CHAPTER 10 COST ESTIMATION

10.1 Importance of Maintaining Accurate Costs

The municipal engineer of the urban commune must always be in a position to respond to the following questions;

- how much money the collection and transport service is costing?
- is the service being implemented efficiently in terms of cost?
- is there a cheaper way to implement the service, what savings are possible?
- what is the projected cost for the service for the next year, after 5 years, etc.?

At present most urban communes are not clear when asked about the costs for SWM, and the cost breakdown by activity (say collection and transport, street sweeping, etc.). This is a very serious problem because knowing the cost is the only way to be able to evaluate the efficiency of the service provided and the costs of expanding and upgrading that service.

10.2 Collection and Transport Service Costs

10.2.1 Costing Items

The collection and transport service is one of the SWM activities and each activity should be costed separately. Other activities include disposal site, intermediate treatment, street sweeping, recycling, and administration. Collection and transport cost usually accounts for 60 to 80% of the total SWM costs and need for accurate costing is therefore evident.

The cost items are broken down into;

- salaries (for supervisors, drivers and workers)
- fuel and lubricants
- maintenance (includes spare parts purchase, maintenance and repairs, equipment for maintenance and repairs, and salaries of the mechanics)
- depreciation of the collection trucks and containers
- depreciation of administrative buildings, furniture, etc.
- administrative and clerical works pertaining to SWM

10.2.2 Accounting of Actual Costs

The unit cost of all SWM activities is expressed in Dirham/ton of collected and disposed of solid waste. Therefore the accounting system must include two records; (1) the actual expenditures, and (2) the transported waste amounts.

The actual expenses should be kept for each truck separately in the form of a daily record of crew number, fuel and lubricants consumed, repairs and spare parts purchase. Truck and container depreciation should be taken into account.

Each month the share of the transport and collection activity of the total administration costs of the urban commune and depreciation costs of the commune's assets should estimated. This share can be similar to the proportion of this activity's staff to the total staff employed by the commune.

Totaling the expenses of all the trucks and the administrative costs the cost for collection and transport can be calculated.

The most actual way to measure the total waste amount collected is by using a truck scale. Under the action program proposed in this study, truck scales are scheduled to be gradually introduced at the disposal sites. In the meantime the communes not having truck scales should record the number of trips implemented daily. Periodically, say once a year the commune should rent a truck scale and make measurements of the waste hauled by truck type. It would then be possible to adopt an average waste weight per trip which can be multiplied by the number of trips to calculate the waste amount collected.

It seems that presently most communes try to follow the above mentioned approach but omit certain elements. Most do not take into consideration any depreciation or administration costs. When estimating waste amount collected and hauled most do not take periodic measurements, but rather use estimated waste densities. The estimated densities usually are very rough figures. Therefore urban communes are strongly urged to improve upon their records of actual costs and estimates of waste amounts collected.

10.2.3 Unit Cost Estimation

In preparing the collection and transport improvement plan it is necessary to estimate the resulting costs. In Chapter 6 the unit costs for a number of collection trucks under various distances to the disposal site were estimated. Table A.10.2-1 shows the general conditions under which the estimation was made.

Table A.10.2-1 General Conditions for Unit Cost Estimation

Truck type	Cap. m^3	Purchase cost (1000 DH)	Container cap. (m^3)	Crew number (exc. Driver)	Primary collection share (%)	Hauled waste density (kg/m^3)	Waste haul time (min/t)	Time at disposal site (min)
Compactor (CL)	16	1,400	2	3	20	550	25	20
Compactor (CM)	12	1,100	1	3	15	550	25	20
Compactor (CS)	8	850	--	4	10	550	25	20
Dump truck (DM)	6	650	--	4	15	420	55	20
Dump truck (DS)	4	540	--	4	10	420	55	20
Flat bed (FM)	6	550	--	4	15	420	55	50
Flat bed (FS)	4	450	--	4	10	420	55	40
Multi-loader (AM)	6	600	6	1	25	400	5 (min)	20
Multi-loader (AS)	3	500	3	1	10	400	5 (min)	20

The general data was prepared based on the information collected in Morocco, while the last three columns depended upon results of time and motion surveys conducted in other similar cities and in Safi city. The primary collection, in which the waste is brought to the collection point by hand cart, share was assumed based on collection system adopted.

Step 1: Estimation of waste amount hauled per shift

Based on haul density and truck capacity waste amount hauled per trip was estimated. In turn total number of trips per shift was estimated based on shift time, time on the route, and time to and from the disposal site taking into consideration disposal site distance. The disposal site distance was taken at 5, 10, 15, 20 and 25 kilometers from the collection route. Therefore total waste hauled per shift was estimated for each collection truck.

Step 2: Estimation of total costs per shift

The next step was to estimate total costs for one truck shift. These costs are mainly divided into six items as follows;

- Salaries
  Include supervisors (1 supervisor responsible for 5 trucks, salary: 3,000 DH/month, driver: 2,200 DH/month, worker: 1,900 DH/month)
- Fuel and lubricants
  Based on distance covered in the collection route, to and from the disposal site and to and from the garage
- Maintenance
  = (40% x truck cost/truck life) + (40% x container no./trip x trip no. x container cost/container life)
  covers mechanics, spare parts, repairs, repair equipment and maintenance
  formula used in similar studies when actual data is unavailable
  truck life assumed to be 8 years, and container life 3 - 5 years
- Depreciation
  = (truck cost/truck life) + (container no./trip x trip no. x container cost/container life)
- Indirect cost
  = 20% x (salaries + fuel + maintenance + depreciation)
  covers unaccounted costs such as administration, buildings and furniture, clothes for workers, etc.
- Primary collection
  = no. of hand carts/shift x (salary of worker + hand cart cost + maintenance cost)

Step 3: Estimation of unit cost

The unit cost = total costs (step 2)/waste amount (step 1)

This estimation is based on assumptions that have to be verified for each Urban Commune, such as suitable truck type, distance to disposal site, travel speeds, time spent on collection route, haul density of the waste, etc. Each commune should within one month of receiving this report estimate its own collection and transport costs based on the actual conditions.

PART B MUNICIPAL WASTE DISPOSAL

PART B MUNICIPAL WASTE DISPOSAL

CHAPTER 1 PLAN FOR WASTE FINAL DISPOSAL

In most developing countries, including Morocco, solid wastes are disposed of at final disposal sites by "open dumping". Final disposal sites are merely referred to as "dumping site" and aesthetic, environmental and sanitary issues are hardly taken into consideration.

Open dumping has become one of the urban public nuisance in major cities in Morocco. With expansion of city urbanization, open dumping is tend to create environmental pollution such as water pollution, soil contamination, offensive odor etc., and also create natural and social environmental problems, especially for surrounding regional inhabitants. Therefore, in order to overcome these issues and minimize the environmental impacts, it is necessary to formulate a proper final disposal plan and introducing the "controlled disposal site".

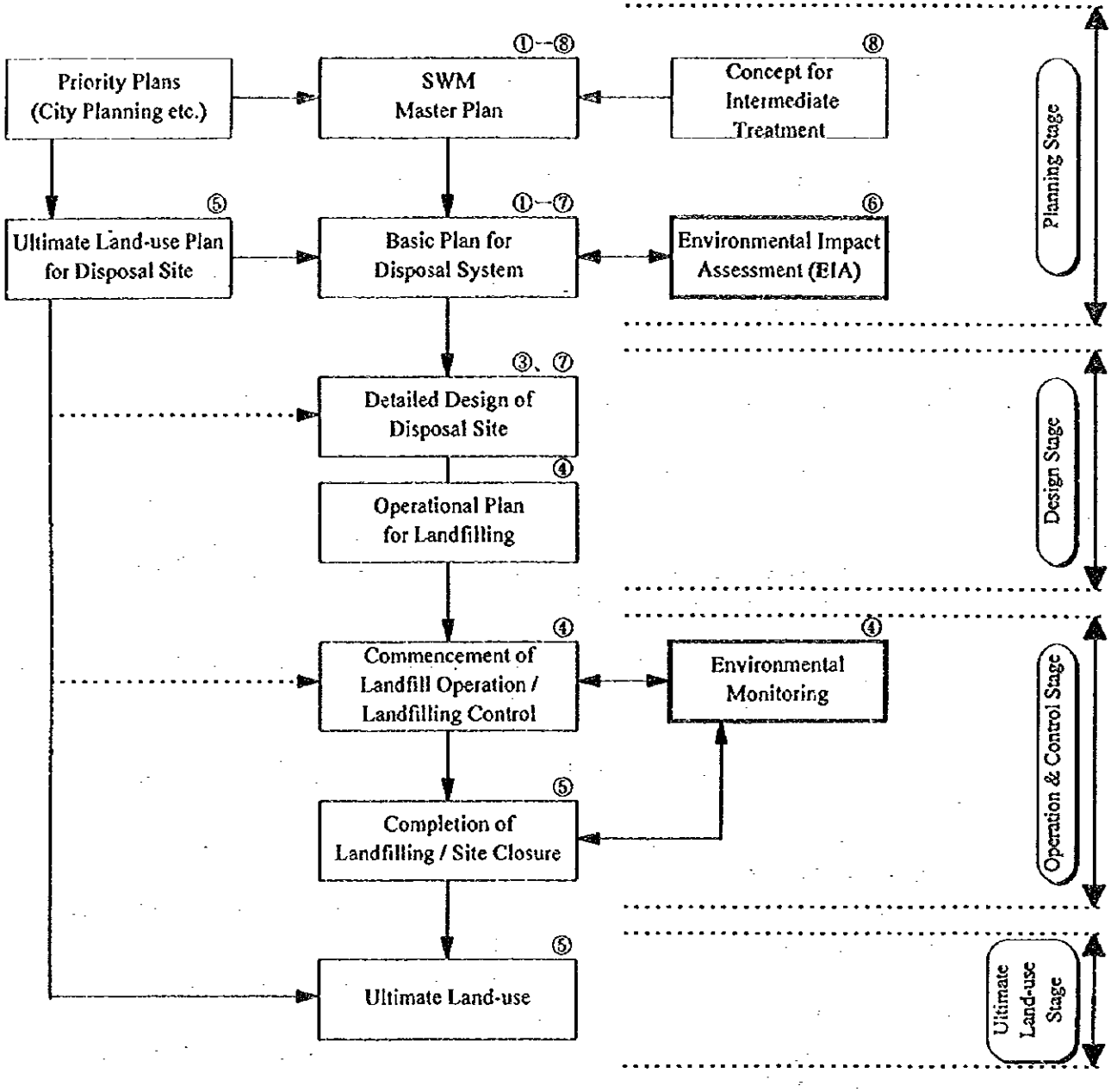
Overall issues for present final disposal site at major cities in Morocco have been identified as follows;

- Sanitary/environmental conditions of present municipal disposal sites are very poor, because of lack of site facilities and landfill operation control.
- Unlimited access to scavengers and animal grazing puts them in dangerous contact with potential hazardous wastes mixed with domestic waste.
- No records of incoming collection vehicles, waste amount and types have been kept, by the reason of lack of waste control plan and its facility.
- Site locations are not proper in some cities: located on steep slopes, close to residential areas, near to public water bodies, etc.
- Capacity of sites is not enough in many cities, by the reason of lack of long and/or medium term plan of final disposal site.
- Almost no waste control have been done by authorities concerned at final disposal site.

1.1 Formulation of a Final Disposal Plan

A final disposal plan should be formulated in order to establish a proper waste handling/haulage system at the site, up to the target year. For the formulation of a final disposal plan, as shown in Fig. B.1.1-1, it is necessary to set up comprehensive and concrete implementation plan taking into consideration the following four (4) stages;

- Planning stage
- Design stage
- Operation and control stage
- Ultimate land-use stage



Remarks ; 1. Applied Guidelines/Chapters :

① Chapter 1 : Plan for Waste Final Disposal
② Chapter 2 : Selection of New Disposal Site
③ Chapter 3 : Waste Disposal Systems
④ Chapter 4 : Operation and Control Plan
⑤ Chapter 5 : Ultimate Land-use and Site Closure
⑥ Chapter 6 : Environmental Impact Assessment (EIA)
⑦ Chapter 7 : Cost Estimation
⑧ Chapter 8 : Intermediate Treatment Plan

2. Legend :

: Direct relation/connection

: Indirect relation/connection

FIG. B.1.1-1 Formulation of Final Disposal Plan

THE STUDY ON THE NATIONAL GUIDELINES FOR SOLID WASTE MANAGEMENT FOR THE KINGDOM OF MOROCCO

At a planning stage of a final disposal plan, the following items shall be carefully considered and examined.

- Improvement, expansion and/or closure plan of existing disposal site
- Selection of new disposal site
- Waste disposal system applied
- Landfill operation and control system applied
- Ultimate land-use and site closure plan
- Environmental Impact Assessment (EIA)
- Estimated cost
- Examination of intermediate treatment

At other three stages, necessary action shall be carried out based on the policy defined in the planning stage. For details of each item described above and/or described in Fig. B.1.1-1, see the following Chapters of this report.

It is noted that, in Waste Disposal Guidelines of this report, a planning stage of a final disposal plan is mainly focused and explained.

1.2 Basic Items Required in the Final Disposal Plan

Basic items which should be established in the Master Plan and/or Basic Plan of final disposal are the following;

1) Designed Landfill Volume

Designed landfill volume is the sum of annual designed landfill volume plus the covering material volume deposited at the disposal site. Annual designed landfill volume up to the target year shall be estimated taking into consideration the estimated waste generation and target collection ratio. The estimation method for designed landfill volume is described in Chapter 2, Article 2.2.1.

2) Target Year

In principle, the target year should be more than 20 years for long term plan and approx. 10 years for medium term plan from the time of formulation of the final disposal plan. However, existing regional conditions of each local authority have to be taken into consideration. In addition to this, as described in Chapter 7, Section 7.1, facilities to be used for a long duration show better cost efficiency. It is therefore recommended to set up the target year for more than 10 years.

3) Required Area for Final Disposal Site

Taking into consideration the design landfill volume up to the target year, the required area for the final disposal site should be settled. Required area is differ from the topographic conditions of designated site. The method of estimating required area of the disposal site is described in Chapter 2, Article 2.2.1.

CHAPTER 2 SELECTION OF NEW DISPOSAL SITE

2.1 General

Siting conditions of dumping sites in major cities in Morocco are rather poor; that is, siting on steep slopes, near to rivers, close to residential areas, etc., and inevitably, these dumping sites may possible create potential environmental harms to surrounding inhabitants; such as waste scattering, diffusion of offensive odor, waste self-burning, breeding of vectors and insects, free discharge of the leachate, etc., and difficult operating conditions. Taking into consideration these conditions, it is extremely important to select a suitable location for the final disposal site.

Basically, final disposal site shall be located at the places which shall not affect to living environment of surrounding inhabitants, shall not contaminate public water bodies for drinking water and shall not interfere existing/future land-use planning area. As the concepts for the selection of the suitable sites for the waste disposal, followings are recommended;

- Preferred locations:

⇒ Sites which bring about environmental improvement by restoring dereliction and/or improving natural contours for ultimate land-use.

⇒ Impermeable sites

- Locations which should not be selected:

⇒ Sites located near public water bodies such as lakes, rivers, etc. Siting near the sea should be avoided.

⇒ Sites where there is a risk of leachate passing directly to groundwater which is the source of a public water supply, or to wells.

Further, the following conditions, as the minimum requirements for the siting of final disposal sites, should be considered for its selection;

- Distance from nearest residential area shall be more than 200m.
- Wells for drinking water shall not be exist within 1.0km downstream. (However, in case a proper leachate treatment will be facilitated at the site, it would be excluded.)
- Large scale intake facilities from rivers and deep wells for drinking water shall not be exist within 1.0km radius.
- Natural conservation area, habitat of precious fauna and flora which shall be protected, etc. shall be avoided.
- Land-use planning area of strategic public facilities shall be avoided.
- Distance from international airport should should be less than 3.0km.

In addition, during the site selection process, some compromises among competing land use, environmental safety and cost efficiency should be made. That is, if the site located near city center and within city's land-use planning area, land acquisition will comparatively difficult and its cost might be high, and high cost for environmental protection measures will be required. Meanwhile, if the site located far from city center, collection efficiency will be declined and its cost will be high. In this point of view, in general, at major cities in Morocco, a disposal site shall be selected more than 10km and less than 20 km radius from city center.

2.2 Site Selection Method and Procedure

The site selection method for new disposal sites is recommended to be divided into the following two (2) stages and the process is illustrated in Fig. B.2.2-1. Details of the process for each stages are described in the following Section 2.2.1 and 2.2.2.

- Stage -1: Selection of potential sites
- Stage -2: Final site selection

Stage-1 shall be performed by technical staffs of authorities concerned, instructed by President of Urban Community/Commune or Mayor of Municipality. On the other hand, Stage-2 shall be carried out by official committee for site selection organized by Urban Community/Commune or Municipality, Kaïdat (local authority from Ministry of Interior) and Ministry of Public Works. In case that potential sites are located at the outside of city urban area, that is, at the territory of Rural Commune, Province (Governor) shall be the head of the committee and the objected Rural Commune shall be the member of the committee.

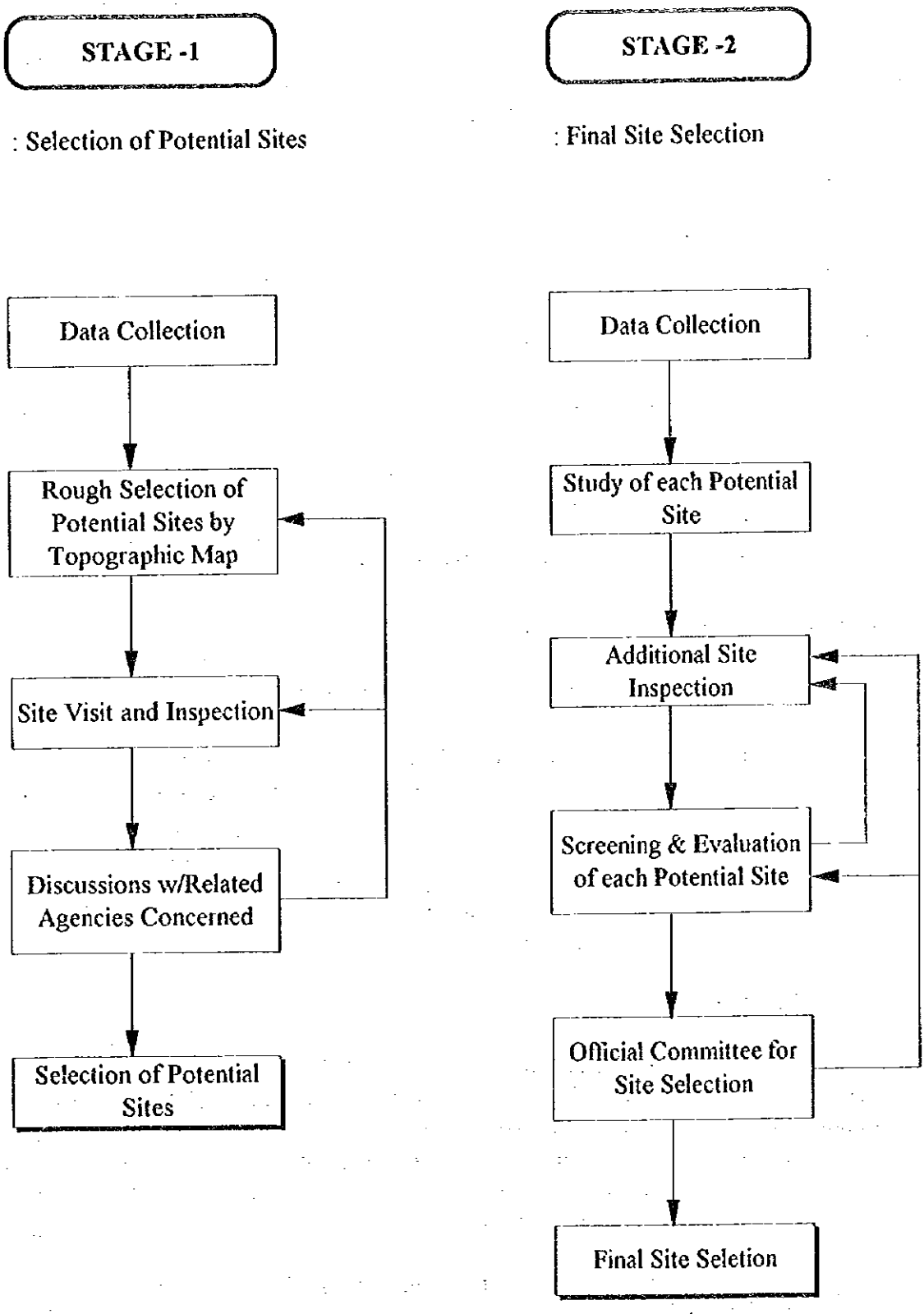


Fig. B.2.2-1 Flow Chart for Selection Procedure of Final Disposal Site

2.2.1 Stage -1

At stage-1, potential sites should be chosen in consideration of two major conditions, that is, availability of land (acquirable lands shall be selected) and required land area (taking into consideration designed landfill volume). In this stage, data collection, rough site selection by using topographic map (scale 1:25,000, if not 1:50,000), hearing survey, site investigation, etc. are required.

Required area for the waste final disposal shall be calculated by the following equation. Here, it is noted that, the following equation is the simplified method for the estimation.

- Required disposal site area : A (hectare)

$$A = (W + w) \div (h \times 10{,}000 \times e)$$

W : designed landfill volume (m^3)
w : volume of cover material (m^3) (= W x 0.2)
h : designed height of accumulated waste (= 10 - 20 m)
e : safety factor : {= (landfill area)/(site total area) = 0.7 - 0.9 }

- Design landfill volume : W (m^3)

$$W = P \times r1 \times r2 \times k1 \times 365 \times T \div (k2 \times 1000)$$

P : present population of Urban Community and/or Commune
r1 : population growth rate (consideration of the target year which should exceed more than 10 years)
r2 : designed collection ratio { = 0.9 - 1.0 (: 90 - 100%)}
k1 : unit waste generation (= 0.6 - 0.7 kg/person/day)
k2 : unit weight of waste at disposal site (= 0.7 - 0.8 ton/m^3)
T : design period (years)

2.2.2 Stage -2

At stage-2, locations for the new disposal site should be screened and evaluated among several potential sites which have been chosen at stage-1 in consideration of four (4) conditions listed in the following Article 2.3.1, 2.3.2, 2.3.3 and 2.3.4. After screening and evaluation of each alternative, an integrated evaluation of the selected alternatives shall be made and the most suitable location of new disposal site should be decided by the official committee for site selection.

Prior to screening and evaluation of potential sites, the following data should be collected as available and/or surveyed for proper evaluation work. Also, hearings to obtain consensus of neighboring communities and authorities concerned should be done. Meanwhile, in case, some data listed below are not available or some difficulty to obtain, it is recommended to cooperate with experts in each field or specific local consultants, as the support of technical aspects.

- Topographic map (scale 1/2,500 to 1/5,000)
- Geological map (scale 1/2,500 to 1/5,000; both surface layer and underground structure)
- Trees and scrubs distribution map and/or vegetation map (scale 1/5,000)
- Rainfall intensity distribution map
- Hydrological data (area of river basin, marshes, outflow, spring water, evaporation, etc.)
- Groundwater table diagram
- Situation of well water usage and its water quality
- Wind force and direction diagram
- Soil profile diagram (physical properties, coefficient of permeability, N-value obtained from standard penetration test for soil bearing capacity, etc.)
- Traffic survey data

2.3 Criteria for Site Selection

In selecting the new disposal site, it is necessary to ensure that the design landfill volume and required landfill area are determined and that the following four (4) conditions are examined in an integrated manner.

