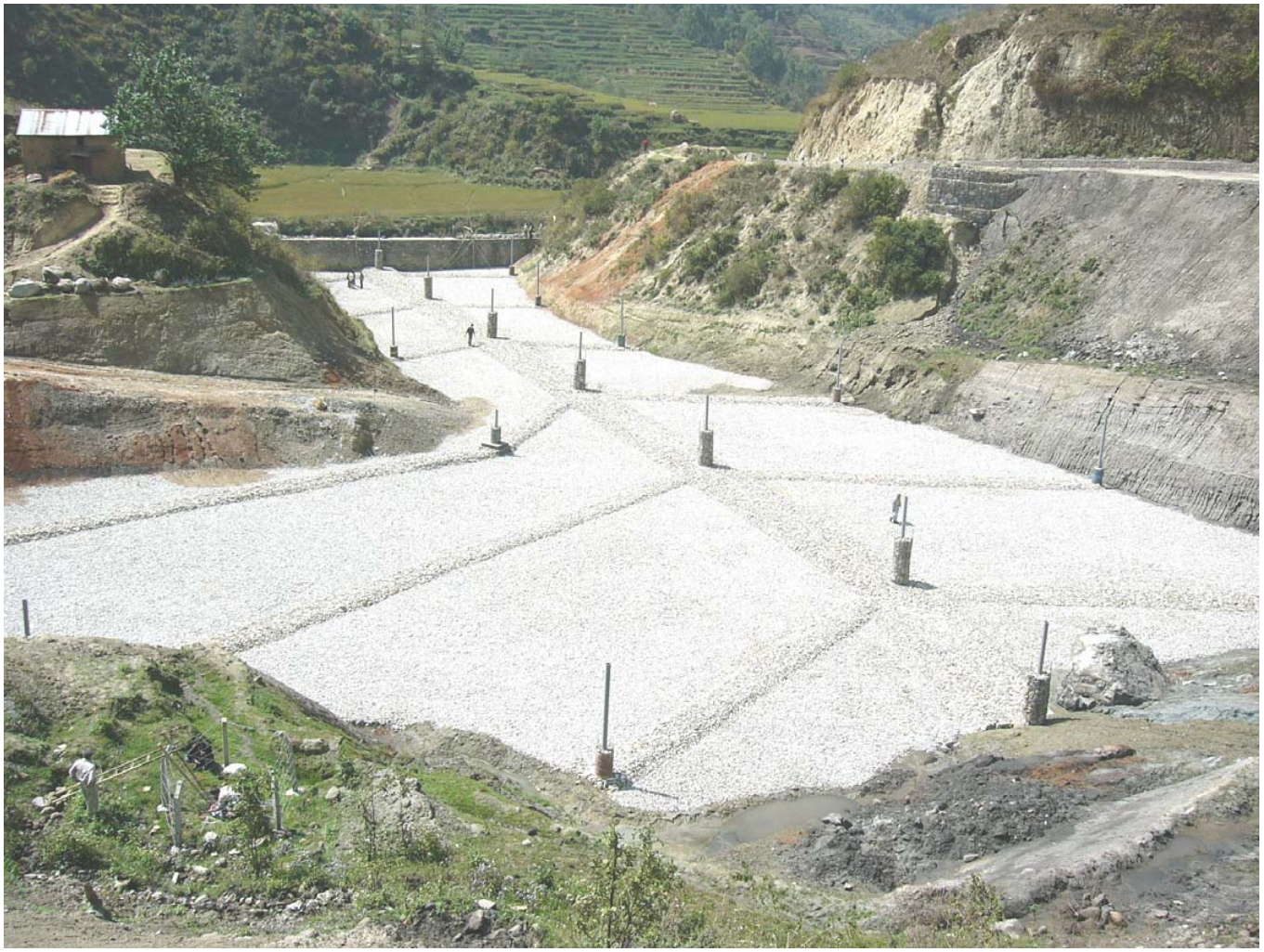
(Draft) Guideline for Solid Waste Management



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Pakistan Environmental Protection Agency

(Draft) Guideline for Solid Waste Management

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Present status of solid waste management in Pakistan and strategy for its improvement

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1. REVIEW AND ANALYSIS OF PRESENT SITUATION OF SOLID WASTE MANAGEMENT IN PAKISTAN

1.1 Introduction

Pakistan, like other developing countries, faces serious environmental problems. Rapid population growth (average annual growth rate of 2.61 percent a year) and impressive GDP growth (of about 6 percent a year) have put enormous pressure on the country's natural resource base and have significantly increased levels of pollution. Pakistan did not address the issues of sustainable development and environmental protection in the national decision-making process. Unregulated use of forests, land, water, urbanization, expansion of agriculture but not attempting to increase the crop yield, misuse of pesticides, ecological and health-wise hazardous industrial processes are due to in-sensitivities to poverty-environment nexus and flaws in policies.

Solid waste collection by government owned and operated services in Pakistan's cities currently averages only 50 percent of waste quantities generated; however, for cities to be relatively clean, at least 75 percent of these quantities should be collected. To achieve this level, a large capital investment is required. Demand for services will grow as urban populations grow and as per capita waste generation rates grow; the latter is projected at one to three percent per year. The increased quantity of waste will also place greater demands on disposal services, thereby exacerbating an already poor situation since present disposal methods for solid waste are totally inadequate. Disposal is by open dumping, primarily on flood plains and into ponds, causing significant environmental damage.

Unfortunately, none of the cities in Pakistan has a proper solid waste management system right from collection of solid waste upto its proper disposal. Much of the uncollected waste poses serious risk to public health through clogging of drains, formation of stagnant ponds, and providing breeding ground for mosquitoes and flies with consequent risks of malaria and cholra. In addition, because of the lack of adequate disposal sites, much of the collected waste finds its way in dumping grounds, open pits, ponds, rivers and agricultural land. Environmental degradation is not only well advanced already, but also is getting progressively worse as the country's population, urbanisation and industrialisation increase, and as its economy develops generally.

This concern has led to a growing recognition that economic development and the health and well-being of Pakistan's population are closely linked with improved environmental management and protection. Resource capture opportunities often prompt a migration of dispossessed inhabitants from affected areas in search of a better life. Receiving areas-whether rural or urban- are frequently ecologically vulnerable and are further degraded as incoming migrants place an additional stress on existing resources.

According to the 1998 census, of the 130.579 million persons living in Pakistan, 67% live in rural areas, while 33 % live in urban areas. (Table 1.1-1)

Table 1.1-1 Province wise population and rural/urban

Area	Households (million)	Population (million)
Pakistan	**19.701**	**130.579**
Rural	13.450	88.121
Urban	6.250	42.458
N W F P	**2.301**	**17.554**
Rural	1.889	14.581
Urban	0.411	2.973
F A T A	**0.357**	**3.137**
Rural	0.347	3.054
Urban	0.009	0.083
Punjab	**10.718**	**72.585**
Rural	7.444	49.885
Urban	3.274	22.699
Sindh	**5.170**	**29.991**
Rural	2.911	15.329
Urban	2.258	14.661
Balochistan	**1.018**	**6.511**
Rural	0.814	4.995
Urban	0.204	1.516
Islamabad	**0.136**	**0.799**
Rural	0.043	0.274
Urban	0.092	0.524

Source: Population and housing census of Pakistan 1998

Furthermore, out of 33 % of persons living in urban areas, 54 % of them live in ten major cities of Pakistan. Table 1.1-2

Table 1.1-2 Population of ten major cities of Pakistan

City	Households (million)	Population (million)
Karachi	1.436	9.269
Lahore	0.740	5.063
Faisalabad	0.278	1.977
Rawalpindi	0.220	1.406
Multan	0.162	1.182
Hyderabad	0.178	1.151
Gujranwala	0.151	1.124
Peshawar	0.149	0.988
Quetta	0.074	0.560
Islamabad	0.092	0.524

Source: Population and housing census of Pakistan 1998

During the last several decades, migration has occurred from rural to urban areas. The chief factors responsible for this migration are: slow progress in the agriculture sector, low crop yields, lack of alternate employment opportunities and environmental degradation due to water logging/salinity, deforestation and desertification. The large rural influx has, in turn, contributed to the overburdening of urban infrastructure and urban services. There has not only been a rapid decline in the quality and availability of basic urban resources and amenities, such as housing, potable water, transportation, electricity, gas, drainage and sewage but also mushrooming of *katchi abadis* (squatter settlements), often located on the most marginal land. Today, squatter settlements account for about 25 to 30% of Pakistan's

overall urban population. The municipal institutions do not have sufficient resources and technical capacity to accommodate the needs of increasing urban population.

The poor communities residing in urban settlements are often engaged in a number of initiatives on self-help basis, e.g., solid waste management and recycling. Almost all the paper, plastic, metals and glass are collected and re-used/recycled. Thus the poor communities in urban settlements play a key role in waste recycling. The only waste which remains on streets and collection points is the organic waste. This could be used for making compost but neither the municipalities nor private sector has moved towards full utilization of this business.

1.2 Solid waste in Pakistan

Presently domestic solid waste in Pakistan has not been carried out in a sufficient and proper manner in collection, transportation and disposal or dumping regardless of the size of the city: therefore the environmental and sanitary conditions have become more serious year by year, and people are suffering from living such conditions.

The scope of problems regarding solid waste management is very wide and involves the consideration of all the aspects relating to solid waste and its management, either directly or indirectly. These aspect may include rate of urbanization, pattern and density of urban areas, physical planning and control of development, physical composition of waste, density of waste, temperature and precipitation, scavenger's activity for recyclable separation, the capacity, adequacy and limitations of respective municipalities to manage the solid waste i.e. storage, collection, transportation and disposal.

1.3 Population and household estimates

The number and growth of population and households is the foremost factor affecting the solid waste and its management at various stages. According to a study "Data collection of national study on privatization of solid waste management in eight cities of Pakistan" conducted by Engineering Planning and Management Consultant during 1996, the selected cities are growing at a growth rate from 3.67% to 7.42% which is much higher than the overall growth rate of Pakistan, i.e. 2.8%. Major cities of them are estimated to double their population in next ten years. These cities are generating high amounts of solid waste which is increasing annually with the respective population growth.

Table-1.3 presents statistics on the population and its growth rate in 1996, 2006 and 2016 for each of the selected cities.

Table 1.3-1 Population Estimates (000's)

S.No	Cities	Census 1981	Estimated		
			1996	2006	2016
1	Gujranwala	601	1,759	3,598	7,361
2	Faisalabad	1,104	2,364	3,928	6,528
3	Karachi	5,208	10,522	16,816	26,873
4	Hyderabad	911	1,733	2,661	4,085
5	Peshawar	717	1,655	2,403	3,489
6	Bannu	48	82	118	169
7	Quetta	286	1,000	2,004	4,017
8	Sibi	28	60	100	166
	Total	**10,884**	**21,171**	**33,634**	**54,704**

Source: EPMC Estimates, 1996

The numbers of households also play an important role in generation and collection of the solid waste. The average household size in the selected cities varies from 6.7 to 7.3 persons. Table-1.3-2 presents size and number of households in each of the selected cities.

Table 1.3-2 Household Estimates (000's)

S.No	Cities	Household size	Number			
			1981	1996	2006	2016
1	Gujranwala	7.3	82	241	493	1,008
2	Faisalabad	7	157	338	561	933
3	Karachi	7	744	1,503	2,402	3,839
4	Hyderabad	7	130	248	381	589
5	Peshawar	7	102	236	343	498
6	Bannu	6.7	7	12	18	25
7	Quetta	7	41	143	286	574
8	Sibi	6.7	4	9	15	25
	Total		**3,248**	**4,726**	**6,505**	**9,507**

Source: EPMC Estimates, 1996

1.4 Waste Generated and for Disposal - Urban and Rural

It is important to note there is a big difference in Pakistan between solid waste generation and the amounts reaching final disposal sites. In developed countries, the two figures are usually much the same since most waste arisings must be disposed of formally (although there are moves towards the segregation of some components of waste at the source in a number of countries). In developing countries, including Pakistan, much more of the waste arising is recovered, mostly by scavengers, before it reaches the point of final disposal. For any figures related to the quantification of wastes to have any meaning they must be interpreted with the foregoing in mind. Also, estimating the amount of waste produced by households and then finally reaching at disposal systems, the statistics can be unreliable.

The situation is made worse in Pakistan as there are no weighing facilities at most of the disposal sites and no tradition of waste sampling and analysis. However, the situation is changing and municipalities are realizing the importance of weighing and recently weighinga facility has been installed at Disposal sites are Lahore. Furthermore, the types and quantities of wastes arising and reclaimed vary with the locality and, to some extent, with the season; and areas with more traditional

lifestyles tend to generate relatively small quantities of waste, and segregation and reclamation practices are more widespread.

As the population grows and affluence increases the quantity of solid waste also is increasing. This is a logical relationship and is in accord with experience internationally. In any country the amount of solid waste generated varies with the standard of living of its people. The composition of municipal waste depends to a large extent on the affluence of the population contributing to the waste stream. It is essential to know the composition of waste, both at the source and at disposal, to assess the most suitable option for disposal and recovery. For example, the feasibility of composting is determined by a combination of the quantities of waste generated and the proportion of organic waste, amongst other factors. The quantity and organic content of solid waste are much less in rural areas where many waste materials are used traditionally and beneficially (e.g. for feeding animals, as soil conditioner, and as fuel).

1.5 Waste Generation Estimates

The Ministry of Environment and Urban Affairs Division, Government of Pakistan undertook a study during 1996 on "Data Collection for Preparation of National Study on Privatization of Solid Waste Management in Eight Selected Cities of Pakistan". The study revealed that the rate of waste generation on average from all type of municipal controlled areas varies from 0.283 kg/capita/day to 0.613 kg/capita/day or from 1.896 kg/house/day to 4.29 kg/house/day in all the selected cities from Sibi to Karachi. It shows a particular trend it shows a particular trend of waste generation wherein increase has been recorded in accordance with city's population besides its social and economic development. Table 2.5 presents city wise waste generation rate with respective daily and annual estimate of solid waste.

Table 1.5 Waste Generation Estimates

S.No	Cities	Generation Kg/c/day	Rate Kg/h/day	Waste Tons/day	Generated Tons/year
1	Gujranwala	0.469	3.424	824.0	300,760
2	Faisalabad	0.391	2.737	924.3	337,370
3	Karachi	0.613	4.291	6,450.0	2,354,250
4	Hyderabad	0.563	3.941	975.7	356,131
5	Peshawar	0.489	3.423	809.3	295,395
6	Bannu	0.439	2.941	36.0	13,140
7	Quetta	0.378	2.646	378.0	137,970
8	Sibi	0.283	1.896	17	6,205
	Total			**10,414.3**	**3,601,221**

Source: EPMC Estimates 1996

1.6 Physical Composition of Waste

Solid waste in Pakistan is generally composed of plastic and rubber, metal, paper and cardboard, textile waste, glass, food waste, animal waste, leaves, grass, straws and fodder, bones, wood, stones and fines to various extents. The detailed physical composition of waste are given in Table 1.6-1

Table 1.6-1 Physical Composition of Waste (% weight)

Items	GWA	FSD	KRI	HYD	PWR	BNU	QTA	SBI
Plastic & Rubber	5.00	4.80	6.40	3.60	3.70	5.30	8.20	7.70
Metals	0.30	0.20	0.75	0.75	0.30	0.30	0.20	0.00
Paper	2.50	2.10	4.10	2.40	2.10	3.30	2.20	2.00
Card board	1.80	1.60	2.40	1.50	1.90	1.60	1.30	1.40
Rags	3.20	5.20	8.40	4.70	4.30	2.30	5.10	5.30
Glass	1.50	1.30	1.50	1.60	1.30	1.20	1.50	2.40
Bones	3.20	2.90	3.00	2.00	1.70	0.20	2.00	0.80
Food Waste	14.70	17.20	21.00	20.00	13.80	16.30	14.30	8.40
Animal Waste	1.00	0.80	3.00	5.80	7.50	2.40	1.70	4.00
Leaves, grass etc.	12.80	15.60	14.00	13.50	13.60	14.70	10.20	14.50
Wood	0.80	0.70	2.25	2.25	0.60	0.50	1.50	1.00
Fines	47.50	43.00	29.70	38.90	42.00	45.40	44.00	44.80
Stones	5.70	4.60	3.50	3.00	7.30	6.50	7.80	7.70

Source: EPMC Estimates 1996

There is considerable content of plastic in the solid waste generated in Pakistan which is a cause of great concern. Plastic waste is released during all stages of production and post consumption every plastic product is a waste. Both the quantity and quality of plastic waste cause environmental problems. Quantitatively post consumption plastic waste is more important. This is so as they are found in large volumes and less weights. Most waste plastic recovered by the formal sector comes from industrial waste, which is less contaminated than the post-consumer stream. This waste is taken care of by the formal recycling sector. The much more heterogeneous domestic waste stream is left to the mercy of the informal sector. Some of the environmental issues of plastic waste are litter, emissions of hydrogen chlorides and dioxins from incinerators; and contamination from chemical additives. Plastic waste also presents a direct hazard to wildlife. Eliminating plastic bags improves the quality of compost and reduce the amount of waste requiring disposal. Kraft bags decompose with the compost, whereas plastic bags don't break down and must be land filled. Currently, no technology exists that is capable of screening out all plastic from the compost. The removal of the plastic bags from the composting program will dramatically reduce the operational costs associated with our composting operation

The composition of waste has revealed that there is a considerable potential in solid waste management to make it a profitable enterprise. It may be realised that through sale of recyclable, composting, energy production and use of waste as earth filler; almost whole of the waste can be put into one of the above said uses. Only hazardous waste from hospitals and industries needs separate arrangements for its management. The typical composition of municipal solid waste in Pakistan is shown in Table 1.6-2. A typical data from the United States and Britain are shown in Table 1.6-3 for comparison.

Table 1.6-2 Typical Composition of Solid Waste in Pakistani Cities (%)

Composition	%
Food Waste	8.4% to 21 %
Leaves, grass, straw, Fodder	10.2 % to 15.6 %
Fines	29.7 % to 47.5 %
Recyclables	13.6 % to 23.55 %

Source: EPMC Estimates, 1996

Table 1.6-3 Typical Composition of Solid Waste Constituents in USA and Britain (%)

Composition	USA %	Britain %
Food	7	20
Yard Waste	18	4
Plastic	8	7
Glass	7	10
Metals	8	10
Miscellaneous	12	8
Others	-	8

Source (USA): Thomas J. Cichonski and Karen Hill, Ed. Recycling Sourcebook, 1993.
Source (UK): Newel, J. Recycling Britain. New Scientific, September 1990:46.

It is clear from the above tables that Pakistan's urban (municipal) solid waste differs considerably from that of cities in developed countries (which is to be expected). One reason for this is that there is a wide range from poverty to affluence in Pakistan's urban population; another is that much of the waste is reclaimed for recycling at various stages from arising to final disposal.

Waste characteristics vary according to the extent of urbanisation, the income level of the area, and the degree of its industrialisation and commercialization

1.7 Waste Collection and Street Sweeping

A number of municipalities of selected cities have deployed the sweepers and sanitary workers. The workers collect the solid waste from small heaps and dustbins with the help of wheel borrows, brooms, etc. and store at formal and informal depots and carry out sweeping of streets and roads. It has been noted that the service of street/road sweeping is not regular and mainly limited to administrative, commercial and other industrial areas.

Further, the number of formal collection bins such as masonry enclosures, containers and trolleys are too less to accommodate their waste generated in these cities. Further these points are not located according to population and area requirements. It is the reason that a large number of open heaps are visible in some cities.

1.8 Waste Collection Estimates

In Pakistan, solid waste is mainly collected by municipalities and waste collection efficiencies range from 0 percent in low-income rural areas to 90 percent in high-income areas of large cities. The proportion of waste collected is much less in many other areas of the country, particularly in poorer areas, where the only means of solid waste disposal is often informal scavenging by people and animals, natural biodegradation and dispersion, burning at the primary point of disposal, and local self-help for disposal to informal (technically illegal) dumping sites.

The responsibility of municipal solid waste management rests basically with the municipality. In Pakistan, traditionally in big cities, the City District Government, collect waste from households in middle to high-income areas and municipalities are in charge of street sweeping.

Public waste collection is usually not efficient and mainly they do not have sufficient funds. Therefore, there is now a trend towards subcontracting a substantial part of waste collection and street sweeping services to private companies, which will be comparatively with higher efficiency. Subcontracting to private companies has so far not been fully practiced in Pakistan. Furthermore, there are a number of NGOs like Waste Buster that are active in waste collection and have done remarkable work.

Collection rate of solid waste by respective municipalities ranges from 51% to 69% of the total waste generated within their jurisdiction. The uncollected waste, i.e., 31% to 49% remains on street or road corners, open spaces and vacant plots, polluting the environment on continuous basis. The rate and amount of the waste collected in all the selected cities are given in Table 1.8

Table 1.8 Waste Collection Estimates

S.No	Cities	Collection Rate %	Daily Collection Tons/day	Waste Tons/day(300days)
1	Gujranwala	52.0	428	128,500
2	Faisalabad	54.0	499	149,737
3	Karachi	53.0	3,419	1,025,550
4	Hyderabad	51.0	498	149,282
5	Peshawar	61.0	494	148,102
6	Bannu	68.0	24	7,344
7	Quetta	50.0	189	56,700
8	Sibi	69.0	12	3,519
	Total		**5,563**	**1,668,734**

Source: EPMC Estimates, 1996

1.9 Waste Treatment and Disposal

The waste is disposed off within or outside municipal limits into low lying areas like ponds etc, without any treatment except recyclable separation by scavengers. The land is also hired/leased on long term basis for disposal. Moreover, the least mitigating measures have also not been reported from any municipality. Table 1.9 represent the city wise disposal practice with allied facilities for the eight-selected city:

Table 1.9 Waste Disposal Practice

No	Cities	Existing Number	Dumps Size	Recyclables Separation	Treatment Plant	Mitigating Measures	Proposed landfill site
1	Gujranwala	3	-	Scavengers	Nil	Nil	Nil
2	Faisalabad	4	-	Scavengers	Nil	Nil	Nil
3	Karachi	Many	-	Scavengers	Nil	Nil	Nil
4	Hyderabad	Many plots	-	Scavengers	Nil	Nil	Plg stage
5	Peshawar	1(on lease)	5 acres	Scavengers	Nil	Nil	Nil
6	Bannu	2	-	Scavengers	Nil	Nil	50 K, Purchased
7	Quetta	1	-	Scavengers	Nil	Nil	Nil
8	Sibi	Many Fields	-	Scavengers	Nil	Nil	Nil

Source: EPMC Estimates, 1996

Treatment and disposal technologies such as sanitary land filling, composting and incineration are comparatively new in Pakistan. Crude open dumping is the most common practice throughout Pakistan and dumpsites are commonly set alight to reduce the volume of accumulating waste, hence adding to the air pollution caused by the uncovered dumped waste itself.

The practice of sanitary land filling is still in its infancy in Pakistan and the first site has yet to be developed. At present, there are no landfill regulations or standards that provide a basis for compliance and monitoring, but national guidelines for these standards are being prepared by the Consultant under NEAP SP.

There is also need that the Government of Pakistan should put forward a clearly opted policy of waste recovery, as well on composting. Compost is considered an attractive product because of its possible use as a soil conditioner for agricultural use.

There is a need for establishment of at least one windrow composting plants in each province to promote composting. However, most of the composting plants built by the private sector that have already been established do not operate efficiently nor at full capacity. Sales revenues usually hardly cover operating expenses, let alone depreciation costs.

1.10 Potential for Waste Recycling

Under the present system, the municipalities are not carrying out any type of recycling activity. What happens normally is that the main recyclable items like paper, plastic, glass and metals are retained by the people themselves, which are later sold to street hawkers/waste dealers for recycling.

Whereas the recyclable mixed with discarded waste are picked up by the scavengers who make 2 to 3 trips of different dumps and earn Rs 80 to 150/day. As a whole, however, according to the estimates the amount of recyclable varies from 1,000 tons/years in Sibi to 513,743 tones/year in Karachi.

The total income works out to be Rs 5,056.5 million per year. Assuming a net expenditure on the collection, storage, separation etc as 50%, the net incomes expected to be Rs 2528.3 million per years. The city wise potential for waste recycling are given in Table 1.10

Table 1.10 Potential for Waste Recycling

No	City	Recyclable Ratio	Ann. Amount Tons	Gross Income Rs (Million)	Net Income Rs (Million))
1	Gujranwala	17.20	42,518	352.5	176.7
2	Faisalabad	18.10	50,189	547.4	273.7
3	Karachi	26.55	513,743	3,515.6	1,757.8
4	Hyderabad	16.55	48,444	269.5	134.7
5	Peshawar	15.30	37,147	232.2	116.1
6	Bannu	14.20	10,800	7.4	3.7
7	Quetta	20.50	23,247	127.2	63.6
8	Sibi	19.60	1,000	4.7	2.4
	Total		**727,088**	**5,056.5**	**2,528.3**

Source: EPMC Estimates, 1996

1.11 Organisation for the solid waste management

The municipalities of eight selected cities have employed the staff for management of municipal solid waste ranging from 188 to 11905 persons including the supervisory staff. The ratio of total staff to population, houses and waste collected varies from 0.62/1000 to 3.54/1000 to 23.72/1000 and 2.63 ton to 15.67/ton respectively. The details of number and ratios of total staff are given in table1.11.

Table 1.11-1 Organization for Solid Waste Management

No.	Cities	Zone/Sector	Total sup. Staff	Supervisors	Total Working Staff	Sweeper/ Sanitary Workers	Total Staff
1	Gujranwala	11	47	30	1,066	1,046	1,113
2	Faisalabad	2	113	68	3,079	2,689	3,192
3	Karachi	4	334	244	11,571	11,142	11,905
4	Hyderabad	1	85	61	1,964	1,860	2,054
5	Peshawar	2	65	30	1,595	1,171	1,632
6	Bannu	1	4	1	270	165	290
7	Quetta	1	43	21	950	870	993
8	Sibi	1	9	6	197	110	188
	Total	**23**	**700**	**461**	**20,674**	**19,053**	**21,367**

Source: EPMC Estimates, 1996

Table 1.11-2 Ratio of total staff to population, household and waste collected.

No.	City	Ratio of total staff To Population	Household (000's)	Waste collected(000's kg)
1	Gujranwala	0.62	4.53	2.63
2	Faisalabad	1.42	9.94	3.79
3	Karachi	1.13	9.91	3.48
4	Hyderabad	1.24	6.68	4.33
5	Peshawar	1.00	7.00	3.34
6	Bannu	3.54	23.72	8.50
7	Quetta	0.99	6.93	5.25
8	Sibi	3.13	20.97	15.67

Source: EPMC Estimates, 1996

1.12 The Private/Informal Sector

In rural areas traditional practices continue to be followed today, but the nature of village waste has changed and scavengers now collect new waste (principally plastics, glass and paper) on an informal basis throughout Pakistan wherever the quantities available offer sufficient (if often very little) profit.

As the city has grown, traditional waste disposal practices are dumping in open spaces posses' serious problem.

The public sector is mainly involved in overall solid waste management throughout Pakistan. As Pakistan is moving towards further urbanization and industrialization, new types of discarded material started to be used in low-income urban areas. Similarly, major cities of Pakistan, like Karachi, Lahore, Rawlpindi, and Faisalabad has potentially the greatest waste collection, transportation and disposal problems and the public sector cannot tackle this problem alone. There is strong need to gradually involve private sector in the solid waste management by offering incentives. There is no organized private sector of waste collection and recycling in operation in Pakistan. Although, there are success stories by NGOs and privet sector

like Waste Buster. While, now there is realizations on the part of municipalities to privatize solid waste collection and transportation and establishment of composting plants but it requires transparency in the award of contracts to private parties on Build Operate and Transfer basis.

1.13 Expenditure on Solid Waste Management

According to the study of selected cities, it has been estimated that Rs. 1037.38 million are annually spent on solid waste management by eight municipalities. The annual expenditure on Solid Waste Management per ton waste collected, per capita and per house varies from Rs 334 to Rs 1000, Rs 35 to Rs 90 and Rs 224 to 603 respectively. Table 2.14 presents city wise municipal expenditure and its ratio to waste collected, population and houses.

Table 1.13 Expenditure on Solid Waste Management

No	City	Total Expenditure (Million Rs)	Rs/Ton	Rs/Capita/year	Rs/house/year
1	Gujranwala	60.63	392	35	255
2	Faisalabad	106.00	796	50	350
3	Karachi	688.00	551	65	455
4	Hyderabad	78.52	453	47	329
5	Peshawar	49.57	334	32	224
6	Bannu	7.34	1,000	90	603
7	Quetta	43.32	627	43	301
8	Sibi	4.00	934	67	449
	Total	**1,037**	**Avg. 636**	**Avg. 54**	**371**

Source: EPMC Estimates, 1996

1.14 Hazardous Waste

Hazardous waste is any waste or combination of waste that poses a substantial danger, now or in the future, to human, plant or animal life and which therefore cannot be handles or disposed of without special precautions. The hazardous solid waste is being generated in Pakistan from the following six sectors:

Table 1.14 Sources of Hazardous Waste

Sectors	Sources	Type of wastes
Agriculture	Planting areas and plant protection/agriculture department, warehouses	Obsolete pesticides, herbicides, insecticides, used chemical containers and contaminated soils.
Hospitals, clinical and Laboratories	Clinic consulting rooms, operation theaters, hospitals, wards, laboratories	Infected human tissues and organs, excreta, blood, sharp instruments, laboratory equipment and tissue cultures drugs etc.
Small Scale Industry	Metal processing, photo finishing, textile processing, printing, leather tanning	Acids, heavy metals solvents, acids, silver cadmium, mineral acid solvents, inks, dyes solvent, chromium etc.
Large Scale Industries	Bauxite processing, oil refining petrochemical manufacture, pharmaceutical manufacture, chlorine production	Rig mud, spent catalysts, oily waste, tarry residues, solvents, mercury.
Commerce	Vehicles services and airports, dry cleaning, electrical Transformers, bus stations, workshops, petrol pumps	Oily, hydraulic fluids, halogenated solvents, polychlorinated biphenyls (PCBs), water management, specialist tyres, plastic etc.
Household	Homes	Used fluorescent tubes, batteries, drugs, cosmetics, vehicle care material.

In Pakistan, there is no systematic mechanism for the collection and disposal of hazardous waste generated from hospital, industries and agriculture activities. The collection and disposal of hazardous waste is mainly the responsibility the municipal corporations, which comes under the Local Government and Rural Development. However, in practice local authorities are handling and disposing of significant quantities of hazardous waste, often without any consistent procedures, and sometimes with no knowledge of the serious problems they may create.

Industrial pollution is a major problem in Pakistan, and little effort has been made until comparatively recently, either to use clean production technologies, or to adopt end-of-pipe methods of pollution control. The minimal response of industry to Solid Waste is mainly due to the poor performance of the sector, lack of information about new technologies and high investments required for changing the processes coupled with weak regulatory mechanism.

Pollution problems affect both large enterprises in such industries as chemicals, petroleum refining, sugar, paper and pulp and iron and steel, as well as the many clusters of small- and medium-sized enterprises in industries such as leather, textiles, marble polishing and food processing.

There is no authenticated study to contain data of hazardous waste generated by industry in Pakistan. According to WWF Pakistan, around 250,000 tons of medical waste is annually produced from all sorts of health care facilities in the country. Similarly, according, to a study conducted by GTZ on "Inventory of Obsolete pesticides in Punjab, Sindh and Baluchistan" by Mr. Wolfgang A Schimpf, it has been estimated that the stocks of outdated pesticides lying in Pakistan is between 1,000 to 1,500 tons.

Most Pakistani industries, located around major cities, are increasingly polluting streams, rivers and the Arabian Sea through untreated hazardous waste. Major industrial contributors to the pollution are the pulp and paper, chemicals, petrochemicals, refining, metalworking, food processing, and textile industries. Some of waste is biodegradable, but much of it is in the form of chemical compounds that do not degrade and cause damage to environment.

