Chapter E-1

Land disposal in Mumbai

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E-1.1 INTRODUCTION

The term "land disposal" is used to mean the final disposal of waste by depositing it on the ground. The term "dumping" is not used because this suggests that disposal is carried out in a careless way. Conversely the term "landfilling" is not used because this carries the connotation that the waste is deposited at a planned and prepared site in accordance with the principles of sanitary landfilling. In order to keep the scope of this chapter as general as possible a title has been chosen that includes all types of disposal operation from dumping to sanitary landfilling.

Many travellers and tourists learn something about waste disposal in Mumbai before they set foot on Indian soil. As their plane prepares to land from the east, passengers on the right side can see a large derelict area with smoke rising from a number of places. This is the Deonar landfill. Or is it? Can such a disposal operation be described as a landfill?

The Deonar site is the largest disposal operation in Mumbai. It is often referred to as a dumping ground, but it is better than an uncontrolled dump. Each incoming load is logged at the gatehouse. Contractors' vehicles are directed to one unloading area and municipal vehicles to another. Waste is levelled by bulldozers. A breakdown vehicle is on hand to help vehicles that become bogged in the waste.

Yet it cannot be described as a sanitary landfill. It is unsanitary in a number of ways. No measures have been taken to prevent pollution of underground and surface waters. The site is bordered by a sea water creek, so although there are signs of pollution at the edges of the creek, drinking water supplies are probably not threatened, since the groundwater supplies in Mumbai were contaminated long ago, and water supplies are brought long distances from surface sources. The waste is not covered, but there is no serious problem from windblown paper and plastic. The most obvious environmental problem is the smoke emerging from many smouldering fires, and complaints about the smoke have been received from residents, and orders from the Pollution Control Board. Little is known about the plans for the site when no more refuse is brought to it. This is fairly typical of the disposal operations of the major cities of India. Is this a sanitary landfill? To many officials it is. If this is sanitary landfilling then a new term is needed to describe a land disposal operation that is run according to the best international practice and in such a way that pollution and nuisance are minimised, and reuse of the site is possible. Ideally the new term should have the words "engineered", "environment-friendly" and "disposal to land" in it, but such a term would be too cumbersome to become popular. Suggestions are invited.

It would appear that many municipal officials believe that such a land disposal operation is the best that is possible. If this is the case, then it is not hard to understand why there is so much interest in alternatives to land disposal. Some alternatives are discussed in chapter E-2. Better management of land disposal sites is possible, but the improvements depend on the technical staff who are on site, and the resources devoted to improving the operation. Improvements are suggested in this chapter, and the problems of staffing landfill sites are discussed in chapter G-1.

Mumbai is a group of islands that have been joined together to form a long peninsula. Land is scarce, so the benefits of reclaiming land from the sea and low-lying areas are obvious. Much has already been done to increase the area of land that can be built upon, especially around the business area near the end of the peninsula. Is a landfill or dump a suitable place to build? Some information on buildings located on past disposal sites has been gathered. The living conditions of those who have illegally built dwellings near the Deonar site are also described briefly.

E-1.2 DISPOSAL QUANTITIES

There are four disposal sites in Greater Mumbai, namely Chincholi (or Malad), Mulund, Gorai and Deonar. Their locations are shown in figure A-3.1. Records obtained at these sites are summarised in table E-1.1 and used to estimate the amount of waste delivered to the different disposal sites in Greater Mumbai.

Table E-1.1: Disposal quantities in Greater Mumbai

	Truck loads	Tonnage brought by MCGM	contractors	TOTAL		Site area	Start of operations
	per day	tons/day (1)	tons/day (2)	tons/day	percent	hectares	
Deonar	650 (3)	840	1540	2380	62	200	1892
Chincholi	230	350	480	830	22	12	1964
Gorai	100	150	210	360	9	12	1965
Mulund	75	110	160	270	7	16	(no data)
TOTAL	1055	1450	2390	3840	100	240	
percent		38%	62%				

Notes

(1) Assuming that 30% of the vehicles are MCGM trucks, including compactor vehicles, bulk refuse carriers and tipper trucks. An average load of about 5.0 tons is considered.