- Availability of landfill
- Acceptability of neighboring consensus and related authorities
- Environmental impacts and disaster prevention measures
- Economic factors

Detailed screening and evaluation items for each condition listed above are described in the following Sections and in Table B.2.3-1. Items which should be taken into consideration in the selection of new disposal site depend on the concept and conditions of each Urban Community and/or Commune, so the authorities concerned can choose the necessary items from them. Also, "importance value" and "points" described in Table B.2.3-1 can be determined by each authority based on the significance of that item to that particular authority. The points shown in the table may be considered as general reference. Table B.2.3-2 shows the evaluation sheet for selection of the new disposal site, for reference.

Meanwhile, for easy understanding of evaluation/screening items listed in Table B.2.3-1, sample case for the evaluation of potential sites and final site decision, which has carried out at El Jadida by El Jadida Province, Municipality and JICA Study Team on November 1996, is attached in Table B.2.3-3 and B.2.3-4. Two potential sites, which are located at Moulay Abdellah Rural Commune named Oulad Regragui and Bettioua, has selected beforehand, and its evaluation was carried out by using Table B.2.3-1, resulted that Bettioua site will be the final disposal site of El Jadida.

2.3.1 Availability of land

The following items should be considered in screening and evaluation of potential sites and final site selection. Detailed description of each item is shown in Table B.2.3-1.

- Land ownership
- Land use restrictions
- Administrative boundaries
- Land capacity (Life expectancy of the site)

2.3.2 Acceptability to neighboring citizens and related authorities

The following items should be considered for screening and evaluation of potential sites and final site selection. Detailed description of each item is shown in Table B.2.3-1.

- Proximity to the nearest residential area
- Neighborhood consensus
- Proximity to strategic public facilities (airport etc.)

2.3.3 Environmental impacts and disaster prevention measures

The following items should be considered for screening and evaluation of potential sites and final site selection. Detailed description of each item is shown in Table B.2.3-1.

- Proximity to public water supply sources (related to water pollution)
- Risk for dust, noise and odor hazard (related to buffer zone)
- Groundwater level (hydro-geological conditions)
- Permeability of base soil of the site (geological conditions)
- Impacts on ecological system (fauna and flora)
- Impacts on man-made assets of historical/religious value
- Impacts on natural landscape
- Impacts down-stream of prevailing wind (direction)
- Impacts on disaster prevention measures

2.3.4 Economic factors

The following items shall be considered in screening and evaluation of potential sites and final site selection. Detailed description of each item is shown in Table B.2.3-1.

- Land acquisition price
- Compensation required
- Distance from waste generation areas (related to waste transport cost)
- Topographic conditions (related to site construction cost)
- Accessibility to the site (w/ access road condition)
- Availability of covering material
- Availability of public utilities/services

Table B.2.3-1 (1/2) Evaluation Sheet for Final Disposal Candidate Sites

No	Evaluation Screening Items	Importance Values	Points	Total
I	**Availability of Land**			
1	Land ownership	3		
	- Local/central government		5	
	- Private ownership (one owner)		3	
	- Private ownership (more than two owners)		2	
	- Social/religious organization		1	
2	Land use restriction	5		
	- Little impact on surrounding land use		5	
	- Medium impact on surrounding land use		3	
	- Large impact on surrounding land use		1	
3	Administrative boundary	3		
	- Within administrative boundary		5	
	- Outside administrative boundary but with integrated SWM concept		3	
	- Outside administrative boundary		1	
4	Land capacity (life expectancy of new disposal site)	5		
	- More than 10 years		5	
	- Between 5 - 10 years		3	
	- Between 3 - 5 years		2	
	- Less than 3 years		1	
II	**Acceptability to Neighboring Citizens and Related Authorities**			
1	Proximity to the nearest residential area	5		
	- More than 500 m		5	
	- Between 300 - 500 m		4	
	- Between 200 - 300 m		2	
	- Less than 200 m		1	
2	Achievement of consensus	3		
	- Acceptance		5	
	- Being motivated		3	
	- Being negotiated		1	
3	Proximity to strategic public facilities	4		
	- More than 2.0 km		5	
	- Between 1.0 - 2.0 km		3	
	- Less than 1.0 km		1	
	- International airport must be located more than 3.0 km		x	
III	**Environmental Impacts and Disaster Prevention Measures**			
1	Proximity to public water supply sources (related to water pollution)	5		
	- More than 1,000 m		5	
	- Between 500 - 1,000 m		3	
	- Between 300 - 500 m		2	
	- Between 200 - 300 m		1	
2	Risk of dust, noise and odor hazard (related to buffer zone)	4		
	- Low risk		5	
	- Medium risk		3	
	- High risk		1	
3	Groundwater level (hydro-geological conditions)	5		
	- More than 10 m		5	
	- Between 5 - 10 m		3	
	- Between 3 - 5 m		1	
4	Permeability of base soil of the site (geological conditions)	5		
	- Permeable coefficient : Less than 10^{-7} cm/sec		5	
	- Between 10^{-6} - 10^{-7} cm/sec		4	
	- Between 10^{-5} - 10^{-6} cm/sec		3	
	- Between 10^{-4} - 10^{-5} cm/sec		2	
	- Higher than 10^{-4} cm/sec		1	
5	Impacts on ecological system (fauna and flora)	4		
	- Little impact on surrounding ecological system		5	
	- Medium impact on surrounding ecological system		3	
	- Large impact on surrounding ecological system		1	

Table B.2.3-1 (2/2) Evaluation Sheet for Final Disposal Candidate Sites

No	Evaluation Screening Items	Importance Values	Points	Total
6	Impacts on man-made assets of historical/religious value	4		
	- Little impact		5	
	- Medium impact		3	
	- Large impact		1	
7	Impacts on natural landscapes	3		
	- Little impact		5	
	- Medium impact		3	
	- Large impact		1	
8	Impact down-stream of prevailing wind (direction)	4		
	- Little impact by main wind		5	
	- Medium impact by main wind		3	
	- Large impact by main wind		1	
9	Impacts on disaster prevention measures	3		
	(flooding, stability of valley slope, catchment area of the site etc.)			
	- Little impact		5	
	- Medium impact		3	
	- Large impact		1	
IV	**Economic Factors**			
1	Land acquisition price (related to land productivity)	4		
	- Low		5	
	- Medium		3	
	- High		1	
2	Compensation requirements	3		
	- Low		5	
	- Medium		3	
	- High		1	
3	Distance from waste generation areas (related to waste transport cost)	5		
	- Less than 5 km		5	
	- Between 5 - 10 km		4	
	- Between 10 - 20 km		3	
	- More than 20 km		1	
4	Topographic conditions (related to site construction cost)	4		
	- Basin at hill side		5	
	- Flat land		4	
	- Valley		3	
	- Wet land		1	
	- Steep slope		1	
	- Hidden ravine		1	
	- Others			
5	Accessibility to the site (w/ access road condition)	5		
	- Good		5	
	- Fair		3	
	- Poor		1	
6	Availability of covering material	4		
	- Inside the disposal site		5	
	- less than 5 km from the site		3	
	- more than 5 km from the site		1	
7	Availability of public utilities/services (water, electric supply, etc.)	4		
	- Within 200 m		5	
	- Between 200 - 500 m		3	
	- More than 500 m		1	
			Total score :	

Table B.2.3-2 Score Sheet for Selection of Final Disposal Site (sample)

Evaluation Items / Potential/Candidate Sites	Score					
	Site-1	Site-2	Site-3	Site-4	Site-5	
I Availability of Land						
1 Land ownership						
2 Land use restriction						
3 Administration boundary						
4 Land capacity (life expectancy of new disposal site)						
- Other considerations						
II Acceptability to Neighboring Citizens and Related Authorities						
1 Proximity to the nearest residential area						
2 Achievement of consensus						
3 Proximity to strategic public facilities						
- Other considerations						
III Environmental Impacts and Disaster Prevention Measures						
1 Proximity to public water supply sources						
2 Risk of dust, noise and odor hazard						
3 Ground water level						
4 Permeability of base soil of the site						
5 Impacts on ecological system						
6 Impacts on man-made assets of historical/religious value						
7 Impacts on natural landscapes						
8 Impacts down-stream of prevailing wind						
9 Impacts on disaster prevention measures						
- Other considerations						
IV Economic Factors						
1 Land acquisition price						
2 Compensation requirements						
3 Distance from waste generation areas						
4 Topographic conditions						
5 Accessibility to the site (w/ access road condition)						
6 Availability of covering material						
7 Availability of public utilities/services (water, electricity supply, etc.)						
- Other considerations						
Synthetic evaluation						

Note; Scoring method of above table could be chosen from the following two ways.

Method -1 ; follow the scoring method shown in the Table B.2.3-1.

Method -2 ; "A" : plus factor for easy selection, "B" : factor of fair, "C" : minus factor for select
"X" : items not considered (mark these letters on the above table)

Table B.2.3-3 Evaluation of Final Disposal Candidate Sites in El Jadida

Evaluation Items	Candidate Sites			
	Site No.1 Oulad Regragui		Site No.2 Bettioua	
	Description	Score	Description	Score
I Availability of Land				
1 Land ownership	Private	6	Private	6
2 Land use restriction	No restriction	25	No restriction	25
3 Administration boundary	Outside of El Jadida	9	Outside of El Jadida	9
4 Land capacity (life expectancy of new disposal sate)	36 ha (30 ha expansion)	25	44 ha (30 ha expansion)	25
- Other considerations				
II Acceptability to Neighboring Citizens and Related Authorities				
1 Proximity to the nearest residential area	200-300 m	10	500 m	20
2 Achievement of consensus	(Provincial decision)	9	(Provincial decision)	9
3 Proximity to strategic public facilities	School/small (1.5 km)	12	School/small (800 m)	4
- Other considerations				
III Environmental Impacts and Disaster Prevention Measures				
1 Proximity to public water supply sources	200 m (public well)	5	800 m (public well)	15
2 Risk of dust, noise and odor hazard	Risky (resident is near)	12	Low risk	20
3 Ground water level	Approx. 8 m (Nov.1996)	15	Approx. 15 m (Nov.1996)	25
4 Permeability of base soil of the site (marl-limestone for both)	(unknown)	--	(unknown)	--
5 Impacts on ecological system	Little impact	20	Little impact	20
6 Impacts on man-made assets of historical/religious value	Little impact	20	Little impact	20
7 Impacts on natural landscapes	Visible from railway	9	Non-visible from sub-road	15
8 Impacts down-stream of prevailing wind	North-east (little impact)	20	North-east (little impact)	20
9 Impacts on disaster prevention measures	Little impact	15	Little impact	15
- Other considerations				
IV Economic Factors				
1 Land acquisition price	100,000 DH/ha	12	100,000 DH/ha	12
2 Compensation requirements	Several houses	9	Not necessary	15
3 Distance from waste generation areas (from El Jadida)	13.2 km (26 minutes)	15	14.0 km (28 minutes)	15
4 Topographic conditions	Gentle slope w/depression	16	Depression at hill side	20
5 Accessibility to the site (w/ access road condition)	2.5 km (poor condition)	5	1.0 km (poor condition)	15
6 Availability of covering material	Available at site	20	Available at site	20
7 Availability of public utilities/services (water, electricity etc.	Water shall be provided	4	Available	12
8 Present land-use	Agriculture (wheat etc.)	--	Agriculture(wheat etc.)	--
- Other considerations				
Synthetic evaluation (Total score)		293		357

Table B.2.3-4 (1/2) Score Sheet for Evaluation of Final Disposal Candidate Sites in El Jadida

No	Evaluation/Screening Items	value	points	Evaluated Score No.1	Evaluated Score No.2
I	**Availability of Land**				
1	Land ownership	3			
	- Local/central government		5		
	- Private ownership (one owner)		3		
	- Private ownership (more than two owners)		2	6	6
	- Social/religious organization		1		
2	Land use restriction	5			
	- Little impact on surrounding land use		5	25	25
	- Medium impact on surrounding land use		3		
	- Large impact on surrounding land use		1		
3	Administrative boundary	3			
	- Within administrative boundary		5		
	- Outside administrative boundary but with integrated SWM concept		3	9	9
	- Outside administrative boundary		1		
4	Land capacity (life expectancy of new disposal site)	5			
	- More than 10 years		5	25	25
	- Between 5 - 10 years		3		
	- Between 3 - 5 years		2		
	- Less than 3 years		1		
II	**Acceptability to Neighboring Citizens and Related Authorities**				
1	Proximity to the nearest residential area	5			
	- More than 500 m		5		
	- Between 300 - 500 m		4		20
	- Between 200 - 300 m		2	10	
	- Less than 200 m		1		
2	Achievement of consensus	3			
	- Acceptance		5		
	- Being motivated		3	9	9
	- Being negotiated		1		
3	Proximity to strategic public facilities	4			
	- More than 2.0 km		5		
	- Between 1.0 - 2.0 km		3	12	
	- Less than 1.0 km		1		4
	- Airport must be located more than 3.0 km		x		
III	**Environmental Impacts and Disaster Prevention Measures**				
1	Proximity to public water supply sources (related to water pollution)	5			
	- More than 1,000 m		5		
	- Between 500 - 1,000 m		3		15
	- Between 300 - 500 m		2		
	- Between 200 - 300 m		1	5	
2	Risk of dust, noise and odor hazard (related to buffer zone)	4			
	- Low risk		5		20
	- Medium risk		3	12	
	- High risk		1		
3	Groundwater level (hydro-geological conditions)	5			
	- More than 10 m		5		25
	- Between 5 - 10 m		3	15	
	- Between 3 - 5 m		1		
4	Permeability of base soil of the site (geological conditions)	5			
	- Permeable coefficient : Less than 10^{-7} cm/sec		5		
	- Between 10^{-6} - 10^{-7} cm/sec		4		
	- Between 10^{-5} - 10^{-6} cm/sec		3		
	- Between 10^{-4} - 10^{-5} cm/sec		2		
	- Higher than 10^{-4} cm/sec		1		
5	Impacts on ecological system (fauna and flora)	4			
	- Little impact on surrounding ecological system		5	20	20
	- Medium impact on surrounding ecological system		3		
	- Large impact on surrounding ecological system		1		

Table B.2.3-4 (2/2) Score Sheet for Evaluation of Final Disposal Candidate Sites in El Jadida

No	Evaluation/Screening Items	value	points	Evaluated Score No.1	Evaluated Score No.2
6	Impacts on man-made assets of historical/religious value	4			
	- Little impact		5	20	20
	- Medium impact		3		
	- Large impact		1		
7	Impacts on natural landscapes	3			
	- Little impact		5		15
	- Medium impact		3	9	
	- Large impact		1		
8	Impact down-stream of prevailing wind (direction)	4			
	- Little impact by main wind		5	20	20
	- Medium impact by main wind		3		
	- Large impact by main wind		1		
9	Impacts on disaster prevention measures	3			
	(flooding, stability of valley slope, catchment area of the site etc.)				
	- Little impact		5	15	15
	- Medium impact		3		
	- Large impact		1		
IV	**Economic Factors**				
1	Land acquisition price (related to land productivity)	4			
	- Low		5		
	- Medium		3	12	12
	- High		1		
2	Compensation requirements	3			
	- Low		5		15
	- Medium		3	9	
	- High		1		
3	Distance from waste generation areas (related to waste transport cost)	5			
	- Less than 5 km		5		
	- Between 5 - 10 km		4		
	- Between 10 - 20 km		3	15	15
	- More than 20 km		1		
4	Topographic conditions (related to site construction cost)	4			
	- Basin at hill side		5		20
	- Flat land		4	16	
	- Valley		3		
	- Wet land		1		
	- Steep slope		1		
	- Hidden ravine		1		
	- Others				
5	Accessibility to the site (w/ access road condition)	5			
	- Good		5		
	- Fair		3		15
	- Poor		1	5	
6	Availability of covering material	4			
	- Inside the disposal site		5	20	20
	- less than 5 km from the site		3		
	- more than 5 km from the site		1		
7	Availability of public utilities/services (water, electricity etc.)	4			
	- Within 200 m		5		
	- Between 200 - 500 m		3		12
	- More than 500 m		1	4	
		Total score :		293	357

CHAPTER 3 WASTE DISPOSAL SYSTEMS

3.1 General

As described in Chapter 1 of this report, open dumping has become one of the urban public nuisance in major cities in Morocco. With expansion of city urbanization, open dumping is tend to create the following environmental impacts.

- Scattering of waste
- Diffusion of offensive odor
- Breeding of harmful insects
- Self-burning of waste
- Out-flowing of waste
- Ground-water and runoff contamination
- Inflammation or explosion hazard
- Destruction of ecology system

In order to overcome and minimize the environmental impacts created at dumping sites, it is necessary to introduce the "controlled landfill" as waste disposal system which equipped with proper facilities for the environmental counter-measures and proper landfill operation.

"Controlled landfill" is the method for disposal of solid waste that minimizes the environmental impacts ad keep proper public health on its surroundings, by introducing landfill facilities, equipment and operation. Waste to be disposed of should be compacted and covered with a layer of soil and after all disposal operations have been completed, ultimate land-use of the site should be utilized effectively. Meanwhile, where there is the possibility of leachate production and contamination to surrounding areas, leachate collection and treatment facilities should be also considered.

3.2 Levels for Waste Disposal Systems

The following five (5) levels of disposal systems might be established for the improvement and/or implementation of a final disposal sites in Morocco, namely;

- Level -0 : Open Dumping
- Level -1 : Controlled Landfill -1
- Level -2 : Controlled Landfill -2
- Level -3 : Controlled Landfill -3
- Level -4 : Controlled Landfill -4

Environmental counter-measures which should be take place in each disposal level are shown in the following Table B.3.2-1 and described in Article 3.2.1. Facility plan and detailed definitions of each level are shown in Table B.3.2-2 and described in the Article 3.2.2.

Table B.3.2-1 Environmental Counter-measures in Each Level

No	Environmental Impacts	Counter-measures	Waste Disposal Systems			
			Level-1	Level-2	Level-3	Level-4
1	Waste scattering	Enclosed fence	XX	XXX	XXX	XXX
2	Odor, Harmful insect, Self-burning, Scattering	Covering soil	XX	XXX	XXX	XXX
3	Waste out-flowing	Embankment		XX	XXX	XXX
4	Ground-water and runoff contamination	Liner, Leachate collection facility, Leachate re-circulation/ treatment system		X	XX	XXX
5	Inflammation or explosion, Destruction of ecological system	Gas removal/treatment facilities			XX	XXX

Note ;

x : Minimum equipped/operated

xx : Fair

xxx : Fully equipped/operated

Table B.3.2-2 Levels for Waste Disposal Systems

Description	Levels of Disposal Site				Remarks
	Level -1 Controlled landfill -1	Level -2 Controlled landfill -2	Level -3 Controlled landfill -3	Level -4 Controlled landfill -4	
1 Site Facilities					
1-1 Main Facilities					
a. Access road	xx	xx	xxx	xxx	
b. Onsite road (Enclosing bound)		xx	xxx	xxx	
c. Partition dike (Divider)		x	xx	xx	if necessary
d. Operational road	xx	xx	xxx	xxx	
e. Surrounding drain		xx	xxx	xxx	
f. On-site drain (Surface water)		x	xxx	xxx	
g. On-site drain (Underground spring)			xx	xx	if necessary
h. Drain for reclaimed area		x	xx	xxx	
1-2 Environmental Protection Facilities					
a. Buffer zone		x	xxx	xxx	
b. Litter control facilities	xx	xx	xxx	xxx	enclosing fence
c. Liner (penetration/seepage control)		x	xx	xxx	
d. Leachate collection facilities			xx	xxx	
e. Leachate treatment/re-circulation			xxx		
f. Sophisticated leachate treatment				xxx	
g. Gas removal facilities			xx	xxx	
h. Gas treatment facilities				xx	if technically established
1-3 Other Related Facilities					
a. Site office	x	xx	xxx	xxx	
b. Truck scale (w/control room)		xx	xxx	xxx	
c. Parking lot for car/equipment	x	xx	xxx	xxx	
d. Washing station			xx	xxx	
e. Safety facilities	x	xx	xxx	xxx	fence, gate, lighting etc.
f. Fire prevention facilities			xx	xx	
g. Monitoring facilities			xx	xxx	monitoring well etc.
2 Equipment					
a. Landfill equipment	x	xx	xxx	xxx	
b. Soil covering equipment	x	xx	xxx	xxx	
b. Others		x	xx	xxx	inspection vehicle etc.
3 Operation and Maintenance					
3-1 Operation					
a. Personnel	x	xx	xxx	xxx	
b. Covering soil	x	xxx	xxx	xxx	
3-2 Utilities					
a. Fuel		x	xx	xxx	
b. Water		x	xx	xxx	
c. Electricity		x	xx	xxx	
3-3 Chemicals					
a. Insecticide			xx	xx	if necessary
b. Monitoring chemicals			xx	xx	if necessary

Legend ; x : minimun equipped/operaqted
xx : fair
xxx : fully equipped/operated

3.2.1 Environmental Countermeasures

- Enclosing Fence

To prevent the scattering of waste and free access by scavengers, suspicious persons and animals, an enclosing fence should be installed surrounding the disposal site. It is also necessary to define the disposal site area, as the boundary facility.

- Covering Soil

Covering soil is the basic and the most effective way of the counter-measures for environmental impacts created at a waste disposal site. Covering soil, which consist of daily and final covering, shall be carried out at proper times during landfill operation, in order to prevent the waste scattering, offensive odor, harmful insects, waste self-burning, reduction of leachate amount, etc. Classification of conering soil and its purposes are shown in Table B.4.2-1 in Chapter 4 of this report.

- Embankment

In order to prevent the waste out-flowing from the disposal site and to perform the waste accumulation at a certain height during landfill operation, an embankment shall be constructed around the disposal site.

- Leachate Collection Facility

For the purpose of collecting leachate and directing it to the leachate re-circulation and/or treatment facilities which are located outside the landfill area, gravity leachate collection facilities shall be installed in the landfill area, if required. Meanwhile, in order to prevent mud condition of the site and keep the proper landfill operation, leachate should be collected from landfill area.

Leachate collection facilities are comprised of horizontal and vertical collection facilities. Planning criteria of each leachate collection facility is as summarized as follows.

i. The horizontal leachate collection pipe should be made of perforated pipe and/or packed gravel consisting of main and sub/branch pipes. These pipes are arranged at the bottom of the landfill area and the maximum pitch of the pipe is about 50 m.

ii. A vertical leachate collection facility should be substitute for the vertical gas removal facilities and be connected to horizontal leachate collection pipes.

- Liner

In order to prevent contamination of groundwater and polluting the public water bodies by leachate, and to mitigate adverse impacts of such pollution to surrounding areas, a liner made of rubber sheeting and/or clay soil shall be installed at the bottom of the whole landfill area and inner-slope of surrounding embankment, if required.

- Leachate Re-circulation Facility

Since the leachate, produced in the landfill area, may be the cause of the contamination to the surrounding water bodies, it is necessary to prepare facilities to prevent the leachate to outflow/discharge outside the disposal site; that is, to keep or eliminate the leachate only inside the disposal site, as a pollution prevention measures. Leachate re-circulation facility, which equipped with leachate collection facilities, retention reservoir and re-circulation pump, is recommended to be facilitated, especially in the region which has seasonal heavy rain.

- Leachate Treatment Facility

Since the leachate or polluted water produced in the landfill area may be the cause of contamination to the groundwater and/or surrounding water bodies, it is necessary to prepare facilities to treat the leachate before discharge to outside of the site, as a pollution prevention measure, especially at the high rainy regions.

In general, four methods are commonly used by solely or with combination as the leachate treatment methods in the world; that is, aeration lagoon and activated-sludge process as the biological treatment, and sand filtration and activated carbon treatment as bio-chemical treatment. Among them, aeration lagoon is introduced here.