In Karachi alone more then 6,000 industrial enterprises, some 60 % of the country's industry, are located along the coastal belt. In Punjab, the industries are located in Lahore and Kala Shah Kaku Industrial Estate, including chemical industries, tanneries, textile plants, steel re-rolling mills etc. There are a number of small ad medium scale enterprises (SME) sector, particularly industries in two triangles Lahore–Sheikhupura-Faisalabad and Lahore-Gujranwala-Sailkot, generate significant pollution load that also finds its way into streams. More then 250 industrial units in Faisalabad discharges high levels of solids, heavy metals, aromatic dyes, inorganic salts and organic materials directly into the municipal sewers and open surface drains, ultimately leading to Ravi River. Discharge from the industries in Sialkot area generally reaches the Chanab River, while from Kasur, where the major tanneries of Pakistan are located, it is disposed off through the Pandoki drain into the Sutlej River. In North West Frontier Province (NWFP), industrial units mainly cluster around Peshawar such as Jamrod Industrial Estate and industrial clusters on Kohat Road and Charsadda Road. Out of 40 major units, only two have wastewater treatment facilities while others discharge their effluent into lakes and tributaries of the Indus River, mainly the Kabul River.

There are Guidelines for Hospital Waste Management since 1998 prepared by the Environmental Health Unit of the Ministry of Health, Government of Pakistan, giving detailed information and covering all aspects of safe hospital waste management in the country including the risk associated with the waste, formation of a waste management team in hospitals, its responsibilities, plan, collection, segregation, transportation, storage, disposal methods, containers, and their color coding, waste minimization techniques etc.

However, these guidelines are not implemented. There are no systematic approaches to medical waste disposal. Hospital wastes are simply mixed with the municipal waste in collecting bins at roadsides and disposed of similarly. Some waste is simply buried without any appropriate measure. A common practice in Pakistan is the reuse of disposable syringes. People pick up used syringes from the hospital waste and sell them.

1.15 System Performance Indicators

The following ratios calculated on the basis of analysis in earlier sections, depict the real performance of existing solid waste management in the eight selected cities of Pakistan.

Table 1.15 Indicators of System Performance.

No	System Indicators	System Performance
1	Rate of Waste Generation	0.283 to 0.613 Kg/c/d
2	Rate of Waste Generation/House	1.896 to 4.291 Kg/h/d
3	Rate of Waste Collection	51 to 69 Percent
4	Expenditure/Waste Collected	334 to 1000 Rs/Ton
5	Expenditure/Person/Year	35 to 90 Rs/c/y
6	Expenditure/House/Year	244 to 603 Rs/h/y
7	Total Staff/Population	0.62 to 3.54 Staff/1000 persons
8	Population/Staff Member	282 to 1613 Person/Staff
9	Total/Staff Member	4.53 to 23.72 Staff/1000 Houses
10	Houses/Staff Member	42.00 to 221.00 Houses/Staff
11	Total Staff/Waste Collected	2.63 to 1567 Staff/Ton
12	Waste Collection/Staff Member	64 to 380 Kg/Staff

Source: EPMC Estimates, 1996

The rate of waste generation in the selected cities is quite in line with World Bank Standard for developing countries which is 0.3 to 0.6 Kg/c/d, whereas the collection rate is too less in major cities in comparison with other developing countries. The expenditure made by the municipalities on solid waste management is almost matching but with lower limit of the range recommended by the World Bank i.e. Rs 70 to 105/capita/year. The waste collected per staff member in selected cities is less than other developing countries like Egypt (250 Kg) and Indonesia (300 Kg). Further, the ratio of total staff to population i.e. 0.62 to 3.54 members/1000 population does not conform to range of workers in developing countries of South-East Asia i.e. 2 to 5/1000 in developing countries of South East Asia.

During 2004, Pakistan Environmental Protection Agency conducted a study of Solid Waste Management in Four Cities of Pakistan which is as follows:

Hyderabad has about 1,270 tons of solid is generated daily out of which 920 tons of waste is collected daily and 350 remains uncollected. Which is due to non-availability of sufficient

vehicles, non-availability of budget, non-availingly of funds, non-viability of proper land filling site and non-availability of sufficient staff?

Faisalabad is faced with unplanned industrialization and there is an inadequate arrangement for the collection, transportation and safe disposal of municipal solid waste. There is unsafe transportation of municipal solid waste in overloaded/open vehicles. There is unsafe disposal of hazardous waste of hospitals. Only two hospitals (Allied and District Headquarter Hospital) have the facility of incineration.

During 2004, Pakistan Environmental Protection Agency conducted a study on Urban Environmental Problems in Pakistan (A case study for urban environment in Hayatabad, Peshawar which concluded as follows:

- The waste generated per household is 5.5 kg, whereas waste generated per capita per day is 0.66 kg. The total waste generated in Hayatabad is 67,000 kg per day.
- The mode of transportation of solid waste is mainly donkey carts to the dumping site, situated at Phase VII, which is now abandoned. Two garbage trucks are also used for waste collection from parks and commercial areas. These trucks also collect waste from primary collection points. The donkey carts are collecting garbage from door to door. This service is provided by the owners of the donkey cart for their own interest to segregate the saleable items from the garbage. Most of the solid about 90 % comprised its organic such as vegetable/fruits and other kichen waste. Saleable or recycled items from solid waste generated in Hayatabad are only 5.5%. Big chunk of solid waste, which is organic are also taken out before going to dumping site by the scavengers to use as a feed to animals.
- Presently, there is no proper dumping site of solid waste in Hayatabad after shutting down the Phase VII site. Now these two trucks are only dumping waste approximately 10 to 15 tons per day to the site located some 15 km away from Hayatabad. Donkey carts owners are dumping garbage waste in ditches and excavated areas of Hayatabad.

The Solid Waste Management and Environment Enhancement Project (Sweep), was funded by United Nations Development Programme (UNDP) during 1997 -2001 at a cost of . The project is based on a two pronged strategy, i.e. mobilization of human resource and social capital for attaining efficient and sustainable solid waste management system in Rawalpindi. The community mobilization in SWEEP was undertaken through the active involvement of NGOs and CBOs, providing them an opportunity to demonstrate the best of their ability to meet project objectives within their designated wards and to build a "model" for participatory waste management systems. The communities were involved to segregate the waste at household level and obtain optimum benefits from the waste resources.
Furthermore, social mobilization under SWEEP was linked with the Preparatory Assistance (PA) phase of the Programme for Improvement of Livelihoods in Urban Settlements (PLUS). With the objective of creating "Civil Society Organizations", the PA phase developed a strategy and an action plan for large scale implementation on participatory approaches. The project was executed and implemented by the Project Management Unit (PMU) of Rawalpindi Municipal Corporation. The project completed its life in June 2001, the salient achievements are:

- RMC waste collecting capacity increased to 80% (Compared to 40-50 % in 1997). The project is active in 75 wards out of 77 wards of the city, including more than 84,500 households.
- Community participation in planning and management at city level strengthened. 153 Sweep Committees and 37 Community Organizations have been formed, actively collaborating with SWEEP/RMC.
- Communities' awareness of solid waste hazards increased. 1340 community members are serving voluntarily as Lane Managers.
- Primary waste collection system is improved with waste segregation at the source

contributing to income-generating activities.

- Social and economic empowerment of women enhanced. Women have played a crucial role in the implementation of the project through waste segregation at the source. Some 62 % of all Lane Managers are women.
- Children and youth are participating through the 106 school/college SWEEP Environment Clubs formed by SWEEP.
- Linkages with line agencies in the Education Department, Health Department and Environment Department established.
- A Community Participating Unit has been established in RMC.
- Network of Community Organization has been facilitated providing a forum for non-governmental stakeholders to debate issues on solid waste management and to strengthen the dialogue with government agencies.
- Experience sharing visits and workshops with institutions and organizations from within or outside of the city conducted.

2.16 Conclusions

The overall conclusion of the study on present status of solid waste management in Pakistan as follows:

- There is an overall fragmented and reactive approach to the solid waste management in Pakistan. There is a limited focus on control mechanisms which is adversely effecting on safety, health and the environment. There is insufficient information on the quantity and composition of waste being generated as such there is an inadequate waste planning.
- There is Pakistan Environmental Protection Act but its regulations are inadequately enforced and solid waste management does not seem to be a priority.
- There is inadequate waste collection system as it collects only 51-69% of the total waste generated.
- Municipal collection of household waste is quite irregular and limited to influential areas. As a result solid waste remains scattered throughout the remaining area.
- Number of dustbins and constructed filth depots are too less in comparison with urban population. Furthermore, most of them are not located according to community's requirements. Moreover, the people are also dominantly inhabitable to make use of such facilities.
- Municipal street sweeping services are irregular and limited to main roads and influential areas.
- Many vehicles available with respective municipalities are reported out of order while remaining is used for many other purposes besides the misuse by staff.
- The operations of loading and unloading of municipal solid waste are generally manual.
- There is a generally inadequate disposal service and no weighing facilities are installed at most of the disposal sites.
- Physical layout of cities which are characterized with narrow and blind streets restricts the extension of municipal services to these areas.
- The most of municipalities have been unable to manage some reasonable piece of land either owned or on lease for the disposal of waste, owing to the lack of funds.
- The scavengers play an important role in solid waste management as they separate recyclable at various stages of existing SWM but there is little support for recycling. During their operation they have been found spreading the waste further and making it more complex to deal with.
- There is poor management of hazardous waste, under the current disposal practice; no proper method is being employed. Hazardous hospital and industrial wastes are being simply treated as ordinary waste. Open burning of waste especially non-degradable components like plastic bags are adding to air pollution.
- Municipalities do spend considerable portion of their budgets on solid waste management but as a return receive limited tax which is insufficient to meet their operation and maintenance costs. This is one of the main reasons why these municipalities can not afford latest techniques and equipment to make solid waste management a profitable enterprise and to achieve the desired standards of environmental quality.

2.. REVIEW OF WORK CARRIED OUT UNDER PERTINENT PREVIOUS AND ON-GOING INITIATIVES

2.1 Introduction

There are various on-going/pipeline projects that form a linkage with the NEAP Support Programme as there is an overlap of some of the outputs and activities planned under these projects and those planned under different Programme Components.

The Planning & Development Division at the federal level and Planning & Development Departments at the provincial levels are responsible for the preparation of development plans and allocation of resources. At the federal level, the Ministry of Environment, Local Government and Rural Development are responsible for the development of policies and programmes under the environment theme. The Pakistan Environmental Protection Agency (PEPA) and provincial EPAs are the main regulatory bodies for environmental monitoring. Overall planning including planning for poverty reduction is the responsibility of the Planning Commission at the federal level. The concerned line departments, such as agriculture, water, health, education, municipalities, etc. are responsible for the implementation. The present Poverty Reduction Strategy views poverty in a more holistic manner, and several line departments are involved in its implementation.

2.2 Government of Pakistan's 7-Point Agenda

Pakistan's political history is chequered with many attempts at delivering a better life for people; however, these initiatives have on the contrary resulted in causing the people further dismay. The non-use, misuse and abuse of political and administrative systems have led to a profound institutional crisis that has slowed down national development and threatened the future. To address the institutional crisis, the present Government has elaborated a seven point agenda, which is as follows:

1. Rebuild national confidence and morale.
2. Strengthen the federation, remove inter-provincial disharmony.
3. Revive economy and restore investor confidence.
4. Ensure law and order and dispense speedy justice.
5. De-politicize state institutions.
6. Devolution of power to grassroots level.
7. Ensure swift and across the board accountability.

The Government of Pakistan has announced a strategy for the reconstruction of local government that not only addresses the agenda point on "Devolution of Power and Responsibility" to the grassroots level but also the rest of the six points as the reconstruction process applies a bottom-up approach. It includes the following key elements:

- Devolution of power for the genuine empowerment of citizens.
- Decentralization of administrative authority.
- Decentralization of professional functions.
- Diffusion of power for checks and balances to preclude autocracy.
- Distribution of resources to the provincial and local level.

The Government of Pakistan has also established a National Reconstruction Bureau, which is preparing policies and plans for economic revival, strengthening of public institutions and preparing action plans for implementing the devolution plan.

2.3 Poverty Reduction Strategy, NEAP, and Local Government (Devolution) Plan and Information Technology Policy

Addressing the poverty-environment nexus holistically stands very high on national development agenda. To this effect, Government priorities and strategies can be found in the following major documents. Alternatively stated, the actions and measures outlined in these documents forms the main elements of the national programme to address the issues related to poverty--environment nexus.

- Poverty Reduction Strategy (PRS)
- National Environmental Action Plan (NEAP)

More recently, the Government has taken concrete steps to implement the Devolution of Power Plan and Information Technology Policy. Both these initiatives provide necessary impetus to translate the actions and measures proposed in the above-referred documents into reality--thus paving the way to achieve the goal of sustainable environmental management.

2.4 Poverty Reduction Strategy

The Government of Pakistan is in the process of finalizing the Interim Poverty Reduction Strategy Paper (IPRSP), in collaboration with all the stakeholders, including the Brettonwoods Institutions, multi /bi-lateral donors and UN Agencies. In the draft paper, poverty has been defined as a multi-dimensional concept, which encompasses economic, political, and social needs that are sine qua non for a meaningful and complete existence. It has been realized that the poor are not simply deprived of income and resources, but they lack basic capabilities like education, health and clean drinking water. Low capabilities combined with social exclusion make it difficult for the poor to access the markets. Moreover, limited access to education, health and nutrition limits their ability to secure gainful employment. However, even if they succeed, these deprivations retard their ability to be productive participants in the economic process thus denying them the opportunity of bringing about an improvement in their lives. Besides income poverty, lack of resources makes them vulnerable to exogenous shocks. This is further exacerbated by institutions of governance that tend to exclude the most vulnerable from the entire decision making process.

The IPRSP aims at forging broad-based alliances with civil society in the quest to eliminate poverty and ensure development. The complex and multi-dimensional nature of poverty warrants that strategies for poverty reduction should encompass plans for rapid pro-poor economic growth, sound macroeconomic policies, structural reforms and social improvement. Therefore, the focus of strategy is on:

- Ensuring broad based economic growth that generates efficient income generating opportunities for the poor and a pattern of growth that is relatively labor intensive.
- Achieving the highest possible growth path that is consistent with the available financial and human capital.
- Ensuring improved access to education, vocational skills training, primary healthcare, nutrition and other social services that help the poor become productive

employees and make them capable of starting their own business ventures on a small scale.
- Provision of social safety nets for the most vulnerable groups who cannot work, e.g., the sick, the old and those who live in resource-poor and drought prone regions.
- Directing public policy debate on the needs of the poor.
- Bringing about an effective transformation of society, by forging partnerships and alliances with civil society and the private sector.
- Empowering the people, especially the most deprived, by increasing access to factors of production, particularly land and credit.
- Creation of employment opportunities for all.

The key elements of the PRS include: (a) introducing a series of macroeconomic and sectoral reforms; (b) promoting agricultural policies geared towards robust and sustainable growth through efficient import-substitution, export orientation, enhanced productivity and poverty reduction; (c) developing an open, market driven, innovative and dynamic industrial sector; and (d) and using information technology as an impetus to generate economic growth in the country. In addition, the PRSP views environment and natural resource management as the main factors which could significantly contribute in poverty alleviation, through community mobilization and organization for improved governance with a focus on minimizing environmental degradation and pollution, eliminating the root causes of environmental degradation (population pressures and poverty) and integration of environment and development to achieve sustainable development.

2.5 National Environmental Action Plan (NEAP)

The first effort to introduce specific legislation for environmental protection in Pakistan was made in 1977. Since then, many institutional, policy and regulatory developments have taken place at the federal and provincial levels. These include, among others, the creation of the Ministry of Environment and environmental protection agencies, promulgation of the Pakistan Environmental Protection Act in 1977 and the Pakistan Environmental Protection Ordinance in 1983. In 1992, the Pakistan National Conservation Strategy (NCS) was developed, and in 1999 the NCS was subject to mid-term review. The NEAP was approved by the Pakistan Environment Protection Council chaired by the Chief Executive in February 2001.

The development objective of the NEAP is to initiate actions and programmes for achieving a state of the environment that safeguards public health, promotes sustainable livelihoods, and enhances quality of life of the people of Pakistan. It will focus on taking immediate measures to achieve a visible improvement in the rapidly deteriorating quality of air, water and land, through effective co-operation between the government agencies and civil society.

Based on the lessons learnt from projects that have attempted to address the issues of poverty-environment nexus, the NEAP strategy calls for shifting the focus, capacities and resources in a limited number of core areas where a high level of impact can be achieved in the near term. It recommends a programme approach as opposed to project approach which has evident merits, such as a higher level of flexibility in addressing core issues, maintaining priorities, directing the actions towards pre-defined targets, and responding to cross-cutting issues, e.g., gender, poverty reduction, capacity building, etc. The NEAP is based on poverty-environment nexus and it is planned to take the following measures to achieve its objectives:

- The focus will be shifted from completion of activities and delivery of services to alleviating poverty, through environmental projects.
- Under the umbrella of 1997 Environmental Protection Act, policy development and enforcement efforts will be directed towards reducing health risks and vulnerability in the poorer segments of the population.
- Programmes for addressing deforestation, desertification, and rangeland degradation will be integrated with the existing social mobilization and organization initiatives at the grassroots level.
- Support will be provided to the existing poverty alleviation programmes to make them environmentally sound and to prevent unforeseen long-term impacts on the poor.
- Reliance on technical and human resources available within the country will be maximized.
- The execution will be through existing provincial government departments and associated agencies, local governments, and rural support programmes and NGOs operating at the grassroot level.
- Enforcement will be supported by suitable regulatory and institutional frameworks in consultation with stakeholders and impacted groups.
- Well-defined outputs, measurable indicators and supporting monitoring and information systems will be established to evaluate the achievements.
- The institutional responsibilities for carrying out monitoring and evaluation will be defined, and procedures for public disclosure of information on expenditures, inputs and outputs will be developed to maintain transparency and accountability.

The NEAP is implementing the above measures and actions through the following major sub-programmes.

- The *clean air programme* that will primarily focus on controlling of (i) vehicular pollution; (ii) emissions from industries; and (iii) indoor air pollution in rural areas.
- The *clean water programme* that will target protecting water quality from: (ii) domestic and municipal effluents; (ii) industrial effluents; and (iii) pesticides and fertilizers.
- The *solid waste management programme* that will aim at mobilizing communities for adopting the 3R (Reduce, Reuse, Recycle) principle of waste management through setting of composting sites, municipal incinerators, levy of taxes and charges for municipal services, empowerment of local governments and enforcement of NEQS for the disposal of industrial wastes.
- The *ecosystems management programme* that will initially focus on a small number of representative ecosystems where management initiatives can be tested. These will include ecosystems located in forests, rangelands, deserts, wetlands, and coastal areas. Priority will be given to protected areas where the government has a higher level of jurisdiction, and areas where pressures on land use are representative of conditions commonly prevailing in the country.
- The other areas of concern included in the NEAP are: (ii) management of fresh water resources; (ii) marine pollution; (iii) toxic and hazardous substances; (IV) energy conservation and management; and (v) compliance with international treaties and protocols.

The major beneficiaries of NEAP will be the poor in rural and urban areas who are suffering from air and water pollution and degradation of natural resources,

especially the women and children. The private sector will also benefit from NEAP activities because of exposure to economical and eco-friendly production processes which will result in creation of job opportunities. The second line of beneficiaries will be the institutions at various levels and NGOs whose capacities will be strengthened as a result of NEAP activities. Last but not the least, the beneficiaries of NEAP will be several species of animals and plants, which are under severe threat due to degradation of their ecosystems.

While the institutional/implementation mechanisms for the individual programmes will inevitably vary, a common institutional framework has been proposed by NEAP for efficient utilization of available resources. The framework is based on ensuring high-level political and administrative commitment to the programmes, allocation of sufficient resources, providing professional leadership, and instituting a system of monitoring at all levels of implementation. It is planned to encourage private sector, NG0s and citizen groups in the execution of projects to the extent possible.

The NEAP implementation strategy calls for raising mass awareness at different levels. It will be linked with the specific initiatives in the key departments and institutions at the federal level including the EPA, Office of the Inspector General of Forests Parks and Wildlife, and the Office of the Director General Environment. Expertise for mass awareness will be made available in the Programme Support Units attached to these departments.

The programme goes much beyond the technical scope of NEAP. It will provide support in the implementation of main sub-programmes outlined above, strengthen the implementation and monitoring arrangements envisaged in the NEAP, and will further cover areas such as environmental disaster management in dry-land (drought prone) areas, environmental governance, energy generation, and strengthening capacities of CBOs in environmental management and natural resources conservation.

2.6 Other Government of Pakistan's Initiatives

As mentioned earlier, the Government of Pakistan has recently taken concrete steps to implement the Devolution of Power Plan and Information Technology Policy. These initiatives provide necessary impetus to translate the environmental management agenda described above. Main features of these initiatives are summarized below.

Devolution of Power Plan: In the present system, the local governments have not enough authority over the development activities in their areas; therefore, their role in the national development is limited. However, the present government has announced a strategy for the reconstruction of local governments[1]. Under the new strategy, Village Councils, Union Councils and District Councils are established through a democratic process, which also allow equal representation of women in each council. The district administration will be headed by the Chief Mayor (*Nazim*) and coordinated by a District Coordination Officer (DCO). The Chief Mayor will create a development vision for the district with the support of government, the private sector, civil society organizations and the local level institutions, such as Village-, Union- and Tehsil-councils. A District Officer heads each District Department. The administration is consist of 13

[1] Devolution of power and responsibility: District Government. National Reconstruction Bureau, Chief Executive Secretariat, Islamabad, 2000.

departments, including one on Environment, headed by District Officers and Deputy District Officer's in-charge of specific functions within them. Assistant District Officers is located in Tehsil towns, wherever possible. The district administration is initially be set up with the existing line departments. However, it will gradually move towards the corporate governance driven by an entrepreneurial approach.

The NEAP-SP will provide opportunities to the officials of line departments engaged in development work with local communities in the pilot areas to implement initiatives in sustainable development, particularly those, which are directly related to poverty-environment nexus. Training in Participatory Learning & Monitoring (PLM) as provided by the linked Poverty Alleviation and Sustainable Development Facility set up in the Planning Commission, would facilitate flow of information and refinement of plans at various levels. The members of various councils and Citizen Community Boards (at the village level)[2] will surely need training/information in sustainable development, participatory planning, implementation and monitoring, and the programme play an instrumental role in this regard.

Information Technology Policy: The GOP has also launched its Information Technology (IT) policy whereby software parks are being established in the country, along with several other ventures, to absorb the youth in income generation activities. The Information sharing through internet, e-conferencing, databases, e-workshops, e-study tours, etc., would bridge the gap between the professionals, policy community and public at large. These activities will directly contribute in achieving the UNDP Administrator's and GOP's plans for IT discussed under the Section on PRSP.

10 Year Perspective Plan 2001-2011: In addition to the above, the Government of Pakistan is currently working on the development of a 10 year perspective plan for 2001-2011 under the aegis of the Planning Commission. The NEAP Support Programme would greatly contribute to this process.

[2] The Citizen Community Boards will be created by the Local Governments / local communities to enable the proactive elements of society to participate in community work and development related activities in both rural and urban areas.

3.ASSESSMENT OF THE AVAILABILITY, ACCESSIBILITY, QUALITY AND RELEVANCE OF AVAILABLE DATA AND IDENTIFICATION OF GAPS

Reasonable and good information concerning solid waste management in Pakistan is available in Pakistan. For example:

- "Data Collection for Preparation of National Study on Privatisation of Solid Waste Management in Eight Selected Cities of Pakistan" by Engineering Planning and Management Consultants, Lahore 1996
- "Final Report for Domestic Solid Waste Management in Pakistan" by Mr Akio Ishii, JICA Short Term Expert 2002.
- "The Pakistan National Conservation Strategy"
- "Environmental Profile of Pakistan" by IUCN, 1998
- "State of the Environment Pakistan 2001" Ministry of Environment, SDPI, SACEP, NORAD, UNEP
- "Industrial Policy and the Environment in Pakistan" by Ministry of Environment, UNDP and UNIDO
- "Guidelines for Solid Waste Management in Punjab." by Environmental Protection Department, Government of Punjab.
- "Hospital and Biomedical Waste Management" by Environmental Health, Health Service Academy.
- "Infectious hospital waste treatment system in Shalamar Hospital in Lahore". I.e. Private sector Hospital Waste Management Program.
- Guidelines for Hospital Waste Management Rules 2002" published by Environmental Health Unit, Health Service Academy. Ministry of Health.
- Specification & Guidelines on Hospital Waste Incinerator prepared by EPA, Government of Sindh, Karachi.
- Composting Plant constructed and operated by Private Company "Waste Buster".
- Composting Plant constructed and operated by Green Force Project.
- "Solid Waste Conditions in Four Cities of Pakistan" conducted by Pakistan Environmental Protection Agency 2004

In addition to the above a lot of information is also available on the internet. Therefore, it is concluded that sufficient information on the status of solid waste management in Pakistan is available both in the print media as well as on the net. Most of the information is reliable and up-to-date.

However, with regard to data on how much solid waste is generated in Pakistan, very little and unreliable data is available. First, it must be understood that in Pakistan at none of the dumping sites, there is any weighing facilities to know the exact quantity of solid waste being dumped. Although, now some of the municipalities like Lahore has realised its importance and have installed weighing facility at their dump site. Similarly, there is no weighing facility to measure the solid waste during collection. The Ministry of Environment and Urban Affairs Division, Government of Pakistan undertook a study during 1996 on "Data Collection for Preparation of National Study on Privatisation of Solid Waste Management in Eight Selected Cities of Pakistan".

There is documented data available on hazardous solid waste generated from hospitals, industries and agricultural activities. Thus, **it is concluded that very**

limited reliable and up-to-date data is available on municipal and hazardous solid waste generation in Pakistan.

There is an urgent need to assess the present system of solid waste management in Pakistan, which is reliable and up-to-date particularly in major cities and to develop baseline information of existing solid waste management system.

It is recommended that the MoELGRD should undertake a study on solid waste management in Pakistan with the objective to assess the present system of SWM in major cities to make future policy planning of solid waste management. It is needed to collect the solid waste management data, such as collected garbage weight data, disposed garbage weight data and garbage generation data. The domestic municipal data should be separated from the hazardous waste.

The objective of the proposed study is to assess the present system of solid waste management in major cities of Pakistan, which involves the following

- Collect, review and update the baseline data on solid waste management already collected of eight cities[1] and to include ten additional cities[2].
- Collect and develop baseline information on hazardous waste management of hospitals, industries and agriculture activity for all the eighteen cities including eight major industrial estates[3] of Pakistan.
- Review various options for solid waste management and involvement of private sector
- Recommend a viable alternative for private sector participation in solid waste management.

[1] Gujranwala, Faisalabad, Karachi, Hyderabad, Peshawar, Bannu, Quetta, Sibi

[2] Islamabad, Rawalpindi, Sheikhupura, Rahim Yar Khan, Nawabsha, Larkana, Gawader, Turbat, D I Khan and Abbotabad

[3] Karachi (SITE, Korangi and Landhi), Lahore (Kala-Shah-Kaku, Lahore-Sheikhupura-Faisalabad, Lahore-Gujranwala-Sailkot), Hattar Industrial Estate, Khurianwala Industrial Estate, Faisalabad.

Furthermore, it is strongly recommended that in order to exchange information, a network should be established to share information about solid waste management in Pakistan to link Federal and Provincial Governments, EPA's, Universities, Private Sector, Industry and communities.

4. REVIEW OF EXISTING LEGAL FRAMEWORK ON SOLID WASTE MANAGEMENT

The Government of Pakistan enacted the Pakistan Environmental Protection Act (PEPA) in 1997--which is the most recent and updated legislation on environment. It provides a framework for establishing federal and provincial Environmental Protection Agencies (EPAs), and suggestions for protection and conservation of species, habitat and biodiversity, and conservation of renewable resources. The MoELGRD is implementing the NEAP – SP for improving the environmental conditions and natural resources protection. The organizational structure of the MoELGRD is being adjusted to improve its capacities to facilitate the implementation of both PEPA and NEAP. The Ministry will continue to take initiatives in collaboration with the Pakistan Environmental Protection Council (PEPC) and provincial EPAs to adjust the PEPA and NEAP to match up with the changing realities on the ground. Within the Ministry, there is also a NCS Unit that is responsible for promoting and monitoring progress of NCS implementation. As a follow-up to these initiatives, it is likely that decrees will continue to be prepared and issued in the near future to further improve the state of environment and regulate the natural resources utilisation and pricing. The MoELGRD under its new structure will have to strengthen necessary capacities to steer the process of policy and legislation formulation, fund management and implementation of the existing laws and NEQS in collaboration with the local administration and judiciary.

The main issues are:

- Inadequate primary legislation. For national decisions.
- Possible need for new ordinances. For Government of Pakistan's decisions.
- Lack of monitoring and control. Depends on new laws/ordinances and the ability of municipalities to enforce them.
- Strengthening health and safety legislation to protect all sectors of society.

Presently, these legal rules and regulations are dealing with solid waste management in Pakistan are as follows:

- Section 11 of the Pakistan Environmental Protection Act prohibits discharge of waste in an amount or concentration that violates the NEQS. Unfortunately, presently we do not have any set of NEQS specific to the solid waste.
- Hazardous Substances Rules of 1999.
- "Islamabad Capital Territory Bye Laws, 1968" by Capital Development Authority Islamabad
- "Section 132 of the Cantonment Act 1924 deals with Deposits and disposal of rubbish etc deals with solid waste management by Jhelum Cantonment Board

The present legal rules and regulations are inadequate and are outdated. There is an urgent need that the solid waste management law should legislate. The law makes clearly to any activities concerned this waste management what part citizen; enterprise and government should take of responsibilities. Factory or company should treat especially industrial hazardous waste, which generated these under governmental control. Citizen, businessman, factory owner and even government should receive a punishment for activity in violation of the law of Solid Waste Management.

The following laws on solid waste management should be considered

Table 4.1 Solid Waste Management Laws to be enacted

Items to be described	Explanatory substance
Industrial waste	Definition of industrial waste, Industrial waste collection, transportation and treatment system controlled by local government, Responsibility of industry which generates waste, such as collection , transportation and treatment , Standardization of treatment facility, Responsibility of private industrial solid waste management company
Service area	Solid waste management service should cover whole city area.
Responsibility	Roll and responsibility of citizen, Roll and responsibility of businessman and enterprise Roll and responsibility of government.
Subsidy	Financial assistance from federal and provincial government to local government for constructing solid waste management facility, such as sanitary landfill site, hospital incinerator, night soil treatment facility and transfer station.
Definition of solid waste management, collection, transportation, treatment and disposal	To make clear the definition.
Hospital waste	Definition of infectious hospital waste, Collection, transportation and disposal system of infectious hospital waste
Constructive standardization of solid waste treatment facility	To make clear the standards of solid waste treatment facility.
Punishment	Punishment for illegality of Solid Waste Management Law
Reduction, recycling strategy	Source reduction, reuse, recycling, material recycling
Solid waste management planning	Every municipality should make solid waste management planning for future 15years.

5. REVIEW OF EXISTING INSTITUTIONAL MECHANISM

At the institutional front, the MoELGRD has to play three important functions as a regulatory agency, technical support agency and public health agency. As a regulatory agency, it is required to work with the corporate or industrial sector so as to provide information on clean technologies, sources of funding and assistance, and access to markets for environment friendly products. In the capacity of technical support agency, it is required to create conditions for sustaining the livelihood economies. This entails community organization and mobilization efforts in order to empower the local communities to protect their natural resource base. As a public health agency, it should undertake and promote research on environment-health nexus, and building a strong constituency around the protection of human health. The NEAP SP programme is building the following capacities to contribute towards the implementation of the National Environmental Action Plan (NEAP):

- Capacity to integrate environmental concerns into economic development planning and policy-making processes;
- Capacity to make informed, knowledge-based decisions, after necessary consultation with major stakeholder groups, including the poor;
- Capacity to improve inter- and intra-institutional cooperation primarily within government administration and at different levels (federal, provincial, district and local levels);
- Capacity to promote partnerships between public and private sector (communities, CBOs, NGOs, business companies);
- Capacity to enhance systemic approaches emphasising participation and incentives in addition to legal enforcement;
- Capacity to promote awareness in society about environmental concerns, and about people-centered solutions taking poor people's livelihoods into account;

Capacities are being strengthened in the following areas:

- The capacities of the MoELGRD and EPAs, and other institutions concerned, in policy formulation and enforcement.
- The institutional capabilities of MoELGRD, as well as of other institutions concerned, in order to enable them meet their mandates and functions.
- A comprehensive programme to meet the human resources and technological capacity building needs of various institutions involved in poverty-environment nexus activities; for the purpose of the programme itself, a targeted training programme will be developed consisting of a wide range of training modules to strengthen the technical and management capabilities of the staff and participants associated with programme implementation.
- Capacity with government institutions to mobilize resources from a multitude of sources and mechanisms, public and private, domestic and foreign, loans and grants, fines, fees, taxes, stakeholder funds, etc.