(2) Assuming that 70% of the vehicles are open trucks of private contractors, carrying about 3.0 tons per load.

(3) Including about 90 loads of debris per day (drain cleaning, construction waste). This material is usually collected by private contractors. 4.0 tons per load are assumed.

The values shown are not precise, but indicate an order of magnitude. Commercial and industrial wastes are included in these figures.

Deonar is by far the largest site, and may provide a long-term solution for waste disposal for Mumbai, especially if it is decided to place the waste up to a significant height in order to make a gently sloping hill. Because of the importance of this site priority should be given to planning the use of the site and considering various options for the final state of the site. Already some of the area of the site had been lost to encroachment as unauthorised huts were built (probably by rag-pickers) and storage sheds for recovered recyclables were erected.

The other sites are relatively small, and have a short life span. They are seen mainly as land reclamation projects rather than waste disposal sites. If it is intended to build housing on these sites after they are no longer used for refuse disposal, extra care should be taken in how the site is operated - hazardous industrial wastes should not be deposited there and care should be taken to ensure that the waste is deposited is as compact and uniform way as possible. Part of the Chincholi site was being used for composting in the semi-mechanical process discussed in chapter E-2.

Considering that the total amount of waste delivered to the landfill sites is approximately 3480 tons per day (excluding debris at Deonar) and the total population of Greater Mumbai is about ten million, the daily per capita collection rate is about 0.35 kg, including domestic, commercial, industrial and institutional waste.

E-1.3 OPERATION AND MANAGEMENT OF DISPOSAL SITES

a) Manpower and machinery

Table E-1.2 shows the machinery and manpower that were allocated to the four sites in 1993. The table calculates the ratios of equipment and staff to waste quantities. The work expected of the bulldozers (which are about 15 tons) seems reasonable, but it would be useful to study further how the

bulldozers are used and to ascertain the instructions that are given to the bulldozer operators. (For example, the bulldozers should not be used to transport the waste - pushing it over a long distance - but to level it and compact it to some extent.) At Gorai and Mulund there was only one bulldozer at each site - sufficient for the work, but a breakdown of the only bulldozer could lead to a total failure of the operations.

Table E-1.2: Manpower and machinery at land disposal sites

	Loads per day	Incoming waste	Bulldozers		Labour		Supervisors	
		(tons/day)	number	tons/veh	number	trucks/cap	number	trucks/cap
Deonar (1)	650	2380	6	400	63	10	15	43
Chincholi (2)	230	830	3	275	12	19	8	29
Gorai (2)	100	360	1	360	6	16	8	13
Mulund (2)	75	270	1	270	6	13	8	9
TOTAL	1055	3840	11		87		39	
Average				320		12		27

Notes: (1) operating three shifts per day (2) operating two shifts per day

The staffing ratios varied considerably. It was unclear why so much labour was required at the large Deonar site. Further investigations of their duties and efficiency and rates of absenteeism might be instructive.

b) Record keeping

At peak periods trucks were arriving at Deonar at the rate of up to one hundred trucks per hour. At such times there was such pressure on the staff in the gatehouse so that it was difficult to keep records and the trucks were delayed, waiting for their loads to be recorded. An alternative arrangement for the entrance to this large site is shown in figure E-1.1 This proposal has two gatehouses, one for municipal vehicles and the other for contractors' trucks.

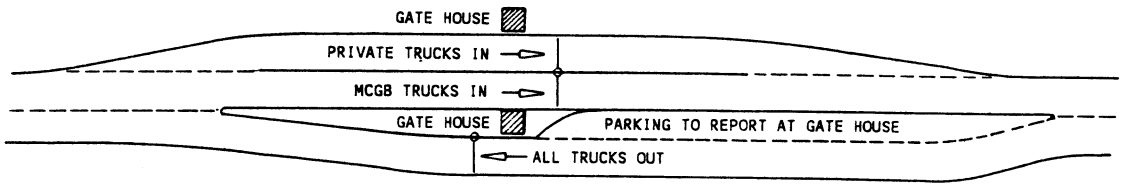

Figure E-1.1 Proposed modification of entrance arrangements at Deonar disposal site

