipment.

12.6.3 Cover Soil Work

1) Effectiveness and Necessity of Cover Soil

In the sanitary landfill system, cover soil is indispensable for conservation of the surrounding environment. The cover soil would prevent dispersing of bad odors, scattering of waste, and breeding of vectors and harmful insects. It would also prevent catching and spreading of fires on the site. In addition, it would provide good appearance for the neighborhood. Further, from an operation and management point of view, it would allow easy solid waste spreading and compaction work, and prevent rainwater from seeping into the inner layers of the landfill site and thus make the leachate volume reduced.

Moreover, if a large amount of cover soil is used, the landfill volume capacity will become less and the permeability and breathability of the landfill will decrease. This will bring detrimental effects in such that organic waste may not decompose very well. Therefore, the thickness and type of cover soil should be properly selected considering the purpose of cover soil and type of filled-up waste.

Availability of cover material is another important issue when preparing a cover soil work plan. It may depend on the geological condition of the landfill site and the financial capability of the management organization. If new cover soil material is not available, the old filled-up waste that was buried for about 3 to 6 months ago can be utilized effectively for cover soil. General considerations of the cover soil work are summarized below:

(1) The filled-up waste should never be left as it is. It must always be covered with soil whose thickness depends on the type of waste and cover material used.

(2) Cover soil should be laid in a designated area to prevent gas dispersion and fire and to secure traffic of collection vehicles, when necessary.

(3) A final cover soil should be laid on the last layer of the filled waste. In this case, the thickness of the final cover soil should be determined in consideration of the way for which a completed landfill site would be used.

(4) Cover soil material should be selected depending on its purpose. Enough amount of the material should be provided to complete the landfill plan, and its quality should be suitable to operate the landfilling economically.

(5) The cover soil should properly cover the landfill wastes. It should be sufficiently spread and compacted with a proper thickness and gradient in designated places.

2) Type of Cover Soil

Depending on the purpose, cover soil can be classified into daily, intermediate and final cover soil.

(1) Daily Cover Soil

When the landfill layer reaches the thickness as specified in the design document, or when a one-day portion of the landfill work is completed, soil cover should be provided on the layer. The purposes of the daily cover soil are the following:

a. To prevent the scattering of waste;
b. To control bad odors; and
c. To stop the growth of harmful vectors like flies.

(2) Intermediate Cover Soil

This cover soil, apart from the daily cover soil, should be provided in accordance with the progress of landfill work. The purposes of the intermediate cover soil are the following:

a. To provide foundation of roads for the collection vehicles; and

b. To provide drainage of rainwater away from landfill areas that will be left for a considerably long period.

(3) Final Cover Soil

When all the landfill work is finished, final cover soil should be placed on top of the last layer. The purposes of the final cover soil are the following:

a. To provide of good appearance for the neighborhood;
b. To enhance usability of the post-closure land; and
c. To reduce leachate volume.

3) Selection of Cover Soil

The cover soil is generally categorized depending on the grain size and clay content. The consistency or permeability of the cover soil will then differ according to different categories used.

In most cases, easily available earth and sand are usually used for the cover soil. In this case, the following types of soil should be avoided as much as possible.

a. Extremely acidic or alkaline soil;
b. Soil containing harmful substances;
c. Soil that could deteriorate the leachate quality; and
d. Soil that would hamper the growth of plants.

Appropriate characteristics of soil depending on the type of cover soil are briefly described below.

(1) Daily Cover Soil

As much as possible, a permeable and porous sand type of soil should be used to render easy spreading and compaction of the solid waste, to stabilize the landfill layer and not to hinder waste decomposition process. Nevertheless, a porous cover soil is not suitable for preventing dispersion of bad odors. Therefore, when such types of soil are used, the cover layer should be made as thin as possible to prevent the soil from becoming anaerobic.

(2) Intermediate Cover Soil

Clayey soil that does not have good breathability is suitable to prevent disorderly dispersion of gases and seeping of rainwater. On the other hand, when the cover soil is to be used as a foundation for roads, crusher stones are recommended.

(3) Final Cover Soil

The final cover soil should be resistant to corrosion by rainwater, of low permeability and suitable for plants. Thus, a loam type of soil, which contains some decomposers and humus property, is recommended. When earth and sand from a construction site are used, they should be checked carefully for toxic substances.

4) Determination of Thickness

The thickness of cover soil should be determined by the purpose of cover soil, composition, type and shape of solid waste to be disposed, and the surrounding environmental condition. According to the type of cover soil, the thickness is generally set up as below.

(1) Daily Cover Soil

- Mainly combustible waste and large in size waste : 30 to 50 cm
- Crushed waste and ash : 15 to 20 cm

When impermeable soil such as silt or clay is used, the cover soil should be as thin as possible. When uncrushed waste is used, the thickness is usually about 45 cm; while, cover soil of crushed waste is about 20 cm thick.

(2) Intermediate Cover Soil

- Cover soil is to be exposed for a fairly long time : 50 cm

(3) Final Cover Soil

- Grass or low plants and bushes are planted : more than 50 cm
- Medium height to tall trees are planted : more than 1.0 m

If a post-closure land use plan is prepared by the time the landfill site is closed, the cover soil of the proper type and thickness as designed in the plan should be provided. However, in most cases, availability of the closed landfill site requires a considerably long time since the land subsidence is predicted. In this case, therefore, an appropriate thickness for planting trees should be secured temporarily to improve the site landscape.

When construction debris is used for final cover soil, the root condition of plants on the soil is to be checked after 7 to 8 years. A study clearly shows that the growth of roots is almost similar and it did not depend on the type of soil. It has been found that drainage conditions of the landfill site had a great effect on root growth. Depending on the type of trees, the roots were within a depth of 1 m. Therefore, when medium or tall trees are to be planted, the final cover soil should be more than 1 m deep.