In Pakistan, municipal governments are usually responsible agency for solid waste collection and disposal, but magnitude of the problem is well beyond the ability of any municipal government. There is a need to devise such mechanisms that help city, town or tehsil government to take steps to develop and improve the existing solid waste management system. An integrated solid waste management system is proposed comprising the source reduction and segregation as the top priority and which includes other important components such as collection, processing, eco scavenging, windrow

type composting, transportation and sanitary landfill operations as defined under Strategies for solid waste management in Pakistan. There is a need that all government and private sector all have the same goals and policies of solid waste management.

Before devolution, the provincial Public Health Engineering Department (PHED) had the main responsibility for the devolvement and maintenance of water and sanitation services including solid waste management, particularly for large scale projects and particularly in rural areas. In addition, Development Authorities (DAs) and Water and Sanitation Authorities (WASA) were providing similar services in large urban centers.

Under the recently devolved local government system, the Town/Tehsil Municipal Administration (TMAs) are responsible for the solid waste collection, transportation and disposal. Although in legislative term water and sanitation services are now clearly assigned to *tehsil* or town (except in the case of city district, where they are district responsibilities, the emerging implementation arrangements are uneven retention of provincial control. Each province in Pakistan has devolved PHED in a different way, even though the pre-devolution structure of the department was the same in all four provinces and the same clause of the Local Government Ordinance governed devolution in all provinces.

Administratively, TMAs have acquired a much strengthened structure under devolution. However, the failure to complete the devolution of PHED has deprived tehsil of the quantity and quality of technical jurisdiction of each TMA. The Municipal Committees (MCs) in districts and tehsil that used to provide municipal services to the urban populations are now required, with little increase in staffing and resources, to deliver these services to a much wider jurisdiction, includes sizable rural areas not previously part of their mandate. Furthermore, the independent and free standing of each tehsil does not allow any equalization across the tehsil of any one district. There are no mechanisms for prioritizing resources within a district to ensure that the relatively deprived rural areas begin to build services equal to those of the former municipalities. As such, TMAs are unable to cope with continuously increasing volumes of municipal waste due to inadequate funds, lack of rules, regulations and standards, lack of know how on the subject, lack of expertise and lack of collection vehicles and equipment.

There is a need to propose regulatory framework for management of solid waste in Pakistan by constituting Solid Waste committees at town/tehsil level, boards at District and Provincial levels and commission at National level. The main objective is to devise a collaborative institutional mechanism, to enhance implementation of relevant strategies, rules, regulations and standards among federal, provincial governments and other local government units like city, town, district, tehsil and union governments, non-government organizations, and the private sector.

The proposed regulatory framework for management of solid waste management should constitute solid waste management committees at town/tehsil level and boards at district and provincial levels and commission at national level. There is a need to draft the roles and terms of reference for these bodies and their interface with each other should be worked out as per following outline:

- Setting up **Local Solid Waste Committee** at tehsil/town level (each town or tehsil municipality may form a town or tehsil Solid Waste committee that shall prepare

and implement Solid Waste measure including a solid waste management plan according to the proposed solid waste management strategy for Pakistan. This should include the safe and sanitary management of solid waste generated in areas under its geographical and political coverage. The plan should establish the estimated cost of collecting, storing, transporting, marketing and disposal of wastes and recyclable material in the town/tehsil level. The plans should evolve the strategy to involve private sector in town or tehsil level. The plans may also provide for the closing or upgrading of all existing open dumps.

- Provision for having a **District Solid Waste Board** at the district level. These boards should prepare their respective ten year Solid Waste plans including solid waste management plans on basis of the individual plans received from the tehsil/town committees. All these boards may receive annual reports from all municipal authorities. Also the district boards may grant authorizations for setting up waste processing facilities, including consideration of regional facilities for the benefit of small municipalities.
- Provisions of a **Provincial Solid Waste Board** in each Province. The Provincial Board should be able to identify opportunities for cooperation between municipalities in various fields of Solid Waste measures including involvement of private sector and setting up of regional disposal facilities.
- Provision of a **National Solid Waste Commission** at federal level to oversee the implement rules and regulation for Solid Waste measures including solid waste management, to encourage private sectors involvement and to address current bottlenecks, to assist Provincial Solid Waste Board in implementations of their plans and to approve projects for funding by the Federal Government.

6. ESTIMATION OF FUTURE SOLID WASTE GENERATION

Presently domestic solid waste in Pakistan has not been carried out in an insufficient and proper manner in collection, transportation and disposal and as such no reliable data based on actual weight is available in Pakistan. However, the data collected during 1996 for preparation of national study on privatisation of solid waste management in eight selected cities of Pakistan does serves as a baseline data.

Keeping in view the population growth of 2.61 % per year, an estimate of solid waste generation in prepared in table 7.1.

Table 6.1 Solid waste Generation on the basis of population for 2004

City	Population (Million) 1998 Census	Population (Million) 2004	Solid Waste Generation Rate (kg/C/day)	Waste Generated (tons/day)	Tons/year
Urban Areas					
Karachi	9.269	10.818	0.613	6,632	2,420,680
Faisalabad	1.977	2.307	0.391	902	329,230
Hyderabad	1.151	1.343	0.563	756	275,940
Gujranwala	1.124	1.312	0.469	615	224,475
Peshawar	0.988	1.153	0.489	564	205,860
Quetta	0.560	0.654	0.378	247	90,155
Bannu	0.046	0.054	0.439	24	8,760
Sibi	0.082	0.095	0.283	27	9,855
Remaining urban areas	27.261	31.818	0.453	14,414	5,261,110
Rural Areas	88.121	102.853	0.283	29,108	10,624,420
Sub-Total	130.579	**152.409**		53,289	19,450,485
Add 3 % for hazardous waste				1,599	583,635
G Total				**54,888**	**20,034,120**

1998 CENSUS

From the above it is concluded that the present rate solid waste generation in Pakistan is 54,888 tons per day which is 20.034 m tons per year. The projected population for the year 2014 will be 197.77 m on the basis of current annual growth rate of 2.61 % and as such the estimated projection for solid waste in 2014 will be 71,018 tons per day which will be 25.921 m tons per year.

7. NATIONAL SOLID WASTE MANAGEMENT STATERGY FOR PAKISTAN

7.1 Introduction

The Solid Waste Management Strategy for Pakistan discusses the overall aim and the strategic objectives of the strategy as well as realistic solid waste management options to improve existing waste collection and disposal systems. It considers technical, financial, institutional and social issues related to solid waste management.

7.2 Aim and strategic objectives of the strategy

The overall aim of the National Solid Waste Management Strategy is:

To provide an effective, efficient, affordable, safe and sustainable solid waste management system for all the urban and rural settlements of Pakistan by 2015.

The strategy serves two purposes:

- to inform the public of the Government of Pakistan's objectives and how the government intends to achieve them, and
- to inform government agencies and state organs of the objectives and their roles in achieving them.

In the context of this strategy, waste is defined as "any substance or thing that the holder discards or dispose of irrespective of its value to anyone, and any substance or thing deemed by a regulation to be waste; and for the purpose of this definition: "holder" means a person in possession of the waste, or a person whose activities produced the waste or a person who carried out pre-processing, mixing or other operations that changed the nature or composition of the waste."

A sustainable waste management strategy is one that recognises amongst other factors, the following as necessary elements for a starting point:

- **Appropriateness** – A waste management system cannot be sustainable if it is not appropriate, as continuous high inputs would be needed to keep it going.
- **Dynamic nature of waste issues** – An appropriate waste management system must take cognisance of dynamic issues, such as the culture of the people, available technology, complexity of waste streams, and level of national development.
- **Priorities at various levels** – Government and local communities will have specific problems that would determine their priorities. Hence, the need to integrate the implementation of the waste management system into the livelihood of society.
- **Political support** – Politicians need to be informed and educated about the environmental and economic impact of waste.
- **Legal requirement** – An appropriate legal framework must support the implementation of a waste management strategy to ensure suitable standards and standardised systems. A legal system without the necessary enforcement tools should be discouraged.

The guiding principles of integrated National Solid Waste Management Strategy (NSWMS) is based on Pakistan Environmental Protection Act, 1997. Following guiding principles for the NSWMS:

- Long-term integrated planning and co-ordination, integrated and co-operative efforts, which consider the whole environment must be used to prevent pollution;
- The Precautionary Principle and the Polluter Pays Principle will be applied;
- Generation of waste must be minimised wherever practicable and waste should, in order of priority be reused, recycled, recovered and disposed of safely;
- Non-renewable natural resources should be used prudently while renewable resources and ecosystems should be used in a manner that is sustainable.

The waste hierarchy has been used as the core around which the strategy and the priority initiatives are presented. The strategic approach applied for the development of the strategy is based on the internationally recognised waste hierarchy, which includes Waste Prevention, Recycling, Collection and Transport, Treatment and Disposal. The Strategy ensured that the focus is on waste prevention (preventing the generation and minimising the waste that is being generated) as a first priority. Thereafter, would follow reuse and recycling of waste (utilising waste as a resource) and finally treatment and disposal of the remaining waste. It also ensures a holistic and integrated approach as all links in the waste management cycle are considered and incorporated. The waste hierarchy is as follows:

- Cleaner Production Prevention* Waste Minimisation
- Recycling*Re-Use
- Recovery
- Composting
- Collection* Transport
- Treatment*Physical
- Chemical
- Incineration
- Disposal*Landfilling

* Standard terminology for the Waste Hierarchy

The waste hierarchy is a hierarchical structure, where the highest priority must be given to the prevention/minimisation of waste. If the prevention/minimisation option is neither practical nor technically or socio-economically feasible, then other solutions have to be considered, for example the re-use or recovery of the waste. If re-use or recycling are not feasible, different treatment alternatives must be considered. Through the application of this hierarchical approach and the process of elimination, the best practical environmental and locally feasible solution with the least negative impact on the environment for any particular waste stream will be selected. Priority initiatives are as follows:

- Solve urgent environmental and health problems
- Give direct, visible and immediate results
- Ensure environmental sustainability
- Enhance prevention and recycling
- Address waste issue that is annoying to the public
- Compliance with international conventions
- Low investment costs

- High operational costs
- Labour intensive technology
- Create jobs in the waste sector
- Improvement and change of technology
- Sufficient legislation in place
- Administrative burden is low
- Create capacity (trained staff) within the waste sector
- Create public awareness

The next step in the implementation of the priority initiatives will involve detailed planning through the development of Action Plans. The "implementing and enabling mechanisms" required to realise the strategy are many and varied. They include: - the preparation of legislative instruments and guidelines, development of monitoring and enforcement systems and procedures, training, information and awareness programme design and implementation, review of institutional portfolios and responsibilities, a range of multi-facetted feasibility studies to provide a sound basis for investments into waste management related infrastructure and equipment.

The following strategic objectives are proposed for the Federal and Provincial Governments in Pakistan to reach the overall aim:

1 To upgrade waste collection and transfer
2 To improve waste disposal and treatment
3 To reduce waste and maximise recovery
4 To ensure the safe and separate collection and disposal of all hazardous wastes
5 To achieve financial sustainability in solid waste management
6 To strengthen institutional and organisational capacity in solid waste management
7 To increase involvement of key stakeholders in solid waste management and raise awareness of solid waste issues.

The options available for solid waste management in Pakistan have to be considered bearing in mind both present and future needs. There are a number of factors that will affect the current situation, including:

- Population growth
- Demographic changes (including movements from rural areas to urban areas)
- Industrialisation
- Increasing affluence
- Changes in food buying and eating habits
- More or less reclamation by the informal sector depending on its profitability and its acceptability in a changing society
- Possible introduction of new regulatory measures and the degree of their application (monitoring and control)

And, as waste management standards improve, there is likely to be:

- More waste to be collected and to be disposed off
- Infectious hospital and industrial hazardous solid wastes to be handled and disposed off separately from the municipal waste flow.

All these factors will affect waste municipal quantities and characteristics. For example:

- Average *per capita* waste production will increase
- Waste density will decline
- Organic content will increase, except in currently semi-urban areas
- The amount of animal waste will decline
- Plastic content will increase

These factors indicate the importance of reliable data regarding the quantities and characteristics of all kinds of waste.

Objective 1: To upgrade waste collection and transfer

Problem:

The total Municipal and hazardous waste generation in Pakistan is currently estimated to be 54,888 tons per day. Generally there is a lack of information about waste quantities and characteristics. Waste collection services, while reasonable in major cities, is still inadequate in medium cities and towns. Rural areas generally have no formal collection services. Collection efficiencies are also hampered by inappropriate waste container design and resultant time-consuming and unhygienic loading procedures as well as time spent scavenging the load in transit.

Further households often dispose of their waste without plastic bags in the streets, which slows down waste collection. Where containers are available, they are not well distributed, old and ill-maintained. Vehicles are often incompatible for the containers and bins used and they are rarely suitable for collection in narrow streets or for unpaved roads. Most waste collection vehicles are imported, which means they are costly to replace, and require spare parts that are difficult to obtain, as well as highly specialized management and maintenance.

Objective : To achieve efficient, effective and sustainable municipal waste collection systems

Programmes/Lines of action:

- Set up a system for regular weighing and analysis of wastes generated and collected in all urban areas of Pakistan (quantities, densities, organic content, dry recyclable content, moisture content). These data are essential to determine the most suitable methods of collection, transportation, disposal and treatment.
- Develop standard designs for collection and transfer for all major rural and urban areas of Pakistan.
- Establish primary collection systems in city centers and where building densities are high. A primary collection system means that waste is collected by small vehicles to a transfer point, from where it is collected by larger vehicles to the disposal site (secondary collection system).
- Encourage collection of waste in plastic bags, as this reduces loading times for the waste collection crews. However, waste collection in plastic bags needs a fixed timing of the collection service, so that scavengers have minimal access to them.
- Encourage door-to-door collection systems in high and middle income urban areas of major cities against a cost covering fee. Kerbside collection, where waste

is collected in certain streets and at corners, is more appropriate for low income urban areas, possibly against a (low) fee.

- Competent private collection companies and NGOs should be encouraged to develop community-based collection schemes.
- Increase the number of containers and street bins and make their design compatible with collection and transportation systems. The design of containers should reduce unnecessary handling of the waste and make loading of vehicles easier. Containers should be heavy and/or chained to poles in order to minimise tipping over by scavengers. Their size should be adapted to the quantities and densities of waste generated.
- Increase the number of containers to collect institutional and industrial waste. Make the frequency of waste collection compatible with waste generation and the nature of the waste. When much organic waste is generated in a particular area like fruit and vegetable markets, collection should be daily or at least every other day to reduce unpleasant odours and the growth of disease vectors.
- Improve vehicle selection in urban centres, taking into account waste quantities and characteristics, the condition of roads and the distance to disposal sites. Tractor-trailers are most appropriate for medium hauling distances, typically less than 10 km to the disposal site.
- Trucks are more appropriate for long haul distances (more than 10km), as their capital costs are much higher than for tractors. Compactor trucks are appropriate to collect low density waste (typically less than 250 kg/m3, i.e. waste that includes much packaging material, plastics, papers, etc.), which may be the case in major urban cities. In rural and medium towns, where much of the waste consists of organic waste, dust and dirt, which has a high density, compactor trucks are not suitable.
- Establish regional collection systems in rural areas, covering several villages and small urban centres.
- Establish proper monitoring and supervision mechanisms for waste collection and transportation to ensure reliability and satisfactory operation of the service. Facilitate the work of supervisors by providing them with means of transportation and pay them incentives for good performance. Raise salaries and incentives of waste collection workers to increase their motivation and thus increase waste collection efficiency.

Objective 2: Improve waste disposal and treatment

Problem:

Disposal of waste is problematic in almost all the major cities of Pakistan due to limited availability of land and improper controls on dumping procedures. The latter causes odour, litter and smoke nuisance as well as posing health risks to nearby communities. Dumping is uncontrolled and waste is set alight daily causing air pollution. In rural areas waste is often dumped or burnt on banks of canals and at the border of villages.

Composting is considered a worthwhile option for waste treatment all over the world that should be promoted in Pakistan with the involvement of private sector.

Objective: To provide properly controlled disposal sites for all urban centres and to reduce air pollution

Programmes/Lines of action:

Disposal

- Introduce controlled tipping practices at all urban disposal sites to remove malodours, litter and other nuisance and to minimise the problem of flies and vermin. Use construction waste and sand as a top layer. Ensure that working equipment such as bulldozers is available at the disposal sites to level the waste. There should be sanitary landfill with leachate treatment facility.
- Select new disposal sites to replace disposal sites that are close to full or that are improperly located. Before granting an approval for the establishment of sanitary landfill site, the project proponent should undertake an Environmental Impact Assessment identifying potential damage of the disposal site to soil, water and air, and to suggest mitigation measures which should be implemented.
- Identify possible regional disposal sites in view of the scarcity of available land in adjoining cities.
- Improve the working conditions of scavengers on disposal sites, because this will improve their health and it increases the life of the disposal site and waste recovery levels.
- Give the rights to waste recovery to a waste dealer who pays the Municipality a monthly fee and has exclusive access to the recovered materials picked by the scavengers. Funds raised in this way can be used to maintain and operate the site.
- Incineration is not considered an option for the treatment of municipal waste due to its high operating and maintenance costs and the low calorific value of waste, but it is the recommended solution for the treatment of clinical and industrial hazardous wastes.

Composting

- Composting is only feasible and appropriate, when quantities of waste and organic content of the waste are high enough, and when there is a market for its products (compost and dry recyclables). This makes composting plants not suitable for areas where much of the waste consists of dirt or dust.
- Carry out proper feasibility and marketing studies for both organic and non-organic materials before any composting plant or recovery unit is installed. Study the prevailing rate of waste recovery, as this has a major influence on the amount of raw material available to the composting plant and thus on its output and revenue.
- Use well-designed locally manufactured equipment for composting plants, as this is low cost and spare parts are readily available. Very sophisticated equipment from abroad unnecessarily complicates operation and maintenance and usually includes spare parts that are expensive and difficult to obtain.
- Select proper disposal sites, when new composting plants are being planned. Composting plants are only a partial solution to the waste problem, as non-compostable waste and rejects still need to be disposed of.
- Investigate opportunities for co-composting with animal waste and/or dried sewage sludge to solve two problems in one time. This will increase the nutritional value of the compost and the moisture content of the raw material.
- Introduce segregation at source of organic waste and separate collection in pilot areas, as this will improve the quality of compost and of dry recyclables, and thus their quality and price. This needs adequate awareness-raising efforts and possibly incentives for the communities involved. Depending on its success it could be extended to other areas.

- Avoid mixing of municipal waste with infectious clinical and industrial waste, especially when waste is collected for composting, as this endangers the life of workers at the picking belt and the quality of the compost.
- Disseminate the operation manual produced of a well established composting plant in Pakistan to other composting plants. Develop maintenance programmes. Design training programmes for staff of composting plants to improve their technical, management and marketing skills. Encourage private sector to develop and maintain composting plants.

Objective 3: Reduce waste and maximize waste recovery

Problem:

Recycling is widely practised throughout the world, in Pakistan recycling is primarily done by the informal sector which recovers paper, cartons, plastics, metals, glass and textiles. The waste is frequently scavenged in unsanitary conditions and sold through a chain of middlemen, peddlers, central collection depots and remanufacturing industries.

Objective: To achieve efficient, safe and sustainable reuse and recycling of waste

Programmes/Lines of action:

- Encourage re-use and recycling at homes and in industry, etc. Improve practices that are hazardous for public health, by collecting hazardous waste separately and by facilitating the sorting work of scavengers at disposal sites. This should enable these people to make a living, while public health is being protected.
- Set up pilot projects for waste segregation at source, for example separate collection of packaging material like plastic and paper/cardboard from schools, universities, governmental buildings, etc.. Another possibility is to introduce a system of segregation of waste into wet (organic) and dry (non-organic) components in a pilot urban area. An NGO or private company could be involved in this.
- Provide opportunities to formalise the informal sector, e.g. by employing scavengers on the picking lines of composting plants.
- Consider the formation of co-operatives among scavengers to engage in kerbside collection of certain types of recyclables. Reserve a separate area at the disposal site for scavengers to search through the newly arrived waste, possibly spreading waste with loaders. Provide scavengers with protective gear and other facilities, as this will increase their efficiency and thus reduce the amount of waste to be disposed at landfills.
- Encourage NGOs and private companies to establish community-based segregation at source, separate collection and waste recovery projects.
- Encourage small and micro-scale waste recovery enterprises with assistance from banks.

Objective 4: Improve hazardous waste management

Problem:

There are no reliable estimates of infectious clinical and industrial hazardous waste generated in Pakistan. Some major hospitals in Pakistan have incineration facilities for safe disposal. However, infectious clinical and hazardous industrial waste can be observed at most disposal sites, as does hazardous waste from other sources like industries and agriculture. The quantities of hazardous waste are

unknown and are not being routinely separated from the waste stream. The health risks this poses to the collectors, scavengers and eventually the community are high.

Objective: To ensure safe collection, disposal and treatment of all hazardous wastes, including clinical wastes

Programmes/Lines of action:

- Identify sources, quantities and characteristics of all infectious clinical and industrial hazardous wastes generated in Pakistan.
- Segregate all clinical waste at source and establish separate collection services, based on hospital waste guidelines. Organise awareness-raising and training for hospital staff. And involve the private sector.
- Establish regional collection systems for clinical waste, where appropriate and involve the private sector.
- Use existing safe incinerators in hospitals. Determine the need for regional treatment facilities. Examine other methods of safe treatment like autoclaving, microwave treatment, etc.
- Establish a separate hazardous waste cells at major disposal sites, with double lining in accordance with international standards, to receive industrial toxic and hazardous waste.
- Identify sources, quantities and characteristics of other types of hazardous waste e.g. from industries and agriculture.
- Evaluate the options available for reducing hazardous waste quantities through segregation, industrial process changes like cleaner production or operational procedures, pre-treatment prior to disposal, etc.
- Explore the most suitable collection, disposal and treatment methods for each of the identified types of hazardous waste. Investigate the feasibility of installing regional facilities. Encourage involvement of private sector in the establishment of Hazardous Waste Treatment Centers on Public Private Partnership basis.

Objective 5: Achieve sustainability and cost recovery

Problem:

There is very little tax which is charged by municipalities for solid waste management. It is proposed that all the municipalities that are providing reasonable solid waste management must charge and generate revenues on cost recovery basis. Therefore, these revenue sources will be required to sustain the service, particularly to attract the private sector, which so far have had very limited success.

Objective: To reduce costs of solid waste management and to increase revenue in order to make the systems financially sustainable

Programmes/Lines of action:

A number of measures can be taken **to improve sustainability and cost effectiveness** of solid waste management:

- Purchase low-cost equipment, preferably locally manufactured, for which spare parts are locally available, which is suitable for the situation and compatible with other equipment.
- Increase the efficiency of waste collection by optimising vehicle and labour utilisation, encouraging the use of plastic bags by households, using proper combinations of primary and secondary collection systems (e.g. combine small trucks and container-trailed systems).

- Improve preventive maintenance, which will increase the productive life of vehicles and equipment and reduce down time.
- Encourage privatisation of waste collection, disposal and treatment will allow greater mobilisation of capital and generally leads to improvements in operating efficiency. However, an enabling environment needs to be created to encourage the private sector to invest in waste collection, treatment and disposal, particularly in collection of fees and better law enforcement.
- Encourage community-based collection systems and clean-up campaigns organised by NGOs .

Several measures can be taken **to raise revenue** for solid waste management:

- Charge a fee for waste collection from household by starting from major cities like Karachi, Lahore and Rawalpindi etc, introduce gate fees at disposal sites and composting plants (based on quantities of waste) and ensure a strict enforcement of litter fines. However, this can only be done once an improved service has been provided.
- Examine the legal options for making a waste collection fee obligatory for all waste producers.
- Introduce different fee rates for households, shops, clinics, etc. to make it affordable for all and facilitate cross-subsidising of poorer households by commercial and institutional establishments.
- Conduct willingness to pay studies before the introduction of any improved waste collection.
- Raise funds and lobby for additional allocations for solid waste management from the Federal and Provincial Governments, EPAs, foreign donors, etc.
- Increase revenue from composting plants by improving the marketing of compost and dry recyclables and by improving recovery, for example by paying employees working at the picking belt incentives according to amounts of waste recovered.
- Contract out disposal sites to a waste dealer or to scavenger co-operatives. The revenue can be used to maintain the disposal site and upgrade the working conditions of scavengers.
- Increase amounts of waste recovered and thus municipal income by setting up small-scale recovery and picking lines at disposal sites.

Financial sustainability in general can be enhanced by:

- Improving book keeping practices (separate budget and expenditure for solid waste management) in municipalities to assess the real costs of different methods of waste collection, disposal and treatment.
- Conduct feasibility and marketing studies for composting plants and other recovery facilities as these reduce the possibilities of an economic failure and will prevent unexpected costs for the municipalities in the long run.

Objective 6: Strengthen institutional and organizational capacity

Problem:

Institutional strengthening is considered essential for lasting improvements in solid waste management. The City District Governments in big cities like Karachi, Lahore and Rawalpindi have established separate Solid Waste Departments to give the required importance to solid waste management and to regulate its operation. An integrated waste management approach will be crucial, while implementing new waste management systems and optimising existing systems, which means

addressing technical, social, economic and environmental aspects of waste management.

A number of institutional problems hamper effective and efficient solid waste management. Governmental officials and decision-makers usually have a limited understanding and awareness of solid waste issues.

Law enforcement is in need of improvement. Salaries and incentives for waste management workers are low and there is too much reliance on seasonal workers. The private sector and NGOs are little involved in solid waste management and lack incentives to do so. Lack of communication between municipalities and citizens does not motivate residents to handle waste properly and to keep to rules and regulations.

Objective: Make institutional and organisational capacity more efficient and effective and improve working conditions in solid waste management

Programmes/Lines of action:

- All the Federal and Provincial Governments in Pakistan including FATA, Northern Areas and Capital Territory should develop a solid waste management action plan for their respective areas. Strengthen the solid waste management department at municipalities with training, facilities, funds, etc. to plan and co-ordinate waste management.
- Establish special departments for solid management at district level, planning and co-ordinating all existing solid waste management activities and supervising all employees. It should have the authority to take decisions regarding operation, management (including purchase of equipment) and maintenance.
- Conduct technical studies (to determine waste characteristics, haul distances, street and traffic conditions, etc.) as well as social studies (on behaviour, satisfaction, willingness to pay, etc.) prior to implementation of any projects. Carry out monitoring and evaluation surveys during and after activities to assess their impact on the population.
- Strengthen the enforcement of laws and regulations on solid waste management (litter fines, regulations regarding construction waste, hospitals and industry etc.) as this will stimulate residents, contractors, etc. to obey the law and it will increase the authority of the municipality.
- Train decision-makers and senior officials to encourage exchange of experiences, strengthen financial and management skills and to raise environmental awareness.
- Improve working conditions of solid waste management employees by increasing their salaries and incentives, providing them with uniforms and other protective gear, etc. This will increase their motivation and morale and thus the efficiency of solid waste management.
- Increase incentives for private sector and NGO participation in waste collection, disposal, treatment and recovery (create an enabling environment by allowing for tax exemptions, provision of low cost land, assistance in obtaining funds from banks, easing regulations for licensing, etc.). Involve NGOs in awareness-raising.
- Encourage opportunities for joint operation and management of waste collection systems by municipalities, NGOs and private companies as well as for full privatisation.
- Establish better communication channels between municipalities and citizens by setting up complaint desks, citizen panels and neighbourhood committees, and

by informing residents of environmental initiatives through newspaper articles, radio, TV, etc.

Objective 7: Increase involvement of key stakeholders and raise awareness

Problem:
Awareness will need to be raised amongst the community to avoid presently unsightly and unhealthy littering practices. Residents lack motivation to engage in proper waste handling. They do not have alternatives but to dump their waste and they do not know the consequences of dumping waste in open spaces. Economic incentives to reduce waste generation or to recycle waste are also lacking, as is law enforcement regarding among others littering and improper disposal of construction waste.

Objective: To involve as many stakeholders as possible, especially disadvantaged groups, in order to establish SWM systems that are socially acceptable and affordable.

Programmes/Lines of action:
- Identify primary (direct) and secondary (indirect) stakeholders in solid waste management, prior to implementation of any project.
- Encourage participation of all stakeholders in improved solid waste management, because this increases a feeling of local ownership, it raises environmental awareness and it encourages willingness to pay for improved services.
- Identify and involve disadvantaged groups (e.g. illiterate people, scavengers, low-income groups, minorities, and women).
- Undertake a detailed socio-economic study of the implications of each improvement in solid waste management in order to evaluate its effects on income, employment and the position of disadvantaged groups.
- Seek people's views through social surveys and focus group discussions about improved waste collection, their willingness to pay, their preferred destination for a remedied disposal site and other issues. Assess their knowledge and attitudes regarding health and environmental issues through interviews and use this information in awareness-raising. Examine improper waste handling practices by households through observation and (group) interviews with municipal waste collectors.
- Use a combination of carrot (persuasion and incentives) and stick (command and control) approaches to raise awareness and increase involvement of stakeholders in solid waste management. For example inform people about new waste collection services, raise their awareness of proper waste handling, while at the same time ensuring strict enforcement of anti-litter regulations.
- Promote and support community-based clean-up campaigns, beautification and tree planting to raise environmental awareness and to create a positive image of the environment among citizens. Organise visits to environmental projects and services, such as composting plants, for example for school children.
- Set up awareness-raising campaigns using a combination of techniques such as posters, leaflets, environmental contests, exhibitions, media (TV/radio/newspapers), home visits, public meetings and workshops, campaigns in schools and universities etc. Possible topics include littering, health risks and environmental damage related to solid waste, and community-based action.
- Target specific groups with awareness-raising. Women, children and youth are considered important target groups for awareness-raising about solid waste,

because of their involvement in waste handling and because children and youth are the future citizens.
- Awareness-raising alone is not enough. In areas with limited waste collection services people need to have access to containers or a regular kerbside collection system, otherwise they will not change their behaviour.
- To develop and institutionalise a Waste Information System (WIS) at local and national level for all types of waste, which will constitute a main data source for the preparation of detailed local and national waste management plans

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PART B

Solid Waste Management Guideline

Solid Waste Management Guideline

1. Introduction

2. Waste Generation, Discharge and Composition

2.1 Waste Generation

The **waste generation** is usually represented by **waste generation rate** – the quantity of waste generated per person per day (kg/day/capita). To hold and monitor the waste generation rate is the first step of proper solid waste management; therefore it is one of essential data to manage the waste. But generally speaking, to know the exact data of generation rate is very difficult, so it is usually conducted random sampling survey to know the generation rate. The generation rate is estimated by the average data of the survey result. The waste generation vary with the population, life style, economical activities of the area and seasonal events.

This guideline requires all municipalities should to monitor the waste generation amount annually.

2.2 Waste Discharge

After waste is generated, people may dispose of it in a number of ways:

- On-site disposal – burning and/or burial.
- On-site composting.
- Recycling, generally involving individual collectors visiting peoples' premises (homes, shops, etc.) or people selling items directly to middlemen.
- Discharge for municipality's collection.
- Illegal/Open dumping.

The amount of waste discharged for collection is usually represented by **waste discharge rate** – the quantity of waste discharged for collection per person per day (kg/day/capita). The waste discharge rate is always less than the waste generation rate. The amount of waste discharged for collection also increases with economic growth. However, it is also strongly dependent on local conditions and the relative proportions of waste disposed of by other means.

The waste discharge rate may be used for SWM planning in a similar way to the waste generation rate.

Figure 2.2-1 on site composting

Figure 2.2-2 Recyclable collector

Figure 2.2-3 collection by municipality

Figure 2.2-4 open dumping

2.3 Waste Composition

The physical composition of solid waste also varies between different societies and with income, as shown below.