c) Prevention of fire

As has already been mentioned, there are usually fires at the Deonar disposal site. These fires are blamed on rag-pickers who were said to set fire to piles of waste in the evening or early morning, and then sift though the ashes looking for pieces of scrap metal with powerful magnets. This burning was causing serious air pollution which aroused complaints from the public and was also harmful to the health of the workers and drivers on the site. Some of the components in smoke produced by this low temperature burning are linked to cancer and other respiratory complaints. It was said that most municipal staff working at Deonar die before they reach retirement age; the smoke and dust that they breathe each day must be the most likely cause of, or at least a contributing factor to, many of these premature deaths. The staff had been issued with dust masks, but they had found them inconvenient to use and so had stopped using them.

Various steps had been taken to stop this nuisance. The Assistant Head Supervisor in charge of the site had tried confiscating the magnets, and had a large cupboard full of them, but this had not stopped the fires. There was a water tanker on site, and this was used from time to time to extinguish

the fires, using a hose. Armed policemen were stationed at the site in order to prevent rag-pickers starting fires, but they seemed unable to stop the burning.

An alternative approach to prevention of burning is suggested in figure E-1.2. It is more difficult to set a level surface on fire than to start a fire in a pile of waste or a sloping surface. The suggested approach involves restricting the area of unloading as much as possible, and levelling the waste as soon as it is deposited. At the end of the day the waste should be covered with a layer of inert material; the most suitable material for this task may be decomposed waste dug from elsewhere on the site. (The reuse of decomposed waste is discussed later in this chapter.) It may be necessary to combine this approach with several other measures because disposal site rag-pickers can become violent when they see their livelihood threatened. The bulldozer drivers may need a police guard. It would be helpful if some alternative source of income could be found for the people who are stopped from burning the waste and sorting through the ashes, but there are many reasons why the municipality cannot become involved in this type of job creation. Such an approach may not be effective immediately, but perseverance combined with other efforts may yield results. When the burning is stopped, the site will become a healthier place to work, and this may lead to other improvements, as discussed in (e) below. The water tanker would then be free to be used to control dust, perhaps taking the highly polluted water from shallow wells in the site and spraying that over the deposited waste where the trucks are operating.

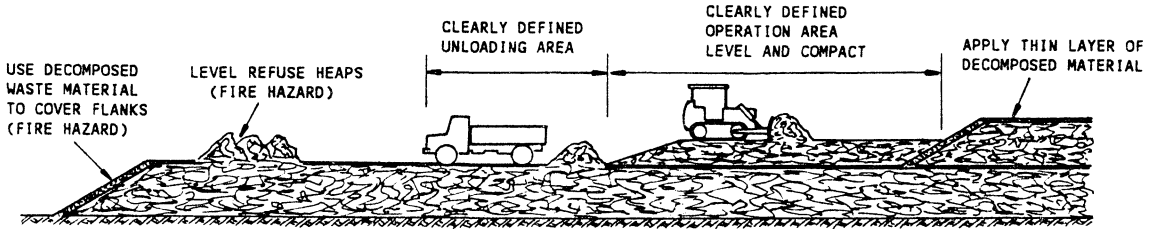

Figure E-1.2 Levelling and covering waste to discourage burning

d) Disposal of slaughterhouse waste

There was a large slaughterhouse near the Deonar disposal ground. Condemned carcasses and unusable parts of the animals, and the contents of the animals stomachs were brought to the disposal site in open trucks and unloaded in one part of the site that was not used for other types of waste. The working conditions of the manual labourers who were shovelling this waste off the trucks were revolting, and the deposited waste was very unpleasant in sight and smell, except to dogs, flies and some birds. Using the machinery already available on the site it would be possible to improve this situation radically, as shown in figure E-1.3. The approach is simply to dig a trench using a 360° excavator, or even a backactor on a JCB. The waste would be unloaded into or beside the trench, and the excavated material would be bulldozed back over the trench at the end of every day, or more frequently, if convenient. Close supervision would be needed to ensure that this procedure was carried out every day.