Aeration is the biological process to remove/eliminate biochemical oxygen demand (BOD), chemical oxygen demand (COD) and suspended solid (SS). The mechanism of aeration can be summarized as follows:

i. To provide oxygen/air to the leachate, aerobic microorganisms contained in the leachate will be activated.
ii. Aerobic microorganisms will eat organic matters contained in the leachate, in other words, biological decomposition of organic matter is carried out by aerobic microorganisms.
iii. Aerobic microorganisms will be settled at the bottom of the aeration lagoon.

- Gas Removal Facility

Generally, several kinds of gas will be produced by organic substances contained in the reclaimed waste during the process of putrefaction and decomposition; these are caused by microorganisms etc. which exist in the reclaimed waste layer. Main components of the gas produced in the landfill area are methane gas, carbonic acid gas and nitrogen, which are colorless and odorless. In addition, although in small amounts, ammonia, hydrogen sulfide, methyl mercaptane, methyl sulfide etc. which are malodorous gases, are also produced.

In order to prevent the fire and/or explosion hazards, destruction of ecological systems, and offensive odor to surrounding areas caused by produced gases, gas removal

facilities shall be installed at landfill area, especially in case, houses are located near the site, precious flora is habitat surrounding the site, etc.

Meanwhile, by keeping the semi-aerobic conditions inside the waste layers by installing gas removal facilities, the waste can be stabilized sooner by the function of microbes to decompose the organic material of the waste. Therefore, in case the sooner ultimate land-use of the site is planned, gas removal facility shall be installed.

On the other hand, from the point of the energy recovery/recycling, a power generation and/or heat recovery by methane gas produced at disposal site might be adopted in the future. There are few sites in the world introducing this system and they are under test-operation stages.

3.2.2 Waste Disposal Levels

In the following explanations, the environmental counter-measures and facilities to be provided described in a lower level are contained/included and/or up-graded in that of the higher level.

1) Level -1 : Controlled Landfill -1

(1) Environmental Impacts to be Counter-measured

- Waste scattering
- Offensive odor, breeding of harmful insects, waste self-burning

(2) Facilities to be Provided

- Establishment of proper access to a disposal site
- Establishment of operational roads to maintain good operating conditions and smooth dumping
- Introduction of periodical soil covering in order to minimize the adverse environmental effects on the surroundings. Frequency of soil covering should not be less than twice a week at this Level-1.
- Introduction of safety facilities, such as enclosing fence, gate and site office
- Introduction of heavy equipment for waste landfilling and soil covering, such as bulldozer, excavator, dump truck, etc.

2) Level -2 : Controlled Landfill -2

(1) Environmental Impacts to be Counter-measured

- Waste scattering
- Offensive odor, breeding of harmful insects, waste self-burning
- Ground-water and runoff contamination (minimum level)

(2) Facilities to be Provided

- Execution of sufficient soil covering (daily covering)
- Introduction of the inspection, control and operational recording system of incoming waste by using a truck scale
- Establishment of enclosing bound and/or on-site roads (embankment)
- Introduction of a partition dike (divider) between present and future landfill area, in order to reduce the quantity of leachate production
- Set up litter control facilities, such as enclosing fences etc.
- Set up safety facilities, such as enclosures, gates, site offices, lighting facilities, etc.
- Stripping top layer and earth compaction, in order to improve the permeability of the base ground of a disposal site
- Introduction of a storm-water drainage system, to prevent rain water flow into the landfill site, in order to reduce the amount of leachate production

Fig. B.3.2-1 shows conceptual drawing of waste disposal system Level-2.

3) Level -3 : Controlled Landfill -3

(1) Environmental Impacts to be Counter-measured

- Waste scattering
- Offensive odor, breeding of harmful insects, waste self-burning
- Ground-water and runoff contamination
- Inflammation or explosion hazard, destruction of ecological system

(2) Facilities to be Provided

- Execution of sufficient soil covering (daily covering)
- Establishment of the inspection, control and operational recording system of incoming waste by using a truck scale
- Establishment of a drainage system in order to divert storm-water and seepage for a reduction of leachate amount
- Installation of liner (clay soil and/or rubber sheet)
- Establishment of a leachate control system by installation of liner, leachate collection and re-circulation/treatment facilities, monitoring facilities etc. Leachate treatment might be a re-circulation system (with aeration lagoon system, if necessary) in this Level-3
- Installation of gas removal facilities (if necessary)
- Introduction of amenity facilities for staffs

Fig. B.3.2-2 shows conceptual drawing of waste disposal system Level-3. Conceptual diagram of leachate re-circulation system with aeration lagoon is shown in Fig. B.3.2-4.

4) Level -4 : Controlled Landfill -4

(1) Environmental Impacts to be Counter-measured

- Waste scattering
- Offensive odor, breeding of harmful insects, waste self-burning
- Ground-water and runoff contamination
- Inflammation or explosion hazard, destruction of ecological system

(2) Facilities to be Provided

- Establishment of a leachate control systems by installation of liner, leachate collection and treatment facilities, monitoring facilities etc.
- Establishment of a sophisticated leachate treatment systems composed of the biological treatment and the bio-chemical treatment, to meet a effluent standard which might be settled in the near future in Morocco
- Installation of gas treatment facilities (if necessary)

Conceptual diagram for the components of controlled landfill Level-4 is shown in Fig. B.3.2-3.

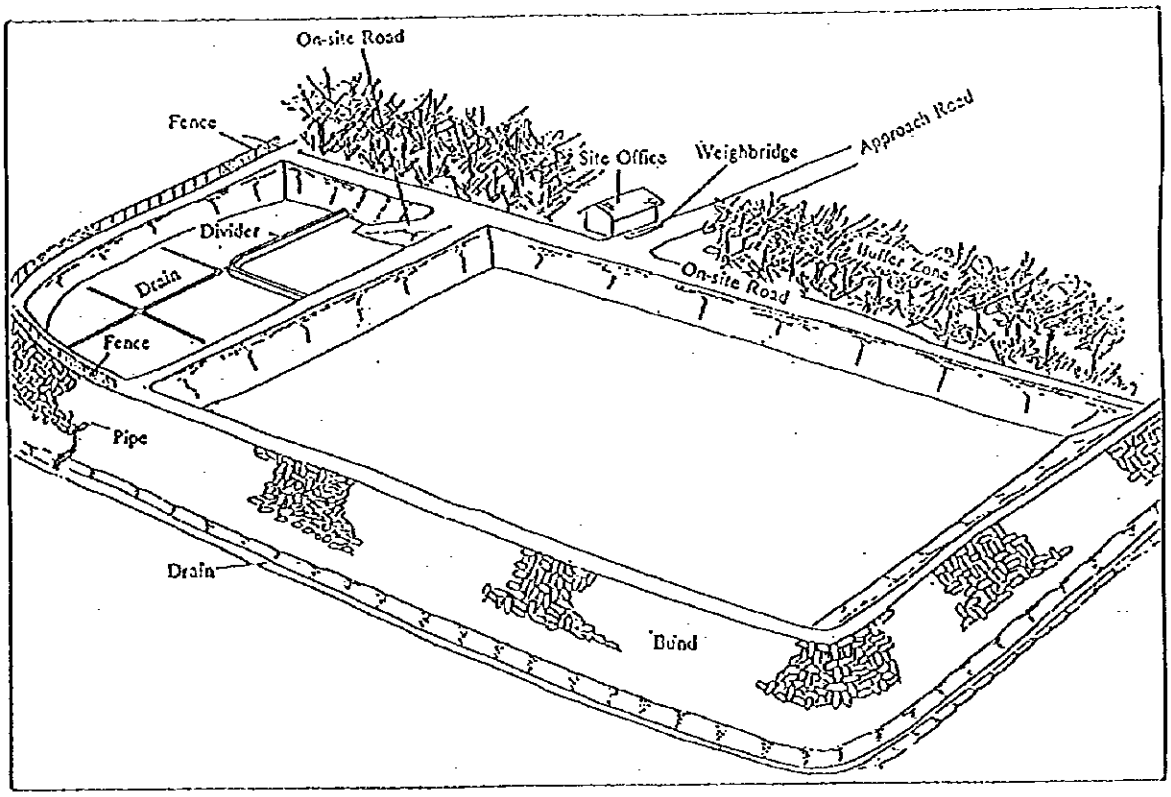


Fig. B.3.2-1 Conceptual Drawing of controlled Landfill (Level-2)

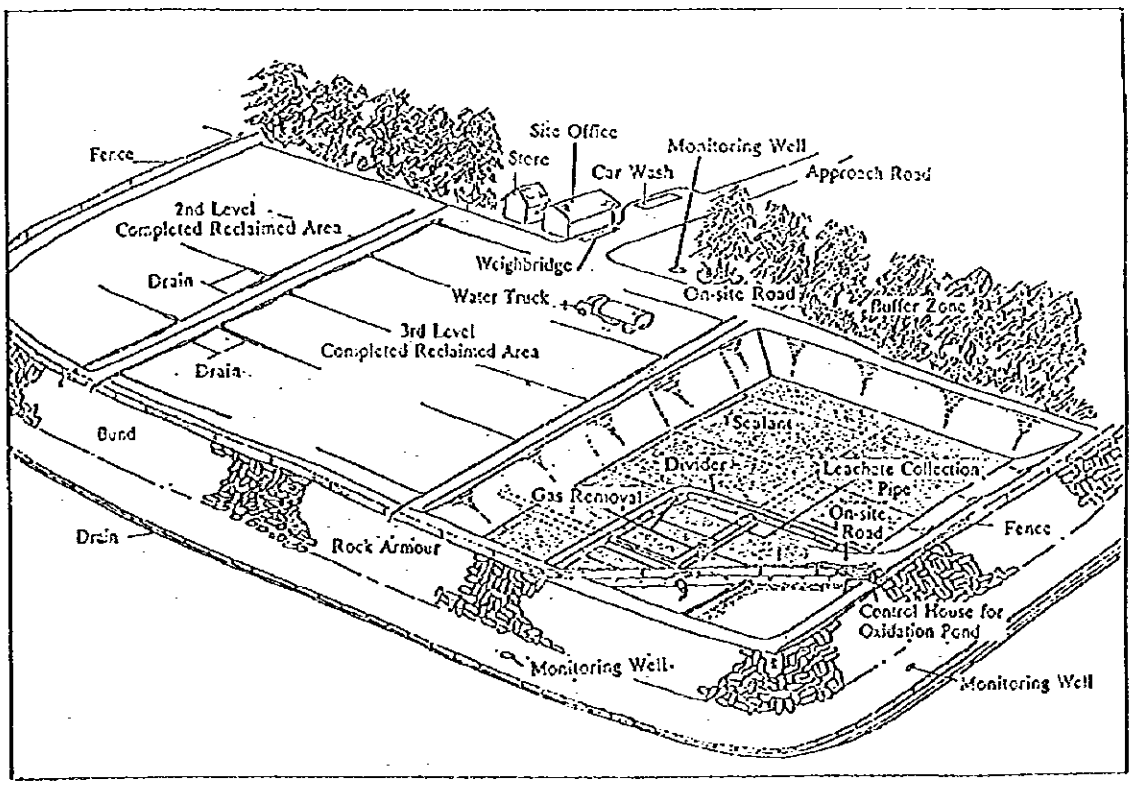


Fig. B.3.2-2 Conceptual Drawing of Controlled Landfill (Level-3)

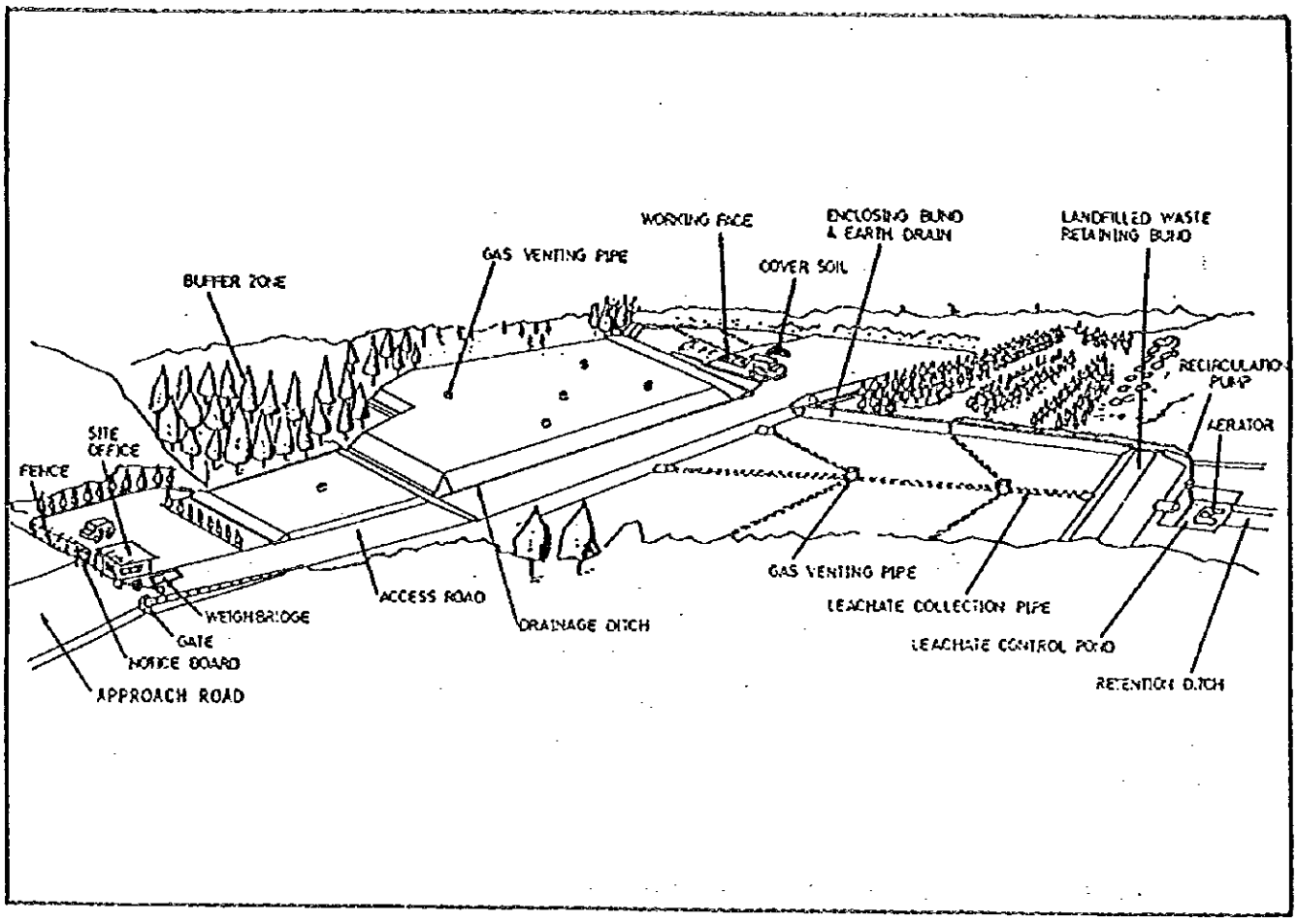


Fig. B.3.2-3 Conceptual Diagram of Controlled Landfill (Level-4)

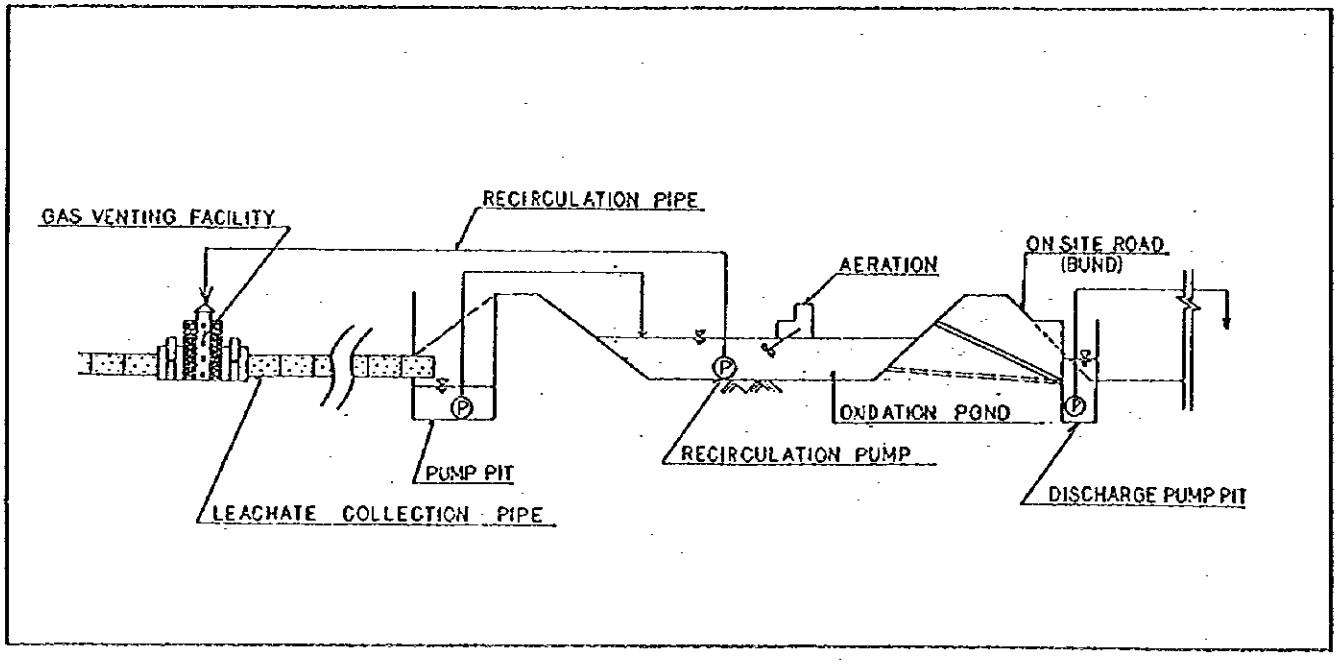


Fig. B.3.2-4 Leachate Recirculation System (w/Aeration Lagoon)

3.2.3 Target Level for Waste Disposal Systems

Taking into consideration the present poor environmental conditions of dumping sites in major cities in Morocco, which are open dumping; 1st, existing disposal site shall be improved sooner, 2nd, newly planned disposal site shall be implemented as controlled landfill.

For the purpose of improving of existing open dumping sites; as a basic requirement to improve the existing poor sanitary conditions of dumping sites, the target disposal system shall be settled as the controlled landfill Level-1 or Level-2 (its depend on the budget allocation of local government). Details of this improvement plan is described in Section 3.4.

Meanwhile, the level of newly planned disposal site shall be determined in consideration of the following three major conditions, and shall be decided by synthetic evaluations/considerations among them.

- Scale (area and/or capacity) of the disposal site
- Rainfall amount and its intensity
- Financial capability of local government

However, taking into consideration the environmental impacts created at disposal sites and its counter-measures, controlled landfill: Level-3 is recommended to be the target for the newly planned disposal site in Morocco, basically.

On the other hand, recently, Ministry of Environment preparing the Waste Disposal Standard, Disposal Site Facility Standard, Disposal Site Operation Standard and Disposal Site Selection Standard, based on the concept of controlled landfill: Level-3. In these standards, disposal site has defined into two types; one is "Basic Standard Type" and another is "Advanced Standard Type". The details will be noticed soon.

1) Scale of the disposal site

In general, municipal waste create serious environmental issues at large and/or medium scale cities. In other words, its depend on the scale (site area and/or site capacity) of the disposal site. Therefore, in large and/or medium scale disposal site, controlled landfill Level-3 or Level-4 shall be considered/adopted. Meanwhile, in small scale disposal site, (i.e. the area is less than 10,000m2 or its capacity is less than 50,000m3: definition in Japan), controlled landfill Level-2 might be acceptable.

2) Rainfall amount and intensity

The main factors in categorizing waste disposal systems is the method of handling the leachate. The amount of leachate is directly affected by the rainfall, in other words, for the regions whose rainfall is low, leachate collection and treatment systems can be omitted and the grade of liner can be lowered (i.e. from Level-3 to Level-2). However, not only rainfall but also rainfall intensity and seasonal rainfall tendency shall be taken into consideration when determining the level. Table B.3.2-3 shows the relationship

between rainfall and disposal level which are recommended, and Fig. B.3.2-5 shows the rainfall map of Morocco.

Table B.3.2-3 Disposal Levels and Rainfall

Rainfall (per year)	Levels for Waste Disposal Systems
less than 200 mm	Level-2
200 - 500 mm	Level-3 or Level-2
500 - 800 mm	Level-3
more than 800 mm	Level -3 (Level-4)

Here, amount of leachate production is calculated by using the following equation, and its detail is described in Book 4-Part 1: Solid waste Management Plan for Safi and/or Book 4-Part 2 : Waste Disposal Plan for El Jadida, of this report.

$$Q = 10 \times C (I - E) A$$

where,
- Q : Leachate amount (m^3/day)
- C : Seepage coefficient (set to 0.7)
- I : Average rainfall (mm/day)
- E : Average evaporation (mm/day)
- A : Landfill operation area (ha)

In addition, a grade of the liner structure shall be determined taking into consideration the geological profile of the proposed disposal site. In case the permeability of the ground is more than 10^{-4}cm/sec, high grade liner shall be considered.

3) Financial capability of local government

As described in Chapter 7 of this report, unit cost to handle/dispose the waste for Level-3 is approximately 1.5 times than that of Level-2. Meanwhile, construction cost of Level-3 is 2 to 3 times than that of Level-2. Therefore, a financial capability of the local government shall be taken into considered for the decision of disposal level.

Rough costs of the construction, equipment procurement and operation for the disposal sites, in several scales (site areas) and Levels (Level-2 and 3), are described in Chapter 7, Table B.7.1-3 and B.7.1-4.

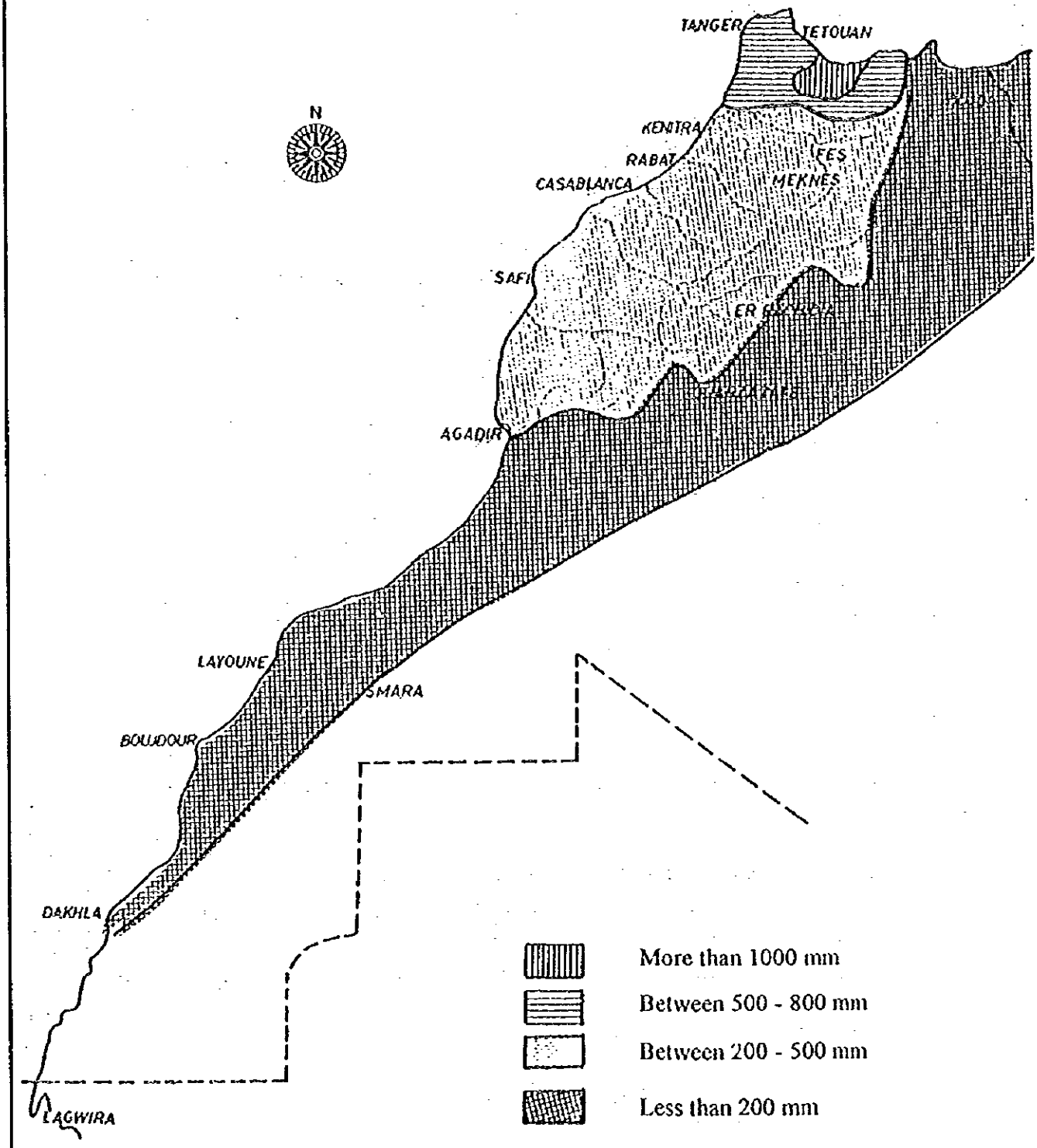


FIG. B.3.2-5 **Rainfall Map in Morocco (1993-1994)**

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3.2.4 Disposal Site in the Desert

For disposal sites situated in the desert, it is not necessary to take into consideration the groundwater contamination issue, because groundwater levels there are rather deep. Therefore, Level-2: Controlled landfill-2 is recommended in desert areas. If the city scale is rather small and the site is far from residential areas, Level-1: Controlled landfill-1 is also acceptable.