Table 2.3: Household Waste Composition

Waste Type	Lahore	Karachi	Tokyo, Japan
Compostables:			
•Food/kitchen	30.72	22.84	26.6
•Grass/wood	21.26	-	9.0
•Bones	1.03	5.50	-
Total	53.01	28.34	35.6
Recyclables:			
•Paper	2.70	8.41	52.5
•Cardboard	0.01	8.11	-
• Plastic	5.63	6.20	6.9
• Glass	0.70	5.21	0.2
• Metal	0.32	4.08	0.4
• Textile	7.45	8.93	4.0
Total	16.81	40.94	64.0
Stone/brick	27.84	8.83	-
Shoppers	-	6.49	-
Plastic Wrappers	-	8.03	-
Other	**2.35**	**7.37**	**0.4**

Source:
1. Lahore data: Solid Waste Management Department, Lahore.
2. Karachi data: Solid Waste Management, Karachi 2005
3. Tokyo, Japan from 1999.

Figure 2.3 Waste Composition Survey (in Nepal)

In addition above, **waste bulk density** is used for selecting and sizing garbage storage containers, public bins and collection vehicles and for converting vehicle trips data to tonnages. **Moisture content** is used for looking at treatment options, especially composting and incineration. **Carbon-nitrogen ratio** is useful for composting. **Calorific value** is useful for incineration.

This guideline requires followings;

1. All municipalities should to monitor the waste composition and waste bulk density annually.
2. All municipalities above 500,000 populations should to monitor Moisture content and Carbon-nitrogen ratio annually.
3. All municipalities above 2,000,000 populations should to monitor Calorific value annually.

3. Waste Reduction (including Reuse and Recycle)

Waste reduction is the first step of minimizing the environmental negative impact and management cost. To reduce the waste amount, it is necessary to enhance the following activities;

- Not to purchase unnecessary amount- it wastes not only your money but also the precious natural resource
- Not to purchase disposal items
- Not to take unnecessary shoppers
- Reuse the materials

Recycling is widely practiced throughout the country and primarily done by the informal sector which recovers paper, cartons, plastics, metals, glass and textiles. The waste is frequently scavenged in unsanitary conditions and sold through a chain of middlemen, peddlers, central collection depots and remanufacturing industries.

4. Waste Collection

Waste collection rate is estimated around 50-80% in Pakistan, but it is almost only imagination. If each municipality have a weighbridge in the dumping site, it is easy to monitor the waste correction amount, control the waste and plan the future plan. Therefore it is called weighing the waste is the first step of managing the waste. But unfortunately only few municipalities have installed the weighbridge.

Waste collection is separated two part, primary collection and secondary collection. Primary collection means waste transportation from the waste generation source, ex. house, shop and park, to collection point, and secondary collection means from collection point to waste disposal/treatment site. The road/street sweeping waste is categorized as primary collection.

This guideline requires followings;

1. All municipalities should to monitor the collection/dumping amount at least once a year.
2. All municipalities above 500,000 populations should to installocal government weighbridge in each disposal/treatment site and monitor the amount daily.

Figure 4 Weighbridge

5. Final Disposal

Final disposal site is basically the place of neither reusable nor recyclable. But actually there are many valuable wastes and it attracts a lot of scavengers/waste pickers to recover the valuable wastes.

Some items decompose very quickly (e.g. food/kitchen waste), while some take a long time (e.g. plastic – over 100 years) and others are hazardous or toxic (e.g. batteries (lead and zinc), tube lights (mercury)). Hence, it is very important to practice good final disposal of waste for our sake and the sake of our children, grandchildren and their children.

For further detail, refer in "Guidelines on solid waste disposal and landfill establishments"

5.1 Types of Landfill Structure

Landfill site have been classified into five types, based on the microbial environments existing in the landfill layers, as follows;

(i) Anaerobic Landfill
(ii) Anaerobic Sanitary Landfill
(iii) Improved Anaerobic Sanitary Landfill
(iv) Semi-aerobic (Sanitary) Landfill
(v) Aerobic (Sanitary) Landfill

The following diagrams show the tree major types of landfill:

5.1.1 Anaerobic Landfill

Waste material is deposited in an excavated hole or natural depression, the lower portion of it is permanently wet or submerged, and it decomposes under anaerobic condition.

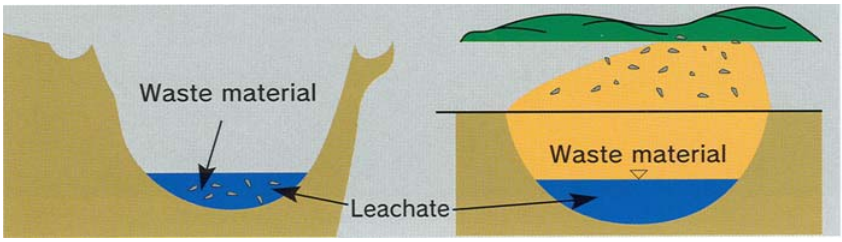


Figure 5.1.1 Anaerobic Landfill

5.1.2 Semi-aerobic Landfill

Leachate is collected in a leachate collection pond through properly sized perforated pipes embedded in graded boulders. As the outlet of the main leachate collection pipe is always open to air, fresh air is drawn into the layers thereby introducing an aerobic condition around the pipes. Since leachate is removed as quickly as it is formed, the internal waste layers have lower water condition.

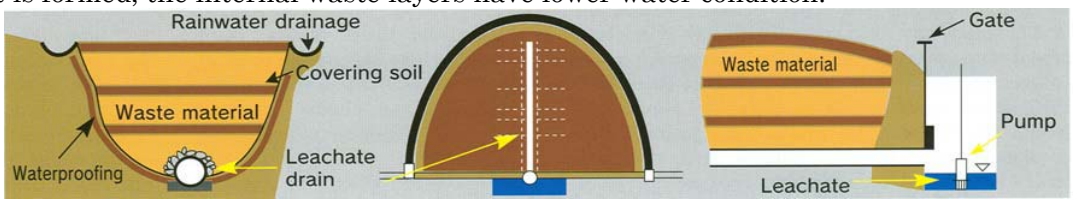


Figure 5.1.2 Semi-aerobic Landfill

5.1.3 Aerobic Landfill

In addition to the leachate collection pipes as in the semi-aerobic design, air-pipes are constructed to pump in air into the waste layers to maximize internal aerobic activity.

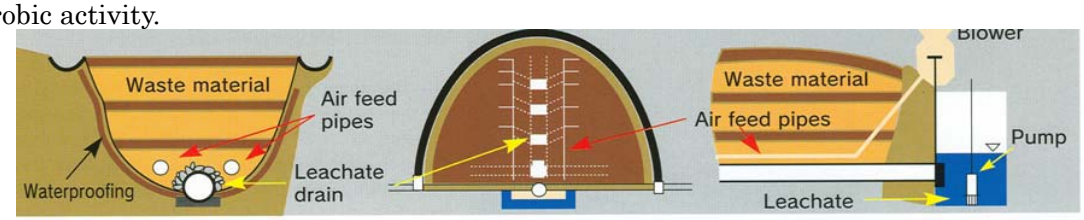


Figure 5.1.3 Aerobic Landfill

5.2 Levels of Landfill

The level of improvement of sanitary landfill system can be achieved in four stages, namely;

(i) Level 1: Controlled tipping
(ii) Level 2: Sanitary landfill with a bound and daily cover soil
(iii) Level 3: Sanitary landfill with leachate recirculation
(iv) Level 4: Sanitary landfill with leachate treatment

In improving sanitary landfill system, it is more efficient if the works are carried out after having first determined the level of improvement to be achieved. This decision should be made after considering the site conditions at the proposed landfill site, the financial capability and the level of technology required for the implementation to be carried out by municipalities. The level of sanitary landfill system, its target, etc. are further described as below table 5.2

Table 5.2 Level of Landfill

	Level 1	Level 2	Level 3	Level 4
Target	**Introduction of controlled tipping**	**Sanitary landfill with a bound and daily cover soil**	**Sanitary landfill with leachate recirculation**	**Establishment of leachate treatment**
Achieved Level	• Establishment of access to site • Introduction of cover material in order to prevent fire, littering of waste and odour • Introduction of inspection, control and operational records of incoming waste	• Establishment of site boundary in order to distinguish the landfill site and to eliminate scavenging • Application of sufficient cover for waste disposal • Establishment of disposal site by construction of enclosing bund • Introduction of divider for unloading area and working face • Establishment of drainage system in order to divert storm water and seepage from surrounding areas and to reduce leachate • Introduction of environmental protection facilities in order to lessen direct impact on surroundings such as buffer zone, litter control and gas venting facilities • Introduction of semi-aerobic sanitary landfill through the installation of gas venting facilities • Introduction of amenities for staff	• Establishment of leachate control by the installation of leachate collection, recirculation and monitoring facilities	• Establishment of leachate treatment by the installation of oxidation pond, etc. • Establishment of seepage control • Establishment of semi-aerobic sanitary landfill
Further Improvement To Next Level	• Establishment of site boundary • Introduction of environmental protection facilities • Introduction of amenities for the staff such as sanitary facilities and locker room • Introduction of semi-aerobic sanitary landfill	• Improvement of semi-aerobic sanitary landfill • Establishment of leachate control • Establishment of leachate treatment	• Introduction of leachate treatment system • Establishment of semi-aerobic sanitary landfill	• Establishment of high level treatment system • Introduction of service system to the surrounding residents
Environmental Issue	• In this level, environmental protection measures are not established except the provision of cover material. Impacts on the surrounding by the landfill operation are great and may include the following; • Surface and groundwater pollution by leachate • Littering and dust • Breeding of insects and rodents • Unpleasant view of landfill • Noise and odour	• In this level, since disposal site and drainage system are already established, landfill operation can be controlled efficiently. Furthermore, with the application of sufficient cover and introduction of some environmental protection facilities, impact from landfill operation is much reduced than Level 1. Besides, the installation of gas venting facilities introduces a semi-aerobic sanitary landfill system. However, leachate is still not controlled and monitoring system has not yet to be established.	• Leachate accumulated at the bottom of landfill site is discharged through drain pipes, i.e. leachate collection pipes. These pipes also permit the natural inflow of air to promote semi-aerobic condition for the decomposition of waste. Thus, although leachate collected is pumped up and sent back to the landfill site without any treatment, quality of leachate is improved and odour is lessened because of the semi-aerobic condition created. To achieve favourable improvement, the monitoring and control of leachate levels and checking for malfunctioning of leachate collection pipes are essential. • In addition to the above, the recirculation of leachate into landfill site may facilitate purification by the wastes through absorption and reduction process.	• The installation of seepage control facilities and oxidation pond with aerator for leachate treatment would put the sanitary level of disposal site above the design principles as stipulated in the NEQS. Furthermore, these installations secure the semi-aerobic sanitary landfill which facilitates active decomposition and prompt stabilization of the wastes. It would eliminate groundwater pollution. • Furthermore, in order to utilize semi-aerobic condition of landfill for the stabilization of waste disposed, recirculation of leachate as well as treatment by oxidation pond is made. The semi-aerobic condition, where part of landfill is in aerobic and part is in anaerobic condition, facilitates reduction and absorption of hazardous parameter in leachate, such as COD and heavy metals by passing over the layers of waste repeatedly. • However, in case that discharge of effluent requires stricter limits such as NEQS, it is necessary to introduce high level treatment system.

Figure 5.2-1 Open dumping site with *katchi abadis* (squatter settlements)

Figure 5.2-2 Landfill with daily cover soil

5.3 Target Level of Landfill

The introduction of an advanced sanitary landfill system requires a large amount of capital investment. Taking into consideration of the size of the local government's annual budget and financial situation, we can expect various problems with regards to funding for the sanitary landfill system.

It is more realistic at the present moment to improve a sanitary landfill system in stages. It is also important that at the same time to consider the need to achieve a balances urban infrastructure improvement and aspects of urban environmental preservation.

Based on the above mentioned, the primary target of the improvement plan for sanitary landfill system should be at Level 3. The implementation programme should contain a plan for continuous upgrading of the system in link with the financial and technical capability of the local government so that Level 4 may be obtained as early as possible.

This guideline requires followings;

1. All municipalities should to target at Level 1.
2. All municipalities above 500,000 populations should to target at Level 2.
3. All municipalities above 2,000,000 populations should to target at Level 3.

6. SWM Cost Reduction

6.1 SWM Operation and Maintenance Costs

SWM budget costs usually make up a high proportion of local government's annual budget, mainly due to many sanitary workers working in SWM. Hence, it is very important to find out how this money is spent and how costs might be reduced. SWM operation and maintenance (O&M) costs may be divided up into a number of categories, as shown below.

Table 6: SWM O&M Costs Breakdown

Category	Typical Items
Technical, supervision and administration	• Managerial, technical, supervisor and administrative staff salaries and allowances (taking into account the percentage of working time spent on SWM works). • Office equipment/expenses. • Miscellaneous.
Discharge/storage	• Regular replacement of containers/skips. • Maintenance/repair of public garbage bins.
Collection: ・Wheelbarrows ・Handcarts ・Hand tractors ・Tractors/trailers ・Lorries ・Compactor Trucks	• Driver and local laborer salaries. • Staff equipment (gloves, aprons, boots, etc.). • Diesel/oil. • Vehicle repair/maintenance. • Trailer repair/maintenance (including periodic frame rebuilding). • Periodic wheelbarrow/handcart frame rebuilding. • Tyres. • Insurance/License. • Depreciation.
Processing/Treatment (e.g. compost facility) and landfill site	• All staff salaries – supervisors, drivers, local laborers • Staff equipment (gloves, boots, wheelbarrows, etc.). • Vehicle costs (e.g. loader). • Civil works maintenance. • Equipment/machinery maintenance. • Equipment/machinery insurance. • Administration. • Leachate removal/treatment. • Land rental. • Electricity. • Water. • Chemicals/additives. • Bagging. • Depreciation. • Other.

Annual costs should be determined for each category and divided by an appropriate tonnage of waste in each case to get the category unit cost. These annual and unit costs are very useful for planning purposes, particularly in looking at ways of reducing SWM costs. Currently, it is very difficult to calculate these SWM unit costs for most local authorities for two reasons:

- Most of local governments do not record SWM expenditure in this way. Instead, the current local government accounting system may, at best, allow the following SWM costs to be determined:
  - ✓ Total salaries.
  - ✓ Office equipment/expenses.
  - ✓ Vehicles.
  - ✓ Disposal.
  - ✓ Other.

- Many local governments do not keep accurate records of the amounts of garbage they are collecting and disposing. SWM tonnages are either not known or must be estimated from approximate vehicle trips data.

Hence, it may take some effort to obtain SWM costs according to the categories listed above. However, consider the following:

- Currently, for most local governments the processing/treatment cost is zero (i.e. there is no centralized composting or recycling facilities).
- Most local governments are spending too little money on final disposal. Spending on this item needs to be increased as a local government progresses from open dumping to controlled tipping/sanitary landfill.
- Typically, SWM collection/transportation makes up to 60% of total SWM costs.

Hence, it is very useful to focus on calculating the SWM collection/transportation costs for different vehicles as the first step in SWM accounting, because the greatest cost savings can generally be achieved in this category, often for relatively little effort.

6.2 SWM Collection and Transportation Costs

The following table shows how SWM O&M collection/transportation costs can be calculated for a tractor/trailer unit, using imaginary data.

Table 6.2: Calculating Tractor/Trailer O&M Collection/Transportation Costs

Item	Unit	Unit Rate	Quantity	Cost
Driver	Rs/month	7,000	1 x 12	84,000
Laborers	Rs/month	5,000	3 x 12	180,000
Staff equipment	Rs/year	2,500	1	2,500
Diesel	Rs/month	4,500	12	54,000
Oil	Rs/month	300	12	3,600
Tractor repair/maintenance	Rs/month	2,000	12	24,000
Tyres	Rs/year	9,000	1	9,000
Trailer repair/maintenance	Rs/year	20,000	1	20,000
Insurance	Rs/year	5,000	1	5,000
License	Rs/year	150	1	150
Depreciation	Rs/year	70,000	1	70,000
Total				452,250
Average trips	Trips/day		2.4	
Average Tonnage	Ton/year		1260	
Unit cost	Rs/Ton			**360**

Notes:

1 Average trips per day = Total number of tractor trips year/number of tractors
2 Average tonnage = Average trips/day x 300days/year x No of ton/trip. No of ton per trip should ideally be measured by weighbridge. Otherwise, it may be calculated from the average tractor filled volume x garbage bulk density

6.3 Keeping Costs Down

The local government should compare its SWM O&M collection/transportation costs for the different types of vehicles it operates with the unit costs shown above. It should then look at ways of reducing high costs. Some important questions to consider include:

- Where is handcart garbage collection necessary and where can it be eliminated?

- Where is hand tractor collection necessary and where can it be eliminated? Ideally, hand tractor usage should gradually be phased out from non-essential areas.
- How can waste scattering and the garbage loading time be reduced? – the new waste discharge rule and new collection system!
- How many trips should each vehicle be able to make each day? How many vehicles actually achieve this?
- How many local laborers should be assigned to each collection vehicle? Introduction of the waste discharge rule and new collection system should make it possible to reduce the number of local laborers per vehicle by at least one.
- How often should garbage be collected from different areas? Where is daily collection necessary? Where can longer collection frequencies are used?
- How much of the trailer capacity is being filled with garbage per trip? If less than 80%, is this due to poor design? – if so, can its filling capacity be increased by modifying it at a reasonable cost?; if not, can the collection route or frequency be modified to ensure the trailer is more than 80% full when it travels to the disposal site.
- Should local laborer working hours be modified to avoid peak traffic times?
- How can stationary trailers be used to reduce collection/transportation costs?
- How much working time is lost due to local laborer absenteeism and/or driver absenteeism? Would privatization save the local government's money?
- What proportion of local laborers salaries does the local government pay out as overtime? Is this cost effective? Could overtime payments be reduced?

Answers to some of the above questions may result in the number of local laborers being reduced. Careful thought should be given to this, as many garbage collection local laborers have very low status in Pakistani society. Often, their parents and even grandparents may have done the same job. Although they may complain about the working conditions and pay, the job of local laborer provides them with some security in the form of a stable job and basic income. Thus, reducing the number of local laborers may save the local government's money but could cause significant social upheaval amongst local laborers and their families. Out of a job, they would have to seek alternative employment, which typically is of a temporary, short term nature (e.g. gardening) and thus less secure.

7. Public Participation

7.1 Introduction

Increasing public participation involves establishing and maintaining an effective public-local government communication system. This involves the local government deciding clearly and reaching consensus on what the local government should do and what the public should do. It is a two way process – the public must do what it is asked to do (improved public participation) and the local government must do what it says it is going to do (improved local government performance), particularly for collecting garbage on time and according to schedule. It should also listen to the publics' ideas and requests, follow up and resolve public complaints, provide them with reminders and feedback on progress/ problems. By doing such things, the local government will gain the public's trust, which is vital to increasing and maintaining public cooperation. The local government should also realize that its ultimate goal is a CLEAN city – this is what the public want and this is more important than setting targets based on the number of trips or tonnes of garbage collected per day.

In doing this, the local government must be practical as well and consider the

following:

- Human resources: are they available? Committed? Enthusiastic?
- Equipment required: does the local government have it? If not, can it borrow or buy them?
- Costs: Can the local government afford this? If not, can it get sponsorship or donor support?
- Effort: how much effort is required – small, medium, local large?
- Time: short or long?, is the starting date realistic?, is there a timetable?

7.2 Support of Council Members

Many garbage collection supervisors and labourers have complained that the implementation of new SWM ideas and practices is hindered by elected Council members. For example, many Councils have a policy that the public should not discharge large quantities of garden and/or building waste for collection. Instead, they should contact the Council to arrange special collection of such wastes for a fee. However, many members of the public dislike this system, complaining that they already pay taxes, so why should they have to pay more for collection of such wastes. Often, they complain about this to their Council members, who will then order the local government supervisors and labourers to collect the offending wastes. Such behaviour undermines the authority of the local government and also increases the likelihood of any new ideas and practices failing.

Hence, it is vital that Council members should be kept informed of proposed changes to SWM practices and asked for their cooperation as early as possible in the planning process, particularly when such changes are going to involve more public participation than the current system. Their comments and ideas should be listened to, while reasons for introduction of the new system and how it will work should be explained carefully to Council members. In particular, Council members should be informed that complaints are likely to increase during introduction of the new system. Rather than giving in to peoples' demands, Council members should make decisions consistent with the changes being introduced, educating the public about why such changes are being made. Otherwise, such changes are likely to fail. As part of this process, it may be worthwhile holding regular orientation on SWM matters for Council members, covering current status, changes and issues. This is particularly important after local body elections, and it may help to generate and maintain interest in SWM amongst them.

7.3 Inform and Educate the Public

The public should be informed about any proposed changes to SWM practices relatively early in the planning stages, so that their ideas and comments can be taken into account in finalising the programme. This is particularly important when the local government is going to ask for their increased participation, which many people may be opposed to. Hence, it is a good idea to explain to people about the problems with the current system, what the new system involves and its benefits to the people and city – educate them!

The information and education process can be done in a large number of ways, including:

- Media: leaflets, posters, murals, notice boards, books, stories, games, videos, newspapers, radio, television.

- Events: public meetings, community discussion groups, competitions, drama/street theatre/music, marches, theme days, cleanup days.
- Other: printed shopping bags or tee-shirts with environmental messages, SWM cartoon character, slogan or logo.
- No publicity!: Simply rely on people's curiosity to generate interest. This is appropriate in some cases, where it is reasonably obvious what the change is for (e.g. bell collection, new enclosed public garbage bins).

Public education and awareness raising is discussed in more detail in the chapter 9.

It is often useful to inform and educate people through existing groups, including:

- Community: Street committees, community based organisations, welfare societies, women societies, funeral assistants' societies, temple/church societies, Sunday schools (children's groups and leaders' committees), schools (children and parents' committees).
- Business: Hotel associations, City Watch committees, Traders Associations, Chamber of Commerce.
- Other: voluntary organisations (e.g. Lions) and non-governmental organisations (NGOs).

Many such organisations are keen to support poverty alleviation, sanitation improvement, city beautification or waste minimisation initiatives, with some of them actively working in these areas. Voluntary organisations may assist with sponsorship for publicity or equipment (e.g. compost barrels), while NGOs may already have established programmes and networks within the community, which the local government may be able to work through.

Utilise a wide range of human resources:

- Local government staff (e.g. labourers, supervisors, inspectors, District Officers with support from the Nazim, Council members, etc.)
- Other government officers (e.g. midwives, Lady Health Workers).
- Community volunteers (e.g. retired people).
- Respected community leaders (e.g. priests, Imam).

Remember that providing information and education is MOST important during the early stages of introducing changes to the SWM system. If you don't do this, people will not know why they are being asked to change nor what they are supposed to do.

7.4 Establish Effective Communication Channels

It is important to establish effective communication channels between the public and local government. Such channels should include the following:

- Direct contact with Supervisor: The community in each neighbourhood should be informed or the name of their SWM Supervisor and how to contact him/her.
- Inspectors: house to house visits.
- District Officers: Community meetings.
- Local government Information/Complaint Line: The local government should inform the public of how to submit both written and verbal information requests and complaints. The minimum requirement here is for an address and telephone number and who to direct such requests/complaints to.
- Means of local government making regular contact with community members: This may be done through the media and/or events, particularly involving existing

community and business groups (refer above section). Alternatively, selected community members and representatives of different organisations may be invited to participate in relevant Council meetings (e.g. Health or Environment Committee meetings).

When working with existing community/business groups, it may be beneficial to ask them to nominate one-two people who will be responsible for liaising with the local government on SWM matters.

In other cases, it may be beneficial to select voluntary health animators at the street or neighbourhood level. These health animators are responsible for liaising with the local government on SWM issues within their neighbourhood. Their name and contact details should be communicated to all people living in the neighbourhood. Local government Area Supervisors should meet with the Health Animators on a regular basis. Ideally, health animators should not be politically aligned. In both cases, the local government will address any communications to the group/neighbourhood through these nominated people/health animators. It should also be made clear to the nominated/selected people that their main concern is SWM issues. Other health issues (e.g. water, storm water drainage, sewage, etc.) will be addressed separately.

7.5 Follow Up and Resolve Complaints

It is vital that the local government follow up and resolve complaints received from members of the public. Often, the PHI or Supervisor of foreman in the particular area in question will be given this task.

These complaints may come in a variety of forms:

- Complaints about the new system. These may take two forms. Some people may oppose the changes - try to convince them of its benefits and encourage them to cooperate. Other people may be happy with the changes, but complain about specific problems. For example, with introducing a bell collection system in Sri Lanka, the vast majority of the public were very happy with the idea, but some people complained about the music not being loud enough, or the tractor not coming on time, or the bell being broken sometimes.
- Complaints about general problems (e.g. local government's waste collection vehicle sometimes does not come or is late). Many of these problems have common solutions (e.g. improving the collection vehicle maintenance system).
- Complaints about specific, local problems (e.g. "outsiders throwing garbage from their vehicles onto vacant land opposite my house"). Many of these problems will have unique solutions specific to the location (e.g. find out who is dumping such waste and fine them).

In each case, the Supervisor/Inspector should listen to the person making the complaint; make a record of it; ask them to write to the local government (if appropriate); explain to them reasons for the problem (if known); inform them of what they will do to solve the problem and by when (date); provide them with relevant contact details; investigate the problem, as necessary; inform relevant local government staff about the problem and required action; and inform the person who made the complaint after any action is taken and the outcome. For this process to be effective, the Supervisor/Inspector or foreman must know their area and the rules. For example:

- If the roads/drains are not clean, do the roads/drains come under the authority of the local government, provincial government or National Highway Authority?
- If there are a pile of tree cuttings under power/telephone lines, who cut them and who should remove them? – local government, provincial government, WAPDA/KESC, PTCL or private contractor?

Don't commit the local government to something it is not responsible for. If you don't know who is responsible, say you will find out and inform them latter. If there don't seem to be any rules, procedures or standard practices in place (e.g. school waste collection policy), check whether this is true first, by consulting with experienced/senior local government staff, checking national and local legislation and asking other Councils and national authorities (e.g. Environmental Protection Agency). If true, new rules, procedures and standard practices may need to be established and informed to relevant parties. Remember – SWM is dynamic!

7.6 Provide Reminders and Feedback to the Public

Often, when new SWM systems or practices are introduced, there is a relatively quick and good response from the public in the early stages, particularly if the public perceive the changes to be of benefit to them. However, some people are more resistant to changing their behaviour while others may forget or slip back into old habits after some time. Hence, it is good to offer people periodic information updates, which remind them of and reinforce the messages contained in the initial information. Such reminders also offer an opportunity for providing feedback to the public on the success and problems of the new system and what efforts the Council is making to improve the new system. Again, this can be done using a variety of methods as described previously.

7.7 Typical Problems for Discussion

Typical daily problems related to dealing with the public are also included next chapter. It may be a useful exercise for Supervisors/Inspectors and in charges for SWM to discuss solutions to these problems based on their knowledge and experience and the information presented in the preceding sections.

8. Effective Community Meetings and Presentations

Supervisors/Inspectors may sometimes have to attend community meetings in varying capacities – sometimes as the chairman, sometimes to make a speech or give a presentation, sometimes to listen and make notes. Hence, it is very important for them to develop the relevant skills to do these things. This section provides a brief summary of what this involves.

8.1 Controlling Meetings

Controlling meetings is a difficult but very important task. Key points are:

- Inform people in advance – why?, when?, where? and for how long? By doing this, people will know the purpose of the meeting, its date, time and location and by when it should be finished.
- Start and finish on time.
- Have a clear purpose.
- Follow standard meeting procedure.
- Limit and keep to the agenda.
- Limit attendance.
- Control and summarise the discussion.
- Press for decision and commitment.
- Minute attendance and action items, including who is responsible for each item?, what they have to do?, by when?, and how other people will know it is done.
- Distribute meeting minutes to attendees and other relevant people.

8.2 Preparing a Speech or Presentation

- Research your audience.
- Prepare an outline.
- Gather material – information, visual aids, photos, etc.
- Prepare the speech/presentation (use small cards). If you are a novice, it may pay to write it out in full; if you are experienced, key points may be enough.
- Rehearse your speech. Is the content and length okay? Edit as necessary.
- Make a list of what you need to take: copy of speech, publicity leaflets, paper and pens for making an attendance register and minutes, etc.

8.3 Using Electronic Media

If you are going to be using electronic media, such as an overhead projector (OHP) or multi-media projector:

- Familiarise yourself with the equipment.
- Check the venue for availability and location of power supply. Is it reliable and safe?
- Make sure a low table is available for placing the OHP/projector on.
- Does the room have a light coloured wall in an appropriate place to use as a screen, or do you need to bring one?
- Can the room be darkened, or do you need to bring a curtain or sheet for darkening the viewing area?
- Make a list of what you need to take: e.g. OHP/projector, computer, screen, OHPs, extension cord, adaptor, handouts, etc.
- Have a contingency plan in the case of a power cut or equipment failure.

8.4 Doing the Speech of Presentation

- Control your nerves.
- Delivery – voice, speed, pauses, eye contact, gestures, body language, humour.

- Check your audience – are they engaged?, looking around?, falling asleep?
- Manage questions.
- Manage hostility.
- Keep to time.

8.5 Sample Topics

A wide range of sample topics for speeches or presentations related to SWM are described for your references. It may be a useful exercise for Supervisors/Inspectors to each pick one topic, spend a short time preparing a 2min speech and then deliver it to their colleagues, who will evaluate their performance. A similar exercise can be done for preparing and giving presentations.

Sample Topics for Preparation of Speeches or Presentations

(1) To encourage people to use durable shopping bags made of natural materials rather than polythene bags.
(2) To encourage parents to package their children's lunches in permanent lunchboxes rather than wrapping them in polythene.
(3) To encourage people to reuse plastic and glass bottles, paper/cardboard, etc. as much as possible.
(4) To encourage people to compost their organic waste at home.
(5) To encourage people to support the traditional recycling system.
(6) To encourage people not to throw their garbage loosely at the roadside or into drains.
(7) To encourage people to discharge their garbage in some type of container for collection.
(8) To explain to people why they should not litter.
(9) To encourage people to keep their neighbourhoods clean.
(10) To explain to people why burning plastics and/or tyres is bad.
(11) To explain to people why it is bad to throw garbage into waterways (streams, river, sea).
(12) To explain to people why the local government needs increased cooperation from them to improve SWM.
(13) To explain to people what the local government is doing to provide a more reliable garbage collection service.
(14) To explain what people should do if they want to complaint to the local government about a SWM issue.
(15) To explain to people how they are going to try and eliminate garbage heaps in their area.
(16) To explain to people how they are going to try and stop outsiders dumping their garbage from vehicles in their area.
(17) To explain to people the local government's garden and building waste collection policy.
(18) To encourage people to clean the drains in their area.
(19) To explain to market traders why it is important to maintain markets in sanitary conditions.
(20) To explain to hospital staff (nurses, cleaners, etc.) why they should keep hazardous waste (sharps, clinical waste, etc.) out of the normal garbage collected by the local government.

9 Public Education and Awareness Raising

9.1 Introduction

Public education is an important new task for Supervisors/Inspectors. Public education in this context involves raising peoples' awareness and teaching them about certain SWM issues so as to encourage them to change their attitudes and behaviour. It requires good communication, understanding how people learn and involves planning, implementing and evaluating an education event or programme. All of these aspects are discussed in this section.

9.2 Communication

Communication, at its simplest, involves the transfer and understanding of meaning between a sender and receiver(s). Everything you do involves communication – hence, effective communication is vital to your work.
Common communication methods are listed below, together with their advantages and disadvantages.

Table 9.2: Common Communication Methods

Method	Advantages	Disadvantages
Oral	• Quick transmission. • Quick feedback (often enabling any uncertainty to be detected and clarified).	• May not be well thought out, logical and clear. • Greater potential for distortion, especially if passed through many people.
Written	• Permanent record (tangible + verifiable). • Often well thought out, logical and clear.	• Takes more time. • Lack of feedback.
Non-verbal	Conveys meaning.	Can be misinterpreted.
Electronic media	• Fast • Expensive.	• Security problems.

Note: Non-verbal content refers to facial expression, gesture, body position, etc.

Good communication is characterised by:

- Commitment: both the sender and receiver must be willing to communicate.
- Pre-planning: get organised first and think about what you are going to say. Write it down if necessary.
- Regularity.
- Relevant: keep to the topic.
- Two-way: communicate what you need to but allow the receiver the chance to respond.
- Timely: don't wait too long to communicate things – otherwise, it may too late or not relevant.
- Clear: keep it short and simple.
- Measured - the right amount: too many words or ideas may confuse people; tailor what you are going to communicate according to your audience.
- Method matches the message: a telephone call is fine for normal conversation, but a formal letter may be necessary to make an invitation or discipline someone.