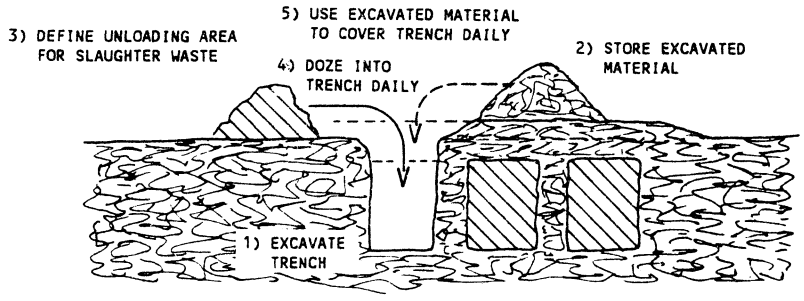

Figure E-1.3 Improved method of disposal of slaughterhouse waste

e) Management

Improvements to large disposal sites do not happen by themselves. The permanent staff at the disposal sites mentioned here were not technically qualified, but responsible for administrative work,

and concerned with supervision of labour and maintenance of records. It is unrealistic to expect that plant operators or administrative supervisors would take initiatives to make improvements in disposal operations because

◊ they are already busy with their appointed tasks
◊ they have no authority to make changes in the operation of the site, and
◊ they lack the necessary engineering and environmental training to take appropriate action.

Engineers are reluctant to work in such unpleasant environments, at tasks that they feel are below their status, and they may not have had any training in sanitary landfilling principles. The problems of motivating engineers to work on landfill sites are discussed in chapter G-1. Engineers in Europe appreciate the challenges, importance and rewards of creating a sanitary landfill, so efforts should be directed towards encouraging Indian engineers to work on India's disposal sites, to turn them into acceptable and sanitary operations.

E-1.4 BUILDING ON OLD LANDFILL SITES

a) Should construction be allowed on sites that have been reclaimed with municipal wastes?

As already mentioned, land in Mumbai is in short supply, and there is great interest in reclaiming land from the sea and low-lying marshy areas. Municipal solid waste has been used for this purpose, but there are several reasons why it should not be used:

◊ Most municipal solid waste in India has a high proportion of biodegradable organic material, which is a very unsuitable foundation material because of its low bearing strength and the settlement that results from its low strength and from bacterial decomposition. The bacterial decomposition may take decades to be complete, and may largely stop if there is a shortage of moisture in the waste, only to start again if the material again becomes moist. Often the settlement is not spatially uniform
  ⇒ because of uneven burning of the waste (cavities may form in some places but not in others as a result of localised fires),
  ⇒ because of different degrees of burning, so that waste that has been thoroughly burned has less organic matter and so compacts less as a result of decomposition than unburned waste,
  ⇒ because fine materials may be washed away and soluble materials leached, and
  ⇒ because of variations in the waste itself - a truckload of soil settles very little compared to a truckload of vegetable waste from a market.
◊ Constructing foundations in old disposal sites is difficult. Foundations should be piled down to firm ground below the waste, but even then there can be problems as the leachate in the waste attacks concrete or as the waste settles, dragging the pile down with it. Drilling or piling through waste can be difficult, depending on the materials encountered.
◊ The decomposition of organic waste in the absence of air produces methane gas, which can be explosive. A number of cases of damaged or destroyed buildings have been blamed on explosions of methane gas from landfills. This is particularly a problem where methane is able to concentrate in confined spaces, such as rooms with little ventilation. The climate of Mumbai may have helped to prevent such explosions since good ventilation is necessary for comfort during most of the year.
◊ Building on land where toxic wastes had been dumped caused birth abnormalities and many other illnesses at Love Canal in North America. Other cases of building on contaminated land have caused illness and outcry. If land is to be used for building at a later stage care must be taken throughout the life of the site to prevent such hazards.

b) Investigations in Mumbai

Four buildings constructed on land reclaimed with solid waste were identified as showing signs of damage, and so were investigated.

♦ Building 11 had been vacated. Columns and beams were being replastered since the building was declared not fit for use according to the Housing Board because the steel was visible. This problem was probably not related to the fact that it was built on reclaimed land.
♦ Building 18 had cracks in the walls - probably a result of differential settlement.
♦ Building 39 had a visible tilt on one side, and on the other side it had settled in the middle. Cracks were visible at the corners and at junctions between columns and beams.
♦ Building 71 had already been demolished in 1973 because of uneven settlement.