5) Operation and Maintenance of the Cover Soil

The cover soil should be spread uniformly and compacted by using the appropriate type of landfill equipment, which would depend on the thickness, area and type of the cover soil.

In particular, it would take some time for the final cover soil on a slope to stabilize, and care must be taken to prevent this final layer from being eroded by rainwater. It is therefore recommended that the slope gradient should be 20 to 30 degrees, while the gradient of about 2 to 3% would be reasonable on plain areas.

Cover soil work is usually carried out by a landfill layer, and spreading and compaction equipment. In the case of the final cover soil work, graders or rollers used in road construction are recommended.

Maintenance of the cover soil is an integral part of the maintenance of post-closure land, besides leachate and gas treatment. The surface of the final cover soil will sink, crack and form potholes due to decomposition and consolidation of the filled waste. This may result in increase of leachate volume, leakage of gas, erosion of the cover soil, landslides and fires. A survey on subsidence of the post-closure land gave the following findings:

a. The landfill site subsides deeper when combustible waste is disposed and shallower when incombustible waste, such as construction debris, is disposed;
b. The deeper the landfill the deeper the site subsides;
c. The site subsidence continues for several years; and
d. The amount of subsidence varies from a few percent to 30% of the landfill thickness.

In particular, if the surface of the landfill area depresses or cracks, rainwater will seep into the inner layers via these areas. This will thus result in increasing the amount of estimated leachate volume. Additionally, these areas will also become points for gas release. Therefore, the surface of the final cover soil and condition of plants should be checked and maintained periodically.

12.6.4 Site Road Work

1) Characteristics of Site Road

Site roads are constructed for traffic of collection vehicles in the sanitary landfill system. There are mainly three (3) kinds of roads, as follows:

a. Roads that are buried under the landfill layer with the progress of landfill operation;
b. Roads that finish operating when the landfill work is completed; and
c. Roads that are continuously used for operation and management of the landfill control facilities.

Major characteristics of the site roads are summarized below:

(1) Installation and route of the roads are determined by a landfill work plan;
(2) Operation life of the roads is generally short because of covering the landfill layer on the roads;
(3) Topographic condition of the site restrict the route of the roads;
(4) The roads are usually constructed on a liner system for leachate control; and

(5) Care tends to be lacking for operation and management of the roads.

2) Design and Planning of Site Road

(1) Design Components of Site Roads

The site roads should be designed to secure safety and smooth traffic of the collection vehicles. To accomplish this, the following design components of the site roads should be examined:

a. Geometric structure of the road	:	road width, number of traffic lanes, plane and longitudinal lines;
b. Pavement structure of the road	:	thickness of paving, pavement type (asphalt-concrete, cement-concrete, gravel, etc.)
c. Others	:	safety measures, guidance and instruction facilities, drainage facilities, etc.

The above-said components to be determined require the following data and information sufficiently:

- Number of traffic vehicles (daily average and peak hours);
- Size of the vehicles and specifications of the vehicles, such as traffic speed;
- Topographic condition; and
- Level of service, i.e., degree of structure required.

(2) Design Criteria of Site Roads

The design of the site roads should be made in accordance with regulations of road structure and construction in the country where the sanitary landfill system is to be established. The following design considerations describe a recommendable level of road structure for reference.

a. Design Traffic Volume

The design traffic volume should be determined based on the traffic volume at peak hours since collection vehicles often go to the landfill site intensively. If the site road is connecting to a public road with heavy traffic, the number of traffic vehicles in a short period, such as 30 or 15 minutes, should be considered.

b. Road Width

Although the road width depends on the traffic volume and shape of the vehicles, the following typical available widths should be adopted:

- Single lane : 3.5 m
- Two lanes : 6 m

c. Longitudinal Slope of the Road

It is recommended that the road slope should be as gentle as possible. In case that there are many topographical restrictions in a mountainous area, the maximum slope should be less than 12%. In particular, slip prevention and stoppage measure should be installed properly when the road is constructed in a snowy or frozen area.

d. Cross Slope of the Road

In terms of operation and maintenance of the road, rainwater should be drained immediately. Therefore, the cross slope should be at least 3%.

e. Pavement Structure

Considering trafficability of the vehicles, workability of road maintenance and strength of the road, the minimum level of pavement should be the gravel type.

f. Safety Measures

The site roads in a mountainous area or high place should be equipped with guardrails.

12.6.5 Slope Adjustment Work

1) Design Concept of Slope Adjustment Work

Dimension and slope of the landfill layer are primarily determined taking into consideration how required landfill volume is secured based on topographic and geological conditions of the site. In this sense, it is preferable that the dimension of the slope should be large and the slope of the layer should be steep. However, a large-scale slope may not suit the landfill work, post-closure land use and conservation of the surrounding environment. Furthermore, improper slope construction may result in erosion and collapse of the slope if it rains and deteriorate the surrounding environment. It is thus of importance that the slope has to be kept safe considering the following matters:

(1) The slope of the landfill layer should be as gentle as possible, and its dimension should be as small as possible;

(2) Sufficient distance between toe of the slope and top of the retaining structure should be secured, so that the weight of the landfill layer will not affect the retaining structure;

(3) Appropriate measures should be taken, so that the slope will not erode by rainfall;

(4) The slope of the landfill layer and slope adjustment should be designed in harmony with the surrounding environment; and

(5) Ease of construction for covering soil on the slope should be considered.

The safety factor of the slope of the landfill layer is generally calculated by the stability against rotation slip. In this calculation, the dynamic characteristics of the solid waste should be set up, such as internal angle and coefficient of cohesion, considering the following factors:

- Type and shape of the waste;
- Compacting condition of the landfill layer;
- Thickness of the layer;
- Water content of the layer; and
- Age of the layer.