Common problems include:

- Distance: too large a physical gap. This may as simple as the other person being too far away to hear properly (for verbal message) or the receiver may be removed from the reality of the sender. For example, the local government Sub-office may ring the

local government main office saying "one of the tractors has broken down and there are piles of garbage everywhere and many people are complaining". The receiver doesn't know if the sender is giving an accurate or exaggerated picture of the problem. He has to either trust them or ask questions of clarification or go and see for themselves.

- Too few communication skills (e.g. reading, writing, speaking, listening and reasoning).
- Serial errors: distortions or omissions in the message passed on or received. Even though we may use the same words, other people may understand them differently, depending age, education and culture.
- Filtering: people only see or hear what they want, depending on their needs, motivations, experience, background and other personal characteristics.
- Emotions: how the receiver feels when the message is received influences how they interpret it. Similarly, what the sender may say may be affected by their emotions.
- Status: this affects upward communication. People may communicate what they think the boss wants to hear rather than the whole picture (manipulation of information).
- Clarity: something that may be obvious to the sender due to the knowledge/information they have on the topic may not be sent clearly or completely to others.
- Trust: lack of trust between parties can lead to people only communicating certain things and not the whole story.

Simple techniques for overcoming such problems include:

- Use feedback. Ask open questions (e.g. "so what do you mean by that?") or get receiver to restate the message sent in own words.
- Simplify the language used. Only use technical jargon where appropriate.
- Listen actively. When someone talks we hear, but too often we don't listen. Listening involves an active search for meaning, whereas hearing is passive. Active listening is difficult – it is often harder than talking, as it demands intellectual effort and concentration.
- Constrain emotions. If you can't, refrain from further communication until you have regained your composure.
- Watch non-verbal cues.

9.3 How People Learn

People learn in different ways – some learn better one way; some another. For example, some people love to read by themselves while others learn best in groups; some love to study while sitting in chairs, others while lying on a bed or floor. Each of us also has a preferred learning style:

- Visual learners like to see pictures or diagrams.
- Auditory learners like to listen.
- Tactile learners learn best by using their sense of touch.
- Kinesthetic learners learn best by moving their bodies.

Overall, people learn best by actually **doing** and then reviewing what they have done. This means that when you are trying to educate people, you should use a variety of means, so that what you are doing will appeal to a wide range of people. For example, the following table lists four educational activities, which use from one to four different educational methods. While just talking requires the least organisation, it will also appeal mainly to people who like listening. Conversely, talking, showing pictures, doing group activities and taking home some handouts

(e.g. notes and pictures) requires much more preparation and resources but willocal governmentppeal to a much wider range of people.

Table 9-3: Range of People Interested by Different Educational activities

Educational activity	People who like to listen	People who like to see pictures/diagrams	People who learn best in groups	People who like to read by themselves
Talk	○			
Talk and show pictures	○	○		
Talk, show pictures and do group activities	○	○	○	
Talk, show pictures, do group activities and give handouts to take home	○	○	○	○

9.4 Behavioural Change and Attitudes

Changing peoples' attitudes and behaviour is a very difficult task and one which can sometimes take many years to succeed on a wide scale. A very important principle to understand is that different people are at different stages in terms of their behaviour on certain issues. One common model says that people are in one of five different stages, as summarised below.

Table 9.4: Different Stages of Behaviour

Stage	Name	Typical Comment	Description
1	Ignorance, or	Huh?	You don't know about the issue and hence don't care, or
	Lack of perceived need	So what?	You know about the issue but see no reason to change your behaviour.
2	Learning/ thinking	Umm…let's look into this…. Oh, that's how!	You've heard about the problem, realise that you may be vulnerable and are seeking information about a solution. Such people often go to the library and read up on the topic, pay close attention to any related news items on radio/TV, or talk with friends about it. They also do a lot of thinking about it.
3	Preparing	What do I need?	You do all the things needed to enable you to actually perform the behaviour (getting organised).
4	Doing	Let's do it!	You actually begin to perform the behaviour. Now, the difficult part is keeping it going.
5	Habit	Do it all the time	You do the behaviour all the time, virtually without planning or thinking – it is part of your normal routine, like brushing your teeth. The length of time required for something to become a habit depends on the behaviour in question, with easy things taking a short time, while hard things may never become habits.

Two examples are given below to help understand this model:

Example 1	Coping with Diabetes
Stage 1	You eat what you like and don't do much exercise but seem healthy.
Stage 2	You seem to be passing urine a lot and losing weight. Your doctor tells you these are symptoms of diabetes. You borrow a book from a friend about diabetes and watch health related TV programmes.

Stage 3	You decide to try and control your diabetes through healthy living. You buy some appropriate food (e.g. bitter gourd and radish; no carrots or beetroot) and make a "fitness" plan.
Stage 4	You start your new diet and walking three times per week.
Stage 5	Three months later and you've managed to keep to your diet/fitness plan most of the time. Your doctor says the diabetes seems to be under control. Well done and keep going!

Example 2	Neighbourhood Cleanliness
Stage 1	You are not aware of the health and environmental problems caused by poor garbage disposal. Normally you discharge your garbage at the roadside.
Stage 2	Your child gets sick, after playing in a nearby waterway. Your neighbour says he never lets his children play there because of the garbage in it.
Stage 3	You buy a dustbin. You and your neighbours ask the Council to remove the garbage from the waterway.
Stage 4	You start to put your garbage out in the dustbin for collection as do some of your neighbours.
Stage 5	A year latter and you are still going + 70% of your neighbours have joined you. Your neighbourhood looks cleaner and the children are healthier!

The practical implications of this model for those trying to get people to change their behaviour are that:

- You must use different tactics according to the stage people are at.
- You must move one stage at a time, building bridges across stages.
- You must allow enough time for people to move through stages.

Another important point to appreciate is the basic principle that "none of us can ever change anyone else". People have free will and a lot of the time, we don't have control over other peoples' actual behaviour – we can't make them change. Maybe they will do the desired behaviour while we sit there watching them, but as soon as we leave, they return to their old ways.

However, if we can change their attitudes towards the issue in question, then they are more likely to change their behaviour themselves and this change is much more likely to be long lasting, even when we are not there! Lasting behavioural change is achieved only when people decide to change themselves.

It is also important to appreciate that there are times when people do not behave consistently with their attitudes, especially concerning risky behaviours. For example, virtually everyone has performed some stupid, dangerous or malicious action at some stages in their lives, even though they knew this. Often, this is a result of peer group pressure. Similarly, when the attitude involves going against the status quo, fear may stop people from behaving consistently with their attitudes. Often, this is a result of community, workplace or political pressure. Hence, you need to consider how to get people to use the new attitude to drive their behaviour.

Another important issue to consider is that people may say "why should I change? – it is not going to make any difference, as everyone else does it!". This is a common reaction. It is important to try to convince people, that even if just one person changes to begin with, this may persuade other people to change. Remember, it takes many streams to make a mighty river!

9.5 Education Programme Planning

9.5.1 Objectives and Key Messages

Public education is most effective when it is properly planned and prepared. In

particular, you should think about what you are trying to achieve - what are your key objectives? - write these down. Then, prepare a number of key messages you want to communicate to people for each objective. Some examples are given below. You then need to think how to communicate these key messages to people so as to achieve your educational objectives.

Table 9.5.1: SWM Education Objectives and Key Messages

Objectives	Key Messages
Improve health	• Garbage that is thrown anywhere attracts flies, rats and other pests, which spread disease. • Mosquitoes can breed in stagnant water in drains blocked by garbage or water trapped in tins, plastic bags, tyres, etc. which have been thrown away. • Don't use any water contaminated with garbage – it can make you sick. • Do not eat any food you find amongst garbage – it can make you sick. • Good sanitation is good health. • Good sanitation will save you money on health care.
Protect from injury/hazards	• Some waste is dangerous and can cause injury; e.g. broken glass, rusty tins, hospital syringes and needles. • Some types of scattered waste are hazardous – they can explode, be poison or give off dangerous fumes when burned (e.g. PVC plastic).
Protect animals/fish and environment	• Don't throw garbage into water. • Garbage thrown into streams/rivers/lakes causes pollution and may kill fish. • Fish/animals swallowing plastic waste may die. • Burning waste can cause air pollution.
Clean up community areas, reducing waste scattering	• Don't throw your garbage on the ground or into drains/waterways – it makes the community look dirty and ugly. • Let's clean up our community. • Put garbage in a bin. • Bring out your garbage for collection when you hear the tractor coming. • Good environment = good living conditions.
Improve public participation	• Good SWM is very important for society. • The local government needs your help to do good SWM. • You can cooperate with the local government in many ways: Follow the waste discharge rule; don't throw waste loosely onto roads or into drains/waterways; sweep the road in front of your house; beautify the area around your house; take your garbage out to the local government tractor when you hear it coming.
Improve local government-public communication	• The local government wants to communicate with you better about SWM. • Form a street committee in your neighbourhood. Invite your Area Supervisor to your meetings and tell them about SWM issues in your community. • Your neighbourhood has a health animator. They are responsible for liaising with the local government on SWM issues. Tell them your concerns!
Reduce waste	• Reduce polythene usage – use durable, long lasting shopping bags. • Reuse glass, plastic and metal containers. • Start home composting.

Garbage is a resource	• You can make money from garbage. • Separate your garbage and sell your recyclables to earn some extra money. • Give your food/kitchen waste to people raising pigs. • Use your organic waste to make compost for growing vegetables or for sale.
Other	• Water thrown in drainage channels blocks them, causing floods during the rainy season.

9.5.2 Target Audience

Think carefully about your target audience – who are the people you should be educating? This may be the people who are responsible for garbage in the household (e.g. the senior woman), the people who cause the problem (e.g. throwing garbage loosely into the road/waterways) or who are most affected by the problem (e.g. children playing in contaminated waterways). Think also about their attitudes and what stage of behaviour they are likely to be at. The choice of target audience affects the type and level of environmental education.

Childrens' education can be most effective. It is easier to change their attitudes and personal behaviour, but it requires a long term approach – often generational change. However, children can sometimes influence their parents/guardian to change their attitudes/behaviour, depending on the social structure within the society.

Adult education can be the most difficult, often being hard to change their attitudes and behaviour. However, if successful, short-medium term changes may be observed.

9.5.3 Duration

If you are concerned with a specific, highly visible problem (e.g. cleaning up scattered waste piles in the neighbourhood), a short-medium term programme may be successful – possibly even a single event.

If you are concerned with a more general problem (e.g. stopping people from continuing to dump garbage loosely around the neighbourhood), it can take a long time to achieve any significant visible changes – sometimes years. In this case, an ongoing programme over several years may be necessary. In such cases, it is often useful to divide the programme into smaller stages, with review/evaluation at the end of each stage.

9.6 Methods

There are a wide variety of educational methods available to you, all varying in terms of the effort, time and resources (equipment and money) required to prepare and use them. In selecting what method you will use, it is important to remember the points made in the preceding sections and the following:

- The best educational activities are simple and fun but have a strong message.
- In all cases, spend a little time and effort to find out what educational resources already exist within your area and nationally which are available for general use. Finding even just one useful thing usually makes this effort worthwhile. In particular, the Environmental Protection Agencies (EPAs) are useful resource.
- Choose methods appropriate to the target audience and within resource/time/skills/cost constraints – see the following table.
- Once you have an idea about which method(s) to use, plan your event or programme. It should include most, possibly all, of the following components, depending on what you decide to do:
  - Introduction: Welcome everyone. Explocal governmentin the purpose of the

event and give them an outline of its content.
- Input: Provide them with some information on the topic (e.g. talk, pictures, video, etc.). This should take between 25-50% of the total time.
- Questions: Provide an opportunity for people to ask questions.
- Discussion: Provide an opportunity for people to discuss what has been presented to them. This can be done by splitting people into small groups or holding a large open forum.
- Activity: Provide people with an activity to do. Often, it is good to split people into small groups for this.
- Reporting back: If people have been split into small groups for discussion or an activity, it is usually important to allow each group to report back to the whole group on what they have done/discussed.
- Summary: Summarise the main points emerging from discussion/presentations. In particular, record any outstanding issues requiring carification or followup and any action points, including who is responsible for doing them and by when.
- Recording: Make a brief record of the meeting proceedings, including venue, date, start and finish times, number of people present, brief description of content, main discussion points, followup and action points.
- Feedback: Provide an opportunity for people to comment on how usefulocal governmentnd interesting the programme was. Often, people are more honest when they are allowed to write down their comments on an unnamed piece of paper rather than having to speak them aloud. This will be useful to you for planning your next education event.

For an educational programme involving a number of events, each may follow this format, but different events will have different topics and there should be some sort of progression throughout the programme, so that each event builds on the previous one.

- Once you have prepared a draft event/programme, trial it. Typical questions to consider are:
  - Does it satisfy your objectives?
  - Does it deliver the key messages?
  - What did people learn?
  - Does it hold peoples' attention/interest?
  - Was it too long/short?
  - How could it be improved?
- It may help to do the trial and go through these questions with a colleague with experience in this area. Alternatively, it can be useful to test the event/programme with a sample target audience, especially if this is the first time you have done this. Following this, revise/modify the event/programme accordingly.
- Make a list of what you need to take for the event/programme: leaflets, flipchart paper, marker pens, etc.
- There are a wide range of educational tools or techniques you may use to enhance your message and/or persuade people to act. Some of these are listed in Section 9.8.
- All education/awareness raising activities require followup practical activities or initiatives to build on the messages being communicated and make the desired action possible. It must be feasible for people to do what the local government is asking them to do. For example, there is no point in telling people to put out their garbage for collection on a certain day and time if the collection vehicle does not keep to this schedule.
- Educators must be seen to be practising what they are encouraging people to do. For example, if you are asking people to separate their garbage into different

categories to promote recycling, then the local government should be doing the same thing within their premises.

The following table lists a variety of educational methods and provides some brief comments on them.

Table 9.6: Possible SWM Education Methods

Method	Comments
Leaflets, Pamphlets	• Relatively simple method that can reach a large number of people. • Short term impact - leaflets/pamphlets are often misplaced or thrown out. • Can utilise existing material (e.g. EPA resources) or produce own leaflets – this can be done on a relatively small (e.g. community) scale using hand drawings at low-medium cost. Large scale professional production requires significant time and money for preparation and printing. One low cost development option involves holding a competition for children to develop the leaflet/pamphlet, also generating more interest in the final product.
Books, stories, songs, games	• Relatively simple method that particularly appeals to children – games/activities stimulate interest and make learning fun. • Long term approach – looking at generational change plus followup needed to check what is being learned. • Ideally, use existing resources. If not available, it generally requires significant time, skilled people and money for developing and printing such resources.
Posters, notice boards, storyboards, murals, banners	• Relatively simple method but must make strong, visual impact – hence, it is vital that posters and other media are appropriately sized, easy to read and attractive. • Short term impact - often quickly covered over, defaced or torn down and deteriorate with time. • Medium time, skilled people and money required for development and production. One low cost development option involves holding a competition for children to make a poster, etc., generating more interest in the process. • Can be erected in problem places (e.g. waste scattering sites) to try to stop such practices (except murals require a permanent surface on which to be drawn).
National radio or TV programmes	• More complex and can reach a wide audience – both children and adults – but competing for attention with programmes on other radio/TV channels. • Impact may be short term, if programme is only broadcast once. • Often relies on suitable programmes being available and broadcast at the appropriate time. However, tape/video copies of programmes can sometimes be bought at low cost for repeated use (requires suitable playing equipment to be available; e.g. TV/video).
SWM Video	• More complex and can reach a wide audience – both children and adults. • Effective, especially when includes local content – visual images often have a stronger impact than words. • Suitable videos may be available, though often they have a national rather than local focus. Producing your own video requires significant time, skilled people and money. • Videos are a resource that may be used many times until they become out of date. • Requires access to power source and TV/video for use.
Public meetings	• Relatively simple and low cost. • Can be very effective if organised properly, particularly if the topic is of strong interest to the community and/or some entertainment is provided to encourage people to come. • May range from meetings with existing community groups (neighbourhood, business, religious) to large open public meetings. • Generally attracts only interested people who may already have a strong

	environmental awareness and knowledge rather than reaching out to those that don't.
Invited speakers	• Relatively simple and low cost. • Good speakers can provide powerful messages that have a strong effect on many people in the audience. • Generally attracts people interested in the topic rather than a wider audience.
Slide/ powerpoint presentations	• Relatively simple but high cost (normal/digital camera, slide/powerpoint projector and screen needed). • Can be very effective, as allows local images to be shown to local people. • Requires some effort – finding the right photo can take time. • Requires some technical knowledge to take photos and use projector. • Equipment must be stored securely.
Competitions	• Relatively simple, low cost and effective, capable of reaching a much wider audience than competition entrants (e.g. publishing winning entries in newspaper or holding an exhibition). • Variety of forms – essays, posters, poems, songs, etc. • Must be well organised and publicised. • Good entries become education resources. • Requires low-medium funding/sponsorship to cover costs.
Drama, street theatre, music	• May reach a wide audience, with the appeal of drama, street theatre and/or music attracting people who otherwise would not be interested in SWM education events. However, you are competing with other forms of entertainment, especially TV, for peoples' time. • Can provide powerful messages. • Significant time input and skill people required. Can be costly unless performers volunteer their services.
Special theme day activities	• Relatively simple but often of limited appeal. • Provide very good means of generating and/or renewing interest in SWM, cleaning up pollution hotspots (e.g. removing litter from beaches) and reviewing progress made over the last year. However, any improvements may only be short-lived. • Requires good organisation (lots of voluntary effort in short time), publicity and various resources, depending on nature of the day. • Requires low-medium funding/sponsorship to cover costs.
Open days at local government SWM Facilities	• Actual visits to SWM facilities shows people what happens to the waste they put out for collection, creating greater awareness of the associated environmental problems and/or potential solutions. • Often short term impact, with people quickly forgetting what they saw. • Must be well organised, including transport. • Particularly appealing to school groups.
Printed thematic products	• Simple but must be attractive and with a strong message to be effective. • Many possibilities; e.g. durable shopping bags or tee-shirts with messages printed on them. • Significant time input and resources may be required for production. Low cost option involves holding a competition to design the product. Some items may be sold to people, generating income to cover costs. • Durable shopping bags with printed messages provides strong educational message to others who observe someone using them, rather than polythene bags.
Creation of a cartoon character or logo or slogan	• Simple but effective – character often of particular appeal to children. • Character, logo or slogan is associated with all media/events, giving a sense of continuity to the education programme. • Character, logo or slogan development costs can be high. Low cost option involves holding a competition to design the character, logo or slogan.

9.7 Resources

The following table lists a variety of environmental/SWM resources and suggests how you may be able to utilise or work with them or use some of the resources they have already created.

Table B-20: Environmental/SWM Resources

Resource	Activities and Comments
Voluntary organisations and non-governmental organizations (NGOs)	Find out about any voluntary organisations and NGOs in your area. They may have already developed local resources on SWM and the environment you can use/borrow and/or may be willing to help you with SWM educational activities.
Schools	Many schools are involved in environmental education programmes You may be able to suggest to schools suitable SWM projects/activities they could undertake in their neighbourhood (e.g. cleanup day). Schools may also be interested in taking part in competitions, creating resources you may be able to use in other educational activities.
Radio/TV	Various programmes on different environmental issues.

9.8 Tools

The following table lists a variety of educational tools or techniques you may use when educating people to get your message across and to encourage them to act.

Table B-21: Educational Tools

Tool	Description	Examples
Influence	You deliberately try to change the person's attitudes/behaviour but in an indirect or informal way. This relies on them taking interest in the issue.	Give them leaflets to read, let them see your own example, invite them to public meetings.
Persuade	You use direct communication to change their attitudes/behaviour – your opinion against theirs. This can become very subjective and argumentative.	Direct discussion with person.
Teach/ educate	You teach/educate them about the issue in a formal environment. this requires getting them to come to the event but lets them make up their own mind (relatively objective).	Public talks, workshops, seminars, etc.
Appeal to religion	Appeal to common religious beliefs or morals concerning the environment.	Buddhism: "protect the environment that protects us".
Encourage	Offer support/praise for good behaviour.	"Your neighbourhood looks much cleaner and the children look healthier!"
Reward	Reward people for good behaviour.	Monthly prize to cleanest neighbourhood
Scare/ frighten	Warn them of the undesirable consequences of not acting.	"You'll have more flies and mosquitoes in your house if you keep throwing garbage in the stream".
Tell off	Tell off for not doing the desired behaviour.	"Don't do that – it makes the neighbourhood look dirty and ugly".
Punish	Punish people for not doing the desired behaviour	Fines, non-collection of waste for people not following the rules.

9.9 Evaluation

Evaluation is important to determine whether your education event/programme actually worked. In its simplest form, evaluation involves looking for signs of change. For big or long term programmes, more systematic evaluation may be required at periodic intervals. In both cases, the evaluation can be based on selecting a number of "Indicators" of success. These should relate to the key objectives and messages you are trying to teach people about. Examples of appropriate indicators include:

- Decrease in incidence of disease ("improve health" objective).
- Reduced garbage in drains/waterways ("protect environment' objective).
- Reduced number of loose/scattered waste piles in the neighbourhood ("clean up community" objective).
- Increased number of houses with garbage bins ("clean up community" objective).
- Increased number of people bringing their garbage out for collection when they hear the tractor ("clean up community" and "improve public participation" objectives).
- Increased number of people coming to community/local government SWM meetings ("improve local government-public communication" objective).
- Reduced number of public complaints ("improve public participation" objective).

For big or long term programmes, it is often wise to use independent evaluators for several reasons including:

- Trainers may be "too close" to the programme to be able to evaluate it properly.
- Independent evaluators bring different, often wider experience to the evaluation.
- The audience may be afraid of stating their true opinions to programme staff compared with external evaluators.

Monitoring/review may also be undertaken 2-3 yrs after programme implementation to check its medium/long term success.

References

1. "Structure and Characteristics of Technical Guideline on Sanitary Landfill (Draft)", Textbook of Landfill Technology for solid waste management Training Course, JICA
2. "Solid Waste Management Guidelines for Local Governments", Final Report of the Study on Improvement of Solid Waste Management in Secondary Cities in Sri Lanka", JICA
3. "The Study on the Solid Waste Management for the Kathmandu Valley, JICA

PART C

Solid Waste Management Action Plan

Solid Waste Management Action Plan

1. Introduction

In this context, organisations may be considered to have two key functions:

- **Maintenance:** normal day-to-day tasks to keep the town/city running in its current state.
- **Improvement:** short, medium and long term measures to improve the town in accordance with a vision and plan.

Maintenance is mainly about **management** while improvement is more about **leadership**. The ultimate aim of both is the same - providing a good service to the public. In addition, local governments operate within a legal and policy framework (e.g. National Environment Action Plan (NEAP), National Environmental Policy, Local Government Ordinance), which sets boundaries on what a local government can and cannot do.

Currently, most local governments mainly operate in a maintenance mode. Proposed improvement measures are heavily influenced by politics, often following the whims of politicians but without any clear, long term planning. Often, such improvement measures are changed when new politicians come to power. Improvement is also affected by the periodic transfer of government servants, the maximum term of office for them in any one place being five years.

SWM Action plans are generally not prepared, but local governments face increasing pressure to prepare such plans for several reasons:

- Garbage is a growing problem – more garbage is being generated, the composition is changing and becoming more difficult to dispose of, while the general public is becoming increasingly vocal in voicing their concerns about the resulting social, health and environmental impacts of poor SWM.
- SWM needs forward planning like other infrastructure services – water, wastewater, drainage, etc. This is becoming increasingly important, as open dumping is no longer acceptable or tolerated in many places but it takes several years to procure, plan, approve and develop a sanitary landfill site. Hence, at least medium term forward planning is vital.
- Donors will increasingly require action plans to be prepared as a pre-condition for obtaining financial assistance for SWM projects. In any case, donors are more likely to support local governments with Action plans than those without.

Hence, SWM Action plans are a very important for improvement measure. Essentially, the Action plan is the "heart" of an improvement "plan-do-review" cycle, as illustrated below.

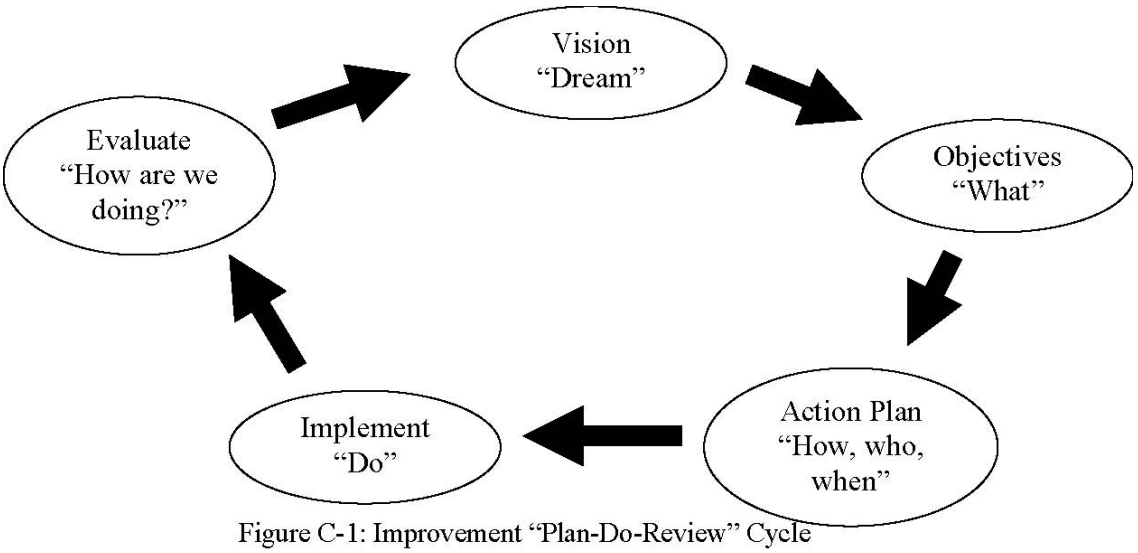


Figure C-1: Improvement "Plan-Do-Review" Cycle

2. Scope

The Action Plan at the very least should contain a five year plan in outline form, a detailed Action plan for the next year, and a final disposal plan for the next three years. Preferably, a ten year outline plan should be prepared, together with a detailed Action plan for the next three years. Generally, the Action plan is divided into short, medium and long term periods, these varying in duration from 2-4 years. It may be useful to define these periods so that they start and end with scheduled Council elections, encouraging the Council to reach certain targets and implement relevant measures during its term of office, thus making them more accountable to the public.

3. Understanding the Present SWM Situation

Before preparing an Action plan, it is vital to have a reasonable understanding of the present SWM situation. A reasonable picture can be gained without too much expense through the following steps:

3.1 General

- Make a list of some of the special features of your town that have implications for SWM. For example:
  - If the town is a busy commercial, trading centre, commercial waste generation may be high.
  - If the town has a high floating population, it may be difficult to get their cooperation for SWM.
  - If the town has reasonable rainfall and lots of vegetation and trees, garden waste generation may be very high.

- If the town is very hilly in some areas, garbage collection may be difficult in such places.
- If it is close to the sea, corrosion of SWM vehicles and equipment may be a serious problem.

3.2 Waste Generation to Disposal

- Make a list of the different sources of waste within the local government limits. Typical categories are households, commercial, markets, industry, institutions, other (public places, street sweepings, drain cleanings). In particular, identify large waste generators and places producing problematic wastes (e.g. hospitals, slaughterhouse, some industries).
- Get an idea of the composition of waste reaching the disposal site by talking to collection workers and landfill staff. Typically, Pakistani waste is 30-40% organic, contains relatively few high value recyclables (metals, glass, hard plastics)and few low value recyclables (paper, soft plastics, textiles), but relatively large amount of other materials (mainly inert). If you have sufficient resources and time, you may undertake a waste composition survey.
- Find out whether any groups are involved in waste reduction activities – e.g. schools, Lions, NGOs, etc. What do they do? How effective is their work?, what problems do they have?
- Find out about waste recycling within the town. How many households are visited by individual recyclable collectors?; do local government collection workers salvage many items for recycling?; are there many middlemen shops within the town and what proportion of the materials they buy come from within the local government?; are there many micro-enterprises involved in reuse or recycling activities (e.g. making paper bags, recycling waste plastics, hand paper making, etc.). What problems do such people and places have?
- Find out if any waste is taken for processing or treatment (e.g. are there any composting facilities or biogas plant processing MSW?). Visit any such facilities and check their operation. What problems do they have? Are they financially viable?
- Find out how much waste is taken for final disposal, by looking at disposal site records, or if these do not exist, counting the number of vehicle loads per day and converting these to tonnes. What factors (e.g. festivals) result in big increases in the waste disposal amount?. Again, if you have sufficient resources and time, you may undertake a "vehicle count" survey at the disposal site.
- Draw a picture or diagram showing where waste comes from and where it goes to, filling in as much information, including quantities, as you can.

3.3 Institutional Arrangements

- Find out the present institutional setup for SWM – drawing a diagram may be useful.
- Find out what works the "waste management section" is responsible for, what these works involve, and the number of workers, vehicles, equipment, etc, involved in these works.
- Find out how much money is spent on SWM and what percentage of local government staff work in SWM. If this is not possible, look at the most recent budget to find out the amount and proportion of the local government's budget allocated to SWM and the number and proportion of SWM workers by cadre.
- Find out if there is any charging system for waste collection and/or disposal. If so, is this being implemented effectively and how much revenue is collected by this means?
- Check what rules and regulations are in place for enforcing SWM.
- Find out about the vehicle repair system. Inspect the workshop, check what repairs it can and cant do, check how spare parts are procured and the administrative system for approving repairs. How much of the workshop's budget is spent on SWM?

3.4 Technical System

- Find out how many zones the town is divided into for SWM purposes and what proportion of the local government population is provided with a garbage collection service. SWM staff should be able to estimate this.
- Find out how people discharge their garbage and how the local government collects this garbage. This can be done by talking to PHIs, supervisors and drivers. However, often the best way is to go and look for yourself. Choose 2-3 areas of the city with different characteristics or discharge/collection systems operating and follow the collection vehicles during their daily work. This is also a very useful way for finding out what the real problems are in the field. Keep an eye out for the number and type of collection points, the amount of waste scattering, how many animals are searching for food amongst discarded garbage, the amounts of garden and building waste and the number of drains containing garbage or blocked by it. Also check how many labourers there are per vehicle, what clothes, protective equipment and tools they have and how many loads they can collect per day on average. What proportion of their time does loading make up?
- Find out how much it costs to operate and maintain different types of vehicles per year.
- Visit the final disposal site and watch how waste is unloaded and disposed of. Is the deposited waste regularly covered with soil? How much reserve capacity does the site

have? What problems can you see, smell or hear? – odour, mosquitoes, flies, rats, birds, grazing animals, scattered waste, smoke, fire, people scavenging for recyclable materials, leachate, etc.? Talk to some residents in the area to find out what problems the landfill might be causing them.

3.5 Social Aspects

- Arrange some community meetings and find out peoples' opinions of the current SWM system and how it might be improved. This may be done, by meeting with existing groups (e.g. Welfare Society, church or temple groups, Chamber of Commerce) or arranging meetings in particular areas.
- Arrange a meeting with cleansing workers to find out about their working conditions, problems and opinions.
- Check what awareness and environmental education programmes are being conducted within the town by the local government, schools, voluntary organisations, NGOs, etc., particularly any related to SWM.

This information can best be collected by a team of people. In some cases, a lot of it may already exist in different places within the Council, so check this first. Some tasks may not be necessary, while additional tasks may need to be added, depending on local conditions. Remember, the idea is to build up a **reasonable and sufficient picture** of the real SWM situation which will form the basis for identifying and prioritising SWM issues, following which the Action plan can be prepared.

3.6 Identification and Prioritisation of Issues

The next step involves identifying key issues and prioritising them. This can often best be done by holding a stakeholders workshop at this point, inviting local government staff, Council members, members of the public, representatives from other government departments, commerce, industry, institutions, NGOs, etc. A useful format to follow involves making a presentation about the present SWM situation and then having open or group discussions to identify the key issues and possible associated improvement measures. Alternatively, the Council may hold internal meetings of relevant staff to do this.

Careful thought should be given to identifying the real issues. For example, if the public say "collection vehicles do not come regularly", is this because the vehicles are old and often breakdown and it takes a long time to repair them (issue = workshop, no vehicle replacement policy problem), or because there are not enough vehicles (issue = number of vehicles), or the tractor has gone somewhere else (issue = political interference, driver/labourer corruption) or because there are not enough senior staff to properly

manage vehicles and labourers (issue = institutional/management capacity).