From the structural point of view, it is recommended to dig a large pit/hole at the landfilling area before operations commence to provide more capacity and longer life time of the disposal site.

From the operational point of view, a tank truck (sprinkler vehicle) is recommended to be procured to prevent dust clouds rising during operation hours.

3.3 Outline of Disposal Site Design

For detailed design of disposal sites, the following items should be settled, based on the design concept designated by authorities concerned.

- Location and area of the site
- Design standard
- Waste disposal system
- Landfill facilities
- Operational method
- Ultimate landuse concept
- Cost estimation

Meanwhile, the following field surveys are required for preparation of design conditions:

- Topographic survey (scale 1:1,000 - 1:5,000)
- Geological survey (machine boring, standard penetration test, thin-walled tube sampling and permeability test)
- Hydro-geological survey (ground water level, flow direction and/or quantity of surface and ground water)
- Environmental impact assessment (EIA)

3.4 Improvement Plan for Existing Dumping Sites

3.4.1 General

The following issues are identified at most of the existing dumping sites in major cities in Morocco.

- Dumping method is open dumping. (no waste compaction, no cover soil and no leachate control)
- No control for incoming waste/vehicles, site operation etc.
- Sanitary conditions of the site are very poor. (open burning, stinking odor, scattering of waste, many flies, etc.)
- No heavy equipment is operated
- Site is not enclosed by fence and access is open
- All types of waste, including municipal, industrial and hospital waste (which may contain toxic/infectious waste) are hauled to the site in mixed form
- Scavengers are active and animals are grazing at the site
- Access road condition is inadequate
- Conditions of operational roads inside the site are poor
- Site location is unsuitable

To overcome the issues listed above immediately, an improvement plan, which does not require large investment for existing dumping sites, is required.

3.4.2 Improvement Plan for Existing Dumping Site

An improvement plan should be implemented based on the concept of controlled landfill Level-1 or Level-2 (the decision depends on budget allocation of local government) which are defined in the above Articles 3.2.2.

The following items are recommended to be implemented in an improvement plan.

1) Environmental Protection Measures

- Construction of Enclosing Fences

To prevent the scattering of waste and free access by scavengers and animals, an enclosing fence should be installed all around the site.

- Designate Blocks at Landfill Area for Each Type of Waste

Basically, industrial waste (include toxic waste) should be treated and disposed of under the producer's own responsibility. But, in consideration of existing conditions in Morocco, this is not realistic at the moment. Therefore, it is necessary to dispose industrial waste at the municipal disposal site for the time being. Regarding hospital waste, the same issue can be defined.

From this point of view, and taking into consideration environmental protection measures, industrial waste, hospital waste and municipal waste must be disposed separately at existing disposal sites. Therefore, blocks for each type of waste should be designated at the site.

2) Operational Controls

- Cover soil

To prevent the scattering of waste, diffusion of offensive odor, breeding of vectors & insects and self-burning of waste, solid waste must be covered by soil. The frequency of cover soil is at least twice a week, while daily covering is recommended. Of course, heavy equipment must be provided for this work.

- Establishment of Landfill Operation Method

In order to stabilize the landfill area and to prolong the life time of the disposal site, waste spreading and compaction should be performed by using the "cell method" and "push up method". Definitions of these methods are described in Chapter 4, Article 4.2.1.

- Improvement of Access Road and Operational Road

Access roads, which connect the site to the main road, should be wide enough for access of collection vehicles and should be asphalt or concrete paved. Dimensions and conditions of the road should follow the document named "Regulations for road works" prepared by the Ministry of Public Works.

Operational roads should be planned for the efficient operation of landfill works. The road is recommended to be paved by gravel for smooth waste discharge and landfill operation.

- Construction of Stormwater Drainage

To prevent rain water flow into the landfill area, in other words, to reduce the amount of leachate production, stormwater drainage should be constructed at the appropriate part of the disposal site.

- Procurement of Landfill Equipment

For sufficient landfill operation, that is, cover soil installation and cell method landfilling, several kinds of landfill equipment are required. Details of landfill equipment are described in Chapter 4, Section 4.4. However, as landfill equipment is expensive, step by step procurement is recommended taking into consideration the budget allocation of each local government.

3) Others

- Execution of Topographic Survey

To be sure of existing site conditions and to implement an urgent improvement plan of the site, execution of a topographic survey (scale 1/1,000 - 1/5,000) is necessary.

- Installation of a Truck Scale

Installation of a truck scale is the first and basic standpoint for SWM. Therefore it is recommended to establish truck scales at the entrance of existing disposal sites as soon as possible. Details of this facility are described in Chapter 4, Section 4.3.

- Construction of Guard House

To start site control, such as for incoming wastes/vehicles, site operation, scavenging activities etc., a guard house should be constructed at the entrance to the site.

CHAPTER 4 OPERATION AND CONTROL PLAN

4.1 Basic Concept of Landfill Operation

Environmental effects on areas surrounding disposal sites, sooner stabilization of the sites and ultimate landuse plan, should be considered over the lifetime of the landfill operation. The following basic concept should be included in the landfill operation plan;

- Solid waste should be spread and compacted sufficiently for its sooner stabilization
- Scattering of solid waste should not be allowed
- Diffusion of offensive odor should not be allowed
- Breeding of vectors and insects should not be allowed
- Self-burning of the waste should not be allowed

Compaction of solid waste is necessary for lengthening the life of disposal site, and it is also helpful to shorten the settlement period after landfilling is completed. Meanwhile, the environmental effects on surrounding inhabitants, such as prevention of scattering of solid waste, diffusion of offensive odor, breeding of vectors and insects and self-burning of the waste should not be allowed.

On the other hand, landfill equipment is required for the proper operation of landfilling.

4.2 Landfill Method and Cover Soil

Solid waste must be sufficiently spread and compacted so as to stabilize the landfill area and to prolong the life time of disposal site. On the other hand, cover soil must be placed systematically and periodically after landfilling of each layer and/or cell of the waste.

4.2.1 Landfill Method

In order to perform the sufficient spreading and compaction of the waste, combination of the "cell method" and "push up method" shall be adopted. Further, the following items should be taken into consideration for waste spreading and compaction work;

- Waste spreading should not be too thick. Normal thickness of one time spreading is about 30 to 50 cm, taking into consideration the waste thickness which might be effective for compaction work carried out by landfill equipment.

- Landfill layer and/or cell should be made as uniform as possible by the push up method, taking into consideration the waste compaction efficiency. Gradient of the waste slope should be 4:1, in consideration of effectiveness of landfill equipment.

- Thickness of each waste layer and/or cell should be less than 3 m, in consideration of waste characteristics and efficiency of landfill work. When the site is planned to be used as early as possible after completion of landfilling or when technically advanced usage of the completed landfill site is considered, the waste layer is recommended to be about 2 m thick.

1) Cell Method

In this method, waste cells topped with a layer of cover soil should be created, where the size of each cell basically consists of one day's amount of waste. Since each cell is implemented independently, the applied cover soil can prevent most of environmental effects described in the Article 4.1.

For the conceptual drawing of "cell method", see Fig. B.4.2-1 & B.4.2-2.

2) Push Up Method

At the final disposal site, hauled-in waste, when create the waste cell, should be spread and compacted by adopting the "push up method", in order to perform sufficient waste compaction, using landfill equipment such as bulldozer or wheel loader. As a result, landfill stabilization might be accomplished more quickly by this method.

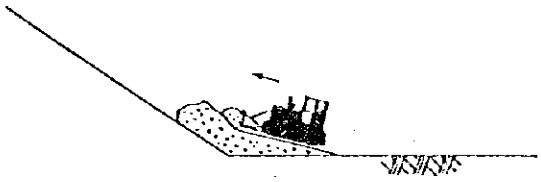
For a conceptual drawing of "push up method", see Fig. B.4.2-1 & B.4.2-2.

4.2.2 Cover Soil

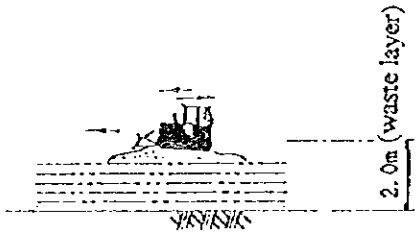
Together with the landfill operation by cell method and push up method, cover soil, which consists of daily covering and final covering, shall be carried out at proper times. The main purposes and thickness of each cover soil are shown in the following Table B.4.2-1. Meanwhile, Fig. B.4.2-1 shows the conceptual drawing of each type of cover soil.

Table B.4.2-1 Cover Soil Classification

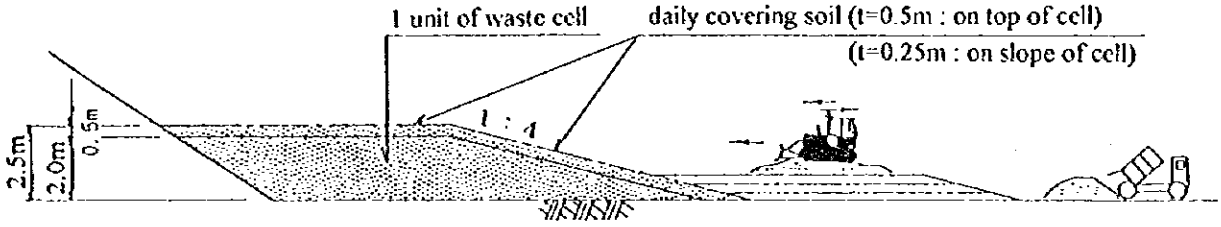
Type of cover soil	Main purposes	Thickness
Daily covering	Prevent scattering of waste Prevent diffusion of offensive odor Prevent breeding of harmful vectors Prevent self-burning of waste Reduction of leachate amount Secure trafficability of landfill equipment and collection vehicle	50 cm (top of waste cell) 25 cm (slope of waste cell)
Final covering	Ultimate land use Landscaping Minimize the leachate amount Environmental prevention measures	50 cm (total 100 cm)



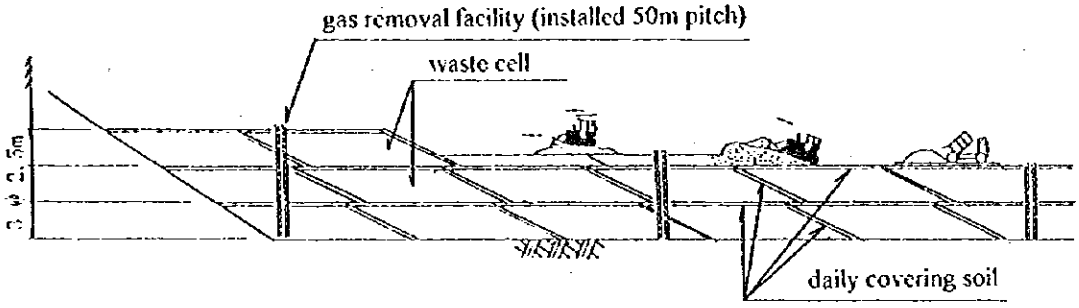
Waste Push Up



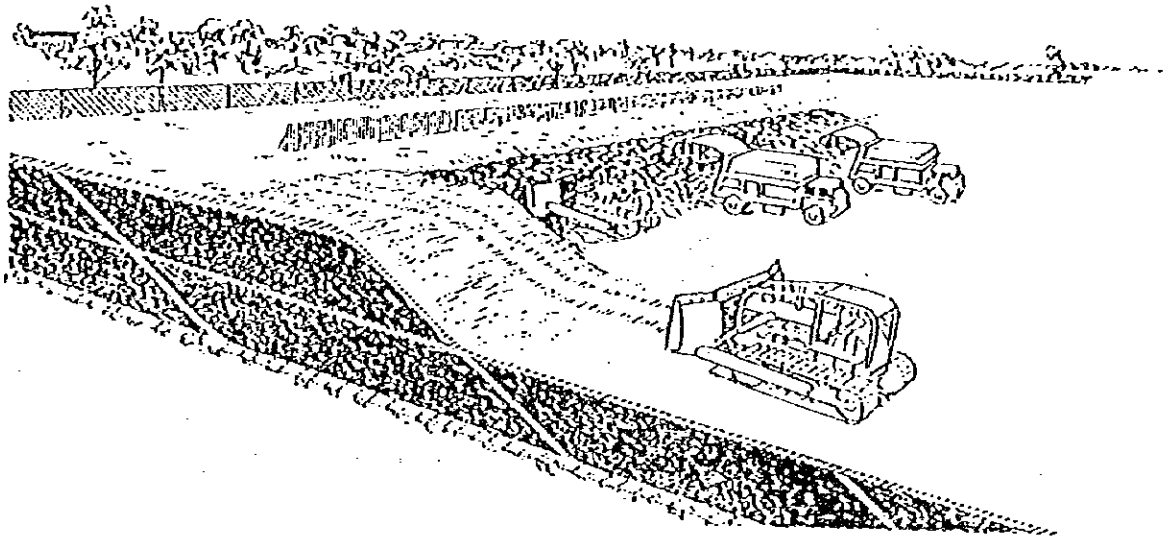
Waste Spread & Compaction



Cell & Cover Soil

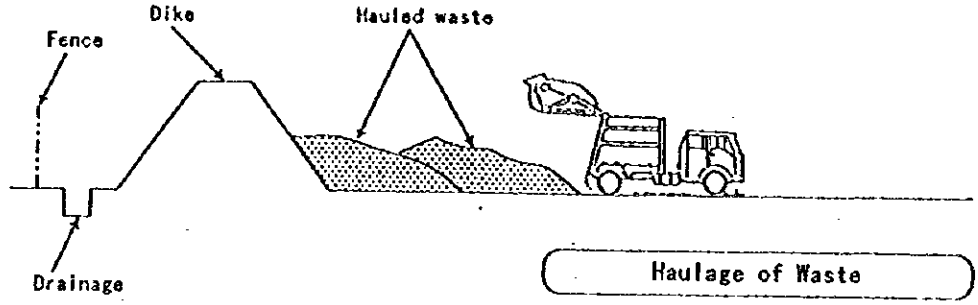


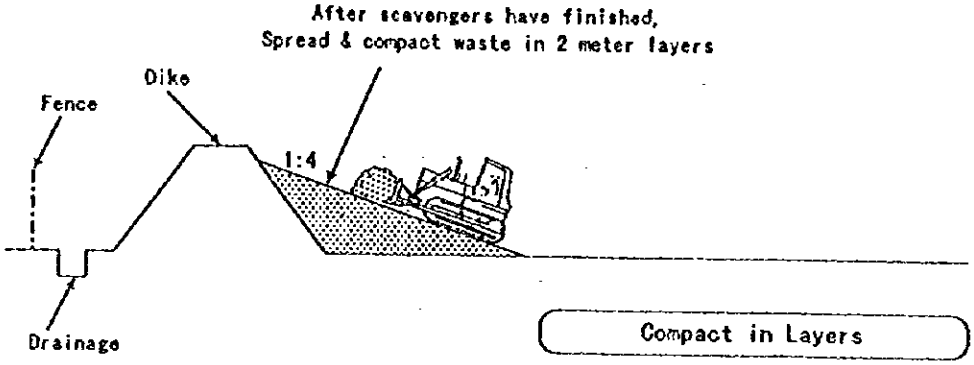
Cell Method Operation – (1/2)

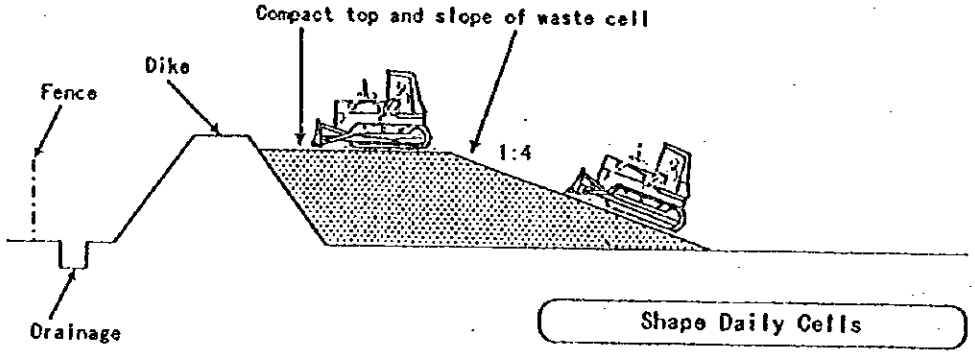


Cell Method Operation – (2/2)

FIG. B.4.2-1 Conceptual Drawing of Landfill Operation (Cell Method)







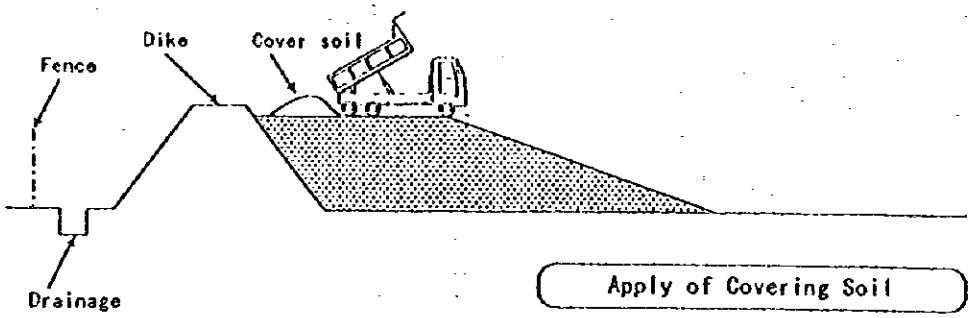


FIG. B.4.2-2 **Landfill Operation Procedures (1/3)**

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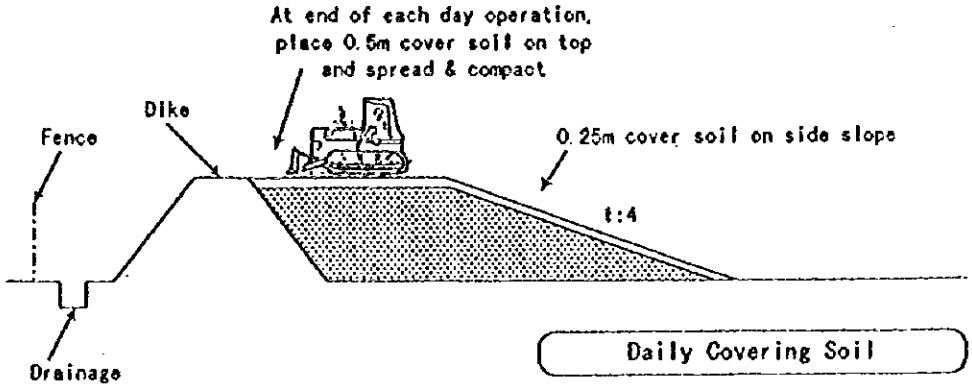

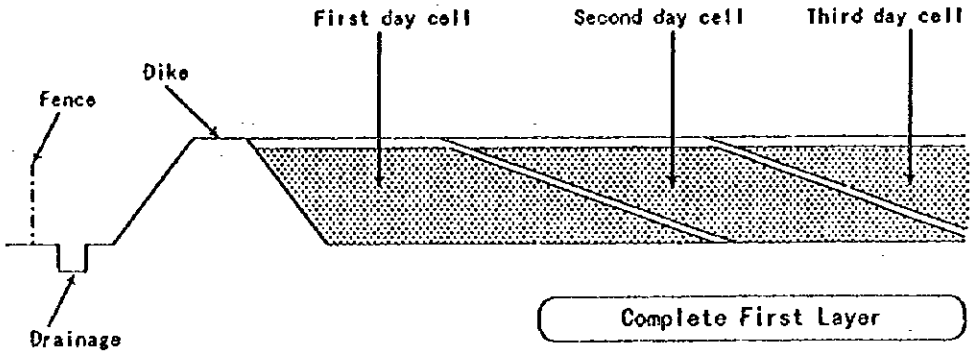

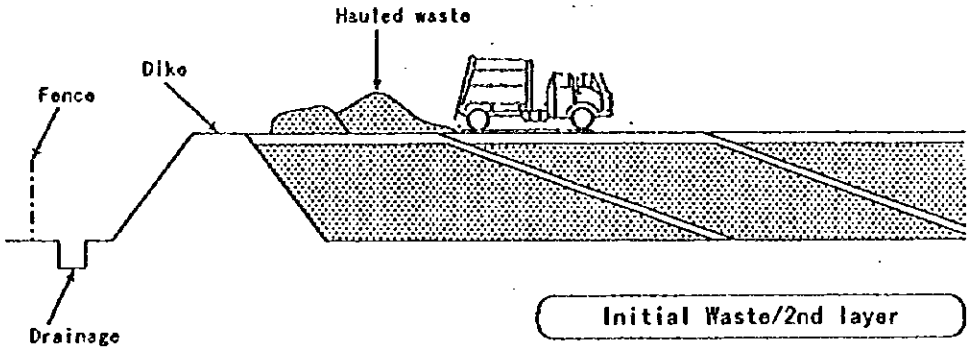

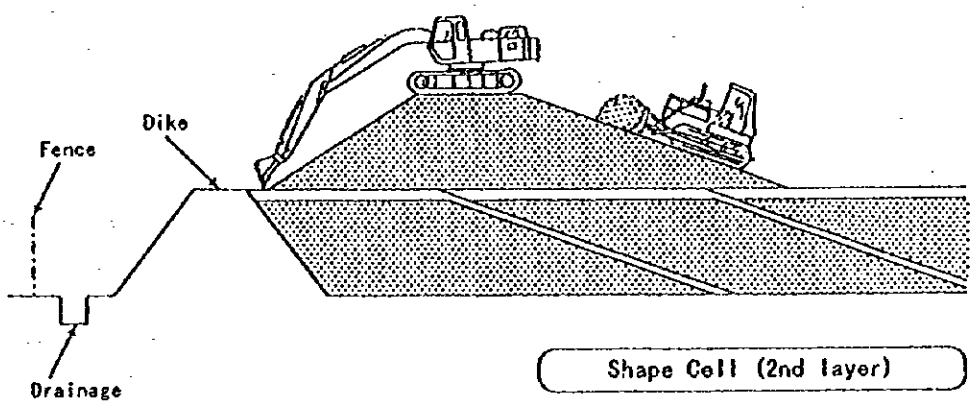

FIG. B.4.2-2 **Landfill Operation Procedures (2/3)**

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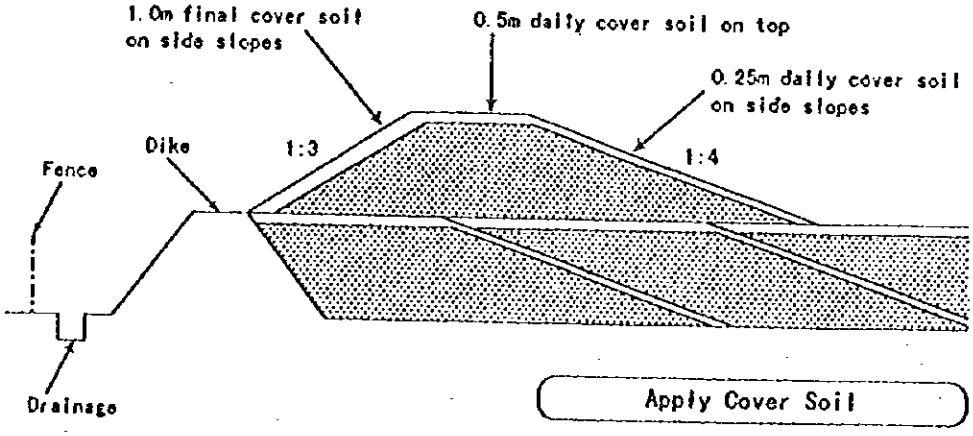