2) Types of Slope Adjustment Work

There are two (2) cases to be considered in the slope adjustment work, as shown in Figure 12.6.10.

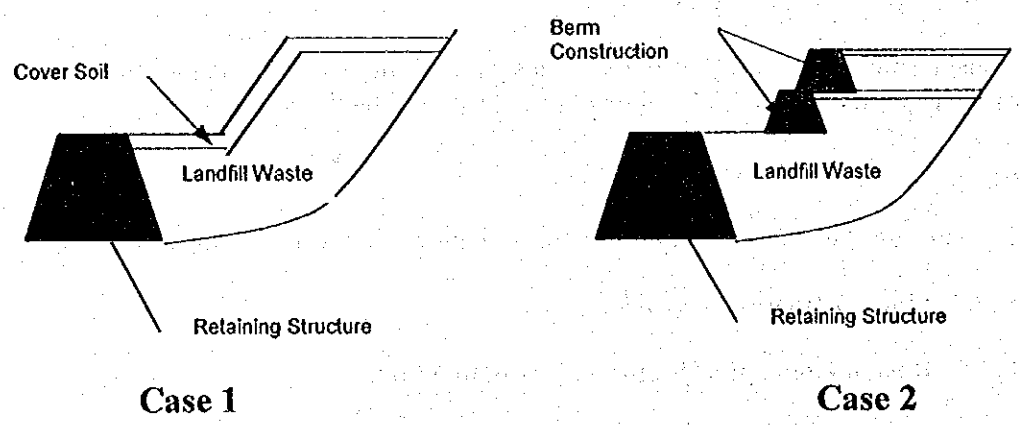


Figure 12.6.10 Types of Slope Adjustment

In Case 1, the slope is adjusted by the solid waste itself and the landfill work can develop the slope of the waste simultaneously. This case can be easily operated, but sufficient compaction of the waste would be difficult. In addition, the final cover could not be done until the elevation of the waste has reached the design landfill height.

On the other hand, in Case 2 where a berm is built in the landfill area, sufficient compaction of the slope could be made resulting in less subsidence of the ground. This will also bring a good foundation for the post-closure land use. Thus, it is recommended that Case 2 be adopted for the slope adjustment work.

3) Method of Slope Adjustment Work

(1) Design of Berm Construction

A berm that is built in the landfill area forms a slope of the final landfill. It is therefore suitable to construct a small berm whose height is set up in accordance with the landfill height to secure the required landfill volume. In this sense, the height of berm should be 3 to 5 m. It is also important to have sufficient horizontal distance between berms if several berms are constructed one by one and the dimensions of slope become relatively large.

(2) Slope Stability

Slope stability depends on the characteristics of the waste to be filled because the landfill slope is usually built on the landfill waste and its back and sides are surrounded with the waste.

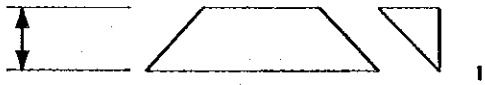
Typical slopes are shown in the following table according to landfill materials and height of the landfill although the slope should be finally determined by calculating the slope stability as a whole.

Table 12.6.3 Typical Slope depending on Landfill Materials and Height of the Landfill

Landfill Materials	Height of the Landfill*1	Slope*2
Grainy Sand, Gravel and Sand mixed with Gravel	Less than 5 m	1.5 : 1 to 1.8 : 1
	5 to 15 m	1.8 : 1 to 2.0 : 1
Not Grainy Sand	Less than 10 m	1.5 : 1 to 1.8 : 1
Rock	Less than 10 m	1.8 : 1 to 2.0 : 1
	10 to 20 m	1.8 : 1 to 2.0 : 1
Sandy Soil, Stiff Clayey Soil, Stiff Clay	Less than 5 m	1.5 : 1 to 1.8 : 1
	5 to 10 m	1.8 : 1 to 2.0 : 1
Soft Clayey Soil	Less than 5 m	1.8 : 1 to 2.0 : 1

Note:

*1 Height of the Landfill



*2 Slope; for example 1.5 : 1

4) Landscape of the Slope

While safety of the slope adjustment work should be considered as the first priority, its feature should also be in conformity with the surrounding environment. The slope adjustment work will therefore have a function of protection of the slope as well as landscaping from aesthetic viewpoints.

The condition that earth and sand of the slope are exposed may deteriorate the surrounding environment and result in erosion of the slope due to heavy rain. Thus, the slope should be covered shortly after it has been built, by the following methods:

(1) Providing structural measures, such as slope protection concrete;

(2) Planting trees; and

(3) Spraying seeds of plants.

The method suitable for the landfill slope should be decided by its conformity with the surrounding environment, post-closure land use, expected life of the landfill site and cost of the work. Considering the construction period, spraying seeds of plants is recommended because of the following reasons:

- The slope has not yet stabilized and continues to subside; and
- The work tends to be affected by gas generated from decomposition of the waste.

Technical consideration to be taken when the seed spraying method is adopted is summarized as follows:

(1) Slope features, such as slope and length;

(2) Geological condition, such as fertilization of soil, hardness of soil, etc.;

(3) Meteorological condition, such as atmospheric temperature, precipitation, wind force, etc.;

(4) Regional condition, such as hours of sunshine, damage from saltwater, degree of humidity, etc.; and

(5) Ease of construction.

SECTION F

WASTE MINIMIZATION AND RECYCLING

SECTION F: WASTE MINIMIZATION AND RECYCLING

1. PAST EXPERIENCE IN MINIMIZING OF WASTE IN ALMATY CITY

In Almaty City there was a certain experience in minimizing the waste. In 70-80's, its major objective was pursued/ recovery of the secondary raw material for the waste recycling.