In this process, it is important to look at what the local government and other groups are doing well in relation to SWM, rather than just problems, and how these successes may be built on and strengthened. Many local governments share similar problems, which may be broadly categorised in order of decreasing seriousness, as follows:

- Weak institutional and organisational system: current SWM management structure does not reflect the significance of SWM within the local government; shortage of senior staff dedicated to SWM works; lack of short, medium and long term development plans; poor supervision; poor labourer management and performance; poor cooperation with other departments involved indirectly in SWM; poor public-local government relations; political intervention; high SWM expenditure and difficulties in finding out how much money is actually spent on SWM.
- Poor final disposal. Generally, this is done by open dumping, with soil cover sometimes being applied, while few, if any, other environmental protection measures are taken, resulting in many social, health and environmental problems. In addition, many landfills have small capacities or will soon be full, while little, if any thought is given to finding a new disposal site. Appropriate disposal of healthcare hazardous waste is also often a problem.
- Lack of a proper waste discharge system, with many people discharging garbage in any container or none, at any time and place, resulting in lots of garbage discharged at the roadside, or at public collection points, which combined with many stray animals searching for food, causes waste scattering, creates mini-dumps and poor sanitary conditions. Often, lots of garden and building waste is also discharged at the roadside, collection points or on vacant land, while drains are often full of, or blocked by garbage.
- Collection and transportation is inefficient and unreliable, being characterised by many handcarts and collection points, double handling and long loading times, many vehicles are too old, frequent vehicle breakdowns and long delays for repairs and a low number of vehicle trips per day. These problems, particularly vehicle breakdowns, make it difficult for local governments to keep to scheduled garbage collection times, routes and frequencies.
- Most local governments have few, if any, centralised garbage processing/treatment (recycling or composting or biogas) facilities. Considering that the composition of Pakistani waste is suitable for composting and the final disposal problems facing many local governments, serious consideratrion should be given to introducing medium-large scale composting and/or biogas facilities.
- Poor public cooperation in SWM, with many people still discharging their garbage

and litter to public places. local governments are partly to blame for this, due to the collection service being unreliable and a lack of ongoing and systematic waste education, public promotion and information dissemination efforts. Conversely, many residents are keen for improvement of the present system and are willing to cooperate.

Other less serious problems, specific to local conditions (e.g. stationary trailer collection/transfer points are poorly designed, problems removing drain cleaning waste from some areas).

4. Defining Your Vision and Objectives

The next step involves thinking about and defining your vision or main goals for SWM over the duration of the Action plan. The vision is the local government's "dream" for SWM - for example: "To make the town a clean, healthy place for people to live and to protect its environment".

Objectives should then be defined. These comprise a number of specific aims designed to achieve the vision. Some useful objectives, consistent with the problems identified above are listed below.

100. Reforming and strengthening the institution and organisation related to SWM works.
200. Promoting waste minimisation at source (3 Rs = reduce, reuse, recycle).
300. Improving public education/awareness and participation in SWM.
400. Improving the SWM technical system including garbage discharge and storage, collection and transportation and hazardous healthcare waste management.
500. Promoting garbage processing and treatment.
600. Improving final disposal.

It is often useful to introduce a numbering system at this stage, as above, which will be used throughout the Action plan. This helps to clearly identify specific strategies and measures related to different objectives (e.g. 110, 120, 130, etc. all related to objective 100) and provides a useful system for keeping track of changes made to the Action plan, as it progresses from a draft form to the final version.

5. Action Plan

The Action plan describes what is actually to be done to fulfil the vision and achieve the objectives. It should identify the strategies (approach) and measures (tasks), required resources (human, equipment, financial), costs, responsible persons, timeframe

for action, evaluation. It answers the questions: "how", "who" and "when". Critical questions to ask at this stage are:

- What basic strategies can be used for achieving the desired objectives?
- What should be the top priority measures in the Action Plan?
- How can the local government afford to implement the Action plan using available resources (human, equipment, financial)? How might it be able to supplement these resources? Improving revenue collection and making full use of internal and external resources are crucial to this, especially by encouraging public participation.
- What targets should the local government set for measuring the success of the Action plan?

Other key points are:

- The Action plan must be practical, affordable and enforceable.
- The objectives, strategies, measures and targets together should be specific, relevant, measurable, achievable and time-framed.
- Strategies and measures may be short, medium or long term.

6. Developing Strategies and Measures

The content of the Action plan may be developed as shown in the following diagram and explained below:

- Address issues one by one in the order of most to least serious. Some of the less serious issues may possibly be eliminated at this stage, as being relatively minor or insignificant.
- Develop solutions for each issue, indicating who will be responsible for implementing these and when they will be implemented, either in terms of which year, or in the short, medium or long term. For example, a possible solution for the very serious issue: "local government's disposal site will be full within 2-3 years" is set out below.

Table C.6-1: Example of Action Plan Item

Code	Item	Responsibility	Time period
620	Find and develop new landfill site		
621	local government will look for new disposal site over next 6 months	Mayor, Commissioner	Months 1-6
622	local government will arrange for relevant topographical and geological surveys at new site	District Officer, Municipal Engineer	Months 6-12
622	local government will seek approval from EPAs for use of new site as landfill	Mayor, Commissioner	Months 6-24
623	local government will consult with residents in area to get their approval	District Officer, Inspector/Supervisor	Months 6-24
624	local government will prepare design and construction plans for landfill	Municipal Engineer (+ external consultants)	Months 18-24
625	local government will construct new landfill	Municipal Engineer (+ contractor)	Months 25-30

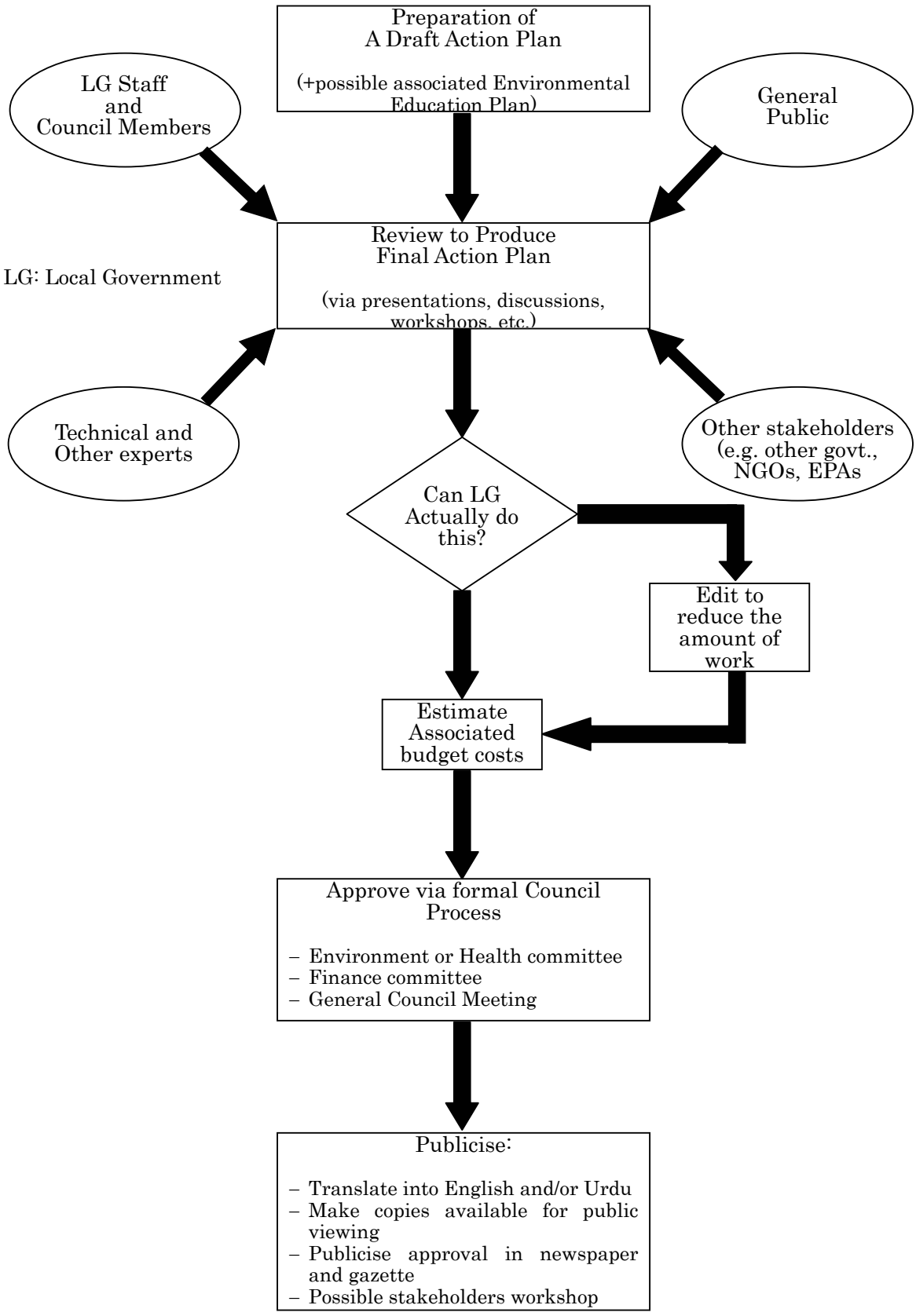


Figure C.6: Process of Preparing an Action Plan

- Compile all these strategies and measures into a single document. This is the draft Action plan. Try to keep this as simple and concise as possible. It is basically a starting point for discussion. Additional detailed information can be included as notes or in appendices. Separate special meetings may be required with the relevant staff and stakeholders to prepare an associated environmental education plan focusing on SWM.
- Revise the action plan one or more times to produce a final draft. This can be done via presentations, workshops and discussions both within the Council (staff and elected members) and externally, covering all relevant stakeholders. Consultation with technical and other experts may be particularly valuable at this stage[1]. This process will help to develop understanding of the plan amongst those not involved in drafting it, increase ownership of it, whilst also ensuring that a broad range of viewpoints are included in the Action plan.
- However, as the amount of consultation increases, the Action plan will also tend to expand, with more and more issues and potential solutions being included. Remember that it is the local government that will have to implement the plan, with its limited resources in terms of people, equipment and money. Ask the critical question – can the local government actually do everything in this Action plan, based on its current capacity and where it hopes to be in 5-10 years time? If not, the Action plan must be edited, to reduce it in size, or implementation of some less urgent items might be shifted to less busy years. To assist in editing, you must consider the effort involved to implement each measure and the potential value of successful implementation, whilst keeping in mind the seriousness of the different issues being addressed, as set out below.

Table C.6-2: Effort versus Value

Effort	Value	Comment
Low	High	Such measures are the simplest and most beneficial to do. They should be given a high priority.
Low	Low	Such measures are also simple but the potential benefit is small. You should question whether they are worth doing.
High	Low	Such measures take a lot of effort but the potential benefit is very small. Question whether they are really worth doing?
High	High	Such measures take a lot of effort but the potential benefit is very high. Often, such measures tackle long-standing serious problems. A lot of commitment is needed to implement them.

[1] Earlier and subsequent consultation may also be useful.

Some examples are given below, of how this editing process might be done.

Table C.6-3: Editing the Action Plan

Item	Effort	Value	Do?	Comment
Provision of appropriate furniture and equipment for new SWM department.	Low	High	aaa	These items are essential to properly establish the new SWM unit.
Improve the labourer control and discipline system.	Very high	High	aa	Generally, a very serious problem but very difficult to address without widespread support and strong management within local government.
Require labourers to wear uniforms while working.	Low	Low	a	A nice idea and may help to lift labourer work performance, but could possibly have little or no benefit.
Regular internal meetings for all local government SWM staff	Low	High	aaa	Very important. Builds team spirit, shares information, identifies and solves problems.
Establish a separate SWM category within the local government budget.	Medium - high	Medium - high	aaa	Very useful for knowing how much money is allocated to SWM, but must be accompanied by separate reporting of actual SWM expenditure to be highly beneficial.
Encourage 3Rs through education and awareness programmes.	Low medium	Medium - high	aaa	Education and awareness raising is very important, but long term approach needed over many years.
Campaign for all school books to be printed with environmental friendly messages	Low	Low	**x**	More a national level issue. Not necessary for local government to pursue.
Distribute compost barrels to households in selected areas	Low	High	aaa	Do in early years of Action plan, possibly expanding depending on initial success.
Hold regular community meetings to discuss SWM issues in different parts of the city.	Low	Medium – high	aa	Very good means of encouraging public participation. However, issues identified at such meetings must be followed up.
Collect garbage on schedule	High	High	aa	Very important to gain the public's trust, but may require overhauling many systems within the local government (e.g. vehicle repair system, spare parts procurement, etc.).
Separate hazardous waste collection system for domestic waste	Medium	Low	a	Likely to be a problem in the long term. Hence, only include in Action plan towards end, if at all.
Replace tractors with small compactors	High	Low	a	Expensive and tractors have about the same capacity as small compactors at present – more a long term option.
Build and run sanitary landfill	Very high	High	aa	The most difficult problem in SWM but must be addressed!

Note: Decision = Include all aaa **and** aa **items. Keep** a **items in separate folder for consideration at next evaluation. Omit x items.**

- Estimate budget costs for implementing the Action plan, at least for the next financial year but preferably for the next three years as well as estimated costs for all major expenditure items (e.g. construction of compost facility or landfill).

- Once the final draft has been produced and budget costs have been estimated, both of these items must be approved via the formal Council process:
  - Discussion and approval at local government Health or Environment Committee.
  - Discussion and approval at local government Financial Committee, particularly focusing on the financial commitments contained within the Action plan.
  - Discussion and approval by the Council at a general meeting.
- Once the Action plan has been approved:
  - It should be translated into English and/or Tamil, as appropriate for each local government.
  - Copies of the Action plan in the relevant languages should be made available for public viewing on request (e.g. display in library, local government office, Environmental Education Centre, etc.).
  - The general public should be informed that the Action plan has been approved by gazette or newspaper advertisement in at least one English, Urdu newspaper, including listing the places where it can be viewed.
  - It may also be useful to hold a workshop for all relevant stakeholders, either at this stage, or just before finalising the Action plan.

7. Implementation

Once the Action plan has been approved, there is a danger that local government staff may relax, thinking the hard work is over. In fact, preparation of the Action plan is the easy part. The real challenge is in implementing it.

All measures should be implemented according to the Action plan timetable. However, in most cases, successful implementation will require reform and strengthening of the institutional and management arrangements related to SWM, as a key to enabling other action plan measures to be successfully implemented. Hence, these issues should be tackled as early as possible and given a high priority.

8. Evaluation

Having an Action plan makes it very easy to know what local government staff should be doing. It also makes it easy to check actual progress against planned measures and targets. Periodic evaluation is recommended, at least once every 3-4 years or near the end of each action plan time period, as the case may be. For some items (e.g. environmental education), annual evaluation may be more appropriate.

Following evaluation, the Action plan may be adjusted to reflect actual versus planned performance, changed circumstances and/or priorities. However, any major changes should be formally approved.

Reference

1. “Solid Waste Management Guidelines for Local Governments”, Final Report of the Study on Improvement of Solid Waste Management in Secondary Cities in Sri Lanka”, JICA

PART D

References

D-1 Guidelines on solid waste disposal and landfill establishments
D-2 Incineration Guidelines
D-3 Guidelines for Treatment and Disposal of Hazardous Waste

PART D

D-1 Guidelines on solid waste disposal and landfill establishments

D-1 Guidelines on solid waste disposal and landfill establishments

1. Introduction

1.1 Scope of Guidelines

The guidelines on solid waste disposal and landfill establishments identify and explain issues that should be addressed for a proposal for solid waste disposal and establishment of landfill facility for municipal and hazardous waste. It is important to focus on key issues for specific proposals.
The matter identified in these guidelines provides guidance, for setting up of solid waste disposal and landfill facility in Pakistan.

It is recognized that there are five stages in the process of developing solid waste and landfill facility and following factors should be considered at each of these stages:

i. The need to have a solid waste disposal and landfill facility
ii. Selection of an appropriate site for solid waste disposal and landfill facility
iii. Installation, commissioning and operation of solid waste disposal and landfill facility
iv. Monitoring and reporting of solid waste disposal and landfill facility
v. Closure of landfill facility

Landfills are disposal sites that can be established successfully if they are well sited, well designed and operated properly. They have the potential to cause environmental harm if not sited, designed and operated properly.

1.2 Context

These guidelines form part of a package of regulations and guidelines which includes

- The Pakistan Environmental Protection Act 1997
- Policy and procedures for filing, review and approval of environmental assessments
- Guidelines for the preparation and review of Environmental Reports
- Pakistan environmental legislation and the National Environmental Quality Standards (NEQS) as amended from time to time.

These guidelines should be read in the context of overall package. A whole series of clearance is required from Environmental Protection Agency for the setting up a solid waste disposal and landfill facility in Pakistan.

1.3 Solid waste

Solid waste is basically waste generated in household, hotels, schools, markets, gardens, hospitals and industries. It can be categorized as follows:

- Domestic/household wastes (including kitchen refuse), wastes from commercial units and markets that are related to foodstuffs, vegetable, textile, glass, paper etc.
- Medical or clinical waste from medical institutions. These can be classified into the following types; general waste, sharp objects such as used needles, blades and scissors; syringes, pathological wastes, including contaminated bandages, dressings, linens, dead tissues, organs etc; and radioactive wastes;

- Industrial wastes generated by industrial processes, and some of which is hazardous;
- Debris from construction, excavation and/or demolition sites.

The wastes generated can also be generalized into the following categories:

- Biodegradable waste (mainly organic wastes such as fruit and vegetables, grass etc), and these constitute the bulk of the wastes generated;
- Non-biodegradable waste, e.g. polythene bags, plastic products, pesticide residues, process wastes, highly flammable and volatile substances, used tyres; industrial wastes including metal scrap and medical wastes such as used needles, plastic and glass bottles and syringes.

1.4 Why manage solid waste

The danger of improper solid waste handling and disposal to human health and the environment cannot be over-emphasized. Some of the common problems associated with unsound solid waste management in the municipalities include:

- Careless and indiscriminate open dumping of wastes creates unsightly and unsanitary conditions within municipalities, e.g. along the roads and highways;
- Delay in delivery of solid wastes to landfills (which are infact dump sites), resulting in nuisance dumps and unpleasant odours, which attract flies and other vectors. Such dumps also lead to pollution of land/soils, ground and surface water through leachate as well as air through emission of noxious and offensive gases;
- Open solid waste dumps can also be a public health risk. Direct contact with refuse can be dangerous and unsafe to the public, as infectious diseases such as cholera and dysentery can be spread through contact with these wastes. In most municipalities, scavenging on refuse dumps is a common practice, and such people face danger of direct exposure to hazardous waste. Open solid waste dumps can also provide suitable breeding places for vermin and flies and other disease vectors, and can also contain pathogenic micro-organisms;
- Some categories of solid wastes block permeability of soils and drainage systems, including water courses, open drains and sewers, thus posing difficulties in the functioning and maintenance of such facilities.

1.5 Solid Waste Disposal Options

Solid waste disposal means the disposal of normally solid or semisolid materials resulting from human and animal activities that are useless, unwanted, or hazardous.

Solid waste from homes, offices, and stores is called municipal solid waste. Generally, there are three methods in order to dispose of solid waste. These are incineration, recycling and waste minimization, and land disposal.

Incineration is the process of burning waste products.

Recycling is the process of reusing materials instead of throwing them away. Commonly recycled materials include metals, glass, and paper.

Waste minimization is the process of producing less waste. The waste minimization efforts should be made prior to considering the hazardous waste for treatment and

disposal. Waste minimization is an important hazardous waste management strategy. The concept of waste minimisation includes the followings:

(1) Source Reduction: Any activity that reduces or eliminates the generations of hazardous waste within a process.

(2) Recycling: Any activity that reduces volume and/or toxicity of hazardous waste with attendant generation of a valuable material, which is subsequently reused.

(3) Treatment: Any activity that reduces volume and/or toxicity of hazardous waste without attendant generation of a valuable material.

Land disposal involves hauling garbage to open area. Such areas range from unsanitary open dumps to properly operated sanitary landfills.

2. Municipal Solid Waste Disposal Options

2.1 Open Dumps

Open dumps are a poor method of waste disposal because they cause environmental problems. For example, they can ruin an area's appearance and provide a home for animals that spread disease. In addition, rainwater drains through refuse and can carry harmful substances to nearby streams and to water used for drinking. Unregulated dumps where waste is burned in the open can cause smoke and foul-smelling air. This method of land disposal of municipal waste had been the prevalent method mainly used in Pakistan. However, due to this method's adverse effects, municipalities should explore municipal waste disposal through sanitary landfill.

Almost all categories of waste may be disposed to better managed landfills directly. However, those types of wastes which will destroy the microbiological degradation processes within the landfill are unwelcome i.e. the non-biodegradable wastes. Management of these could include: incineration, recycling and reusing.

2.2 Land filling

Landfills include:

- Any site which is used for more than a year for the temporary storage of waste; and,
- Any internal waste disposal site, that is to say a site where a producer of waste is carrying out its own waste disposal at the place of production.
- Landfills do not include:
- Any facility where waste is unloaded in order to permit its preparation for further transport for recovery, treatment or disposal elsewhere;
- Any site where waste is stored as a general rule for a period of less than three years prior to recovery or treatment; or,
- Any site where waste is stored for a period of less than one year prior to disposal.

Any landfill facility must have a liner system for all portions of the landfill. The liner system must have a liner that is designed, constructed, and installed to prevent any migration of wastes out of the landfill to the adjacent sub-surface soil or groundwater or surface water at anytime during the active life (including the closure period) to the landfill. The liner must be constructed of materials that prevent wastes from passing into the liner during the active life of the facility.
The liner must be:

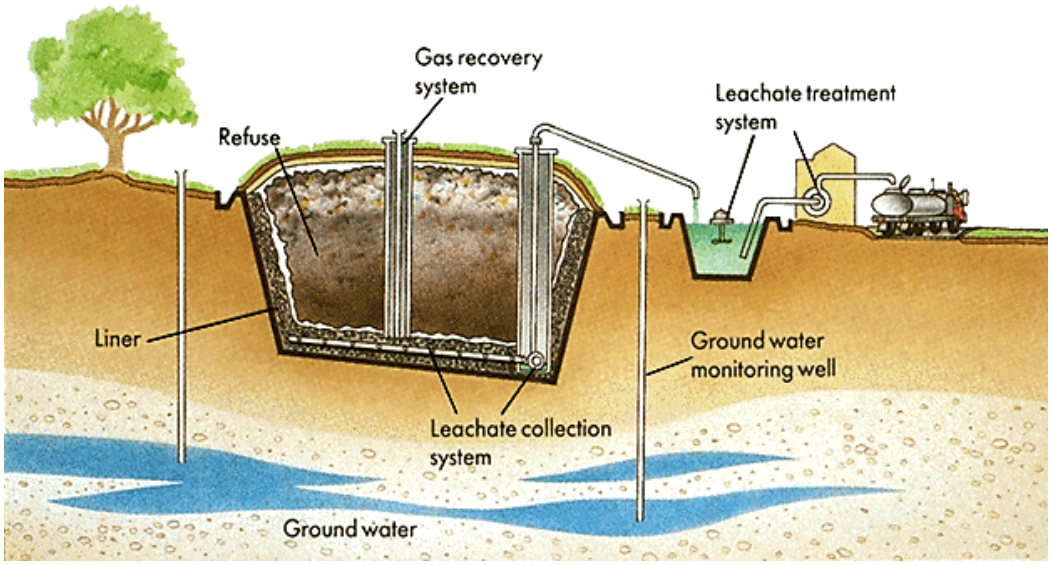
(1) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to the pressure gradients (including static head and external hydrogeologic forces), physical contact of the waste or leachate to which they are exposed, climatic conditions, the stress of installations and the stress of daily operations.
(2) Placed upon a foundation or base, which is capable of providing support to the liner and resistance to the pressure gradients above and below the liner to prevent any failure of the liner due to settlement, compression or uplift.
(3) Installed to cover all surrounding earth which is likely to be in contact with waste or leachate

2.3 Sanitary Landfill

The sanitary landfill provides a way of safely disposing of solid waste in a controlled manner. The landfill site is lined with an impermeable material such as clay or plastic, and soil is used to surround and contain the waste materials. Municipal solid waste and, at times, certain industrial and agricultural wastes are spread in layers and compacted by heavy bulldozers to reduce their volume. At least once every 24 hours, a layer of soil of a minimum 15 cm (6 in) in thickness is spread on top of the compacted waste and is itself compacted before more waste is added. When the waste-soil mound reaches a certain height, it is covered with a layer of soil at least 60 cm (2 ft) thick. The water table under the site must be at least 2 m (6 ft) deep and the site not subject to flooding. Soils vary greatly in their ability to contain and renovate the ordinary decomposition products of solid waste, so only a small proportion of potential sites are suitable for use as sanitary landfills.

The decomposition of organic wastes generates biogas, a mixture of methane and carbon dioxide. This by-product is also an inexpensive source of energy. However, the heterogeneous nature of the materials in landfills causes uneven settlement of the mound, and ordinarily a closed landfill cannot be used as a building site. It may be reclaimed however, for recreational use.

Sanitary landfill is the cheapest satisfactory means of disposal, but only if suitable land is within economic range of the source of the wastes; typically, collection and transportation account for 75 percent of the total cost of solid waste management. However, recycling and waste reduction must also be employed together with the landfill to further reduce the costs involved. These help lessen the amount of refuse that is buried in landfills, thereby increasing the lifespan of the same.



An illustration of a basic sanitary landfill system

2.4 Kinds of Sanitary Landfills

There are three basic types of sanitary landfills, classified according to the method of land filling used, namely, the trench method, the area method and the ramp method.

2.4.1 Trench Method

A trench is first excavated, its base and sides being properly lined. Waste is then spread and compacted in an excavation. The cover material used comes from the excavated soil. This method is best suited for flat or gently sloping land where the groundwater table is deep below the surface. It is called for when the soil is highly cohesive, easy to excavate, and is suitable for cover. Places where glacial till or clay soil abound are ideal for trenching, because the walls between the series of trenches can be thin and nearly vertical, and trenches can be spaced very closely. Weather and the length of time, the trench is to remain open affects soil suitability and these factors, should be considered in forming the slope of the trench. If the trenches are aligned perpendicularly to the prevailing wind, the amount of the wind blown litter will be greatly reduced. Drainage can be a problem. To solve this, the bottom of the trench should be slightly sloped for drainage and provision should be made for surface water to run of at the low end of the trench. The trench can be as deep as soil and groundwater conditions will safely allow, and it should be at least twice as wide as any heavy equipment that will be working in it. Small trenches usually measure 8 to 10 ft. deep and are 2 to 3 times as wide as the machine excavating them. Larger ones may be 30 to 40 ft. deep, 60 to 80 ft. wide and 200 to 300 ft. in length. These are suitable for sites receiving 300 to 500 tons per day. It is set in order to avoid truck trolley congestion.

Trenches are excavated at a rate geared to land filling demands. The immediate availability of cover without the need for expensive specialized equipment to haul it from long distances is a major advantage of the trench method. If the landfill is to be brought above ground level, nearby cover material is an advantage. The trench has some disadvantages; however, if more cover materials are excavated than can be used immediately, it will have to be stock-piled and moved again, entailing additional expenses.

There are three ways to trench. One way is to excavate the entire trench and window cover material along the sides until it is needed; a second way is to excavate as far as to provide a single day's working space and dirt cover. This is called the Progressive Trench. It will require handling the cover material once a day. The third way is to excavate a second trench in segments parallel to the first one and use the excavated material as cover for the first trench. Care is taken to leave at least 2 feet separating the 2 trenches. This method may also allow for handling the cover material only once.

2.4.2 Area Method

In this method, the waste is spread and compacted on the natural surface of the ground, and cover material is spread and compacted over it. This method is best-suited for flat or gently sloping landsites where no natural slopes exist. It can be adapted, however, to ravines, valleys and other land depressions. It should be noted that disposing of waste in a ravines site requires the construction of diversion ditches for surface run-off water before any waste is received. Waste is pushed into layers, compacted and adequately covered. Then during succeeding days, incoming waste is dumped at the toe of the preceding day's waste and pushed up the face, compacted, and covered at the end of each working day. A machine such as a bulldozer or landfill compactor spreads and compacts the material. Soil for daily cover is hauled in from other location.

2.4.3 Ramp Method

The ramp method is a combination/variation of the area and trenching techniques. Waste is spread and compacted on an existing slope. Cover material is excavated directly in front of the working face and then spread over the waste and compacted. The excavated area thus becomes a part of the cell to be worked the following day. Like the progressive trench method, some operators consider the ramp method ideal because they do not have to haul in cover material which translates to additional costs for the use of expensive handling equipment. They may only need to handle the cover once and do have to prepare the land in advance. They consider this an excellent way to start a landfill with minimum equipment. However, if more than one lift is required, cover will have to be hauled to the working face and expenses will have to be incurred. The depth of the water table is a factor to consider. This is not as critical as with the trench method that normally requires deeper excavation.

2.5 Considerations on Landfilling

The trench and area methods may have to be used at the same site to adjust to site conditions. For example, in a site with a thick soil zone over much of it and only a shallow soil layer over the remaining portion, the trench method should be used in the thick soil zone. The extra soil material obtained can then be used in carrying out the area method over the rest of the site. The settling or subsidence of the mass buried in a landfill must be taken into account when final capping is done, otherwise ponding is bound to occur.
Consideration must be given to completing the landfill by phases, so that portions of it can be used as parks and playgrounds while other parts are still accepting solid waste.

Land filling shall be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Land filling shall also be carried out for residues of waste processing facilities as well as pre-processing rejects from waste processing facilities. Land filling of mixed waste shall be avoided unless the same is found unsuitable for waste processing. Under unavoidable circumstances or till installation of alternate facilities, land-filling shall be done following proper norms. Landfill sites shall meet the specifications as given below

2.6 Site Selection

(1) Adequate land area and volume to provide the landfill capacity to meet projected needs for at least twenty five years, so that costly investments in access roads, drainage, fencing and weighing stations are justifiable.
(2) The land area should not be in areas where adequate buffer zones are not possible or in areas immediately upwind of a residential area in the prevailing wind direction(s).
(3) Areas characterized by steep gradients, where stability of slopes could be/are problematic.
(4) The seasonally high table level (i.e. 10 year high) of the groundwater should be below the proposed base of any excavation or site preparation to enable landfill development. Soils above the groundwater's seasonable high table level are relatively impermeable (preferably, less than 10-6cm/s permeability when undisturbed).

(5) No environmentally significant wetlands of important biodiversity or reproductive value, sensitive ecological and/or historical areas should be present within the potential area of the landfill development.
(6) None of the areas within the landfill boundaries should be part of the ten-year groundwater recharge area for existing or pending water supply development.
(7) There should be no private or public irrigation, or livestock water supply wells down-gradient of the landfill boundaries because they are at risk from contamination - alternative water supply sources are readily and economically available.
(8) Area should not be in close proximity to significant surface water bodies, e.g. watercourses or dams.
(9) No major lines of electrical transmission or other infrastructure (e.g. sewer, water lines) should be crossing the landfill development area, unless the landfill operation would clearly cause no concern or rerouting is economically feasible.
(10) No residential development should be adjacent to the perimeter of the site boundary. The waste disposal site should be at least outside a radius of one thousand meters away from a residential or commercial area and water sources.
(11) Landscaping and protective berms should be incorporated into the design to minimize visibility of operations from residential neighborhoods.
(12) Unstable areas are not recommended – i.e. there should not be any significant seismic risk within the region of the landfill which could cause destruction of berms, drains, or other civil works, or require unnecessarily costly engineering measures.
(13) There should not be fault lines or significantly fractured geological structure that would allow unpredictable movement of gas or leachate is within 0.5km of the perimeter of the proposed landfill development.
(14) Groundwater quality monitoring facilities need to be provided during the site development phase. Consideration has to be made for when there will be the need in the future to install a gas monitoring system near to buildings close to the site which may become at risk from gas migration once waste land filling has started.
(15) In areas falling under the jurisdiction of the concerned municipality it shall be the responsibility of concerned municipality to identify the landfill sites and hand over the sites to the concerned operator for operation and maintenance.
(16) Selection of landfill sites shall be based on examination of environmental issues. The concerned Federal/Provincial Environmental Protection Agencies shall co-ordinate with the concerned operator for obtaining the necessary approvals and clearances.
(17) The landfill site shall be planned and designed with proper documentation of a phased construction plan as well as a closure plan.
(18) The landfill sites shall be selected to make use of nearby wastes processing facility. Otherwise, wastes processing facility shall be planned as an integral part of the landfill site.
(19) The existing landfill sites which continue to be used for more than five years shall be improved in accordance of the specifications given in these guidelines.
(20) Biomedical wastes shall be disposed off in accordance with the Guidelines for Hospital Waste Management 2002, issued by the Environmental Health Unit, Ministry of Health, Government of Pakistan, as amended from time to time.
(21) A buffer zone of no-development shall be maintained around landfill site and shall be incorporated in the concerned municipality's land-use plans.
(22) Landfill site shall be away from airports. Necessary approval of airport or airbase authorities like Civil Aviation Authorities of the Government of Pakistan

prior to the setting up of the landfill site shall be obtained in cases where the site is to be located within 10 km of an airport.