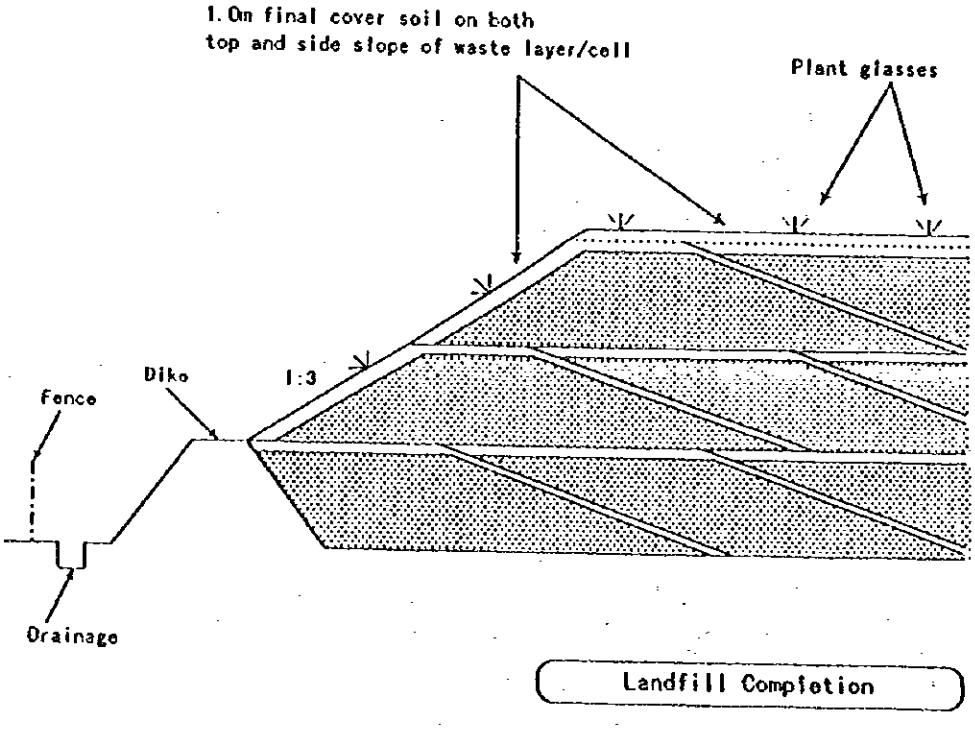

Source:
"Landfill Management Plan" by
International City Managers Association
(Washington D.C.) in 1992

FIG. B.4.2-2 **Landfill Operation Procedures (3/3)**

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4.3 Truck Scale

Installation of truck scale is the first and basic requirement for SWM planning. This facility is to ensure that the landfilled waste meets the requirement stipulated. The amount of landfill waste is also measured and recorded. Therefore, it is essential to introduce the truck scale at the entrance of controlled landfill site.

4.3.1 Truck Scale Operation

Every hauled-in waste shall be weighed by using truck-scale so as to obtain several important data for SWM. Truck scale shall be installed at strategic position of disposal site where the collection vehicles will pass through whenever entering and leaving the site, therefore entrance point of the disposal site is recommended for its siting. Meanwhile, to secure the access for other objected vehicles, such as site construction, site patrol, visitors vehicle, etc., a detour road/access shall also be prepared besides/along the truck-scale.

Waste type and quality shall also be checked periodically. By understanding the type/quality of landfill waste: type of gas production, leachate quality, subsidence of the waste, etc. can be predicted, and then, these data are very important for ultimate land-use plan of the site as well as for future disposal site plan. Meanwhile, in case that toxic substances are contained in landfill waste, environmental pollution will be caused by it. Therefore, hauled-in waste should be checked periodically. Waste sampling place for checking waste shall be prepared beside the truck-scale.

4.3.2 Data Collection and Analysis

Data which shall be collected and analyzed regularly by using a truck-scale are shown in the following Table B.4.3-1. Analyzed data shall be reported on daily, weekly, monthly and yearly, whenever required. These data are essential for the following control items of SWM;

- Understanding the waste disposal amount should be the basic factor for future disposal site planning
- Understanding the waste type/quality could be the basic data for ultimate land-use plan of the site
- Understanding the working time and the waste collected by each vehicle/truck, are the basic factors for planning effective collection routes and methods
- Checking hauled-in waste amounts are the basic data for collection of tipping fees

The landfilled waste volume, waste type/quality, hauled-in place and time for each type of waste, etc. shall be reported with above mentioned monthly report. Further, these data are recommended to be prepared by using a plan and section drawing of disposal site.

Table B.4.3-1 Input Data of Truck Scale (example)

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

4.3.3 Specification of Truck Scale

In general, truck scale of the load cell type is popular in the world because of its simple mechanism and easy maintenance. Also, automatic weighing system with computer is commonly used.

Truck scale components of load cell system are shown in Fig. B.4.3-1, and its specification is described as follows.

- Weighing capacity : 30 ton / unit
- Load-cell type and four-point support system
- Automatic digital counter
- Control post with card reader
- Connected computer with printer to input and arrange the data

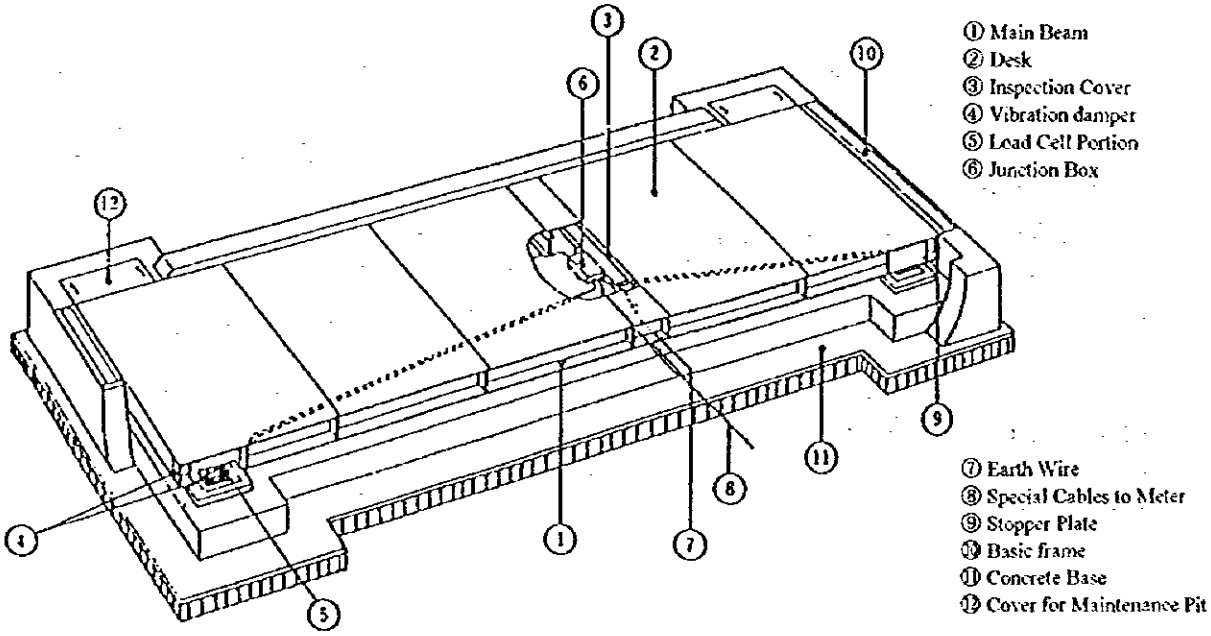


Figure B.4.3-1 Structure of Truck Scale

4.4 Landfill Equipment

Landfill equipment plan, that is; examination for the necessity of equipment, its type and numbers, etc., shall be established at the planning stage of final disposal plan which is described in Chapter 1 of this report.

4.4.1 Selection of Landfill Equipment

In selecting of suitable landfill equipment, the following design conditions should be determined, as the first step;

- Volume of solid waste discharged at the final disposal site per day
- Volume of covering soil required per day
- Volume of covering soil to be excavated per day at the source point
- Volume of covering soil to be transported per day

As the second step, the relationship between necessary landfilling works and functions of each heavy equipment should be taken into consideration. Table B.4.4-1 shows recommended suitable equipment for each type of landfilling works.

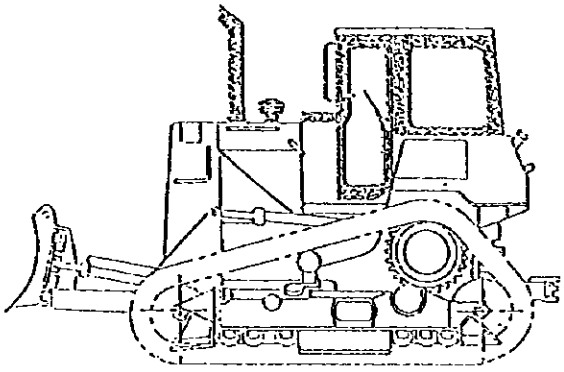
Table B.4.4-1 Landfilling Works and Equipment

Landfilling works	Landfill equipment	Capacity
Waste push up and spread	Bulldozer (w/ trash rack)	HP 150 - 300 Blade 8 - 15m3
Waste compaction	Landfill compactor Bulldozer	HP 200 - 400 HP 150 - 300
Excavation of cover soil	Back hoe (Hydraulic excavator)	Bucket 0.5 - 1.5m3
Loading cover soil on to dump trucks	Wheel loader	HP 100 - 200 Bucket 1.0 - 3.0m3
Cover soil transport	Tipper (dump) truck	Box 8 - 12 m3
Spread and compaction of cover soil	Bulldozer	HP150 - 300 Blade 2.5 - 6.0m3

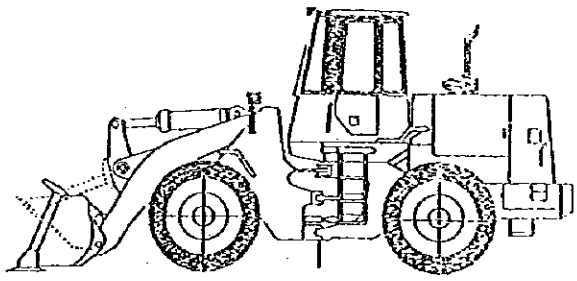
Typical drawings of landfill equipment are shown in Fig. B.4.4-1, and its rough unit price is described in Table B.7.1-3 and -4.

As the final step, numbers of equipment required, equipment specifications; that is, its horse power, blade capacity of each equipment etc., shall be calculated/decided by using certain equations provided by authorities concerned or equipment manufacturers. It is recommended that the final step shall be carried out under the cooperation with the expert and/or specific local consultant.

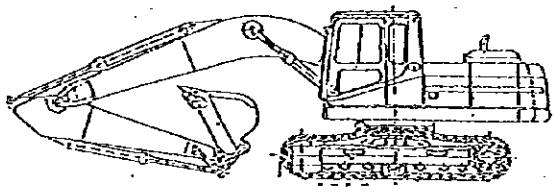
On the other hand, from the viewpoint of ease of maintenance and repairing, equipment types should be standardized as much as possible. Of course, financial availability is also an important measure.



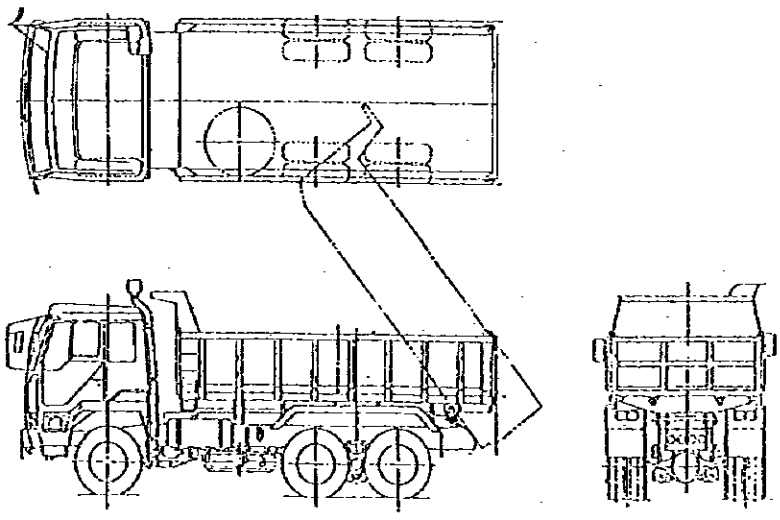
Bulldozer (200HP, 300HP)



Wheel Loader (1.5m^3)



Back Hoe (0.7m^3)



Dump Truck (15ton)

FIG. B.4.4-1	Typical Drawings of Landfill Equipment

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4.4.2 Maintenance of Landfill Equipment

Procurement costs of landfill equipment are rather high in Morocco compared with labor cost. Under this situation, it is very important for authorities concerned which control and operate the final disposal site to utilize such expensive equipment effectively for long periods through proper maintenance and repair. In other words, poor maintenance could easily cause lower operation rate and shorten the life time of equipment.

The following items shall be recommended to establish a proper maintenance and repair system.

- Introduction of daily inspection.
- Introduction of regular maintenance services, namely, every 50 hours and 250 hours operation.
- Ensure quick procurement of spare parts and maintain an adequate stock of spare parts, in cooperation with and/or under the responsibility of equipment suppliers/manufacturers.
- Contracting out of the major maintenance and repairing matters.

4.5 Environmental Monitoring

For the proper control of a final disposal site, both during its operation and after site closure, it is necessary to monitor the landfill sinkage, quality of underground water and quality of discharged water.

Required monitoring items, purposes, required cases and its monitoring methods are surmised in the Table B.4.5-1, and explained in the following Articles.

Table B.4.5-1 Environmental Monitoring at Final Disposal Site

No	Monitoring Items	Monitoring Purpose	Required Case	Monitoring Method
1	Sinkage of landfill site	• Ultimate land-use	• High and medium level land-use is planned for post-closure	• Sinkage meter
2	Quality of groundwater	• Monitoring of ground-water contamination • Checking the function of liner	• Public well is located at downstream of the disposal site • Groundwater level is high	• Water analyzer • Monitoring well • Existing well
3	Quality of discharged water	• Monitoring of public water contamination • Operation plan of leachate treatment plant after site closure	• Leachate is discharged to public water bodies	• Water analyzer

1) Sinkage of Landfill Site

In case high and/or medium level land-use, which are described in Chapter 5 of this report, is planned for post-closure of a final disposal site, landfill sinkage shall be monitored periodically. Land sinkage can be measured by sinkage meter. In general, sinkage of a landfill site might be continued approximately five years after landfill completion.

2) Quality of Groundwater

In case there are some possibility of groundwater contamination and affecting to surrounding inhabitants; especially public well for drinking water and irrigation is located at downstream of the disposal site, and/or groundwater level is high, quality of groundwater shall be monitored periodically.

The purposes for the monitoring of groundwater are the followings;

- To check if the function of liner system and/or impermeable layer of the disposal site are effective of not.
- In the case that the function of liner system and/or impermeable layer of the disposal site are not effective for some reason, checking the diffusion degree of harmful substances contained in leachate flow into groundwater, and degree of affects to living environment.

Check sample of groundwater can be taken from surrounding existing wells and/or monitoring wells, then its quality will be checked by water analyzer at least once a year. Check items shall be the followings;

- pH, BOD, COD, SS, Coliform group number, N-hexane extracts, NH_4^+-N, T-N, T-P, etc.

In case a groundwater contamination have observed and its affect to the surrounding inhabitants are feared, proper counter-measures shall be carried out.

3) Quality of Discharged Water

As for the monitoring of discharged water (if any), its water quality, especially pollutant and harmful substances contained in discharged water/leachate, should be checked/monitored periodically so as to prevent environmental impacts to surrounding public water bodies. Check items for its quality are same with that of groundwater, and check frequency shall be every two or three months.

4) Others

Besides the above items, factors affecting environmental impact described in Chapter 6, Table B.6.1-1 of this report shall also be considered to monitor (if necessary).

CHAPTER 5 ULTIMATE LAND-USE AND SITE CLOSURE

5.1 Ultimate Land-use

5.1.1 Need for Ultimate Land-use Planning

Ultimate land-use shall be planned and carried out in order to perform effective usage of the final disposal site after its landfill completion. Several ways of ultimate land-use, which are described in the following Article 5.1.2, might be considered and selected.

As shown in Fig. B.1.1-1 in this report, an ultimate land-use plan should be considered at the beginning of the disposal site plan. This is because, it is directly and/or indirectly connected to the basic concept of disposal site design, including the waste disposal system and necessary facilities, landfill operation method, environmental monitoring system, etc.

Meanwhile, a plan for ultimate land-use can sometimes be helpful to get the consensus of neighboring citizens when the authorities concerned try to find/select the location of new disposal site.

5.1.2 Level of Ultimate Land-use and Site Conditions

Ultimate land-use can be categorized into three (3) levels, that is, level-1: Agriculture, level-2: Park and level-3: Structure. Considerable facilities, required site conditions and environmental counter-measures for each land-use level are described in Table B.5.1-1.

Meanwhile, for the proper planning of ultimate land-use, the following sitting conditions of a final disposal site, as one of the major conditions, is recommended to be taken into consideration:

- Topographic condition: Proper ultimate land-use should be adopted dependent on the topographic conditions of the site, such as hill-side, open field, depression, etc.
- Traffic condition: Accessibility for the expected land users (distance from city center) and road network conditions connected to the land shall be considered.
- Urbanization condition: If urbanization of the surrounding area of the land proceeds various, then, efficient and/or high level land-use can be adopted.
- Land price: If the surrounding land price is low, land-use for selling the land divided in lots, for several purposes, will be difficult

Table B.5.1-1 Levels of Ultimate Land-use

Land-use Types	Land-use example	Required site conditions	Environmental counter-measures
Level-1 : Agriculture	• Grass field • Grove field • Agricultural land	• Toxicity of generated gases (CO_2 and CH_4) to root systems shall be limited • Soil oxygen, nutrient status and soil moisture shall not be low	• Generated gas shall be monitored • Effective thickness of soil layer for the plant is required • Proper soil for vegetation shall be installed for final covering • Proper choice of plant species is required
Level-2 : Park	• Small scale park • Playground • Sports field • Golf course	• Toxicity and/or combustion of generated gases shall be limited or not be exist • Slope failure of the site shall not be occur	• Monitoring and counter-measures for generated gases are required to keep a proper living environment
Level-3 : Structure	• School, office • Warehouse etc. • Industrial estate • Housing estate	• Site sinkage shall be very little • Ground shall be able to bear heavy loads of proposed structure • Toxicity and/or combustion of generated gases shall not be exist • Slope failure of the site shall not be occur	• Careful monitoring and counter-measures for site sinkage is required • Careful monitoring and counter-measures for generated gases is required to keep a proper living environment • Produced leachate quality and quantity shall be monitored

The necessary areas for each land-use facility listed above are shown in Fig. B.5.1-1. Fig. B.5.1-2 shows a sample drawing of ultimate land-use plan for sports park.