It was said that the area was built on as soon as the depositing of waste finished, that no time was given for the waste to settle before construction was started.

Dharavi - a large slum area (described in chapter A-2) - was previously a dumping ground. The foundation cost in this area was said to be 40% more than for normal foundations.

c) Recommendations -

- ◊ Records should be kept of all sites where waste has been dumped, so that it is clear in which areas special attention should be given to foundations. Only small buildings should be erected on such sites.
- ◊ Ideally, a closed landfill area should not be built on immediately, but a period of twenty years should be allowed to pass before the site is used for construction. In the intervening period it might be used as a park, or for agricultural purposes. In Mumbai and many other Indian cities it is very likely that such an area would quickly be covered by slum housing, if it were not used immediately or tightly controlled.
- ◊ Consideration should be given to the problem of methane gas. The best solution would probably be to construct the buildings in such a way that there are no enclosed spaces for methane to accumulate (but sometimes owners or residents close in spaces that were intended to be open). To build a gas control system would be very expensive and it would require very careful operation.
- ◊ If a site is to be used for construction at a later date, the type of waste brought to the site should be carefully monitored, so that hazardous materials are not present, and every effort should be made to lay the waste as densely and uniformly as possible.
- ◊ There is no doubt that it is better to avoid building on sites where organic waste has been deposited. A more suitable fill material that is readily available is discussed in the next section.

E-1.5 REUSE OF DECOMPOSED WASTE

by Manfred Scheu and J K Bhattacharyya

The landfill site at Deonar has been is use since the turn of the century and so holds a very large amount of waste, much of it at an advanced state of decomposition. This section is concerned with investigations into the reuse or mining of this decomposed material.

a) Observations

A group of about twelve labourers was observed extracting decomposed material from one part of the Deonar site. The waste in this area and depth was thought to be between 4 and 12 years old. After allowing the decomposed material to dry in the sun, it was thrown against a sloping screen with apertures of about 8 mm. (The operation is shown in one of the photographs on the cover.) The fine material was bagged and removed from the site. The coarse material was left where it was.

It transpired that two companies were involved in this work, having started in 1989. The Municipal Corporation was paid Rs 100 per ton as a lifting charge and Rs 6 per truck as a weighing charge. Estimates of the amount of screened material removed in this way varied from 15 to 20 truckloads per month to 30 tons per day.

The fine material was taken to the contractor's premises where it was mixed with cow dung, dolomite, gypsum, and neem cake (the residue after the extraction of oil from neem seeds) and sold as a mixed fertiliser. The company, which also sold agricultural chemicals, marketed the product in an attractive way, claiming that it would

- ◊ increase root aeration,
- ◊ increase yield,
- ◊ reduce pest and weed nuisance (because neem cake is a pest repellent, and because the organic content is fully cured - unlike uncured cow dung which is often used and which contains viable weed seeds);
- ◊ increase microbial activity
- ◊ correct micronutrient and secondary nutrient deficiency (since it contains trace quantities of micronutrients like copper, zinc and boron, and secondary nutrients like calcium and magnesium);
- ◊ increase water retention;
- ◊ increase fertiliser use efficiency

The analysis of the blended product, according to the supplier, is shown in table E-1.3

Samples of decomposed waste, similar to those used by the contractor, were taken from the site and analysed. The composite sample, weighing 53.9 kg, was taken from four different locations from a layer of decomposed waste that was about 2.5 m thick . The age of the sample could not be

determined precisely, but the date on packaging within the sample indicated that at least part of the sample was less than five years old. The results of a simple analysis of this decomposed waste sample are given in table E-1.4.