2.7 Facilities at the Site

(1) Landfill site shall be fenced or hedged and provided with proper gate to monitor incoming vehicles or other modes of transportation.

(2) The landfill site shall be well protected to prevent entry of unauthorised persons and stray animals.

(3) Approach and other internal roads for free movement of vehicles and other machinery shall exist at the landfill site.

(4) The landfill site shall have wastes inspection facility to monitor wastes brought in for landfill, office facility for record keeping and shelter for keeping equipment and machinery including pollution monitoring equipments.

(5) Provisions like weigh bridge to measure quantity of waste brought at landfill site, fire protection equipments and other facilities as may be required shall be provided.

(6) Utilities such as drinking water (preferably bathing facilities for workers) and lighting arrangements for easy landfill operations when carried out in night hours shall be provided.

(7) Safety provisions including health inspections of workers at landfill site shall be periodically made.

2.8 Specifications for land filling

(1) Wastes subjected to land filling shall be compacted in thin layers using landfill compactors to achieve high density of the wastes. In high rainfall areas where heavy compactors cannot be used alternative measures shall be adopted.

(2) Wastes shall be covered immediately or at the end of each working day with minimum 10 cm of soil, inert debris or construction material till such time waste processing facilities for composting or recycling or energy recovery are set up.

(3) Prior to the commencement of monsoon season, an intermediate cover of 40-65 cm thickness of soil shall be placed on the landfill with proper compaction and grading to prevent infiltration during monsoon. Proper drainage berms shall be constructed to divert run-off away from the active cell of the landfill.

(4) After completion of landfill, a final cover shall be designed to minimize infiltration and erosion. The final cover shall meet the following specifications :--

i. The final cover shall have a barrier soil layer comprising of 60 cms of clay or amended soil with permeability coefficient less that 1 x 10-7 cm/sec.

ii. On top of the barrier soil layer there shall be a drainage layer of 15 cm.

iii. On top of the drainage layer there shall be a vegetative layer of 45 cm to support natural plant growth and to minimize erosion.

2.9 Pollution prevention

In order to prevent pollution problems from landfill operations, the following provisions shall be made:-

(1) Diversion of storm water drains to minimize leachate generation and prevent pollution of surface water and also for avoiding flooding and creation of marshy conditions;

(2) Construction of a non-permeable lining system at the base and walls of waste disposal area. For landfill receiving residues of waste processing facilities or mixed waste or waste having contamination of hazardous materials (such as

aerosols, bleaches, polishes, batteries, waste oils, paint products and pesticides) minimum liner specifications shall be a composite barrier having 1.5 mm high density polyethylene (HDPE) geomembrane, or equivalent, overlying 90 cm of soil (clay or amended soil) having permeability coefficient not greater than 1 x 10-7 cm/sec. The highest level of water table shall be at least two meter below the base of clay or amended soil barrier layer;

(3) Provisions for management of leachates collection and treatment shall be made. The treated leachates shall meet the NEQS.

(4) Prevention of run-off from landfill area entering any stream, river, lake or pond.

2.10 Water Quality Monitoring

(1) Before establishing any landfill site, baseline data of ground water quality in the area shall be collected and kept in record for future reference. The ground water quality within 50 metres of the periphery of landfill site shall be periodically monitored to ensure that the ground water is not contaminated beyond acceptable limit as decided by the concerned Federal/Provincial Environmental Protection Agency. Such monitoring shall be carried out to cover different seasons in a year that is, summer, monsoon and post-monsoon period.

(2) Usage of groundwater in and around landfill sites for any purpose (including drinking and irrigation) is to be considered after ensuring its quality meets the WHO guidelines for drinking water supply.

2.11 Ambient Air Quality Monitoring

(1) Installation of landfill gas control system including gas collection system shall be made at landfill site to minimize odour generation, prevent off-site migration of gases and to protect vegetation planted on the rehabilitated landfill surface.

(2) The concentration of methane gas generated at landfill site shall not exceed 25 per cent of the lower explosive limit (LEL).

(3) The landfill gas from the collection facility at a landfill site shall be utilized for either direct thermal applications or power generation, as per viability. Otherwise, landfill gas shall be burnt (flared) and shall not be allowed to directly escape to the atmosphere or for illegal tapping. Passive venting shall be allowed if its utiliztion or flaring is not possible.

(4) Ambient air quality at the landfill site and at the vicinity shall be monitored to meet the following specified standards :-

No.	Parameters	Acceptable levels
(i)	Sulphur dioxide	120 mg/m3
(ii)	Suspended Particulate Matter	500 mg/m3
(iii)	Methane	Not to exceed 25 per cent of the lower explosive limit (equivalent to 650 mg/m3)
(iv)	Ammonia daily average	
	(Sample duration 24 hrs)	0.4 mg/m3 (400 μ g/m3)
(v)	Carbon monoxide	1 hour average : 2 mg/m3 8 hour average : 1 mg/m3

(5) The ambient air quality monitoring shall be carried out by the concerned Federal and Provincial Environmental Protection Agency on quarterly basis in a year.

2.12 Plantation at Landfill Site

A vegetative cover shall be provided over the completed site in accordance with the and following specifications:-

(1) Selection of locally adopted non-edible perennial plants that are resistant to drought and extreme temperatures shall be allowed to grow;
(2) The plants grown be such that their roots do not penetrate more than 30 cms. This condition shall apply till the landfill is stabilised;
(3) Selected plants shall have ability to thrive on low-nutrient soil with minimum nutrient addition;
(4) Plantation to be made in sufficient density to minimize soil erosion.

2.13 Record keeping

The operator of a landfill facility should maintain in the operating record of the following items:

(1) On a map, the exact location and dimensions, including depth of each cell.
(2) The contents of each cell and the approximate location of each type of hazardous waste within each cell
(3) The quantities and types of wastes being treated and disposed of should be recorded in the daily logbook.
(4) The daily analytical data of the effluent from leachate treatment system should be recorded. The parameters to be analysed must be in accordance with the concerned Federal/Provincial Environmental Protection Agency's regulations

2.14 Leachate Management System

There should be a leachate collection and removal system immediately above the liver which is deigned, constructed, maintained and operated in order to collect and remove the leachate generated from the landfill activity. The depth of leachate over the liner should not exceed 30 cm (one foot). The leachate collection and remove system should be:

(1) Constructed of materials that are chemically resistant to the waste and leachate, and of sufficient strength and thickness to prevent collapse under the pressures exerted by deposited wastes, cover materials, and by any equipment used at the landfill.
(2) Designed and operated to function without clogging through the scheduled closure of the landfill.
(3) The collected leachate should be treated before discharging to the sewer or surface water as per NEQS. While discharging treated leachates into inland surface waters, quantity of leachates being discharged and the quantity of dilution water available in the receiving water body shall be given due consideration.

The operator of the facility must design, construct, operate, and maintain a run-on control system capable of preventing flow on to the active portion of the landfill.

If the landfill contains any particulate matter, which may be subject to wind dispersal, the operator should cover or otherwise manage the landfill to control wind dispersal.

2.15 Monitoring and Inspection

During construction or installation of liners and cover systems, the owner or operator should inspect for uniformity, damage and imperfections (e.g. holes, cracks, thin spots, or foreign materials)

The operator of the facility should invite the concerned Federal/Provincial Environmental Protection Agency officials periodically during the construction and/or installation of liners and cover systems for inspection.

While landfill is in operation, the operator should inspect at least once in a week and after storms to detect:

(1) Deterioration, malfunctions, or improper operation of run-on and run-off control systems.
(2) Proper functioning of wind dispersal control systems.
(3) The presence of leachate in and proper functioning of leachate collection and removal systems, where present.
(4) The treatment system of the leachate for proper operation, functioning and treatment efficiency.

2.16 Special Requirements for ignitable or reactive Wastes

The operator of the landfill facility should ensure that the ignitable or reactive waste are not being placed in a landfill, unless the waste is treated or mixed before or immediately after placement in a landfill so that the resulting waste, mixture, or dissolution of material no longer has the characteristics of ignitability or reactivity.

Ignitable wastes in containers should be first conditioned or the wastes should be disposed of in such a way that they are protected from any material or conditions which may cause them to ignite. The containers holding such type of wastes should be covered daily with soil or other non-combustible material to minimise the potential for ignition of the wastes. Such type of wastes should not be disposed of in cells/areas which may generate heat sufficient to cause ignition of the waste.

2.17 Special requirements for non-compatible wastes

The owner of a landfill facility should ensure that the non-compatible wastes, or materials are not being disposed of in the same cell or area in the landfill.

2.18 Special requirements for containers

Unless they are very small, such as an ampule, containers should be:

(1) At least 90 percent full when placed in the landfill.
(2) The emptied containers should be crushed, shredded, or similarly reduced in volume to the maximum possible extent before burial in the landfill.

2.19 Closure requirements

At final closure of the landfill or upon closure of any cell, the operator of a landfill facility should cover the landfill or cell with a final cover designed and constructed to:

(1) Provide long-term minimization of migration of liquids through the closed landfill.
(2) Function with minimum maintenance.
(3) Promote drainage and minimize erosion or abrasion of the cover.
(4) Accommodate setting and subsistence so that the cover's integrity is maintained.

(5) Have permeability less than or equal to the permeability of any bottom liner system or natural sub-soil present.
(6) After the closure of the landfill site, the appropriate vegetation should be grown over the cover.

The concerned Federal/Provincial Environmental Protection Agency's officials should be invited periodically for inspection during the final closure operations.

2.20 Closure of Landfill Site and Post-care

(1) The post-closure care of landfill site shall be conducted for at least fifteen years and long term monitoring or care plan shall consist of the following, namely :-

i. Maintaining the integrity and effectiveness of final cover, making repairs and preventing run-on and run-off from eroding or otherwise damaging the final cover;
ii. Monitoring leachate collection system in accordance with the requirement;
iii. Monitoring of ground water in accordance with requirements and maintaining ground water quality;
iv. Maintaining and operating the landfill gas collection system to meet the standards.

(2) Use of closed landfill sites after fifteen years of post-closure monitoring can be considered for human settlement or otherwise only after ensuring that gaseous and leachate analysis comply with the specified standards.

2.21 Special provisions for hilly areas

Cities and towns located on hills shall have location-specific methods evolved for final disposal of solid wastes by the municipality with the approval of the concerned Federal and Provincial Environmental Protection Agency. The municipality shall set up processing facilities for utilization of biodegradable organic wastes. The inert and non-biodegradable waste shall be used for building roads or filling-up of appropriate areas on hills. Because of constraints in finding adequate land in hilly areas, wastes not suitable for road-laying or filling up shall be disposed of in specially designed landfills.

2.22 Standards for Composting, Treated Leachates and Incineration

(1) The waste processing or disposal facilities shall include composting, incineration, pelletisation, energy recovery or any other facility based on state-of-the-art technology duly approved by the concerned Federal and Provincial Environmental Protection Agency.
(2) In case of engagement of private agency by the municipal authority, a specific agreement between the municipal authority and the private operator shall be made particularly, for supply of solid waste and other relevant terms and conditions.
(3) In order to prevent pollution problems from compost plant and other processing facilities, the following shall be complied with:-

i. The incoming wastes at site shall be maintained prior to further processing. To the extent possible, the waste storage area should be covered. If, such storage is done in an open area, it shall be provided with impermeable base with facility for collection of leachate and surface water

run-off into lined drains leading to a leachate treatment and disposal facility;

ii. Necessary precautions shall be taken to minimise nuisance of odour, flies, rodents, bird menace and fire hazard;

iii. In case of breakdown or maintenance of plant, waste intake shall be stopped and arrangements be worked out for diversion of wastes to the landfill site;

iv. Pre-process and post-process rejects shall be removed from the processing facility on regular basis and shall not be allowed to pile at the site. Recyclables shall be routed through appropriate vendors. The non-recyclables shall be sent for well designed landfill site(s).

v. In case of compost plant, the windrow area shall be provided with impermeable base. Such a base shall be made of concrete or compacted clay, 50 cm thick, having permeability coefficient less than 10–7 cm/sec. The base shall be provided with 1 to 2 per cent slope and circled by lined drains for collection of leachate or surface run-off;

vi. Ambient air quality monitoring shall be regularly carried out particularly for checking odour nuisance at down-wind direction on the boundary of processing plant.

vii. In order to ensure safe application of compost, the following specifications for compost quality shall be met:-

Parameters	Concentration not to exceed * (mg/kg dry basis , except pH value and C/N ratio)
Arsenic	10.00
Cadmium	5.00
Chromium	50.00
Copper	300.00
Lead	100.00
Mercury	0.15
Nickel	50.00
Zinc	1000.00
C/N ratio	20-40
PH	5.5-8.5

* Compost (final product) exceeding the above stated concentration limits shall not be used for food crops. However, it may be utilized for purposes other than growing food crops.

3. Evaluation Criteria for landfill selection process in Pakistan

3.1 Introduction

In order to hold an evaluation in between candidate sites for setting up a landfill facility, the examination of the following key features and characteristics of the study areas for the final selection of the most suitable site for land filling should be made:

a) Land use;
b) Economic, social and cultural characteristics;
c) Geologic and hydrogeologic characteristics;
d) Natural environment characteristics;
e) Resource inventories
f) Significant drainage features; and
g) Transportation system.
h) Budgetary cost estimates including cost of land, on-site development costs, off-site costs, and anticipated annual operating costs.

3.2 Evaluation Criteria

Before starting the examination of a long list of candidate sites, it is imperative to "short list" the sites representing the complete range of target opportunities. Utmost efforts in this regard should be made by city development/ local government authorities to identify only two or a maximum of three candidate sites. Candidate sites can be screened in a sequence of elimination rounds, to narrow the field, discarding those that are obviously unsuitable. Point scoring method has been used to rank alternatives and isolate infeasible sites. To determine the total points, it is necessary to lost out the main characteristics and their corresponding features along with their associated weighting:

3.2.1 Main Characteristics

Following are main characteristics.

(1) Geo-technical:
(2) Environmental;
(3) Socio-Economical:
(4) Technical/Operational:
(5) Investment/ Operating Costs:

Each Characteristic has several features, which are listed below:

3.2.2 Geo-Technical

(1) Soil conditions including permeability and bearing capacity: (deep clay or other impermeable soil should be given preference.)
(2) Water table conditions and aquifer thickness: (landfill should have a minimum 1.2 meter separation distance between the bottom of the landfill and the seasonal water table; also look at the design parameters)

3.2.3 Environmental

(1) Land fill gas management (look at design performance standards)
(2) Orders nuisance (look at design performance standards)
(3) Local Ecological Conditions/ Habitats: (wetlands, wildlife or critical habitats should be given low preference)
(4) Risk of groundwater contamination (Risk could be categorized as low, medium, high: also see the design parameters. The soil liner of at least 0.5m thickness

should be provided. A permeability of less than 10^{-7}cm/sec is required. The minimum bottom slopes of the liner should be 2 percent on controlling slopes and 0.5 percent on the remaining slopes.)

(5) Proximity to water Courses: (less than 200 meter with approval of EPA, or greater than 200 meters. The ideal site has no major watercourses, is not at a high elevation, has moderate slopes and does not drain into a surface drinking water source. A minimum of 100 meter set back is required from any surface waters. A minimum of 300 meters set back fro existing and operating water supply wells)

(6) Occurrence of Flooding (sites prone to flooding should be given the least priority unless protected by engineering designs)

3.2.4 Socio- Economical

(1) Useful life/ Capacity: (more than 5, 10, 20, or more years. Preferably the site should have a useful life of 20 years or more. The capacity of landfill should be determined. Ideally the sites should be between 100 to 200 acres for an average population of 6 to 8 million population)

(2) Land Value/ Use: (developed, undeveloped, or public land)

(3) Public acceptability: (the level of acceptability could be good, fair or opposed)

(4) Property lines: (The population density should be considered. Any housing scheme with in the radius of 300 meters nay have high impacts)

(5) Archaeological/ cultural sites: (look from the historical/ cultural preservation perspective)

3.2.5 Technical Operational

(1) Cover material availability (availability of suitable for landfill within the footprint of the landfill should be given preference. The excavation of soil within the landfill footprint minimizes transportation costs and reduce the need to develop an offsite borrow pit)

(2) Access Road (cost could escalate if landfill site is away from the major highways. A long access road will cost more keeping in mind the load capacity of collection vehicle. The gradient should be less than 6 %)

(3) Distance from the waste consumption (The areas more than 40 kilometres from the waste generation centre may require a transfer station which could escalate the cost; a consideration for optimizing the routes is required to determine the total haulage distance and available transport capacity)

(4) Proximity t Airport (airports utilized by commercial aircraft should be at least 10 kilometre from landfill site)

3.2.6 Investment/Operating costs

Capital/ operating cost (consider host of factors which could influence both capital and operating costs. A site that minimizes the capital and operating cost for development, and closure of the landfill site should be preferred). The capital cost include land cost, on-site development costs (cost of roads, ground slopes, fences, leachate control, liners, etc) and off-site costs (bringing access roads up to anticipated load-carrying capacity etc). A 2 to 10 degrees ground slope is preferred to reduce the development costs. The operating cost includes the transportation cost and the anticipated annual O & M costs. The site recommended should be the one with the lowest cost (trucking plus disposal) per ton.

3.3 Weighting of Criteria

Once the analysis of all potential characteristics and features at each location is completed, sites should be ranked in order of preference based on weighting criteria which highlights both quantitative and qualitative techniques. A sensitivity analysis may also be conducted to ensure that the results of both the quantitative and qualitative analyses made are reasonably strong, and not sensitive to minor changes in criteria scores. The following table shows the scoring technique that could be applied to facilitate the comparison of sites using all of the evaluation criteria:

Candidate Site Name:

No	Characteristics/ Features	Considerations	Recommendation for weighting	Total Score
1.	**Geo-Technical**		**20%**	
	Soil condition including permeability and bearing capacity	Poor→Excellent	8%	
	Water table conditions and aquifer thickness	Poor→Excellent	12%	
2.	**Environmental**		**20%**	
	Land fill gas management	Poor→Excellent	2%	
	Odors nuisance	Poor→Excellent	1%	
	Local Ecological conditions/ Habitats	Unacceptable ↓ Acceptable	2%	
	Risk of groundwater contamination	Low→High	5%	
	Proximity to water courses	Poor→Excellent	5%	
	Occurrence of Flooding	Low→Excellent	5%	
3.	**Scio-Economical**		**30%**	
	Useful Life/ Capacity	Poor→Excellent	10%	
	Land Value/ Use	Low→High	4%	
	Public acceptability	Low→High	6%	
	Population density	Low→High	3%	
	Property Lines	Poor→Excellent	3%	
	Archeological/ Cultural sites	Nil→Objectionable	4%	
4.	**Technical/Operational**		**20%**	
	Cover material	Low→High	5%	
	Access Road	Low→High	5%	
	Distance from the waste consumption	Poor→Excellent	5%	
	Proximity to Airports	Poor→Excellent	5%	
5.	**Investment/ Operating Costs**		**10%**	
	Capital/ Operating cost	Poor→Excellent	10%	
	Total			

Source: Criteria for landfill selection process in Pakistan by Irfan S. Alrai

3.4. Assumptions

All candidate sites infrastructure is to be identical and include fencing, guardhouse gates, weigh-bridge, all-weather paved access road, leachate collection, treatment and disposal system, surface runoff collection and drainage system, gas collection and flaring system, laboratory, storage, administration and staff buildings, compactors and bulldozers etc.

PART D

D-2 Incineration Guidelines

D-2 Incineration Guidelines

1. INTRODUCTION

1.1 Scope of Guidelines

The Incineration Guidelines identify and explain issues that should be addressed for setting up incineration facility for healthcare infectious waste, narcotics and hazardous industrial waste. It is important to focus on key issues for specific proposals. The matters identified in these guidelines should provide guidance, for setting up an incineration facility.

It is recognized that there are five stages in the process of developing incineration facility and following factors should be considered at each of these stages:

i. The need to put up an incineration facility
ii. Selection of an incinerator
iii. Installation, commissioning and operation of an incineration facility
iv Monitoring and reporting of incineration facility
v Disposal of ash

1.2 Context

These guidelines form part of package of regulations and guidelines which includes

- The Pakistan Environmental Protection Act 1997
- Policy and procedures for filing, review and approval of environmental assessments
- Guidelines for the preparation and review of environmental reports
- Pakistan environmental legislation and the National Environmental Quality Standards (NEQS)

These guidelines should be read in the context of overall package. A whole series of clearance is required from Environmental Protection Agency for setting up an incineration facility. The guidelines may be reviewed/modified as and when required by the respective Federal/Provincial Environmental Protection Agency. These guidelines shall be applicable only to the new installation of incinerators. However, the existing incinerator should be upgraded with additional facilities as mentioned in these guidelines.

2. INCINERATION OPTIONS

2. 1 Introduction

Incineration used to be the method of choice for most hazardous healthcare and industrial hazardous wastes and is widely used. However, recently developed alternative treatment methods are becoming increasingly popular. The final choice of treatment system should be made carefully, on the basis of various factors, many of which depend on the local conditions as follows:

- Disinfection efficiency
- Health and environmental considerations
- Volume and mass reduction
- Occupational health and safety considerations
- Quantity of wastes for treatment and disposal/capacity of the system
- Types of waste for treatment and disposal
- Infrastructure requirements
- Locally available treatment options and technologies
- Options available for final disposal
- Training requirements for operation of the method
- Operation and maintenance considerations
- Available space
- Location and surroundings of the treatment site and disposal facility; investment and operating costs
- Public acceptability
- Regulatory requirements

Certain treatment options effectively reduce the infectious hazards of health-care waste and prevent scavenging but, at the same time, give rise to other health and environmental hazards. For example, incineration of certain types of health-care waste, particularly those containing chlorine or heavy metals, may under certain conditions (such as insufficiently high incineration temperatures, inadequate control of emissions) release toxic material into the atmosphere. Land disposal may result in groundwater pollution if the landfill site is inadequately designed and/or operated. In choosing a treatment or disposal method for healthcare and industrial hazardous waste, particularly if there is a risk of toxic emissions or other hazardous consequences, the relative risks, as well as the integration into the overall framework of comprehensive waste strategy, should therefore be carefully evaluated in the light of local circumstances.

2.2 Incineration

2.2.1 Principal of incineration

Incineration is a high-temperature dry oxidation process that reduces organic and combustible waste to inorganic, incombustible matter and results in a very significant reduction of waste volume and weight. This process is usually selected to treat wastes that cannot be recycled, reused, or disposed of in a landfill site. The combustion of organic compounds produces mainly gaseous emissions, including steam, carbon dioxide, nitrogen oxides, and certain toxic substances (e.g. metals; halogenic acids), and particulate matter, plus solid residues in the form of ashes. If the conditions of combustion are not properly controlled, toxic carbon monoxide will also be produced. The ash and wastewater produced by the process also contain toxic compounds, which have to be treated to avoid adverse effects on health and the environment.

Most large, modern incinerators include energy-recovery facilities. In cold climates, steam and/or hot water from incinerators can be used to feed urban district-heating systems, and in warmer climates the steam from incinerators is used to generate electricity. The heat recovered from small hospital incinerators is used for preheating of waste to be burnt.

An input of appropriate fuel may overcome a slightly deficient heating value or slightly excessive moisture content.

Incineration requires no pretreatment, provided that certain waste types are not included in the matter to be incinerated.

2.2.2 Types of incinerators

Incinerators can range from extremely sophisticated, high-temperature operating plants to very basic combustion units that operate at much lower temperatures. All types of incinerator, if operated properly, eliminate pathogens from healthcare waste and reduce the waste to ashes. However, certain types of healthcare and industrial hazardous wastes, e.g. pharmaceutical or chemical or other industrial wastes, require higher temperatures for complete destruction. Higher operating temperatures and cleaning of exhaust gases limit the atmospheric pollution and odors produced by the incineration process.

Incineration equipment should be carefully chosen on the basis of the available resources and the local situation, and of risk-benefit considerations balancing the public health benefits of pathogen elimination before waste disposal against the potential risks of air or groundwater pollution caused by inadequate destruction of certain wastes.

Two basic kinds of incineration technology are of interest for treating health-care waste:

- **Double-chamber pyrolytic incinerators**, which may be especially designed to burn infectious health-care and industrial hazardous waste;
- **Rotary kilns operating at high temperature**, capable of causing decomposition of genotoxic substances and heat-resistant chemicals.

Incinerators designed especially for treatment of health-care waste should operate at temperatures between 900 and 1200°C. Mobile incinerators for health-care waste have been tested in Brazil. These units permit on-site treatment in hospitals and clinics, thus avoiding the need to transport infectious waste through city streets. Test results for units with a capacity of 30 kg/hour were satisfactory in terms of function, performance, and air pollution (Bartone, 1998). High-temperature incineration of chemical and pharmaceutical waste in industrial cement or steel kilns is practiced in many countries and is a valuable option, no additional investments are required and industry benefits from a supply of free combustible matter.

2.2.3 Assessment of waste parameters

Specific waste parameters should be assessed at the planning stage to determine the most suitable type and size of incinerator:

- Current extent of waste production and types of health-care waste
- Estimated future waste production
- Production waste to be incinerated per day (and per bed per day)

All the physical parameters that determine the suitability of waste for incineration, such as low heating value and moisture content.

2.3 Comparison of treatment technologies

Technology or method	Infectious waste	Anatomical waste	Sharps	Pharmaceutical waste	Cytotoxic waste	Chemical waste	Radioactive waste
Rotary kiln	Yes	Yes	Yes	Yes	Yes	Yes	Low-level infectious waste
Pyrolytic incinerator	Yes	Yes	Yes	Small quantities	No	Small quantities	Low-level infectious waste
Single-chamber incinerator	Yes	Yes	Yes	No	No	No	Low-level infectious waste
Drum or brick incinerator	Yes	Yes	Yes	No	No	No	No
Chemical disinfection	Yes	No	Yes	No	No	No	No
Wet thermal treatment	Yes	No	Yes	No	No	No	No
Microwave irradiation	Yes	No	Yes	No	No	No	No
Encapsulation	No	No	Yes	Yes	Small quantities	Small quantities	No
Safe burial on hospital premises	Yes	Yes	Yes	Small quantities	No	Small quantities	No
Sanitary landfill	Yes	No	No	Small quantities	No	No	No
Discharge to sewer	No	No	No	Small quantities	No	No	Low-level liquid waste
Inertization	No	No	No	Yes	Yes	No	No
Other methods				Return expired drugs to supplier	Return expired drugs to supplier	Return unused chemicals to supplier	Decay by storage

The advantages and drawbacks of different treatment methods as follows:

TREATMENT/DISPOSAL METHODS	ADVANTAGES	DRAWBACKS
Rotary Kiln	Adequate for all infectious waste, most chemical waste, and pharmaceutical waste.	High investment and operating costs.
Pyrolytic incineration	Very high disinfecting efficiency; adequate for all infectious waste, and most pharmaceutical and chemical waste.	Incomplete destruction of eytotoxics. Relatively high costs of investment and operation.
Single Chamber incinerator	Good disinfecting efficiency; Drastic reduction of weight and volume of waste. The residues may be landfilled. No need for highly qualified operators. Relatively low investment and operation costs.	Generation of significant emissions of atmospheric pollutants; need for periodic slag and soot removal; chemicals and drugs such as eytotoxics.
Drum or brick incinerator	Drastic reduction of weight and volume of the waste. Very low investment and operating costs.	Only 99% destruction of micro-organisms. No destruction of many chemicals and pharmaceuticals. Massive emission of black smoke, flying ashes, toxic flue gas and odours.
Chemical disinfecting	Highly efficient disinfect ion under good operating conditions. Costly if the chemical disinfectants are expensive	Requirement of highly qualified technicians for operation of the process. Use of hazardous substances which require comprehensive safety measures. Inadequate for pharmaceutical, chemical and some types of infectious waste.
Wet-Thermal Treatment	Environmentally friendly, Relatively low investment and operation costs.	Shredders are subject to frequent breakdowns. Operation requires qualified technicians. Inadequate for anatomic waste, pharmaceutical and chemical waste or waste which is not easily penetrable by steam.
Microwave Irradiation	Good disinfecting under appropriate operational conditions. Environmentally friendly.	High investment and operation costs; potential operation and maintenance problems.
Safe Burying	Low costs. Relatively safe if access restricted and where natural infiltration is limited.	Only safe if access of site is limited.
Encapsulation	Simple, low-cost and safe. May also be applied to pharmaceuticals.	Not recommended for non-sharp infectious waste.
Inertization	Relatively inexpensive	Not applicable to infectious waste.

2.4 Before Operation

The guidelines in this part will be applicable to the operators of facilities that incinerate hazardous wastes. The following facility operators are considered to incinerate hazardous waste:

- Who destroy hazardous waste by thermal process using incinerator or any other method.
- Who burn hazardous waste in boilers or in industrial furnaces in order to destroy them and/or for any recycling purpose or as energy source?

2.4.1 Waste Analysis

The operator of a facility having incinerator should first ascertain the waste for the combustible characteristics, before incinerating the waste. Throughout normal operation, the operator should conduct sufficient waste analysis and decided about the physical and chemical composition required for burning the wastes.

2.4.2 Operating standards

The incinerators shall meet the following operating and emission standards:-

(1) The combustion efficiency (CE) shall be at least 99.00%.
(2) The combustion efficiency is computed as follows:

$$C.E. = \frac{\%CO2}{\%CO2 + \%CO} \times 100$$

(3) Emission Standards

Parameters	Concentration mg/Nm3 at (12% CO2 correction)
(a) Particulate matter	150
(b) Nitrogen Oxides	450
(c) HCl	50

(d) Minimum stack height shall be 30 meters above ground.
(e) Volatile organic compounds in ash shall not be more than 0.01 %.

(4) Suitably designed pollution control devices shall be installed or retrofitted with the incinerator to achieve the above emission limits, if necessary.
- Wastes to be incinerated shall not be chemically treated with any chlorinated disinfectants
- Chlorinated plastics shall not be incinerated.

2.4.3 Operating requirements

An incinerator should be operated in accordance with the requirements specified in the license to be issued by the concerned Federal/Provincial Environmental Protection Agency.

During Start-up, shut-down, and operation of an incinerator, the operator should not feed the hazardous waste into the incinerator unless the incinerator is operating within the conditions of safe operation (temperature, air feed rate, etc). The incinerator should be operated at a specified minimum temperature as per the waste characteristics, in order to achieve complete destruction of the waste and also to avoid generation of toxic emissions like dioxin.

Fugitive emissions from the combustion zone may be controlled by:

1. Keeping the combustion zone totally sealed against fugitive emissions: or
2. Maintaining a combustion zone pressures lower than atmosphere pressure.

The operator of a facility should operate an incinerator with a safety system to automatically cut off waste feed to the incinerator when operating conditions deviate.

2.4.4 Monitoring, Inspection and Record keeping

The operator of a facility should conduct, as a minimum, the following monitoring while incinerating hazardous waste for effective incineration:

(1) Combustion temperature carbon monoxide should be monitored and recorded on a continuous basis.
2. The off gases from incinerator should be monitored and recorded on a continuous basis for the air pollutants prior to release to the atmosphere as specified by the concerned Federal/Provincial Protection Agency.

(2) The incinerator and associated equipment (pumps, valves, conveyors, pipes, etc.) should be subjected to thorough visual inspection, at least daily for leaks, spills, fugitive emissions, and signs of tempering.

(3) The emergency waste feed cut off system and associated alarms should be tested daily to verify operability.