The scrap metal and waste-paper were primarily subjected to stocking up and recovered.

Under conditions of the economic plan, every enterprise had a plan for recycling of the metal scrap, waste-paper and, depending upon the specific character of activities, of some other secondary raw material. None of the enterprises under the former conditions could acquire the new equipment without recycling of the equivalent amount of the metal scrap and precious metals recovered from the devices and equipment. Special campaigns were conducted for collection of the metal scrap in the city's territory, and school children/ students took an active on its part in such campaigns.

The population of the city were active in separate collection of the waste. The main incentive for the population was the deficit of certain commodities in the retail trade: some types of clothes and other consumer goods.

There were special stations for reception of the scrap and utility-refuse from the population. At these points (stations), in case of the waste-paper and textiles, the special coupons were given to the people. Therefore, they could sell books, textile (cotton, silk, flax, woolens) - the consumer goods, and only dirty textile was disposed to the final disposal site.

The separation of the waste, amount of the secondary raw material, was performed at the Plant of SDW Mechanized Processing. During one year, about 300,000m^3 of the SDW entered and approx.1,000tons of the ferrous metal scrap, approx. 50tons of the non-ferrous scrap, relatively pure waste-paper, bones, plastic material and broken glass were recovered up.

The collection of the glass were widely practiced; i.e. all types of bottles including the bottles for the drink and milk production, and jars which have a certain mortgage (hypothecation) value. This process was effected by various ways: the specialized shops and stalls were opened for collection of the glass; the bottles and jars were received practically at every food shop in the manner of exchange with the goods and money. Besides, special collectors of the glass were engaged in collecting it directly from the residents' flats. As a result of such arrangement of collecting the glass, only the broken glass came to be the waste to be disposed.

It was executed to collect the food waste from the population:

For the food waste collection, specials containers located in the yards of the multi-storey dwelling houses were used; the collected food waste were transferred to the swine ranches of the state farms in the Oblast. However, this system of the food waste collection have not continuously performed because the introduction of this system was not well organized, because of;

- The clarifications of the matter and conversations with the population were not conducted, etc.
- No provisions were made for any material incentive for the food waste collection by the people.
- The collection and storage/ accumulation of the food waste were organized on the low level.
- The removal of the accumulated waste were performed not regularly.

Because of poor organization and responsibility of the executors, glass, wire, pieces of metal and other waste into the food waste that rendered the waste unsuitable for their further utilization for its proper purpose. As a result of it, this system of the food waste collection from the population died out gradually.

2. BRIEF CHARACTERISTIC OF THE PAST RECYCLABLE RESOURCES USERS

Up to 1995, there were the following organizations for the potential consumers of the recyclable recourses: *the Vtorma JSC*, *the Vtorchermet JSC*, the Almaty *Vtortsvetmet CE* and *Zharys enterprise*, as well as some industrial enterprises, *Birlesu JSC*, *Alua Kazakh-Russian JV*, *Polimertara SE*, the Almaty Plant for the DSW Mechanized Processing and the *Sunkar JSC*.

The Vtorma JSC collected and stored up the waste paper, secondary textile material. broken glass and plastic material. This enterprise was equipped with imported equipment such as automated pressing continuos flow line «Personer» and «Lindemann» of German manufacture. The Enterprise's capacity was 13,000 tons/year for the waste paper. The secondary textile, waste paper (paper cuttings, packing paper and cardboard tare) and the broken glass of various types were accepted by the Enterprise without any incidental impurities. The waste paper was sent for reprocessing to the cities of Kzyl-Orda and Pavlodar, and the broken glass to the glassworks.

The Almaty Vtortsvetmet CE accepted only the scrap of non-ferrous metals that should meet the requirements of the GOST (State Standard) 1639-78. The value of one ton of non-ferrous metal was determined by the price-list 02-05 with the inflation coefficient as of November 1, 1995 - 600. The Enterprise's capacity in acceptance of non-ferrous metals were approx. 5,000 tons per year.

The Vtorchermet JSC accepted only the scrap of the ferrous metals which collected at the DSW (Domestic Solid Waste) collection points.

The Zharys Enterprise of the Almatysnab Joint Stock Company stocked up the waste paper by the contractual price, then pressed and delivered it to the consumer in Pavlodar City. In 1994 there were stocked up of 760 tons of waste paper.

The Birlesu JSC (The Nonwoven-Fabrics Factory) accepted the secondary textile for reprocessing in conformity with the existing standards. At the enterprise there were spare capacities for the reception of additional amount of the textile raw material from the DSW, during the separate waste collection period.

The Polimertara SE accepted some volumes of pure secondary polymeric materials (polyethylene film of the agriculture use, worn-out tare, etc.) which were reprocessed into the production.

The Alua Kazakh-Russian JV (the former The Abai Glassware): the yearly demand of the broken glass of them were amount to 15,000 tons.

The Tekhmet Scientific and Production Commercial Company accepted the second-hand technical units/ goods, car spare parts and sanitary ware by measuring weight and by its assessed value with the substantiation of the component parts of its origin.

The Almaty Plant for the Mechanized DSW Processing (WPP) accepted the waste in the amount of 300,000 m^3 per year (including approx. 60,000 tons of DSW), and it produced about 35,000 tons of compost.

In 1995, the compost products were distributed to the summer residents, horticulture farms and the arboretum, in total about 500 tons. The large remaining volume of the compost was transferred to the city's disposal site.

At the plant there was a shop for production of the fiber boards with the output 85,000 m^2 and with the dimensions 1950 x 1220 x 7 mm. These fiber boards were manufactured from relatively pure waste paper which was specially brought to the Plant from the Enterprises of the city. The paper wastes collected from the DSW are not unsuitable for manufacturing the fiber boards.