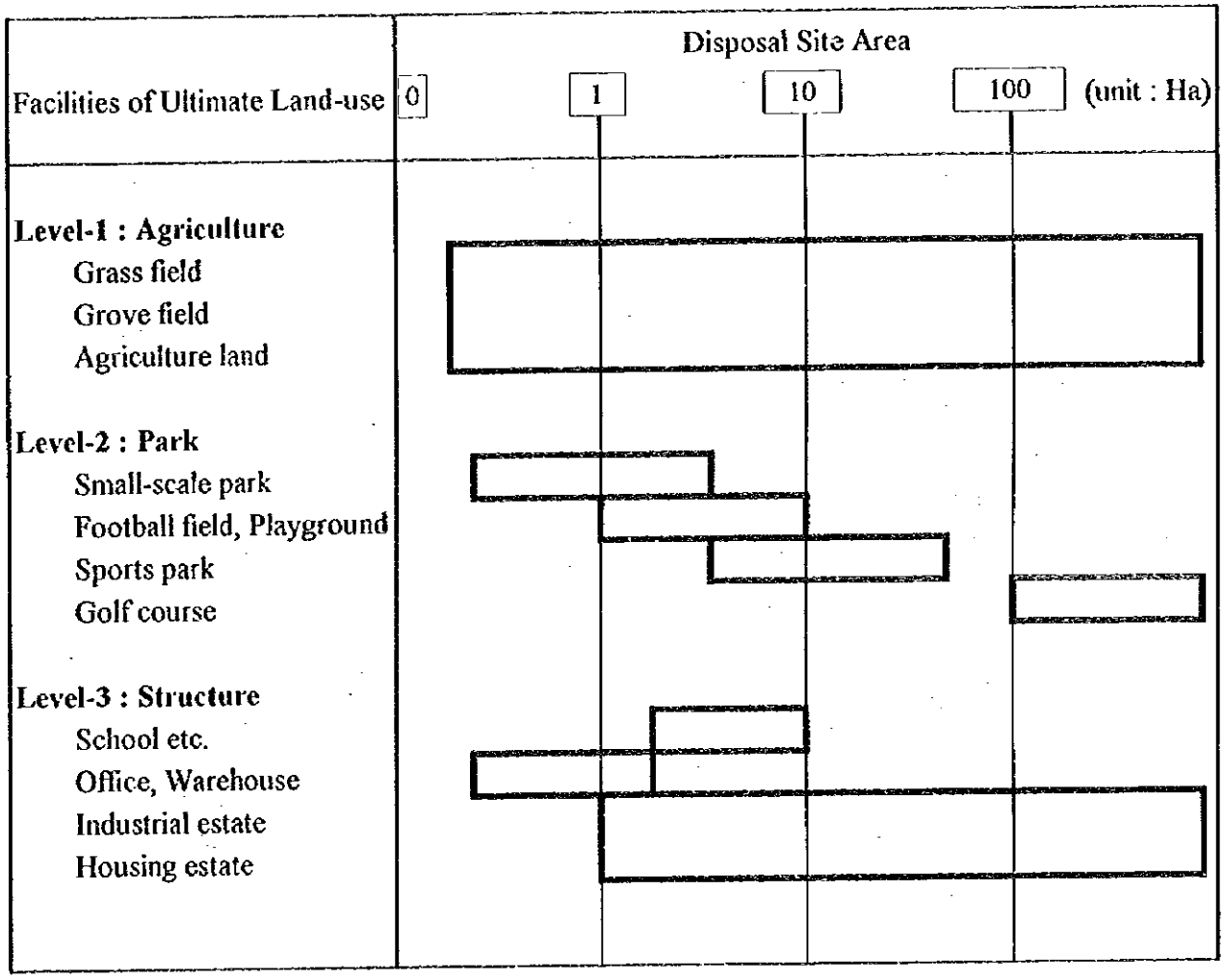

FIG. B.5.1-1 Required Area for Facilities of Ultimate Landuse

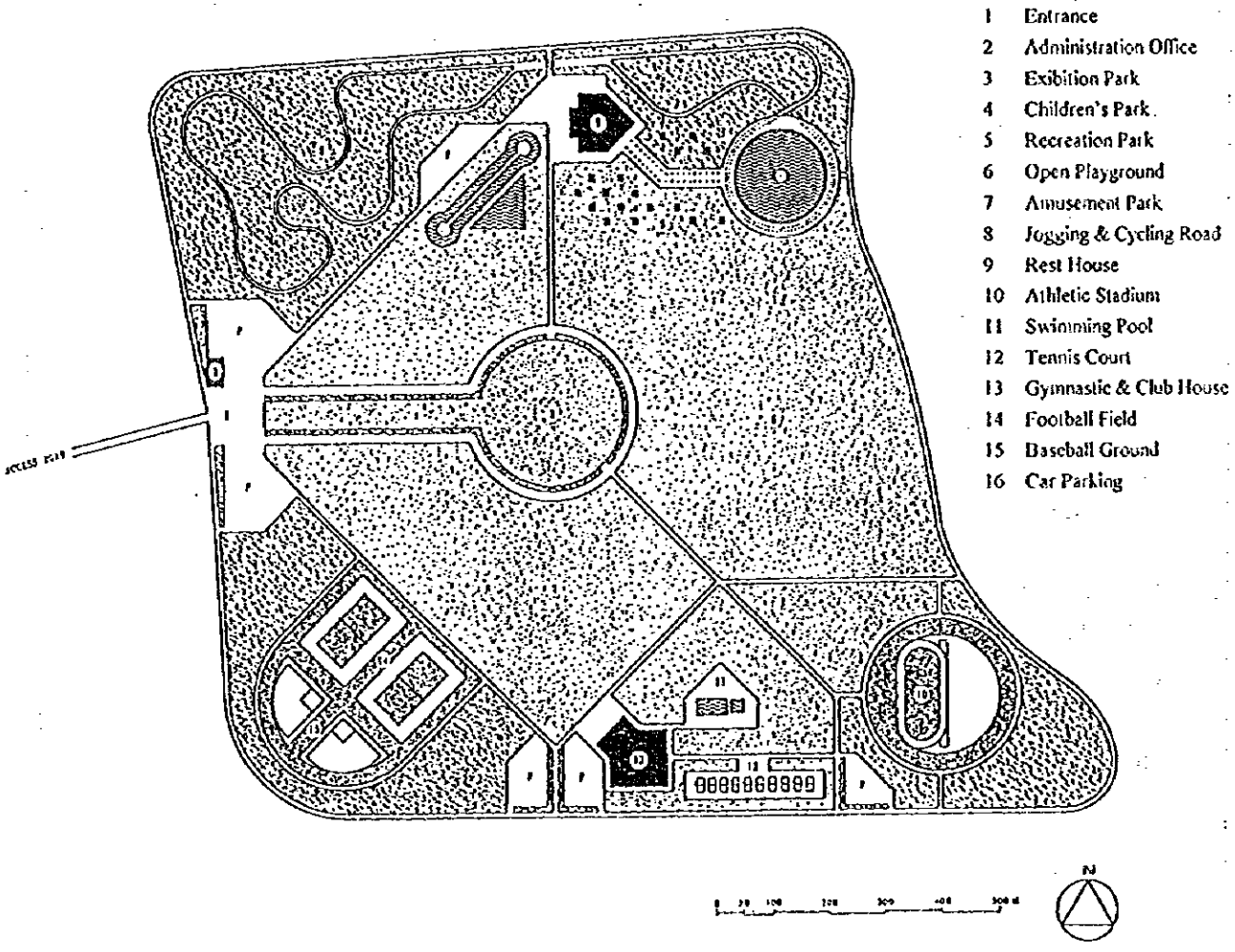

FIG. **Ultimate Landuse Plan (Sample)**

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5.1.3 Countermeasures for Site Stabilization for Ultimate Land-use

In generally, at a final disposal site, the following phenomena are observed continuously for a long period even after completion of landfill work.

- Subsidence of the ground (approx. 5 years after landfill completion)
- Production of gas (15 years or more after landfill completion)
- Production of leachate

The above phenomena can sometimes be a hindrance to ultimate land-use, therefore, in order to accelerate stabilization of the final disposal site and to perform effective ultimate land-use of the site, the following facilities are recommended to be installed and/or operated at the site. It is noted that its necessity is depend on the levels of ultimate land-use.

- Drainage facilities for rainwater
- Gas removal facilities (if required)
- Leachate treatment facilities (if required)

The stabilization period of the disposal site, after landfill completion, is depend on the height of waste, types and amount of waste, kinds, amount and thickness of cover soil, the landfilling operation method, geological features of the site, and so on. Therefore, depend on the necessity for its levels of ultimate land-use, monitoring of a stability of the ground, generated gases and quality of the leachate shall be carried out continuously until the site conditions are properly stabilized.

5.2 Site Closure

For environmental prevention measures and/or urging the early site stability for proper ultimate land-use, the following facilities/counter-measures should be considered and provided when the final disposal site closed.

- Final cover soil (thickness is 1.0 m) should be installed at the top and slope edge of the landfilled waste.
- A fence must be installed (if not existing) around the site to prevent easy access to the site
- Gentle slopes must be formed at the top surface of landfilled waste by final cover soil in order to allow for smooth discharge of rain water and minimize the amount of leachate production.
- Storm-water drainage must be equipped (if not existing) and/or re-arranged around the completed site to prevent rain water flow into the site (in order to reduce leachate production)
- Vegetation is recommended on the surface of covering soil to keep the soil in a stable condition

- Environmental prevention facilities (if any) such as leachate collection pipe, gas removal facilities, leachate treatment facilities shall be continuously settled and/or operated until a final disposal site reached required stable level for its ultimate land-use.
- Environmental monitoring for the site sinkage, produced gases and leachate quality and quantity shall be continuously performed, in order to carry out the proper ultimate land-use and/or to prevent environmental pollution. In case produced gases, it is noted that, the quantity of methane produced after landfill closure may not be sufficient to support combustion.

In addition, it is recommended that a topographic survey (scale 1/2,500 to 1/5,000) shall be carried out in order to understand the present site features and assist in proper planning of site closure and ultimate land-use.

CHAPTER 6 ENVIRONMENTAL IMPACT STUDY FOR SOLID WASTE DISPOSAL

6.1 Introduction

Based on the recognition of the importance of environmental issues, Environmental Impact Study shall be carried out for the purpose of contributing to the Projects with sufficient environmental considerations.

In general, the Environmental Impact Study is divided into two phases in accordance with the Study objectives, including an Initial Environmental Examination (IEE) applied for the Master Plan Study and Environmental Impact Assessment (EIA) applied for the Feasibility Study whose objectives has evaluated/selected during Master Plan Study process as Priority Projects. The details and procedures of IEE and EIA is described in the following Article 6.2 and 6.3, respectively.

6.2 Initial Environmental Examination (IEE)

6.2.1 Basic Concept of IEE

In Initial Environmental Examination (IEE) process, negative environmental aspects/impacts in the Master Plan Study area shall be identified based on the existing information, data and reconnaissance site visit by using screening and scoping method which are defined by the "JICA Environmental Guidelines". IEE process shall be carried out in a short period at a low cost.

IEE has the following two objectives;

- To evaluate whether EIA is necessary or not for the Project and, if necessary, to define the contents/items which has negative environmental impacts
- To examine, from environmental viewpoint, the counter-measures for alleviating the effects of the Project which requires environmental consideration, however, its not a full-scale environmental impact assessment.

6.2.2 Screening and Scoping

1) Screening

Necessity of the environmental consideration shall be evaluated in each items listed in Table B.6.2-1, based on the findings of the field surveys and data analysis. If it is evaluated that EIA is required for the Project, then scoping should be undertaken.

The evaluation result of each environmental items shall be noted on the format, described in Table B.6.2-1, whether or not environmental impacts exist. As the overall evaluation, the conclusion and the reason for evaluating whether or not EIA is required should be described briefly on the format.

Table B.6.2-1 Format for Screening

No.	Environmental Item	Description	Evaluation	Remarks (Reason)
Social Environment				
1.	Resettlement	Resettlement due to land occupancy (Transfer of rights of residence/land ownership)	[Y][N][?]	
2.	Economic Activities	Loss of bases of economic activities, such as land, and change of economic structure	[Y][N][?]	
3.	Traffic and Public Facilities	Impacts on schools, hospitals and present traffic conditions, such as the increase of traffic congestion and accidents	[Y][N][?]	
4.	Split of Communities	Community split due to interruption of area traffic	[Y][N][?]	
5.	Cultural Property	Damage to or loss of value of churches, temples, shrines, archaeological r4emains or other cultural assets	[Y][N][?]	
6.	Walter Rights and Rights of Common	Obstruction of fishing rights, water rights, rights of common	[Y][N][?]	
7.	Public Health Condition	Deterioration of public health and sanitary conditions due to generation of garbage and the increase of vermin	[Y][N][?]	
8.	Waste	Generation of construction wastes, debris and ash	[Y][N][?]	
9.	Hazards (Risk)	Increase in danger of landslides, cave-ins, etc.	[Y][N][?]	
Natural Environment				
10.	Topography and Geology	Changes of valuable topography and geology due to excavation of filling work	[Y][N][?]	
11.	Soil Erosion	Topsoil erosion by rainfall after reclamation and deforestation	[Y][N][?]	
12.	Groundwater	Pollution by leachate	[Y][N][?]	
13.	Hydrological Situation	Changes of river discharge and riverbed condition due to landfill and drainage inflow	[Y][N][?]	
14.	Coastal Zone	Coastal erosion and change of vegetation due to coastal reclamation and coastal changes	[Y][N][?]	
15.	Fauna and Flora	Obstruction of breeding and extinction of species due to changes of habitat conditions	[Y][N][?]	
16.	Meteorology	Changes of temperature, precipitation, wind, etc. due to large-scale land reclamation and building construction	[Y][N][?]	
17.	Landscape	Change of topography and vegetation due to reclamation, deterioration of aesthetic harmony by structures	[Y][N][?]	
Pollution				
18.	Air Pollution	Pollution caused by exhaust gas or toxic gas from vehicles and factories	[Y][N][?]	
19.	Water Pollution	Pollution caused by inflow of silt, sand and drainage from treatment plants into rivers and groundwater	[Y][N][?]	
20.	Soil Contamination	Contamination of soil by leakage and diffusion of ash and incombustible refuse	[Y][N][?]	
21.	Noise and Vibration	Noise and vibration generated by collection cars and treatment plants	[Y][N][?]	
22.	Land Subsidence	Deformation of land and land subsidence due to lowering of groundwater table	[Y][N][?]	
23.	Offensive Odor	Generation of exhaust gas and offensive odor from treatment plants and dumped waste	[Y][N][?]	
Overall Evaluation: EIA is necessary for the project implementation?			[Y][N][?]	

Source : "JICA Environmental Guidelines"

It should be applied for all environmental impacts that may be caused by the Project implementation, not only in the project area but also in any area that may be directly or indirectly affected during the preparation/construction and after operation of the project facilities.

2) Scoping

To grasp the features and define the issues of the environmental items/impacts selected in the screening process and studied in EIA, scoping shall be carried out using the checklist methods.

The checklist for scoping of the project is shown in Table B.6.2-2. To use the checklist for scoping, the following conditions and procedures shall be taken into account:

(1) Application conditions

- Periods covered by scoping
  Scoping should cover both the construction and operation periods.
- Spatial extent of scoping
  Scoping should cover not only the project site for final disposal sites but also the entire area where the impacts would affect directly or indirectly, including the routes of waste collection vehicles, and where the effluent is discharged.
- Types of environmental impacts
  Environmental impacts subject to scoping are those having negative impacts on the existing environment.

(2) Evaluation method of important fields and items

The evaluation of each item should be rated according to the following categories:

A: serious impact is expected
B: some impact is expected
C: extent of impact is unknown but further examination is required because it might become clear as the study progresses
D: no impact is foreseeable and EIA is not required

Important fields and items for EIA should be identified with reference to "possible environmental impacts," "useful factors for evaluation," "measures," and "related subjects for study" as listed in Table B.6.2-3.

(3) Overall Evaluation

The evaluation results of each environmental item and the reasons for the evaluation should be clearly described on the check list. The items evaluated as A, B, or C should be examined based on the screening concept to determine whether or not EIA is required, and the policies for further study of those items should be outlined. If it is

possible to alleviate or avoid some environmental impacts by taking adequate measures, the contents should be described.

If, as the result of the evaluation, there are items which are evaluated as "C" or higher, some studies should be conducted for these items.

Table B.6.2-2 Checklist for Scoping

No.	Environmental Item	Evaluation	Reason
Social Environment			
1.	Resettlement		
2.	Economic Activities		
3.	Traffic/Public Facilities		
4.	Split of Communities		
5.	Cultural Property		
6.	Water Rights and Rights of Common		
7.	Public Health Condition		
8.	Waste		
9.	Hazards (Risk)		
Natural Environment			
10.	Topography and Geology		
11.	Soil Erosion		
12.	Groundwater		
13.	Hydrological Situation		
14.	Coastal Zone		
15.	Fauna and Flora		
16.	Meteorology		
17.	Landscape		
Pollution			
18.	Air Pollution		
19.	Water Pollution		
20.	Soil Contamination		
21.	Noise and Vibration		
22.	Land Subsidence		
23.	Offensive Odor		

Note : Evaluation categories: Source: "JICA Environmental Guidelines"

A: Serious impact is expected.

B: Some impact is expected.

C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progress).

D: No impact is expected. EIA is not necessary.

Table B.6.2-3 Explanation of Item

Item	
Description	
Cause of Impact	
Possible Environmental Impacts	
Useful Factors for Evaluation	
Measures	
Related Subjects for Study	

Source: "JICA Environmental Guidelines"

6.3 Environmental Impact Assessment (EIA)

6.3.1 Basic Concept of EIA

1) Purpose of EIA

The purpose of Environmental Impact Assessment (EIA) is require development projects to take environmental preservations into consideration. In advance of project implementation, survey, forecasting and evaluation should be done for the following environmental elements;

- Pollution control
- Conservation of natural environment
- Conservation of social environment

Regarding factors affecting environmental impact in the construction of a final disposal site, the following factors/stages should be considered;

- Construction stage
- Landfill operation stage
- After site closure (incl. ultimate land-use stage)

The relationship between environmental elements and factors affecting environmental impact is shown in Table B.6.3-1. Meanwhile, at the implementation of EIA study, it is important to focus on the factors and/or elements which are expected to have a serious impact on the environment, in order to avoid excessive work in the EIA study.

2) EIA Procedures

EIA shall be carried out taking into consideration and making clear the following basic items;

- Scope of work for EIA
- Schedule of total work
- Cooperation with authorities concerned
- Work share
- Preparation of environmental impact statement (EIS) / EIA report
- Practical use of local consultants

General procedure of EIA study is shown in Fig. B.6.3-1.

In addition, it is recommended that EIA study itself shall be carried out by the experts of each field; that is, natural environment, social environment and pollution control; and/or specific local consultant. Then, study result shall be evaluated and/or approved by authorities concerned.

Table B.6.3-1 EIA Items for Forecasting and Evaluation of Final Disposal Site

Environmental Element		Factors Affecting Environmental Impact					
		Construction Stage		Landfill Operation Stage		After Site Closure	
Conservation of Social Environment	Resettlement	Inhabitants removal Scavengers matter	v v				
	Traffic Safety / Living Facilities	Safety in the region Effect on living facilities by traffic volume increase		Safety in the region Effect on living facilities by traffic volume increase	v	---	
	Entitlement to Water	Obstacle by quality change Obstacle by quantity change		Obstacle by quality change		Obstacle by quality change	
	Waste (sludge, earth & sand etc.)	Obstacle by disposal		---		---	
	Health & Sanitation	---		Scattering waste, breeding of vectors and insects	v	---	
	Disaster (flood control etc.)	Drainage water increase by topographic change		---		---	
	Greenery Area	Disappearance or change in greenery area		---		---	
Conservation of Natural Environment	Topography (Geology	Topographic change Disappearance or change in singular topo. feature	v	---		---	
	Soil Erosion	Surface water change Increase of bare land		---		---	
	Groundwater	Water level down Water quality change		Water quality change	v	Water quality change	v
	Fauna	Escape or disappearance of precious animals Change of habitat fauna	 v	Water quality change	v	Water quality change	
	Flora	Change or disappearance of precious plants Change of flora colony	 v	Water quality change	v	Water quality change	
	Landscape	Scenic change	v	Scenic change		---	
	Field Recreation etc.	Disappearance or change of field recreation area		---		---	
Pollution Control	Air Pollution	Flue gas by const. vehicle Dust scattering		Dust scattering			
	Water Pollution	Turbid water by reclamation Turbid water by drain work		Leachate discharge	v	Leachate discharge	v
	Soil Contamination	---		Leachate discharge Toxic substance effluence	v	Leachate discharge Toxic substance effluence	v
	Noise	Construction work Road traffic	 v	Construction work Road traffic (collection veh	 v	---	
	Vibration	Construction work Road traffic		Construction work Road traffic		---	
	Offensive Odor	---		Exhaust gas	v	Exhaust gas	

Remarks; v : Items which need special attention

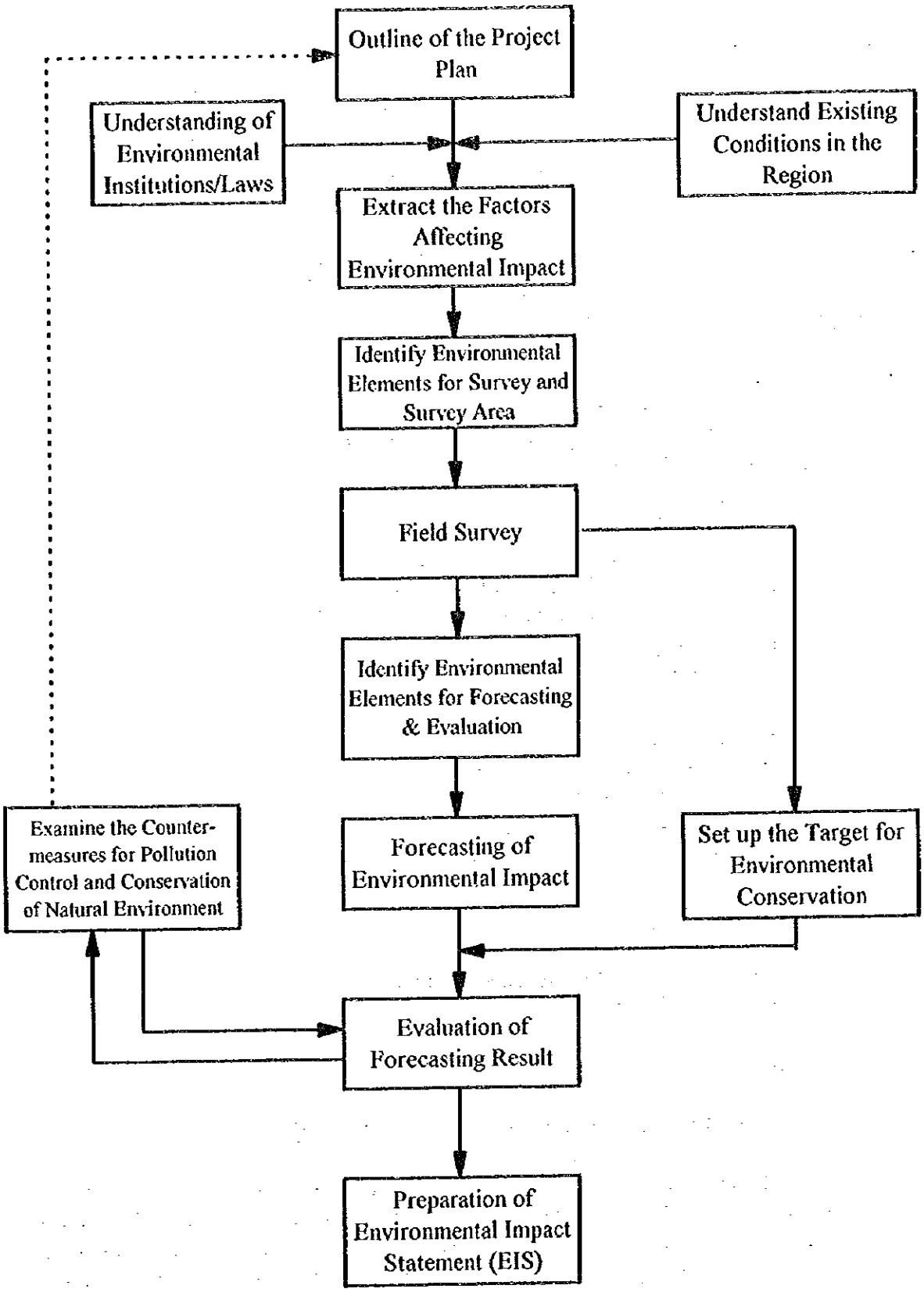


FIG. B.6.3-1 Flow Chart for the Process of Environmental Impact Assessment(EIA)

6.3.2 Extraction of Items for EIA

1) Extraction of Factors Affecting Environmental Impact

As described in Article 6.3.1, in the case of extraction of "Factors affecting environmental impact", three (3) stages should be considered, construction stage, landfill operation stage and post-closure stage. These factors should be broken down into more detail in order to settle the proper survey items and areas for EIA study. The following are factors affecting environmental impact, should be contained in the disposal site plan;

- Construction stage
  - Traffic of construction vehicles
  - Land leveling (including cutting down of trees)
  - Land reclamation
  - Excavation works
  - Drainage works
  - Piling works (if necessary)
  - Hauling road (inside & outside of the site)
  - Construction of site facilities
  - Disposal of surplus soil
  - Alteration of the land

- Landfill operation stage
  - Traffic of collection vehicles
  - Landfill operation work
  - Existence and/or decomposition of waste
  - Leachate discharge
  - Exhaust gas
  - Existence of site facilities

- Post site closure (include ultimate land-use stage)
  - Decomposition of waste
  - Leachate discharge
  - Exhaust gas

2) Selection of Environmental Elements in EIA Studies

In selecting the environmental element in order to settle necessary field survey items relating to factors affecting environmental impact listed in Article 6.2.2, local regulations/laws, environmental standards, regional characteristics etc. (if any or when established in the future) shall be taken into consideration. Detailed items of the environmental element are described in Table B.6.3-1 (left side column of the table).

Table B.6.3-1 shows items which should be selected for the field survey, forecasting and evaluation of EIA studies of final disposal site plans (especially " v " marked items must be selected).

6.3.3 Survey, Forecasting and Evaluation of EIA

1) Outline of Survey

The methodology for carrying out the survey of present conditions can be either in the form of collecting and analyzing existing data and/or actual field survey. The method to be adopted depends on the required level of evaluation.