(4) The operator of a facility should keep daily records of monitoring and inspections in the operating records.

3. Guidelines for Design and Construction of Healthcare Waste Incinerator

3.1 Introduction

The incinerator shall be specifically designed to destroy all types of medical/clinical waste. All incinerators to be supplied shall be of multiple chamber type, minimum double chamber. The incinerator shall be housed in a building, to protect it from the rain. The design of the building shall be provided by the consultant, after consultation with the manufacturer. Centralized incinerator facilities will be preferred than individual incinerators.

3.2 Capacity of Incinerator

The incinerator capacity may vary according to the type and quantity of waste generated in the hospital per day. The minimum capacity of the incinerator should be 50 kg/hour. The hospital wishes to install the incinerator must apply for Environmental Impact Assessment (EIA) approval from Federal Provincial EPA. The EPA will examine the type, capacity and the emission standards.

3.3 Type of Incinerator

The incinerator shall be designed in such a way that it can be operated in pyrolytic mode with the required quantity of air for proper combustion. The incinerator may be of fixed bed type or rotary kiln type and should have the following:

Two chambers i.e., primary and secondary:

- Primary chamber: Temp.range 600-800 degrees Celsius.
- Secondary chamber: temp range 900-1200 degrees Celsius with retention time of minimum 2 seconds.

The design should incorporate complete combustion safety and necessary interlocking.

Economic life of incinerator to be minimum 15 years. Automatic temperature indication control system both on primary & secondary chambers. One induced draft fan should be provided for large incinerators of above 100 kg/hr capacity. Self supported incinerator stack 10 ft higher than nearest building.

During normal operation, the temperature of the primary combustion chamber should be within the range of 600-800 degrees Celsius, The temperature on the surface of the outer casing shall not be more than 60 degrees Celsius. All hot surfaces must be protected by wire mesh.

3.4 Characteristics of medical/clinical waste

The average calorific value of the medical/clinical waste will vary between 3,000 to 8,000 keal/kg. The average density is about 0.8 kg/1. The medical/clinical waste will normally consist of the following:

- Pathological waste from the clinic and operation theatre.
- Laboratory waste inclusive of blood and urine samples.
- Sharps inclusive of syringes, needles, cutters and broken glasswares.
- Plastic containers inclusive of gloves IV bottles etc.

3.5 Overall dimension and weight of Incinerator

The manufacturer has to specify the overall dimension and weight of the incinerator to enable the consultant to design the building. The salient design requirements are as follow:

Waste type	Medical/Clinical waste	
Waste Calorific value	min.	: 3000 kcal/kg
	Max.	: 8000 kcal/kg
Mode of charging/operation	Batch or Continuous	
Operating Temperatures	Primary Chamber	: 600-800 C
	Secondary Chamber	: 900-1200 C

The fuel to be supplied by the hospital may be Natural gas/Diesel/LPG.

3.6 Initial Environmental Impact Assessment approval

As per clause(12) 1 of PEPA, the proponent of every project before its commencing, construction & operation shall submit to the EPA'S an initial environmental examination (IEE) or where the project is likely to cause an adverse environmental affects, an environmental impact assessment (EIA) and has obtained approval from the EPA'S in respect thereof.

3. 7 Hospital waste storage and ash disposal

The hospital must provide proper storage facility for the hospital waste. Special care must be taken to ensure that the waste will not contaminate the surroundings, not accessible to unauthorized personnel properly ventilated and lighted, and other conditions deemed necessary. In addition, hospitals should specify the mode of ash disposal submitted through IEE/EIA to EPAs and maintain a proper record of waste/ ash generated and disposed off.

3. 8 Emission standards and monitoring

The emission from the incinerator, irrespective of the operation mode, shall comply with the standards as specified in the EPA of Pakistan NEQS-1997 SCHEDULE H AIR EMISSION. Hospitals should maintain in-house continuous monitoring record of Stack emissions, which may be provided to EPA s, whenever required.

3.9 Air Pollution Control Device

It is not possible to comply with the emission limit of 150 mg/Nm3 (corrected to 12% CO_2) for particulate matter, without Air Pollution Control Device (APCD). Therefore, a Healthcare waste incinerator shall always be equipped with APCD. No incinerator shall be allowed to operate unless equipped with APCD.

The incinerator shall be equipped with High Pressure Venturi Scrubber System as ordinary APCD such as wet scrubber or cyclonic separator cannot achieve the prescribed emission limit. For the facilities operating for 24hrs a day, APCD in terms of dry lime injection followed by bag filter can be considered.

3.10 Technical details of incinerator

3.10.1 Incinerator

Following design criteria may be adopted for better performance:

1. The incinerator shall be designed for capacity more than 50 kg/hr. For 50-kg/hr capacity, the minimum hearth area shall be 0.75 sq. m (8 sq. feet) and the minimum flow of the flue gas in the secondary chamber shall be 0.6 m3/sec at 1050°C. Each incinerator must be installed with an air pollution control system.
2. The size of the opening through which the waste is charged shall be larger than the size of the waste bag to be fed. The volume of the primary chamber shall be at least five times the volume of one batch.
3. The double chamber incinerator shall preferably be designed on "controlled-air" incineration principle, as particulate matter emission is low in such incinerator. Minimum 100% excess air shall be used for overall design. Air supply in the primary and secondary chamber shall be regulated between 30%-80% and 170%- 120% of stoichiometric amount respectively. Primary air shall be admitted near / at the hearth for better contact. Flow meter / suitable flow measurement device shall be provided on the primary & secondary air ducting. The combustion air shall be supplied through a separate forced draft fan after accounting for the air supplied through burners.

   Optional: For higher capacity incinerators, typically above 250 kg/hr, other design e.g. Rotary Kiln shall be preferred.
4. A minimum negative draft of 1.27 to 2.54 mm of WC (Water Column) shall be maintained in the primary chamber to avoid leakage of gaseous emissions from the chamber and for safety reasons. Provision shall be made in the primary chamber to measure the Water Column pressure.

5. The waste shall be fed into the incinerator in small batches after the fixed interval of time in case of fixed hearth incinerator and continuous charging using appropriate feeding mechanism incase of rotary kiln incinerator or as recommended by the manufacturer. The size of the hearth i.e. primary chamber shall be designed properly.

6. The sides and the top portion of the primary and secondary chambers shall preferably have rounded corner from inside to avoid possibility of formation of black pockets/dead zones.
7. The size of the secondary chamber shall be properly designed so as to facilitate a minimum of one second of residence time to gas flow. For the estimation of residence time in the secondary chamber its volume shall be calculated starting from the secondary burner tip to the thermocouple.
8. The refractory lining of the chamber shall be strong enough to sustain minimum temperature of 1000° C in the primary chamber and 1200° C in the secondary chamber. The refractory & insulation bricks shall have minimum 115 mm thickness each.
9. The Incinerator shell shall be made of mild steel plate of adequate thickness (minimum 5 mm thick) & painted externally with heat resistant aluminum paint suitable to withstand temperature of 250°C with proper surface preparation. Refractory lining of the hot duct shall be done with refractory castable (minimum 45 mm thick) & insulating castable (minimum 80 mm thick). Ceramic wool shall be used at hot duct flanges & expansion joints.
10. The thermocouple location shall be as follows:
    In Primary chamber - Before admission of secondary air
    In Secondary chamber - At the end of secondary chamber or before admission of dilution medium to cool the gas
11. There shall be a separate burner each for the Primary & Secondary chamber. The heat input capacity of each burner shall be sufficient to raise the temperature in the primary and secondary chambers as 800±50°C and 1050±50°C respectively within maximum of 60 minutes prior to waste charging. The burners shall have automatic switching "off/on" control to avoid the fluctuations of temperatures beyond the required temperature range.
    (i) Each burner shall be equipped with spark igniter and main burner.
    (ii) Proper flame safeguard of the burner shall be installed.
    (iii) Provide view ports to observe flame of the burner.
    (iv) Flame of the primary burner
        (a) Shall be pointing towards the center of the hearth.
        (b) Shall be having a length such that it touches the waste but does not impinge directly on the refractory floor or wall.
    (v) The secondary burner shall be positioned in such a way that the flue gas passes through the flame.
12. There shall not be any manual handling during charging of waste in to the primary chamber of the incinerator. The waste shall be charged in bags through automatic feeding device at the manufacturer's recommended intervals ensuring no direct exposure of furnace atmosphere to the operator. The device shall prevent leakage of the hot flue gas & any backfire. The waste shall be introduced on the hearth in such a way so as to prevent the heap formation. Suitable raking arrangement shall be provided for uniform spreading of waste on the hearth.

3.10.1 Waste feeding system

The feeding of the waste may be carried out manually/ semi automatic/automatic. For incinerator of large capacity it is recommended that a semi-automatic feeding system be installed.

3.10.2 Charging door

The dimension of the door shall be big enough to allow the normal plastic bag (fully filled with waste) to be charge into the incinerator without any obstruction.

A peeping hole shall be provided. The peeping hole is to be protected by a safety glass. The safety hole shall not be less than 12 mm diameter, and shall be located in such apposition to allow the operator to view the inside of the furnace during operation.

3.10.3 Primary combustion chamber

The incinerator shall be designed to allow batch / continuous loading. The manufacturer has to provide the volume of the primary combustion chamber.

The burners shall be located at suitable location to allow the most effective heating of the furnace. Air blowers will be used to supply the air to the furnace. Whenever the charging door is opened, the blower should be switched off automatically, to ensure safety of the operator.

At least one unit of thermal couple will be installed on top of the primary combustion chamber. The thermal couple shall be strategically positioned so as to measure the temperature inside the furnace accurately, and at the same time not easily damaged by the operator.

At least one unit of door shall be provided for the primary combustion chamber. The ash door shall be suitably sized and located in strategic locations to allow easy removal of ash.

3.10.4 Secondary combustion chamber

The incinerator shall be equipped with a secondary combustion chamber to ensure complete destruction of any incompletely burnt flue glass. The chamber shall be designed to have a minimum gaseous retention time of 2 seconds, with an operating temperature ranges between 900-1200 degrees Celsius.

At least one unit of burner shall be provided in the secondary combustion chamber. The capacity of the burner shall be enough to maintain the required temperature. The burner shall preferably be the high / low type.

An additional tertiary air blower shall be provided for the secondary combustion chamber. The capacity of the air blower shall always ensure excess air in the secondary combustion chamber so as to ensure complete combustion of flue gases.

At least one unit of temperature control and indicator system shall be installed in the secondary combustion chamber.

At least one ash door shall be provided. The ash door shall be positioned in such a way so that ash is removed easily from the secondary combustion chamber.

3.10.5 Chimney

The chimney shall be constructed preferably stainless steel / any suitable material. The height of the chimney shall be not less than 10 ft to the height of the nearest building & in case of installation in congested areas, dust collector/scrubber is highly recommended.

3.10.6 Electrical Control Panel

The electrical control panel can either be wall mounted or floor mounted type.

The control panel to be supplied shall comply with the specification to ensure safety in addition to following function (not limited to)

- Safe start of blowers (Blowers, Excess Air & I.D fan)
- Will check necessary Interlocking for startup & running cycle.
- Safe start of primary Burner & secondary Burner.
- Continuous Flame Monitoring.
- Alarm on interlockers failure.
- Temperature Indication & control system for primary secondary Chamber.

3.10.7 Induced draft fan

For large incinerator more than 100 kg/hr, at least one unit of induced draft fan is required to draw the flue gas from the incinerator and the flue gas cleaning system to be emitted through the chimney. The induced draft fan will create a negative pressure in the incinerator at all time to prevent smoke and fire from coming out of the doors.

3.10.8 Temperature controller

The temperature controller shall have a range between 0 to 1600 degrees Celsius. A tamper-proof PLC (Programmable Logic Control) based control system shall be installed to prevent:

- Waste charging until the required temperature in the chambers is attained during beginning of the operation of the incinerator.
- Waste charging unless primary & secondary chambers are maintained at the specified temperature range.
- Waste charging in case of any unsafe conditions such as - very high temperature in the primary & secondary chambers; failure of the combustion air fan, ID fan, recirculation pump, low water pressure & high temperature of the flue gas at the outlet of air pollution control device.

3.10.9 Emergency vent

The incineration system must have an emergency vent. The emergency vent shall remain closed i.e. it shall not emit flue gases during normal operation of the incinerator.

3.10.10 Data recording

Each incineration system shall have graphic or computer recording devices, which shall automatically and continuously monitor and record dates, time of day, batch sequential number and operating parameters such as temperatures in both the chambers. CO, CO_2, and O_2 in gaseous emission shall also be measured daily (at least ½ hour at one minute interval).

3.10.11 Heat recovery

The possibility of providing heat recovery system/heat exchanger with the incinerator shall also be considered wherever possible.

3.10.12 Flue gas exhaust

The incinerator flue should avoid the use of sharp bends or pockets in the run of the flue. Adequate access for cleaning should be provided. Incinerator flues should never be connected into flues for other fuel burning equipment. They should be correctly located and of sufficient height to conform to the requirements of the ambient air to ensure that no down wash will carry products of combustion in to the hospital or nearby buildings. The operator, based on design information where appropriate, should obtain any necessary authorization.

3.10.13 Chimney

The incinerator manufacturer should select the materials of construction for chimney to suit the design and operating conditions of the incinerator and prevent the over heating of any metal flue by diluting the flue gases with air to ensure the flue gas temperature does not exceed 400°C.

Any limitation of use and any protective equipment (e.g. temperature alarm) not already specified by the purchaser, together with maintenance requirements, should be identified by the manufacturer.

The installation should comply with the requirements as appropriate, of the Federal/Provincial EPA's environmental regulations (e.g. planning approvals, chimney height and efflux velocity), together with the correct engineering practice for flue systems operating at the temperature levels involved. Considerations should include the requirements of chimney construction, fire regulations, thermal expansior and contraction, and provision for inspection, cleaning and testing.

3.10.14 Surface temperature

No part of the incinerator that has to be touched during normal operation shall have surface temperature in excess of 50°C (corrected to 20°C ambient temperature). No other external part of the incinerator that can be touched during normal operation shall have a temperature in excess of 80°C (corrected to 20°C ambient temperature).

3.10.15 Combustible matter in residues from incineration

Unburnt combustibles in the residue from incineration shall not exceed 5 % by mass.

3.10.16 Noise

The maximum level of noise at 1.0 m from the prime source of sound shall not exceed 85 dB (A) sound pressure level.

3.10.17 Volumetric heat release rate

The volumetric heat release rate shall not exceed 350 kw/m3.

3.10.18 Gas residence time

A minimum gas residence time of 0.5 s at 800°C shall be provided within the combustion zone in which oxidizing conditions prevail. For an incinerator designed to operate with temperature in excess of 800°C, the criteria of time and temperature shall be adjusted by calculating the equivalent gas volume and residence time at 800°C.

3.10.19 Carbon monoxide concentration

The carbon monoxide concentration at the outlet of the final combustion zone, and before dilution or cooling, shall be not more than 0.5 % by volume (dry basis). The gas temperature shall be not less than 800°C when the incinerator is operating at design capacity.

3.10.20 Oxygen concentration

The oxygen concentration at the outlet of the final combustion zone, and before dilution or cooling, shall be not less than 10.0 % by volume (dry basis).

3.10.21 Incinerator room and waste storage room

The incinerator structure shall be built in a room with proper roofing and cross ventilation. There shall be minimum of 1.5 m clear distance in all the directions from the incinerator structure to the wall of the incinerator room.

Adjacent to the incinerator room, there shall be a waste storage area. It shall be properly ventilated and so designed that waste can be stored in racks and washing can be done very easily. The waste storage room shall be washed and chemically disinfected daily.

The floor and inner wall of the incinerator and storage rooms shall have outer covering of impervious and glazed material so as to avoid retention of moisture and for easy cleaning.

The incineration ash shall be stored in a closed sturdy container in a masonry room to avoid any pilferage. Finally, the ash shall be disposed in a secured landfill.

3.11 Operator of the incinerator

A skilled person shall be designated to operate and maintain the incinerator. The operator shall have adequate qualification in relevant subject and shall be trained and certified by the incinerator manufacturer in operation & maintenance of the incinerator.

There shall be at least one assistant designated at the incinerator plant to keep track of the wastes, records of incinerator operation, cleanliness of the surrounding area and incinerator & waste storage room. They shall also take care of waste charging and incineration ash disposal.

All the staff at the incinerator plant shall put on protective gears such as gumboots, gloves, eyeglasses, etc. for safety reasons.

Any accident occurred shall immediately be reported to the facility operator. The facility operator shall have well defined strategies to deal with such accident/emergency.

3.12 Safeties

To ensure safe operation, it is mandatory for the manufacturer to provide all safety related devices, alarms, detailed technical guidelines & training of the concerned personal regarding installation, operation and maintenance of the incinerator. manufacturer should also submit an undertaken/guarantee to meet the National Environmental Quality Standards (NEQS) limits of air emissions to its client and copy /to respective Federal/Provincial EPA.

3.13 Emission limits

Proposed incineration of hazardous healthcare waste must be accompanied by the technical information about the facility, technology, manufacturers' emissions

guarantees, specifications, existing regulatory agency permits and operating licenses, and mandatory maintenance schedules to ensure guaranteed performance. The air emission limits are summarized in the following table.

Parameter	Maximum value
Particulate matter (PM_{10}) mg/Nm^3	100
Carbon monoxide (CO) ppmdv	40
Nitrogen oxide (NOx) ppmdv	250
Hydrogen chloride (HCl) ppmdv	100
Mercury (Hg) mg/Nm^3	0.55
Cadmium (Cd) mg/Nm^3	0.16
Dioxins / Furans (CDD/CDF) ng/m^3	125(Total)

3.14 Emission of grit and dust

The emission of grit and dust shall not exceed the figures given in table 1.

Table 1. Grit and dust emissions*

Calculated heat release (see clause 8 of BS 3316: Part 2: 1987)	Maximum emission of Grit and dust
KW	g/h
300	450
600	900
900	1350
1200	1600
1500	1800
3000	3000
4500	4000

* Intermediate values can be found by interpolation.

3.15 High Pressure Venturi Scrubber System

The venturi scrubber shall have minimum pressure drop of 350 mm WC to achieve the prescribed emission limit. The temperature of the flue gas at the outlet of the venturi scrubber shall be approx 70-80° C to ensure the saturation of the flue gas.

The venturi scrubber shall preferably be made of stainless steel - 316L grade or better material or mild steel lined with acid resistant bricks to avoid corrosion.

The water to be used in venturi scrubber shall be added with caustic soda solution to maintain the pH of the scrubbing liquid above 6.5.

The scrubbing medium shall be circulated @ 2-2.5 ltrs/m^3 of saturated flue gas at venturi outlet. This shall be done using a pump & piping made of stainless steel - 316 grades or better material. The scrubbing medium shall be recirculated as far as possible.

Venturi scrubbers shall be followed by centrifugal type droplet separator to remove water droplets from flue gas.

The material of construction of the droplet separator and interconnecting ducting from venturi scrubber to droplet separator, droplet separator to ID fan & ID fan to stack, shall be mild steel lined from inside with minimum 3 mm thick natural hard rubber suitable for the duty conditions to avoid corrosion due to oxygen and acids in the wet flue gas.

3.16 Ash handling

All hospital incinerators should have the facility for containing the ash and incombustible items produced by burning continuously for a normal working day. The incinerator should be able to contain this quantity of ash with out endangering operators, creating nuisance or impeding the combustion process. The facility should be provided to allow the operator to be able to remove this debris easily with out nuisance or danger whether or not the debris is at elevated temperature. All necessary special tools or containers, etc. necessary to carry out the deashing process should be provided.

3.17 Training operational and maintenance

3.17.1 Training operational

After commissioning and testing on site, the operational staff should be trained to use the plant by experienced competent persons over a minimum of two complete working shifts, except where a more complicated machine is being commissioned, when a longer period is recommended.

Normal hospital waste should be processed, but the difficulties experienced with certain wastes, i.e. dense plastics, should be demonstrated together with the methods of control.

The manufacturer should provide two sets of operating instructions stating the correct sequence and method of operation and testing of safety devices, together with any emergency procedures.

Daily operator instructions should be suitable for permanent wall display.

3.17.2 Training Maintenance

During the operational training period the incinerator operator should receive training in the day-to-day requirements of the plant servicing expected as part of normal duties. Areas of maintenance requiring the skills of engineering craftsmen should be identified to designated persons from the works department.

Two sets of maintenance instructions should be provided containing the following sections:

- Manufacturer's operating and adjusting instructions
- Manufacturers servicing and maintenance procedures
- Instructions on frequency and method of testing safety and alarm devices
- Oil and grease points and recommended lubricants
- Spares details for reordering
- Fault finding routines and line diagrams showing location of valves and controls
- Valves schedules
- Schedule of electrical equipment and fitting
- Wiring diagrams

3.18 Safety and Emergency measures

3.18.1 Waste reception and storage

The waste reception and storage area should be adjacent to the incinerator and arranged to easily receive waste from vehicles without interfering with any other traffic flow and carry no unauthorized vehicle or pedestrian to prevent accidental contact with hazardous waste materials such as syringe needles, cans, glass or other sharp or contaminated articles. Ideally, the waste should be incinerated on the same day as it is received to reduce the risk of attracting rodents or other pests.

All waste should only be moved by a trained operator equipped with protective gloves and clothing.

3.18.2 Design consideration

The incinerator and associated plant should be designed so that together with the appropriate controls' if any item malfunctions to create a potential hazard then the item should revert to a fail safe condition and if need be the incinerator automatically be shut down.

The restarting of the incinerator following this occurrence should only be accomplished by a competent engineer having first made the appropriate checks and examination and not by the plant operator.

3.18.3 Operational Access

Adequate space for access to all parts of the plant should be provided where it is necessary for safe and frequent attendance with items such as charging doors arranged to facilitate the easy charging from the waste storage area with out the waste or operator being subject to the radiation from the primary combustion chamber. Suitable face protectors, gloves and clothing should be provided for the operators use when charging the incinerator.

3.18.4 Fire Precautions

Heat detectors and manual call points linked to the fire alarm system should cover the whole of the incineration plant area. Additionally, where a fuel supply line is installed a fire valve should be fitted and operated by one or more fusible links situated above the incinerator. Whilst it is essential that waste bags remain un opened, obvious dangerous items such as aerosols, cans or bottles containing high flammable substances should not be incinerated. Fire extinguishers and hose reels should be provided for first aid fire fighting, but applied with caution if the incinerator is hot.

3.18.5 Emergency Measures

Arrangements should be made at local level to ensure that the operator, if suffering illness or accident, does not remain unattended. A medical first aid kit should be provided.

If the condition of the burning waste is such that the incinerator appears to be going out of control, then the use of an appropriate "STOP" button, situated in a convenient position together with an alarm should enable the plant to be shut down and preferably should reduce or exclude any air input to the incinerator to reduce the burning rate whilst maintaining a free passage of the flue gases to the chimney.

PART D

D-3 Guidelines for Treatment and Disposal of Hazardous Waste

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1. Introduction

The waste minimization efforts should be made prior to considering the hazardous waste for treatment and disposal. Waste minimization is an important hazardous waste management strategy. The concept of waste minimization includes the followings:

1. Source Reduction: Any activity that reduces or eliminates the generations of hazardous waste within a process.
2. Recycling: Any activity that reduces volume and / or toxicity of hazardous waste with attendant generation of a valuable material, which is subsequently reused.
3. Treatment: Any activity that reduces volume and / or toxicity of hazardous waste without attendant generation of a valuable material.

2. Treatment Methods

Many different hazardous waste treatment technologies can be used prior to ultimate disposal. Their aims are modification of the physical and / or chemical properties of the waste. The choice of the best practicable way of treating the waste depends on the availability and suitability of treatment or disposal facilities, discharge standards and cost considerations. Generally, the following types of treatments are provided to the wastes:

2.1. Physical treatment

These processes include various methods of phase separation and solidification. The phase separation includes lagooning, sludge drying in beds, and prolonged storage in tanks. All these processes depend on the gravitational settlement. Lagooning and tank storage are widely used to separate oil and water from mixed wastes. Solidification or Fixation processes convert the waste into an insoluble, rock-hard material and they are generally used as pre-treatment prior to landfill disposal. The conversion is achieved by blending the waste with various reactants to produce a cement-like product.

2.2 Chemical treatment

Chemical treatment methods are used both to facilitate the complete breakdown of hazardous waste into non-toxic gases and, more usually, to modify the chemical properties of the waste for example to reduce water solubility or to neutralize acidity or alkalinity.

2.3 Biological treatment

Many industrial wastes are treated by biological methods similar to those used for sewage treatment. Hazardous waste is occasionally amenable to study treatment, even though the concentrations of toxic materials present are often lethal to microorganisms. Major industrial users of land treatment have included petroleum refining, industrial organic chemicals, petroleum production, plastic materials, residues and paints and allied products.

The choice of appropriate technology in any particular case should be based on the concept "best practicable means". The operator of a hazardous waste management facility should have a sufficient knowledge of waste characteristics expected and treatment technologies required, so as to decide the best practicable technology for

the waste. The detailed design of the treatment facility including the technologies to be used should be submitted to the respective EPA/EPD for their approval.
The treatment and disposal of hazardous waste in a centralized facility depends upon the types of wastes received. However, any centralized facility should have certain minimum facilities for storage, treatment and disposal.

3. Disposal Methods

Depending upon the characteristics of the waste, two types of disposal methods can be used for hazardous wastes. The predominant method for hazardous wastes disposal after treatment and reuse are:

(1) Landfill
(2) Incineration

3.1 Landfill

3.1.1 Design and operating requirements

The operator of a facility must follow the design and operating criteria described below:

3.1.2 Liner system

Any landfill facility must have a liner system for all portions of the landfill. The liner system must have a liner that is designed. Constructed, and installed to prevent any migration of wastes out of the landfill to the adjacent sub-surface soil or groundwater or surface water at anytime during the active life (including the closure period) to the landfill. The liner must be constructed of materials that prevent wastes from passing into the liner during the active life of the facility. The liner must be:

(1) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to the pressure gradients (including static head and external hydro geologic forces), physical contact of the waste or leachate to which they are exposed, climatic conditions, the stress of installations and the stress of daily operations.
(2) Placed upon a foundation or base, which is capable of providing support to the liner and resistance to the pressure gradients above and below the liner to prevent any failure of the liner due to settlement, compression or uplift.
(3) Installed to cover all surrounding earth which is likely to be in contact with waste or leachate.

3.1.3 Leachate Management System

There should be a leachate collection and removal system immediately above the liner which is deigned, constructed, maintained and operated in order to collect and remove the leachate generated from the landfill activity. The depth of leachate over the liner should not exceed 30 cm (one foot). The leachate collection and remove system should be:

(1) Constructed of materials that are chemically resistant to the waste and leachate, and of sufficient strength and thickness to prevent collapse under the pressures exerted by deposited wastes, cover materials, and by any equipment used at the landfill.
(2) Designed and operated to function without clogging through the scheduled closure of the landfill.

(3) The collected leachate should be treated before discharging to the sewer or surface water as per NEQS of Pakistan.

The operator of a facility must design, construct, operate, and maintain a run-on control system capable of preventing flow on to the active portion of the landfill.
If the landfill contains any particulate matter, which may be subject to wind dispersal, the operator should cover or otherwise manage the landfill to control wind dispersal.

3.1.4 Monitoring and Inspection

During construction or installation of liners and cover systems, the operator should inspect for uniformity, damage and imperfections (e.g. holes, cracks, thin spots, or foreign materials).
The operator of facility should invite the respective EPA/EPD's officials periodically during the construction and / or installation of liners and cover systems for inspection.
While landfill is in operation, the operator should inspect at least once in a week and after storms to detect:

(1) Deterioration, malfunctions, or improper operation of run-on and run-off control systems.
(2) Proper functioning of wind dispersal control systems.
(3) The presence of leachate in and proper functioning of leachate collection and removal systems, where present.
(4) The treatment system of the leachate for proper operation, functioning and treatment efficiency.

3.1.5 Record keeping

The operator of a landfill facility should maintain in the operating record the following items:

(1) On a map, the exact location and dimensions, including depth of each cell.
(2) The contents of each cell and the approximate location of each type of hazardous waste within each cell
(3) The quantities and types of wastes being treated and disposed off should be recorded in the daily logbook.
(4) The daily analytical data of the effluent from leachate treatment system should be recorded. The parameters to be analyzed must be in accordance with the respective EPA/EPD regulations.

3.1.6 Special Requirements for ignitable or reactive Wastes

The operator of a landfill facility should ensure that the ignitable or reactive waste are not being placed in a landfill, unless the waste is treated or mixed before or immediately after placement in a landfill so that the resulting waste, mixture, or dissolution of material no longer has the characteristics of ignitability or reactivity.
Ignitable wastes in containers should be first conditioned or the wastes should be disposed off in such a way that they are protected from any material or conditions which may cause them to ignite. The containers holding such type of wastes should be covered daily with soil or other non-combustible material to minimize the potential for ignition of the wastes. Such type of wastes should not be disposed of in cells / areas which may generate heat sufficient to cause ignition of the waste.

3.1.7 Special requirements for non-compatible wastes

The operator of a landfill facility should ensure that the non-compatible wastes, or materials are not being disposed off in the same cell or area in the landfill.

3.1.8 Special requirements for containers

Unless they are very small, such as an ampoule, containers should be:

(1) At least 90 percent full when placed in the landfill.
(2) The emptied containers should be crushed, shredded, or similarly reduced in volume to the maximum possible extent before burial in the landfill.

3.1.9 Closure requirements

At final closure of the landfill or upon closure of any cell, the operator of a landfill facility should cover the landfill or cell with a final cover designed and constructed to:

(1) Provide long-term minimization of migration of liquids through the closed landfill.
(2) Function with minimum maintenance.
(3) Promote drainage and minimize erosion or abrasion of the cover.
(4) Accommodate setting and subsistence so that the cover's integrity is maintained.
(5) Have permeability less than or equal to the permeability of any bottom liner system or natural sub-soil present.
(6) After the closure of the landfill site, the appropriate vegetation should be grown over the cover.

The respective EPA/EPD officials should be invited periodically for inspection during the final closure operations.

3.2 Incinerators

The guidelines in this part will be applicable to operators of facilities that incinerate hazardous wastes. The following facility operator is considered to incinerate hazardous waste:

(1) Who destroy hazardous waste by thermal process using incinerator or any other method.
(2) Who burn hazardous waste in boilers or in industrial furnaces in order to destroy them and / or for any recycling purpose or as energy source.

3.2.1 Waste Analysis

The operator of a facility having incinerator should first ascertain the waste for the combustible characteristics, before incinerating the waste. Throughout normal operation, the operator should conduct sufficient waste analysis and decided about the physical and chemical composition required for burning the wastes.

3.2.2 Operating requirements

An incinerator should be operated in accordance with the requirements specified in the license by the respective EPA/EPD.
During Start-up, shut-down, and operation of an incinerator, the operator should not feed the hazardous waste into the incinerator unless the incinerator is operating within the conditions of safe operation (temperature, air feed rate, etc). The incinerator should be operated at a specified minimum temperature as per the waste

characteristics, in order to achieve complete destruction of the waste and also to avoid generation of toxic emissions like dioxin.
Fugitive emissions from the combustion zone may be controlled by:

(1) Keeping the combustion zone totally sealed against fugitive emissions: or
(2) Maintaining a combustion zone pressures lower than atmosphere pressure.

The operator of a facility should operate an incinerator with a safety system to automatically cut off waste feed to the incinerator when operating conditions deviate.

3.2.3 Monitoring, Inspection and Record keeping

The operator of a facility should conduct, as a minimum, the following monitoring while incinerating hazardous waste for effective incineration:

(1) Combustion temperature carbon monoxide should be monitored and recorded on a continuous basis.
(2) The off gases from incinerator should be monitored and recorded on a continuous basis for the air pollutants prior to release to the atmosphere as specified by the respective EPA/EPD.
(3) The incinerator and associated equipment (pumps, valves, conveyors, pipes, etc.) should be subjected to thorough visual inspection, at least daily for leaks, spills, fugitive emissions, and signs of tempering.
(4) The emergency waste feed cut off system and associated alarms should be tested daily to verify operability.
(5) The operator of a facility should keep daily records of monitoring and inspections in the operating records.

4. REFERENCES

- British standards for Incinerators (BSI) BS 3316: Part 1:1987, BS 3316: Part4: 1987
- Solid Waste Management Guide Lines India
- UK Clean Air Act