At present the program document on minimization of the waste is unavailable in the city. Works in this direction are not officially carried out. Selection of the secondary raw material from the waste is being carried out spontaneously at the place of the waste accumulation (including illegal dumping sites), its transfer process and disposal sites mainly by the poor and homeless population.

3. EXPERIMENT ON THE SEPARATE COLLECTION OF THE DSW IN 1997

After the dissolution of the USSR, the enterprises engaged in collecting the utilizable waste didn't fulfill their obligations to the population. Accordingly, the population's attitude to the collection of utilizable waste has drastically changed. Main reasons are;

- The deficit as to the consumer goods has disappeared.
- The economic level of the living standards has considerably dropped for the majority of the population.
- Collection and recycling of the secondary raw material for the enterprises became unprofitable.

Such affairs resulted in the stoppage of the separate collection of the waste by the population, and it leads the increase of the waste haulage volume to the disposal site and then production of illegal dump site. In this connection, sanitary and ecological situation of the city getting worse.

In 1997 the *Almatyecologostroi* Scientific-and-Production Association by the order of the Almaty City Department for the Environment Protection, an experiment was executed in separate collection of the waste in one of the districts of the city. The residents from 13 dwelling houses and 220 apartments with the population of 836 persons took part in this experiment.

The objectives of this experiment were as follows:

- To determine the potentiality and feasibility of introducing the foreign expertise concerning the DSW collection at the threshold of their households, when the population itself should perform this activities.
- To reveal the desire of the population itself to participate in it.
- To establish the principles of organizing the separate collection of the DSW.
- To exercise the practical working of these principles at a small district in the well-organized region of the city.
- To study the market of demand for the recycled resources recovered from the waste.

This experiment was conducted in the course of two months by two versions of the arrangement. While, in the yard, waste accumulation site, adjacent to the five containers painted with various colors were settled and having the inscriptions for which types of the waste they are designated for.

The first version: the owners of the flats were given two bags (the propylene bags with handles). In every flat the metal waste, textile, glass (including the broken glass), waste paper, polyethylene and plastic materials were put into one bag, while the rest garbage was put into the other bag. The mixed garbage was removed by the residents as usually and put into the common containers.

The selected utilizable raw material was delivered to the specially employed worker (the sorter) who selected the waste by the types, weighted it and distributed in the containers. In addition, the sorter kept track on the observance of the experiment conditions, registered participation of the residents set in the experiment, had an explanatory talks with the population, kept records as to the accumulation and removal of the mixed waste.

The second version: the residents in their flats themselves put the utilizable waste into diverse bags and the waste accumulated in the bags put into the containers destined for the type of waste, however, the mixed waste they removed were put into the common containers as usually.

97% of the residents took stable participation on this experiment. As a result, it has found that the task of introducing the selective collection of the DSW in Almaty city has realistic in the flats residents. In this case, up to 30% of the waste hauled to the disposal site can be reduced.

The opinion survey of the residents conducted upon completion of the experiment and it stated that the majority of the experiment's participants were agreed to introduce the selection of the waste throughout the city. However, in this case, it is necessary to make the points for reception of the utilizable waste.

The major unfavorable factor when introducing the selection of the waste is the lack of precisely organized system for the utilizable waste collection and lack of sufficient number of the enterprises for their recycling. Accordingly, the further development of the experiment in the day-to-day life of the citizen doesn't happen, and the problem concerning the separate collection of the waste has remained unsolved.

At the same time, the inquiry of the population conducted during the period of the spring phase has revealed that the majority of the city's population , about 70% of the total number of the inquired, agree to participate in the separate collection of the waste in their flats. Therewith, the most part of them, 53.8% of the respondents, consider that for successive realization of this process it is required some incentives and the economic leadership.

Approximately equal number of the inquired by the Rayons of the city have expressed there desire to participate in selecting the waste: from 64% in the Turksib Rayon to 75% in the Almaly Rayon.

SECTION G

MEDICAL WASTE AND INDUSTRIAL WASTE

SECTION G

G-1: INDUSTRIAL WASTE DEFINITION ACCORDING TO EU DIRECTIVES

COUNCIL DIRECTIVE OF 12 DECEMBER 1991 ON HAZARDOUS WASTE (91/689/EEC)

THE COUNCIL OF THE ROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community, and in particular Article 103s thereof,

Having regard to the proposal from the Commission (1),

Having regard to the opinion f the European Parliament (2),

Having regard to the opinion of the Economic and Social Committee (3),

Whereas Council Directive 7 /319/EEC of 20 March 1978 on toxic and dangerous waste (4),established Community rules on the disposal of dangerous waste; whereas in order to take account of experience gained in the implementation of that Directive by the Member States, it is necessary to amend the rules and to replace Directive 78/319/EEC by this Directive;

Whereas the Council resolution of 7 May 1990 on waste policy (5) and the action programme of the European Communities on the environment, which was the subject of the resolution of the Council of the European Communities and of the representatives of the Government of the Member States, meeting within the Council, of 19 October 1987 on the continuation and implementation. of a European Community policy and action programme on the environment (1987 to 1992) (6), envisage Community measures to improve the conditions under which hazardous wastes are disposed of and managed;

Whereas the general rules applying to waste management which are laid down by Council Directive 75/442/EEC of 15 July 1975 on waste (7), as amended by Directive 91/156/EEC (8), also apply to the management of hazardous waste;

Whereas the correct management of hazardous waste necessitates additional, more stringent rules to take account of the special nature of such. waste;

Whereas it is necessary, in order to improve the effectiveness of the management of hazardous waste in the Community, to use a precise and uniform definition of hazardous waste based on experience;

Whereas it is necessary to ensure that disposal and recovery of hazardous waste is monitored in the fullest manner possible;

Whereas it must be possible rapidly to adapt the provisions of this Directive to scientific and technical progress; whereas the Committee set up by Directive 75/442/EEC must also empowered to adapt the provisions of this Directive to such progress,

HAS ADOPTED THIS DIRECTIVE:

Article 1

1): The object of this Directive, drawn up pursuant to Article 2 (2) of Directive 75/442/EEC, is to approximate the laws of the Member States on the controlled management of hazardous waste.