The survey area should include urbanized areas and water catchment areas which will be affected or expected to be affected by the project.

2) Outline of Forecasting

If possible, expected environmental changes should be recorded quantitatively based on counter-measures for environmental preservation, otherwise, it should be described qualitatively.

3) Outline of Evaluation

Evaluation should be done basically to compare the results of the survey and forecasting environmental preservation targets. The targets should be determined by authorities concerned.

6.3.4 Pollution Control Measures and Conservation of the Natural Environment

For pollution control measures and conservation of the natural environment, guidelines published by the World Bank entitled "Environmental Assessment Source-book, Volume II, Sectoral Guidelines" should be introduced as shown in the Table B.6.3-2.

6.3.5 Contents of EIA Report

EIA Reports should contain the following items;

- Outline of the project plan
- Existing conditions of the region
- Environmental institutions/laws
- Extract the factors affecting environmental impact
- Environmental elements for survey and survey area
- Field survey
- Environmental elements & items for forecasting & evaluation
- Environmental conservation targets
- Forecasting environmental impacts
- Evaluation of forecasting results
- Counter-measures for pollution control and conservation of natural environment

Table B.6.3-2 Counter-measures for Environmental Impact

No	Potential Negative Impacts	Mitigating Measures
1	Dust from unloading and spreading/grading operations at land disposal sites.	• Provide buffer zone around land disposal site. • Pave access road. • Design location of working face to minimize truck traffic. • Water spray the working areas to suppress dust.
2	Smoke from open burning or refuse at land disposal sites.	• Spread and compact incoming refuse, cover daily with soil, install gas control systems.
3	Odors from land disposal sites.	• Same as above.
4	Contamination of ground and/or surface water by leachate from land disposal sites.	• Locate land disposal systems where soils underlying landfill are relatively impermeable and have attenuative properties. • Provide an adequate depth between the bottom of the landfill and the top of the groundwater. • Provide adequate horizontal distance to nearest surface water.
5	Restriction to beneficial uses of receiving waters contaminated by leachate.	• Do not locate land disposal upgradient of any ground or surface water whose usage could be affected by receipt of contamination, unless the distance between the land disposal and the receiving water is adequate to dilute, disperse or attenuate contamination.
6	Loss of deep-rooted vegetation (e.g., trees) from landfill gas.	• Provide gas control systems in landfills.
7	Explosion of toxic response from accumulated landfill gas in buildings.	• Same as above. • Also restrict development of buildings in the vicinity of landfills. • Install gas monitoring wells around the site.
8	Emission of potentially toxic volatile organics from land disposal sites.	• Restrict potentially hazardous wastes from being disposed in landfill for general refuse.
9	Land use conflicts when solid waste facilities are not well located.	• Plan locations of facilities to fix existing and planned land use. • Provide buffer zones to minimize aesthetic impact of facilities. • Try to limit truck traffic to use of major roadways which do not have residential development.

CHAPTER 7 COST ESTIMATION

7.1 General

It is noted that detailed cost estimation, at the project detailed design and its implementation stage, is recommended to be carried out by a local consultant because of its manifold and/or specific works. In this Chapter, a result of rough cost estimation and its conditions/procedures are described.

Project costs for the final disposal site consist of the following components;

- Construction cost
- Equipment procurement cost
- Operation and maintenance cost
- Land acquisition cost
- Engineering Service cost

Project costs of controlled landfill, Level-2 and Level-3, were estimated taking into consideration city size (population parameter was used). Annualized project costs and unit costs per ton (DH/ton) for each landfill system are calculated in the following Table B.7.1-1 and Table B.7.1-2 respectively. For the detailed information/figures in the following tables, refer to Table B.7.1-3 and Table B.7.1-4 which are the original calculation sheets.

Table B.7.1-1 Annualized Project Cost for Controlled Landfill : Level-2

I	Population	100,000	200,000	300,000	400,000	500,000	750,000	1,000,000	1,500,000
II	Waste amount (ton/day)	84	168	252	336	420	630	840	1,260
III	Required site area (Ha)	5	10	15	20	25	38	50	75
IV	Project cost (x 1000 DH)								
1	Construction cost	1,280	1,584	1,886	2,128	2,328	2,878	3,414	4,335
2	Equipment procurement cost	1,000	1,000	1,000	1,000	1,460	2,437	3,113	4,030
3	O/M cost	976	1,151	1,326	1,501	2,024	3,098	4,069	5,581
	Contingency	40	40	40	40	57	89	116	148
	G. Total (x 1000 DH)	3,296	3,775	4,251	4,669	5,869	8,502	10,713	14,094
4	Land acquisition (unit cost)	5	5	5	5	5	5	5	5
	Unit cost - total (DH/ton)	112	66	51	43	43	42	40	36

Table B.7.1-2 Annualized Project Cost for Controlled Landfill : Level-3

I	Population	100,000	200,000	300,000	400,000	500,000	750,000	1,000,000	1,500,000
II	Waste amount (ton/day)	84	168	252	336	420	630	840	1,260
III	Required site area (Ha)	5	10	15	20	25	38	50	75
IV	Project cost (x 1000 DH)								
1	Construction cost	2,238	3,077	4,021	4,862	5,650	7,651	9,640	13,272
2	Equipment procurement cost	1,000	1,000	1,217	1,217	1,677	2,653	3,113	4,030
3	O/M cost	976	1,151	1,557	1,733	2,206	3,356	4,092	5,604
	Contingency	40	40	52	52	66	102	117	149
	G. Total (x 1000 DH)	4,253	5,268	6,847	7,862	9,599	13,763	16,963	23,055
4	Land acquisition (unit cost)	5	5	5	5	5	5	5	5
	Unit cost (DH/ton)	144	91	79	69	68	65	60	55

As a result of these cost estimations, the following unit costs for each type of landfill systems have been concluded;

- Controlled Landfill (Level-2) : 40 - 60 DH/ton
- Controlled Landfill (Level-3) : 60 - 100 DH/ton

As described in the above two tables, it is obvious that the cost efficiency of the disposal sites with areas less than 10 hectares is rather poor. Therefore it is recommended that the disposal sites should have an area of more than 10 hectare. If the size of the Urban Community and/or Urban Commune, which are planning to construct disposal site, is small, that is, with a population of less than 200,000, it is recommended that an inter-municipal disposal site should be planned by combining several administrative areas.

The following items, which are shown in the above tables, should be calculated in the following manner;

- Waste amount : see the equation shown in Part B, Chapter 2, Article 2.2.1 of this report.
- Required site area : see the equation shown in Part B, Chapter 2, Article 2.2.1 of this report.
- Unit cost (DH/ton) : equivalent cost required to handle one ton of the waste

Unit cost = (Total project cost) / (Total waste amount to be hauled)

Meanwhile, engineering service cost must also be considered in the project cost. Amount of an engineering service cost is depend on the project scale, scope of works, etc., however, in general, it can be estimated between 5 - 15% of the project construction cost.

7.2 Cost Estimation methods and Assumptions

Rough costs of the construction, equipment procurement, operation and maintenance, land acquisition and engineering service are estimated based on the following manner:

1) Construction Cost

The items/facilities which should be taken into consideration for estimation disposal site costs are listed in Table B.3.2-2 in Part B, Chapter 3 of this report. Unit prices should be estimated by using local costs in Morocco. Cost estimates for controlled landfill, Level-2 and Level-3, are shown in Table B.7.1-3 and Table B.7.1-4 respectively.

2) Equipment Procurement Cost

Heavy equipment and other vehicles required for the site operation are described in Part B, Chapter 4, Section 4.4 of this report. Present prices are adopted as unit prices for each type of equipment.

The method of calculating depreciation shown in Table B.7.1-3 and Table B.7.1-4 is as follows;

- Depreciation

  Depreciation = (Unit price of the equipment) / (Life time of the equipment)

  Here, Life time of each equipment is as follows;

  5 years : Bulldozer, Excavator, Wheel loader, Landfill compactor
  6 years : Dump truck, Tank truck, Pick up

Required numbers of heavy equipment for controlled landfill, Level-2 and Level-3, taking into consideration city scale and/or waste amount, is described in the cost estimates shown in Table B.7.1-3 and Table B.7.1-4 respectively.

3) Operation and Maintenance Costs

For operation and maintenance costs, the following items should be considered;

- Personnel and salaries
- Fuel for the equipment
- Maintenance cost of the equipment
- Contingencies

The following items which are shown in Table B.7.1-3 and Table B.7.1-4 should be calculated as follows;

- Personnel : Required personnel for each type of landfill system shall be determined.
- Fuel : Fuel ratio and operating hours of each equipment shall be determined.
- Annual maintenance cost : summarized as follows;

  Annual maintenance cost = (Unit price x 40%) / (Life time of the equipment)

  Life time of each equipment is described in Article 7.3 above.

- Contingency : assumed to be five percent of the above items

  Contingency = (Personnel salary + Fuel cost + Equipment/Vehicle maintenance cost) x 5%

4) Land acquisition Cost

Land cost is mainly depend on its sitting conditions. It is difficult to set a general land cost, however, for the rough cost estimation, it has set DH 300,000/ha tentatively.

5) Engineering Service Cost

In general, an engineering service of the project contains the following items;

- Field survey
- (Environmental impact assessment (EIA))
- Basic and detailed design
- Cost estimation
- (Preparation of tender document and tendering support)
- Construction supervision

Engineering service cost is depend on its scope of works, etc., however, in general, it can be estimated between 5 - 15% of the project construction cost.

Table B.7.1-3 (1) Surmised Project Cost for Controlled Landfill -2 : Level -2

I Population			100,000		200,000		300,000		400,000		500,000		750,000		1,000,000		1,500,000	
II Waste Amount (ton/day & ton/10 year)			84	306,600	168	613,200	252	919,800	336	1,226,400	420	1,533,000	630	2,299,500	840	3,066,000	1,260	4,599,000
III Required Disposal Site Area for next 10 Years (Ha)			5		10		15		20		25		38		50.1		75	
IV Cost	Unit	Unit Price (DH)	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
1 Construction Cost																		
1-1 Main Facilities																		
a. Access road	m	3,400	1,500	5,100,000	1,500	5,100,000	1,500	5,100,000	1,500	5,100,000	1,500	5,100,000	1,500	5,100,000	1,500	5,100,000	1,500	5,100,000
b. Onsite road (Enclosure bound)	m	2,400	1,100	2,640,000	1,550	3,600,000	1,900	4,560,000	2,200	5,280,000	2,400	5,760,000	3,000	7,200,000	3,600	8,640,000	4,200	10,080,000
c. Partition dike (Divider)	m	1,000	450	450,000	600	600,000	750	750,000	850	850,000	900	900,000	1,150	1,150,000	1,350	1,350,000	1,600	1,600,000
d. Operational road	m	800	650	520,000	850	680,000	1,100	880,000	1,250	1,000,000	1,350	1,080,000	1,700	1,360,000	2,000	1,600,000	2,350	1,880,000
e. Storm water drainage (big)	m	400	2,300	920,000	3,150	1,260,000	4,000	1,600,000	4,600	1,840,000	5,000	2,000,000	6,250	2,500,000	7,500	3,000,000	8,750	3,500,000
-"- (small)	m	200	800	160,000	1,050	210,000	1,350	270,000	1,550	310,000	1,700	340,000	2,100	420,000	2,500	500,000	2,950	590,000
1-2 Environmental Protection Facilities																		
a. Gas removal facilities	m	0		0		0		0		0		0		0		0		0
b. Site grading & formation (w/clay soil)	ha	200,000	5	1,001,143	10	2,002,286	15	3,003,429	20	4,004,571	25	5,005,714	38	7,508,571	50	10,011,429	75	15,017,143
c. Liner (penetration/seepage control)	m2			0		0		0		0		0		0		0		0
d. Leachate collection facilities	m			0		0		0		0		0		0		0		0
e. Leachate circulation facilities (40m3/ha)	m3			0		0		0		0		0		0		0		0
f. Leachate treatment facilities (40m3/ha)	m3																	
1-3 Other Related Facilities																		
a. Admi. area work (site office, car park etc.)	LS		LS	400,000	LS	600,000	LS	750,000	LS	850,000	LS	950,000	LS	1,150,000	LS	1,350,000	LS	1,550,000
b. Truck scale (w/control room)	unit	1,192,000	1	1,192,000	1	1,192,000	1	1,192,000	1	1,192,000	1	1,192,000	1	1,192,000	1	1,192,000	2	2,384,000
c. Surrounding works (gate, fence, lighting, water supply, buffer zone etc.)	LS		LS	425,000	LS	600,000	LS	750,000	LS	850,000	LS	950,000	LS	1,200,000	LS	1,400,000	LS	1,650,000
Sub-Total				12,808,143		15,844,286		18,855,429		21,276,571		23,277,714		28,780,571		34,143,429		43,351,143
+ V.A.T tax (%)																		
Annualized Capital Cost (1)				1,280,814		1,584,429		1,885,543		2,127,657		2,327,771		2,878,057		3,414,343		4,335,114
Cost per Ton (DH/ton)				42		26		20		17		15		13		11		9
2 Equipment Procurement Cost																		
a. Landfill equipment																		
- Bull dozer	unit	2,300,000	1	2,300,000	1	2,300,000	1	2,300,000	1	2,300,000	2	4,600,000	3	6,900,000	4	9,200,000	5	11,500,000
b. Soil covering equipment																		
- Excavator	unit	1,700,000	1	1,700,000	1	1,700,000	1	1,700,000	1	1,700,000	1	1,700,000	1	1,700,000	1	1,700,000	2	3,400,000
- Wheel loader	unit	2,000,000		0		0		0		0		0	1	2,000,000	1	2,000,000	1	2,000,000
- Dump truck	unit	700,000	1	700,000	1	700,000	1	700,000	1	700,000	1	700,000	2	1,400,000	2	1,400,000	3	2,100,000
b. Others																		
- Tank truck	unit	800,000		0		0	0	0	0	0	0	0	0	0	1	800,000	1	800,000
- Pick up	unit	500,000	1	500,000	1	500,000	1	500,000	1	500,000	1	500,000	1	500,000	2	1,000,000	2	1,000,000
Sub-Total				5,200,000		5,200,000		5,200,000		5,200,000		7,500,000		12,500,000		16,100,000		20,800,000
Depreciation (2)				1,000,000		1,000,000		1,000,000		1,000,000		1,460,000		2,436,667		3,113,333		4,030,000
+ V.A.T tax (%)																		
Annual Maintenance Cost (3)				400,000		400,000		400,000		400,000		584,000		974,667		1,245,333		1,612,000
Cost per Ton (DH/ton)				46		23		15		11		13		15		14		12

Table B.7.1-3 (2) Surmised Project Cost for Controlled Landfill -2 : Level -2

3 Operation and Maintenance Cost																	
3-1 Operation																	
a. Personnel																	
- Manager	year	60,000	1	60,000	1	60,000	1	60,000	1	60,000	1	60,000	1	60,000	1	60,000	1	60,000
- Secretary/Accountant	year	36,000		0		0		0		0		0		0	1	36,000	1	36,000
- Weighing technician	year	36,000	1	36,000	1	36,000	1	36,000	1	36,000	1	36,000	1	36,000	1	36,000	1	36,000
- Civil engineer	year	54,000		0		0		0		0		0		0	1	54,000	1	54,000
- Operator	year	26,400	3	79,200	3	79,200	3	79,200	3	79,200	4	105,600	7	184,800	9	237,600	12	316,800
- Mechanic	year	26,400		0		0		0		0	1	26,400	1	26,400	1	26,400	1	26,400
- Guard	year	22,800	1	22,800	1	22,800	1	22,800	1	22,800	1	22,800	1	22,800	1	22,800	1	22,800
- Labor	year	22,800	1	22,800	1	22,800	1	22,800	1	22,800	2	45,600	2	45,600	2	45,600	3	68,400
b. Covering soil	m3	20	8,760	175,200	17,520	350,400	26,280	525,600	35,040	700,800	43,800	876,000	65,700	1,314,000	87,600	1,752,000	131,400	2,628,000
3-2 Utilities																		
a. Fuel																		
- Bull dozer	year	87,600	1	87,600	1	87,600	1	87,600	1	87,600	2	175,200	3	262,800	4	350,400	5	438,000
- Excavator	year	52,560	1	52,560	1	52,560	1	52,560	1	52,560	1	52,560	1	52,560	1	52,560	2	105,120
- Wheel loader	year	52,560	0	0	0	0	0	0	0	0	0	0	1	52,560	1	52,560	1	52,560
- Dump truck	year	26,280	1	26,280	1	26,280	1	26,280	1	26,280	1	26,280	2	52,560	2	52,560	3	78,840
- Tank truck	year	19,710	0	0	0	0	0	0	0	0	0	0	0	0	1	19,710	1	19,710
- Pick up	year	13,140	1	13,140	1	13,140	1	13,140	1	13,140	1	13,140	1	13,140	2	26,280	2	26,280
Sub-Total (4)		536,270		575,980		750,780		925,980		1,101,180		1,439,580		2,123,220		2,824,470		3,968,910
Contingency (5)				40,019		40,019		40,019		40,019		57,379		89,194		115,890		147,646
G-Total / Annual Cost (1+2+3+4+5)				3,296,413		3,775,278		4,251,542		4,668,856		5,868,730		8,501,805		10,713,370		14,093,670
Cost per Ton (DH/ton)				108		62		46		38		38		37		35		31
4 Land Acquisition Cost (annual)	ha	300,000		150,171		300,343		450,514		600,686		750,857		1,126,286		1,501,714		2,252,571
Cost per Ton (DH/ton)				5		5		5		5		5		5		5		5
G. Total / Annual Cost				3,446,585		4,075,570		4,702,056		5,269,542		6,619,588		9,628,091		12,215,084		16,346,241
Cost per Ton (DH/ton)				112		66		51		43		43		42		40		36

Table B.7.1-4 (1) Surmised Project Cost for Controlled Landfill -3 : Level -3

I Population				100,000		200,000		300,000		400,000		500,000		750,000		1,000,000		1,500,000
II Waste Amount (ton/day & ton/10 year)			84	306,600	168	613,200	252	919,800	336	1,226,400	420	1,533,000	630	2,299,500	840	3,066,000	1,260	4,599,000
III Required Disposal Site Area for next 10 Years (Ha)				5		10		15		20		25		38		50.1		75
IV Cost	Unit	Unit Price (DH)	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost	Q'ty	Cost
1 Construction Cost																		
1-1 Main Facilities																		
a. Access road	m	3,400	1,500	5,100,000	1,500	5,100,000	1,500	5,100,000	1,500	5,100,000	1,500	5,100,000	1,500	5,100,000	1,500	5,100,000	1,500	5,100,000
b. Onsite road (Enclosing bound)	m	2,400	1,100	2,640,000	1,500	3,600,000	1,900	4,560,000	2,200	5,280,000	2,400	5,760,000	3,000	7,200,000	3,600	8,640,000	4,200	10,080,000
c. Partition dike (Divider)	m	1,400	450	630,000	600	840,000	750	1,050,000	850	1,190,000	900	1,260,000	1,150	1,610,000	1,350	1,890,000	1,600	2,240,000
d. Operational road	m	800	650	520,000	850	680,000	1,100	880,000	1,250	1,000,000	1,350	1,080,000	1,700	1,360,000	2,000	1,600,000	2,350	1,880,000
e. Storm water drainage (big)	m	750	2,300	1,725,000	3,150	2,362,500	4,000	3,000,000	4,600	3,450,000	5,000	3,750,000	6,250	4,687,500	7,500	5,625,000	8,750	6,562,500
-"- (small)	m	350	800	280,000	1,050	367,500	1,350	472,500	1,550	542,500	1,700	595,000	2,100	735,000	2,500	875,000	2,950	1,032,500
1-2 Environmental Protection Facilities																		
a. Gas removal facilities	m	250	2,000	500,000	4,000	1,000,000	6,000	1,500,000	8,000	2,000,000	10,000	2,500,000	15,000	3,750,000	20,000	5,000,000	30,000	7,500,000
b. Site grading & formation (w/clay soil)	ha	700,000	5	3,504,000	10	7,008,000	15	10,512,000	20	14,016,000	25	17,520,000	38	26,280,000	50	35,040,000	75	52,560,000
c. Liner (penetration/seepage control)	m2	140	250	35,000	350	49,000	450	63,000	500	70,000	550	77,000	700	98,000	800	112,000	950	133,000
d. Leachate collection facilities	m	450	4,000	1,800,000	5,500	2,475,000	7,300	3,285,000	8,500	3,825,000	9,700	4,365,000	12,000	5,400,000	14,500	6,525,000	17,000	7,650,000
e. Leachate circulation facilities (40m3/ha)	m3	10,000	300	3,000,000	400	4,000,000	600	6,000,000	800	8,000,000	1,000	10,000,000	1,500	15,000,000	2,000	20,000,000	3,000	30,000,000
f. Leachate treatment facilities (40m3/ha)	m3	---																
1-3 Other Related Facilities																		
a. Admi. area work (site office, car park etc.)	LS		LS	600,000	LS	900,000	LS	1,100,000	LS	1,250,000	LS	1,400,000	LS	1,700,000	LS	2,000,000	LS	2,300,000
b. Truck scale (w/control room)	unit	1,192,000	1	1,192,000	1	1,192,000	1	1,192,000	1	1,192,000	1	1,192,000	1	1,192,000	1	1,192,000	2	2,384,000
c. Surrounding works (gate, fence, lighting, water supply, monitoring facilities, buffer zone etc.)	LS		LS	850,000	LS	1,200,000	LS	1,500,000	LS	1,700,000	LS	1,900,000	LS	2,400,000	LS	2,800,000	LS	3,400,000
Sub-Total				22,376,000		30,774,000		40,214,500		48,615,500		56,499,000		76,512,500		96,399,000		132,722,000
+ V.A.T tax (%)																		
Annualized Capital Cost (1)				2,237,600		3,077,400		4,021,450		4,861,550		5,649,900		7,651,250		9,639,900		13,272,200
Cost per Ton (DH/ton)				73		50		44		40		37		33		31		29
2 Equipment Procurement Cost																		
a. Landfill equipment																		
- Bull dozer	unit	2,300,000	1	2,300,000	1	2,300,000	1	2,300,000	1	2,300,000	2	4,600,000	3	6,900,000	4	9,200,000	5	11,500,000
b. Soil covering equipment																		
- Excavator	unit	1,700,000	1	1,700,000	1	1,700,000	1	1,700,000	1	1,700,000	1	1,700,000	1	1,700,000	1	1,700,000	2	3,400,000
- Wheel loader	unit	2,000,000		0		0		0		0		0	1	2,000,000	1	2,000,000	1	2,000,000
- Dump truck	unit	700,000	1	700,000	1	700,000	1	700,000	1	700,000	1	700,000	2	1,400,000	2	1,400,000	3	2,100,000
b. Others																		
- Tank truck	unit	800,000		0		0	1	800,000	1	800,000	1	800,000	1	800,000	1	800,000	1	800,000
- Pick up	unit	500,000	1	500,000	1	500,000	2	1,000,000	2	1,000,000	2	1,000,000	2	1,000,000	2	1,000,000	2	1,000,000
Sub-Total				5,200,000		5,200,000		6,500,000		6,500,000		8,800,000		13,800,000		16,100,000		20,800,000
+ V.A.T tax (%)																		
Depreciation (2)				1,000,000		1,000,000		1,216,667		1,216,667		1,676,667		2,653,333		3,113,333		4,030,000
Annual Maintenance Cost (3)				400,000		400,000		486,667		486,667		670,667		1,061,333		1,245,333		1,612,000
Cost per Ton (DH/ton)				46		23		19		14		15		16		14		12