2): Subject to this Directive, Directive 75/442/EEC shall apply to hazardous waste.

3): The definition of 'Waste' and of the other terms used in this Directive shall be those in Directive 75/442/EEC.

4): For the purpose of this Directive "hazardous waste means":

- wastes featuring on a list to be drawn up in accordance with the procedure laid down in Article 18 of Directive 75/442/EEC on the basis of Annexes and II to this Directive, not later than six months before the date of implementation of this Directive. These wastes must have one or more of the properties listed in Annex III. The list shall take into account the origin and composition of the waste and, where necessary, limit values of concentration. This list shall be periodically reviewed and if necessary by the same procedure,

- any other waste which is considered by a Member State to display any of the properties listed in Annex III. Such cases shall be notified to the Commission and reviewed in accordance with the procedure laid down in Article 18 of Directive 75/442/EEC with a view to adaptation of the list.

5): Domestic waste shall be exempted from the provisions of this Directive. The Council shall establish, upon a proposal from the Commission, specific rules taking into consideration the particular nature of domestic waste not later than the end of 1992.

Article 2

1): Member States shall take the necessary measures to require that on every site where tipping (discharge) of hazardous waste takes place the waste is recorded and identified.

2): Member States shall take the necessary measures to require that establishment and undertaking which dispose of, recover, collect or transport hazardous waste do not mix different categories of hazardous waste or mix hazardous waste with non-hazardous waste.

3): By way of derogation from paragraph 2, the mixing of hazardous waste with other hazardous waste or with other waste, substances or materials may be permitted only where the conditions laid down in Article 4 of Directive 75/442/EEC are complied with and in particular for the purpose of improving safety during disposal or recovery. Such an operation shall be subject to the permit requirement imposed in Articles 9, 10 and 11 of Directive 75/442/EEC.

4): Where waste is already mixed with other waste, substances or materials, separation must be effected, where technically and economically feasible, and where necessary in order to comply with Article 4 of Directive 75.1442/EEC.

Article 3

1): The derogation referred to in Article 11 (1) (a) of Directive 75/442/EEC from the permit requirement for establishments or undertakings which carry out their own waste disposal shall not apply to hazardous waste covered by this Directive.

2): In accordance with Article 11 (1) (b) of Directive 75/442/EEC, a Member State may waive Article 10 of that Directive for establishments or undertakings which recover waste covered by this Directive:

- if the Member State adopts general rules listing the type and quantity of waste and laying down specific conditions (limit values for the content of hazardous substances in the waste, emission limit values, type of activity) and other necessary requirements for carrying out different forms of recovery, and
- if the types or quantities of waste and methods of recovery are such that the conditions laid down in Article 4 of Directive 75/442/EEC are complied with.

3): The establishments or undertakings referred to in paragraph 2 shall be registered with the competent authorities.

4): If a Member State intends to make use of the provisions of paragraph 2, the rules referred to in that paragraph shall be sent to the Commission not later than three months prior to their coming into force. The Commission shall consult the Member States. In the light of these consultations the Commission shall propose that the rules be finally agreed upon in accordance with the procedure laid down Article 18 of Directive 75/442/EEC.

Article 4

1): Article 13 of Directive 75/442/EEC shall also apply to producers of hazardous waste.

2): Article 14 of Directive 75/442/EEC shall also apply to producers of hazardous waste and to all establishments and undertakings transporting hazardous waste.

3): The records referred to in Article 14 of Directive 75/442/EEC must be preserved for at least three years except in the case of establishments and undertakings transporting hazardous waste which must keep such records for at least 12 months. Documentary evidence that the management operations; have been carried out must be supplied at the request of the competent authorities or of a previous holder.

Article 5

1): Member States shall take the necessary measures to ensure that, in the course of collection, transport and temporary storage, waste is properly packaged and labelled in accordance with the international and Community standards in force.

2): In the case of hazardous waste, inspections concerning collection and transport operations made on the basis of Article 13 of Directive 75/442/EEC shall cover more particularly the origin and destination of such waste.

3): Where hazardous waste is transferred, it shall be accompanied by an

identification form containing the details specified in Section A of Annex I to Council Directive 84/631/EEC of 6 December 1984 on the supervision and control within the European Community of the transfrontier shipment of hazardous waste (1), as last amended by Directive 86/279/EEC (2).

Article 6

1): 1) : As provided in Article 7 of Directive 75/442/EEC, the competent authorities shall draw up, either separately or in the framework of their general waste management plans, plans for the management of hazardous waste and shall make these plans public.

2): 2) : The Commission shall compare these plans, and in particular the methods of disposal and recovery. It shall make this information available to the competent authorities of the Member States which ask for it.

Article 7 ARTICLE 7

In cases of emergency or grave danger, Member States shall take all necessary steps, including, where appropriate, temporary derogations from this Directive, to ensure that hazardous waste is so dealt with as not to, constitute a threat to the population or the environment. The Member State shall inform the Commission of any such derogations.

Article 8 ARTICLE 8

1): In the context of the report provided for in Article 16 (1) of Directive 75/442/EEC, and on the basis of a questionnaire drawn up in accordance with that Article, the Member States shall send the Commission a report on the implementation of this Directive.

2): In addition to the consolidated report referred to in Article 16 (2) of Directive 75/442/EEC, the Commission shall report to the European Parliament and the Council every three years on the implementation of this Directive.

3): In addition, by 12 December 1994, the Member States shall send the Commission the following information for every establishment or undertaking which carries out disposal and/or recovery of hazardous waste principally on behalf of third parties and which is likely to form part of the integrated network referred to in Article of Directive 75/442/EEC: - name and address, - the method used to treat waste, - the types and quantities of waste which can be treated. Once a year, Member States shall inform the Commission of any changes in this information. The Commission shall make this information available on request to the competent authorities in the Member States. The format in which this information will be supplied to, the Commission shall be agreed upon in accordance with the procedure laid down in Article 18 of Directive 75/442/EEC.

Article 9

The amendments necessary for adapting the Annexes to this Directive to scientific and technical progress and for revising the list of wastes referred to in Article 1 (4) shall be

adopted in accordance with the procedure laid down in Article 18 of Directive 74/442/EEC.

Article 10

1): The Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive before 12 December 1993. They shall forthwith inform the Commission thereof.

2): When Member States adopt these measures, they shall contain a reference to this Directive or shall be accompanied by such reference on the occasion of their official publication. The methods of making such a reference shall be laid down by the Member States.

3): Member States shall communicate to the Commission the texts of the main provisions of national law which they adopt in the field governed by this Directive.

Article 11 ARTICLE 11

Directive 78/319/EEC is hereby repealed with effect from 12 December 1993.

Article 12 ARTICLE 12

This Directive is addressed to the member States.

Done at Brussels, 12 December 1991.

For the Council The President J.G.M. ALDERS

1(1)OJ N° C 295,19.11.1988, p. 8, and OJ N° C 42,22.2.1990, p. 19.
(2)OJ N° C 158,26.6.1989, p. 238.
(3)OJ N° C 56,6.3.1989, p. 1
(4)OJ N° L 84, 31. 3. 1978, p. 43.
(5)OJ N° C 122, 18. 5. 1990, p. 2.
(6)OJ N° C 328,7.12.1987, p. 1.
(7)OJ N° L 194, 25. 7. 197 5, p. 39.
(8)OJ N° L 78,26.3.1991, p. 32.
(1)OJ N° L 326, 13. 12. 1984, p. 3 1.
(2)OJ N° L 18 1, 4. 7. 1986, p. 13.

ANNEX I CATEGORIES OR GENERIC TYPES OF HAZARDOUS WASTE LISTED ACCORDING TO THEIR HATURE OR THE ACTIVITY WHICH GENERATED THIEM (*) (WASTE MAY BE LIQUID, SLUDGE OR SOLID IN FORM)

ANNEX I.A.

Wastes displaying any of the properties listed in Annex III and which consist of.

1. anatomical substances, hospital and other clinical wastes;
2. pharmaceuticals, medicines and veterinary compounds;
3. wood preservatives;
4. biocides and phyto-pharmaceutical substances;
5. residue from. substances employed as solvents;
6. halogenated organic substances not employed as solvents excluding inert polymerized materials;
7. tempering salts containing cyanides;
8. mineral oils and oily substances (e.g. cutting sludges, etc.);
9. oil/water, hydrocarbon/water mixtures, emulsions;
10. substances containing PCBs and/or PCTs (e.g. dielectrics etc.)
11. tarry materials arising from refining, distillation and any pyrolytic treatment (e.g. still bottoms, etc.);
12. inks, dyes, pigments, paints, lacquers, varnishes;
13. resins, latex, plasticizers, glues/adhesives;
14. chemical substances arising from. research and development or teaching activities which are not identified and/or are new and whose effects on man and/or the environment are not known (e.g. laboratory residues, etc.);
15. pyrotechnics and other explosive materials;
16. photographic chemicals and processing materials;
17. any material contaminated with any congener of polychlorinated dibenzo-furan;
18. any material contaminated with any congener of polychlorinated dibenzo-p-dioxin;

ANNEX I.B.

Wastes which contain any of the constituents listed in Annex II and having any of the properties listed in Annex III and consisting of;

19. animal or vegetable soaps, fats, waxes;
20. non-halogenated organic substances not employed as solvents;
21. inorganic substances without metals or metal compounds;
22. ashes and/or cinders;
23. soil, sand, clay including dredging spoils;
24. non-cyanidic tempering salts;
25. metallic dust, powder;
26. spent catalyst materials;
27. liquids or sludges containing metals or metal compounds;
28. residue from pollution control-operations (e.g. baghouse dusts, etc.) except (29), (30) and (33);
29. scrubber sludges;
30. sludges from water purification plants;
31. decarbonization residue;
32. ion-exchange column residue;
33. sewage sludges, untreated or unsuitable for use in agriculture;
34. residue from cleaning of tanks and/or equipment;
35. contaminated equipment;
36. contaminated containers (e.g. packaging, gas cylinders, etc.) whose contents included one or more of the constituents listed in Annex II;
37. batteries and other electrical cells;
38. vegetable oils;
39. materials resulting from selective waste collections from households and which exhibit any of the characteristics listed in Annex III;
40. any other wastes which contain any of the constituents listed in Annex II and any of the properties listed in Annex III.

(*) Certain duplications of entries found in Annex II are intentional.