Table B.7.1-4 (2) Surmised Project Cost for Controlled Landfill -3 : Level -3

3 Operation and Maintenance Cost																	
3-1 Operation																	
a. Personnel																	
- Manager	year	60,000	1	60,000	1	60,000	1	60,000	1	60,000	1	60,000	1	60,000	1	60,000	1	60,000
- Secretary/Accountant	year	36,000		0		0	1	36,000	1	36,000	1	36,000	1	36,000	1	36,000	1	36,000
- Weighing technician	year	36,000	1	36,000	1	36,000	1	36,000	1	36,000	1	36,000	1	36,000	1	36,000	1	36,000
- Civil engineer	year	54,000		0		0		0		0		0	1	54,000	1	54,000	1	54,000
- Operator	year	26,400	3	79,200	3	79,200	4	105,600	4	105,600	5	132,000	8	211,200	9	237,600	12	316,800
- Mechanic	year	26,400		0		0	1	26,400	1	26,400	1	26,400	1	26,400	1	26,400	1	26,400
- Guard	year	22,800	1	22,800	1	22,800	1	22,800	1	22,800	1	22,800	1	22,800	1	22,800	1	22,800
- Labor	year	22,800	1	22,800	1	22,800	2	45,600	2	45,600	2	45,600	3	68,400	3	68,400	4	91,200
b. Covering soil	m3	20	8,760	175,200	17,520	350,400	26,280	525,600	35,040	700,800	43,800	876,000	65,700	1,314,000	87,600	1,752,000	131,400	2,628,000
3-2 Utilities																		
a. Fuel																		
- Bull dozer	year	87,600	1	87,600	1	87,600	1	87,600	1	87,600	2	175,200	3	262,800	4	350,400	5	438,000
- Excavator	year	52,560	1	52,560	1	52,560	1	52,560	1	52,560	1	52,560	1	52,560	1	52,560	2	105,120
- Wheel loader	year	52,560	0	0	0	0	0	0	0	0	0	0	1	52,560	1	52,560	1	52,560
- Dump truck	year	26,280	1	26,280	1	26,280	1	26,280	1	26,280	1	26,280	2	52,560	2	52,560	3	78,840
- Tank truck	year	19,710	0	0	0	0	1	19,710	1	19,710	1	19,710	1	19,710	1	19,710	1	19,710
- Pick up	year	13,140	1	13,140	1	13,140	2	26,280	2	26,280	2	26,280	2	26,280	2	26,280	2	26,280
Sub-Total (4)		536,270		575,580		750,780		1,070,430		1,245,630		1,534,830		2,295,270		2,847,270		3,991,710
Contingency (5)				40,019		40,019		51,575		51,575		66,475		107,130		117,030		148,786
Total / Annual Cost (1+2+3+4+5)				4,253,199		5,268,199		6,846,788		7,862,088		9,598,538		13,763,317		16,962,867		23,054,696
Cost per Ton (DH/ton)				139		86		74		64		63		60		55		50
4 Land Aquisition Cost (annual)	Ha	300,000		150,171		300,343		450,514		600,686		750,857		1,126,286		1,501,714		2,252,571
Cost per Ton (DH/ton)				5		5		5		5		5		5		5		5
G Total / Annual Cost				4,403,370		5,568,542		7,297,302		8,462,774		10,349,395		14,889,603		18,464,581		25,307,267
Cost per Ton (DH/ton)				144		91		79		69		68		65		60		55

CHAPTER 8 INTERMEDIATE TREATMENT PLAN

8.1 Introduction

In recent years, securing of landfill sites has been getting rather difficult especially in advanced countries. On the other hand, more than 85% of solid waste generated worldwide is hauled to disposal sites. Under these conditions, several kinds of intermediate treatment systems have been developed and adopted by local governments of European countries and Japan for the purpose of volume reduction and resource recovery/recycling etc. of solid waste. Incineration is the most common method, but other methods, such as composting, pyrolysis, RDF (refuse drive fuel), methanization, etc. have been introduced on a very limited scale.

In Morocco, intermediate treatment systems for municipal waste are not widely spread, and composting is the only system introduced here. However, compost plants have not been operated successfully.

8.2 Purposes of Intermediate Treatment

The purposes of intermediate treatment recognized world-wide are the followings;

- Reduction of solid waste volume : In order to expand the life time of disposal sites and to save waste transportation cost, the volume reduction method of solid waste shall be taken into consideration.

- Resource recovery/Recycling : There are two methods for resource recovery from solid waste; i.e. one is the extraction of economically re-usable materials from solid waste, and the other is the extraction of energy from solid waste.

- Prevention of environmental pollution : In order to prevent the surrounding environment from being polluted by the disposal sites, proper treatment systems should be considered. This should mainly be adopted for the toxic waste, such as specific industrial and hospital waste.

8.3 Selection of Intermediate Treatment Systems in Morocco

Three intermediate treatment systems; i.e. incineration, crushing/shredding and sorting, have been commonly used in advanced countries. Its reason shall be verified and basic idea for the selection of intermediate treatment systems in Morocco shall be briefly examined.

- Incineration : Securing of landfill site is tend to be very difficult in advanced countries and paper have contained in its waste with high ratio which leads high calorific value. For that reason, for the purpose to reduce the waste volume and to extend the life-time of disposal site, incineration have been introduced and widely spread in advanced countries.

- Crushing/Shredding : Wastes, in the advanced countries, contain much amount of bulky and hollow articles, even pieces of furniture etc., crushing is sometimes used as a preliminary treatment before landfilling. By shredding cartons, breaking bottles and pulverizing cans in a hammer-mill, a fairly homogeneous mixture of wastes and reduced particle size are produced. And, because of this size reduction, less space at the time of landfilling is aquired, and consolidated landfilling without voids can be formed.

- Sorting : Re-usable materials; such as glass, metal, plastic, etc., have contained with high ratio in the waste of advanced countries. In order to extraction of re-usable materials for recycling purpose, mechanical sorting system is commonly used in advanced countries.

On the other hand, waste characteristics and/or composition in Morocco is differ from that of advanced countries. It tends to be high moisture content, high content of putrescible matters, low calorific value, denser and fine-grained (contains few bulky waste), low portion of re-usable materials, etc. In addition, securing of landfill site in Morocco is not seriously difficult compare with advanced countries.

Taking into account these conditions in Morocco, above described intermediate treatment systems are not applicable, however, biological treatment systems might be recommended in Morocco.

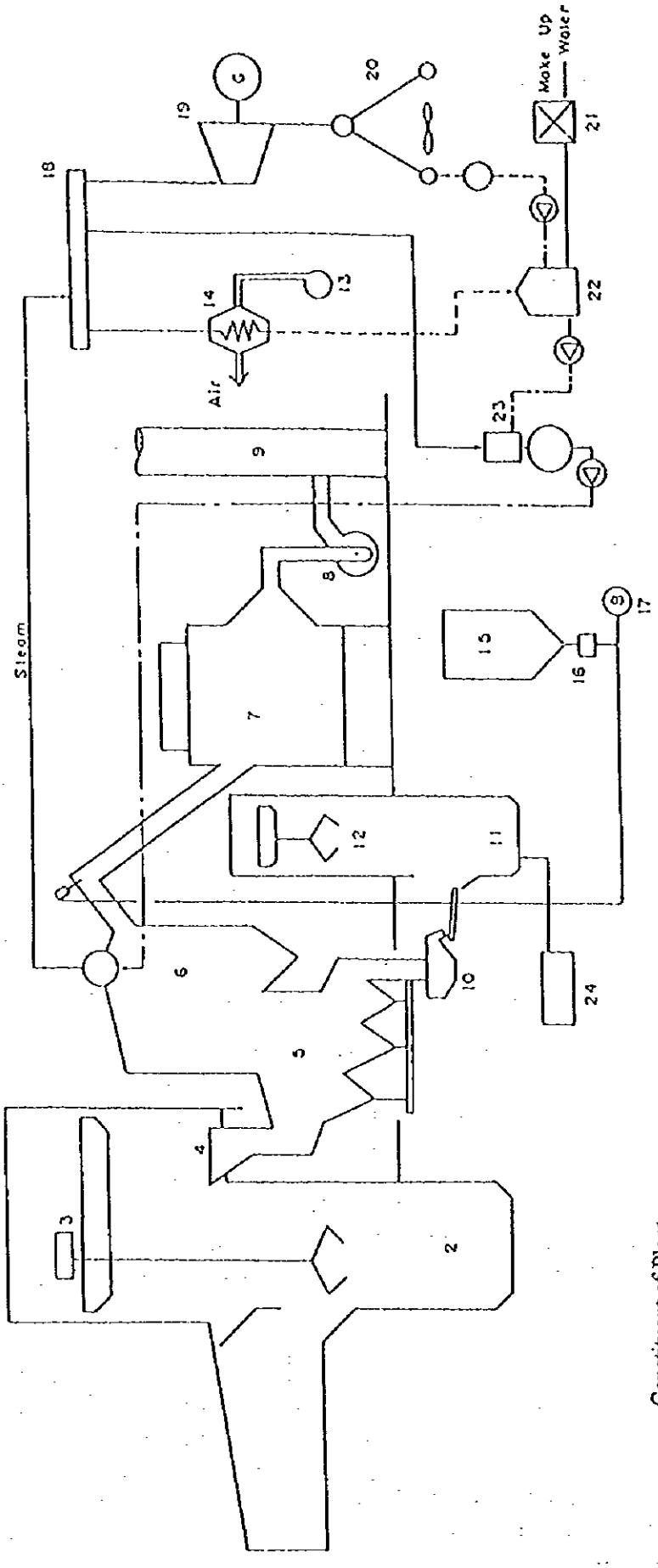
8.4 Examination of the feasibility of Incineration and Composting in Morocco

Considering the rate of diffusion of various treatment systems through the world, the targeting of municipal waste, waste quality and present conditions in Morocco; two treatment systems; namely incineration and composting shall be selected provisionally and examined of its feasibility more detail in this article.

8.4.1 Incineration

1) Feasibility of Incineration in Morocco

The primary purpose of incineration is to render the wastes inert, which also reduces volume and weight of the wastes, and may sometimes provide a source of energy. Fig. B.8.4-1 shows a schematic flow diagram of incineration plant.



Constituent of Plant

1. Tipping yard
2. Storage Pit
3. Waste Charging Crane
4. Charging Hopper
5. Incinerator
6. Waste Heat Boiler
7. Electrostatic Precipitator
8. Induced Fan
9. Stack
10. Ash Discharger
11. Ash Pit
12. Ash Crane
13. Forced Fan
14. Air Pre-heater
15. Lime Storage Silo
16. Table Feeder
17. Ejector Blower
18. Steam Header
19. Turbine/Generator
20. Steam Condenser
21. Water Purifier
22. Condensed Water Tank
23. Deaerator
24. Waste Water Treatment Equipment

FIG. B.8.4-1 **Schematic flow Diagram of Incineration Plant**

The feasibility of incineration depends largely on; 1st, the availability of land for a waste disposal site and its price, 2nd, waste treatment cost (financial aspect), 3rd, characteristics of waste and its amount (technical aspect). For the following reasons, introduction of incineration in Morocco is resulted not to be applicable, at present. However, it is recommended that its feasibility and introduction shall be examined after calorific value of the waste in Morocco exceed 1,200 kcal/kg.

i. Compared with European and Japanese cities, large vacant and/or not highly used lands exist in the surrounding area of cities in Morocco. Therefore, it is not very difficult for local government to acquire land for waste disposal.

ii. Investment and operating costs for incineration are very high compared with controlled landfill which introduced in Chapter 3. Unit cost of incineration, to handle/dispose one tonnage of waste, is about 10 times higher than that of controlled landfill. Cost comparison of incineration and controlled landfill is shown in Table B.8.4-1.

Table B.8.4-1 Unit Costs Comparison of Incineration and Controlled Landfill

(Unit : DH/ton)

No	Items	Controlled Landfill (Lvel-3)	Incinerator
1.	Construction and Equipment	45 - 80	800
2.	Operation and Maintenance	10 - 15	140
3.	Land Acquisition	5	0
4.	Sub-Total (= 1 + 2 + 3)	60 - 100	940
5.	Value of Heat Recovery	--	50
6.	Net Cost (= 4 - 5)	60 - 100	890
7.	Disposal of Incineration Ash	--	10
8.	Total (= 6 + 7)	DH 60-100/ton	DH 900/ton

iii. For self sustaining combustion of wastes, the lowest calorific value of the waste should be more than approx. 1,200 kcal/kg (about 2,500 kcal/kg in Japan). Meanwhile, the value of wastes in Morocco is estimated between 900 to 950 kcal/kg, taking into account the waste quality survey result carried out in Safi in 1996 by JICA Team, resulted that the waste contains high moisture (66.2%) and high putrescible matters (76.9%). Waste quality of other cities in Morocco might not be big difference compare with that of Safi. Therefore, for the proper operation of an incineration plant, a large amount of supplementary fuel is required, which implies a higher operation cost.

iv. In general, a minimum furnace capacity of 200 ton/day might be required for incineration plant in order to perform energy recovery to generate electricity. Meanwhile, the city in Morocco which generated and collected more than 200 tons of waste per day, taking into account the waste collection ratio, safety factor, etc., are Casablanca, Fes, Marrakech, Rabat/Sale and Tanger, whose population is more than 500,000. Therefore, only from the point of energy recovery, above five cities has some possibility to introduce incineration.

2) Advantages and Disadvantages of Incineration

Understanding the advantages and disadvantages of incineration is expected to support the authorities concerned to examine its feasibility and/or introduction. Table B.8.4-2 shows its characteristics.

Table B.8.4-2 Advantages and Disadvantages of Incineration

Advantages	Disadvantages
• The system has wide range of applicability among waste types. Almost all kinds of waste, except bulky inert materials, can be treated by incinerator. • Volume and weight of the waste can be reduced with high rate (volume can be • reduced by 5 to 10%, and weight by 15 to 20%). Therefore, transportation and landfill operation cost can be lower. • Stabilization of disposal sites can be performed. • In general, environmental impact by ash is less than that by raw waste. • Heat produced during the incineration process can be recovered and used in several ways. • Revenue will be expected from the sales of surplus heat and/or electricity produced by means of power generator. (The treated waste should have higher heating values.)	• High investment and operation & maintenance costs are required. • Residues still remain. Therefore, these must be transported and discharged at the disposal site. • A pollution control system must be equipped at the plant. Therefore, additional capital cost is required.

8.4.2 Composting

1) Feasibility of Composting in Morocco

Composting is the most commonly used biological process for the conversion of organic waste to a stable humus-like material called compost.

From the point of waste reduction and recycling, it is very useful method for the treatment of municipal waste. Also, waste quality in Morocco is suitable for composting because of its high content of putrescible matter, even though its C/N ratio (Carbon-Nitrogen factor to determine the speed at which decomposition take place) is low. However, two aspects, which are major conditions affecting the feasibility of composting; i.e. 1st, securing of compost market and its sales routes related to cost recovery (financial aspect), 2nd, waste quality and plant operation (technical aspect), should be carefully considered and examined for successful introduction of composting.

i. Securing of compost market and its sales routes (related to cost recovery)

Market conditions are an extremely important factor which affect the feasibility of composting. Many compost plants in the world have failed due to insufficient demand

for compost. For farmers, the costs of using compost depend on the price of compost products and transportation cost from the plant to its place of use. In general, if the transport distance is within 20 km from the plant, it may be feasible for farmers to use compost products. Meanwhile, it should be noted that compost demand is not constant, in specific seasons of the year.

It should be noted that at the compost plant in Rabat, which is the only plant operating in Morocco at present, annual sales of compost products is estimated DH 562,000/year, which is about 38% of the operating cost of DH 1,462,000/year. The annual loss is equivalent to the sum of DH 900,000/year, in addition to the amortization of the initial investment plant construction.

ii. Waste quality and plant operation

According to the result of the waste composition survey done by the JICA Team in November 1996 at Safi, the wet base content of organic matter, comprised of kitchen waste, paper, wood, leather and textiles, was 87.3% and kitchen waste itself was 76.9%. (Meanwhile, waste quality of other cities in Morocco might not be big difference compare with that of Safi.) The survey result shows that the waste in Morocco is suitable for composting, however, following waste conditions shall be carefully examined and necessary counter-measures shall be taken into account for the plant facility and its operation.

- The moisture content of kitchen waste was 78.4%. If however the moisture content exceeds 55%, water begins to fill the interstices between the particles of wastes, reducing interstitial oxygen and causing anaerobic conditions; this results in a rapid fall in temperature and production of offensive odor. Therefore, it is necessary to reduce the amount of contained water before fermentation.

- The C/N ratio of waste was between 10-14 (reported by Solid Waste Collection Study in Safi in 1987). However, the ideal C/N ratio for waste composting is between 30 and 35. Therefore, some adjustment, such as adding papers etc., will be required for proper fermentation.

- The plastic bag content is rather high in Moroccan waste. Therefore, care must be taken to ensure that there is a proper waste separation system in the plant.

2) Additional Items to be Considered for Introduction of Composting

Followings are additional points which should be taken into account for successful introduction and operation of composting, and also, these items might be used to evaluate and make rehabilitation programs for existing compost plants in Morocco.

- Delivery of suitable waste types such as domestic, market waste etc. to the plant (Separate collection, introduction of suitable sorting system etc. should be taken into consideration.)
- Support of agricultural authorities concerned, and unify/coordinate studies and efforts made by various agencies in the government related to composting

- Quality control and standardize of compost products
- Confirm the advantages of combined usage of compost and chemical fertilizer
- Financial analysis and evaluation, and, if necessary, introduction of subsidy system.

3) Advantages and Disadvantages of Composting

Understanding the advantages and disadvantages of composting is expected to support the authorities concerned to examine its feasibility and/or introduction. Table B.8.4-3 shows its characteristics.

Table B.8.4-3 Advantages and Disadvantages of Composting

Advantages	Disadvantages
• Compost products are used as organic fertilizer and soil conditioner. • A certain quantity of usable materials can be recovered by sorting, either manual or mechanical, at the pre-treatment stage of the system. • A certain reduction in the volume of organic wastes can be expected. • Stabilization of organic wastes is performed in the fermentation process. • Harmlessness of certain hazardous substances can be expected in the fermentation process.	• Recovery rates for compost products range between 20 - 50% of the total weight of the waste. Residues must be hauled to disposal site again. • Suitable waste for composting is limited to organic waste only (even for organic waste, moisture content, C/N (Carbon-Nitrogen) ratio etc. of the waste shall be examined for proper operation). Therefore, in order to collect suitable waste for composting, either some modification of waste collection systems or sorting system at the pre-treatment stage is required. • It takes a long time for fermentation (2 - 4 weeks, in case of windrow type), and large stock yards for fermentation and storage are required. • Compare to chemical fertilizer, bulk density is rather high. Therefore, handling costs, such as transportation, spreading at farm etc., are high. • It is usually difficult to keep stable market demands and routes. • Generation of offensive odor.

8.5 Intermediate Treatment Systems in General

It is noted that intermediate treatment systems are not recommendable for Morocco, except composting, as described in Article 8.3, instead, the introduction of controlled landfill is recommended at present. However, taking into account the world trend in advanced countries, evaluation items/points of its introduction shall be briefly introduced.

In general, at present, nine kinds of intermediate treatment systems are introduced worldwide separately or in combination, and some are widely spread while others are in the trial and error stage; i.e. RDF (refuse derived fuel), pyrolysis, methanization, incineration, sorting, crushing/shredding, ash solidification, composting and feeding.

As the synthetic evaluation of intermediate treatment systems and its introduction, the following points shall be carefully taken into considered and examined by authorities concerned.

- Cost of construction, operation & maintenance, procurement of heavy equipment and repair
- Acceptability of various kinds of wastes
- Applicability of waste quality for type of treatment system
- Volume reduction effects for disposal sites
- Marketability and price stability of recovered materials
- Ease of operation
- Simplicity in design of the treatment plant
- Reliability and stability of the treatment system (degree of technical development and operational conditions etc.)
- Environmental impact on surroundings
- Economic feasibility

Classification of intermediate treatment systems, from the viewpoint of resource recovery, is shown in Fig. B.8.5-1.

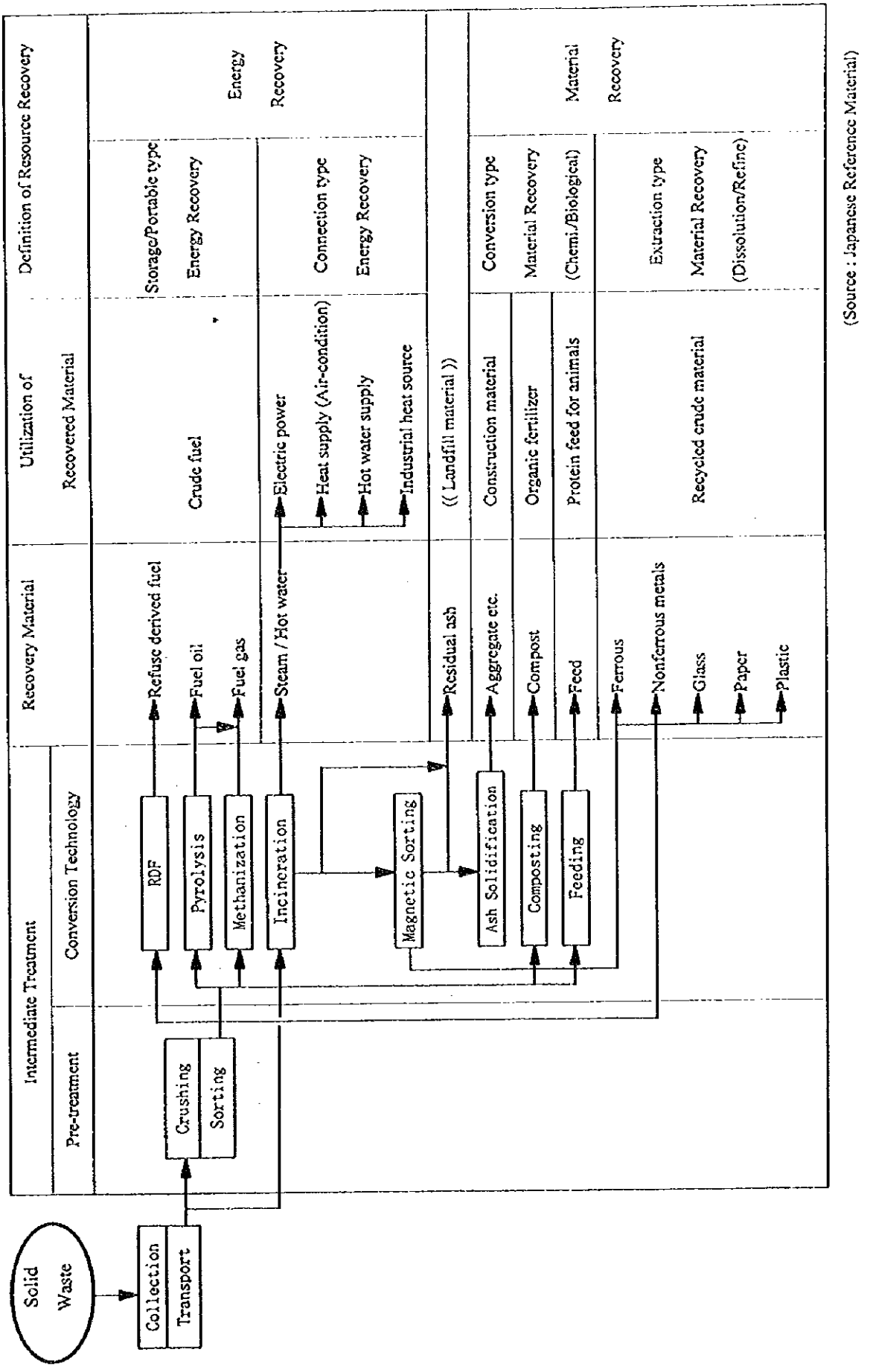


FIG. B.8.5-1 Classification of Intermediate Treatment Systems

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