ANNEX II CONSTITUENTS, OF THE WASTES IN ANNEX I.B. WHICH RENDER THEM HAZARDOUS WHEN THEY HAVE THE PROPERTIES DESCRIBED IN ANNEX III (*)

Wastes having as constituents:

C1 beryllium; beryllium compounds;

C2 anadium compounds;

C3 hromium (VI) compounds;

C4 obalt compounds;

C5 ickel compounds;

C6 opper compounds;

C7 inc compounds;

C8 rsenic; arsenic compounds;

C9 elenium; selenium compounds;

C10 silver compounds;

C11 cadmium; cadmium compounds;

C12 tin compounds;

C13 antimony; antimony compounds;

C14 tellurium; tellurium compounds;

C15 barium compounds; excluding barium sulfate;

C16 mercury; mercury compounds;

C17 thallium; thallium compounds;

C18 lead; lead compounds;

C19 inorganic sulphides;

C20 inorganic fluorine compounds, excluding calcium fluoride;

C21 inorganic cyanides;

C22 the following alkaline or alkaline earth metals: lithium, sodium, potassium, um, magnesium in uncombined form;

C23 acidic solutions or acids in solid form;

C24 basic solutions or bases in solid form;

C25 asbestos (dust and fibres);

C26 phosphorus: phosphorus compounds, excluding mineral phosphates;

C27 metal carbonyls;

C28 peroxides;

C29 chlorates;

C30 perchlorates;

C31 azides;

C32 PCBs and/or PCTs,

C33 pharmaceutical or veterinary compounds;

C34 biocides and phyto-pharmaceutical substances (e.g. pesticides, etc.);

C35 infectious substances;

C36 creosotes;

C37 isocyanates; thiocyanates;

C38 organic cyanides (e.g. nitriles, etc.);

C39 phenols; phenol compounds;

C40 halogenated solvents;

C41 organic solvents, excluding halogenated solvents;

C42 organohalogen compounds, excluding inert polymerized materials and other substances referred to in this Annex;

C43 aromatic compounds; polycyclic and heterocyclic organic compounds;

C44 aliphatic amines;

C45 aromatic amines

C46 ethers;

C47 substances of an explosive character, excluding those listed elsewhere in this Annex;

C48 sulphur organic compounds;

C49 any congener of polychlorinated dibenzo-furan; C50 any congener of polychlorinated

C50 dibenzo-p-dioxin;

C51 hydrocarbons and their oxygen; nitrogen and/or sulphur compounds not otherwise taken into account in this Annex.

(*) Certain duplications of generic types of hazardous wastes listed in Annex I are intentional.

ANNEX III PROPERTIES OF WASTES WHICH RENDER THEM HAZMWOUS

H1 'Explosive': substances preparations which may explode under the effect of flame or which are more sensitive to shocks or friction than dinitrobenzene.

H2 'Oxidizing': substances and preparations which exhibit highly exothermic reactions when in contact with other substances, particularly flammable substances.

H3-A 'Highly flammable': - liquid substances and preparations having a flash point below 21°C (including extremely flammable liquids), or - substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any application of energy, or - solid substances and preparations which may readily catch fire after brief contact with a source of ignition and which continue to burn or to be consumed after removal of the source of ignition, or - gaseous substances and preparations which are flammable in air at normal pressure, or - substances and preparations which, in contact with water or damp air, evolve highly flammable gases in dangerous quantities.

H3-B 'Flammable': liquid substances and preparations having a flash point equal to or greater than 21°C and less than or equal to 55°C.

H4 'Irritant': non-corrosive substances and preparations which, through immediate, prolonged or repeated contact with the skin or mucous membrane, can cause inflammation.

H5 'harmful': substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may involve limited health risks.

H6 'Toxic': substances and preparations (including very toxic substances and preparations) which, if they are inhaled or ingested or if they penetrate the skin, may involve serious, acute or chronic health risks and even death.

H7 'Carcinogenic': substance and preparations which ' if they are inhaled or ingested or if they penetrate the skin, may induce cancer or increase its incidence.

H8 'Corrosive': substances and preparations which may destroy living tissue on contacts.

H9 'Infectious': substances containing viable micro-organisms or their toxins which are known or reliably believed to cause disease in man or other living organisms.

H10 'Teratogenic': substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce non-hereditary congenital malformations or increase their incidence.

H11 Mutagenic: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce hereditary genetic defects or increase their incidence.

H12 Substances and preparations which release toxic or very toxic gases in contact with water, air or an acid.

H13 Substances and preparations capable by any means, after disposal, of yielding another substance, e.g. a leachate, which possesses any of the characteristics listed above.

H14 'Ecotoxic': substances and preparations which present or may present immediate or delayed risks for one or more sectors f the environment.

Notes

1. 1.Attribution of the hazard properties 'toxic' (and 'very toxic'), 'harmful', 'corrosive' and 'irritant' is made on the basis of the criteria laid down by Annex VI, part I A and part II B, of Council Directive 67/548/EEC of 27 June 1967 of the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances (1), in the version as amended by Council Directive 79/831/EEC (2).
2. 2.With regard to attribution of the properties 'carcinogenic', 'teratogenic' and 'mutagenic', and reflecting the most recent findings, additional criteria are contained in the Guide to the classification and labelling of dangerous substances and preparations of Annex VI (part II D) to Directive 67/548/EEC in the version as amended by Commission Directive 83/467/EEC (1). Test methods The test methods serve to give specific meaning to the definitions given in Annex III. The methods to be used are those described in Annex V to Directive 67/548/EEC, in the version as amended by Commission Directive 84/449/EEC (2), or by subsequent Commission Directives adapting Directive 67/548/EEC to technical progress.

   These methods are themselves based on the work and recommendations of the competent international bodies, in particular the OECD. (1)OJ N° L 196, 16. 8. 1967, p. 1. (2)OJ N° L 259, 15. 10. 1979, p. 10. (1)OJ N° L 257, 16. 9. 1983, p. 1. (2)OJ N° L 251, 19. 9. 1984, p. 1.