Table E-1.3 Analysis of reinforced decomposed waste soil conditioner

Source: Fertiplant Engineering Co. Pvt. Ltd. Mumbai

Moisture	10% to 12%
pH (dilution 1:10)	7 to 8
Organic carbon	15% to 17%
Organic matter (assumed 2 x organic C)	30% to 34%
Nitrogen as N	0.9% to 1.3%
Phosphorus as P_2O_5	1.5% to 1.9%
Potassium as K_2O	0.5% to .08%
Sulphur as S	0.55% to 0.7%
Calcium as Ca	5% to 7.5%
Magnesium as Mg	0.5% to 0.8%
Copper as Cu	200 ppm
Zinc as Zn	900 ppm
Iron as Fe	900 ppm
Manganese as Mn	250 ppm
Boron as B	120 ppm

Table E-1.4 Results of tests on sample of decomposed waste 21.11.94

Description	Result	Notes
Density of wet sample	960 kg/m^3	
Percentage passing 8 mm mesh	63.5%	Sample from this taken for analysis
Stones greater than 25 mm	31.5%	
Other materials	3.9%	
Evaporation and sieving losses	1.1%	
Moisture content, fine material	14%	Determined by drying in sun
Organic matter, fine material	14.5%	Sample 10.80g, I hour at 650C
Constituents of 3.9% "other materials"		Sample weight 2.1 kg
Plastic (soft)	0.2 kg	Percentage of total weight 0.4%
Rags	0.6 kg	1.1%
Glass and ceramic	0.5 kg	0.9%
Metals	0.2 kg	0.4%
Rubber and leather	0.3 kg	0.6%
Coconut and wood	0.3 kg	0.6%
Further laboratory tests on fine material		Conducted at GLA, Munich, Germany
pH	7.2	
Organic carbon	5.8%	
Nitrogen	0.5%	
Sulphur	0.4%	
Calcium carbonate	12.6%	
Soluble aluminium	1000 ppm	
Soluble manganese	270 ppm	
Soluble iron	4800 ppm	

A grain size analysis of the fine sample was also performed, and it showed a relatively straight line on a logarithmic plot from 0.6 mm to 6.5 mm. The material was said to "well compactable if at least 20% of coarse material is mixed." Since there were stones making up 31.5% of the sample, the material qualifies as "well compactable", meaning that the material can be used as fill material for land reclamation, though it should not be used to support the foundations of large buildings (but large buildings should never be built on backfilled material).

It is interesting that the percentages of "other materials" such as plastic, glass and metal were so small, particularly considering that much of the organic material had been lost to decomposition - and probably also to burning. This suggests that the work of rag-pickers at different stages of collection and disposal had been very effective.

b) Recommendations

- ◊ Consideration should be given to increasing this practice, because it not only provides useful materials but it also increases the life of the disposal site by releasing more void space for incoming waste. The constraints that limit the size of the contractors' operations should be investigated to see if these companies can be encouraged to increase their throughput.
- ◊ The excavated material can be used for land reclamation. It is much better suited to this purpose than fresh solid waste because the decomposition processes within it have virtually finished, so settlement will be less and gas generation negligible. Large buildings should not be constructed on areas reclaimed in this way unless they have piled foundations that penetrate the filled material.
- ◊ The sieved material would be suitable as a final cover material on landfill sites because it would cover the wastes and would probably be suitable for supporting the growth of ground cover plants which help to prevent erosion and help to make the site blend in with the surroundings. There is a very slight risk of the presence of pathogens in the material which might be made airborne by the passage of trucks, particularly when the cover is dry; such pathogens might be inhaled by site workers. (It is very probable that the risk is very much less than the risk posed by trucks driving over fresh waste.) The pathogens of main concern might be TB and certain moulds. Before recommending the use of this material for intermediate cover it would be advisable to investigate how the concentration of respiratory infection pathogens in decomposed waste compares with the concentration in fresh waste and in soil.
- ◊ It is recommended to investigate the feasibility of using empty open trucks (that have just unloaded their waste at the disposal site) to transport the waste back towards the city. To save time the trucks should be loaded by a wheeled front-end loader or 360° excavator. One of the key issues to study would be the willingness of the drivers and crews to undertake the unloading of the material (unless large quantities were going to one place in which case labourers could be hired at the unloading points to empty the trucks). A supplementary payment for this extra work would probably be the best solution. It is likely that the feasibility of the utilisation of the return trips of the trucks would depend on the quantities of sieved material required at any one site, favouring the sites where large quantities were required, because of the administration and the delays experienced by the drivers in looking for unknown sites.
- ◊ The scale of the operation could easily be increased by using a rotating drum screen instead of the fixed, sloping screen. This scaling up would be feasible if the demand for the screened material could be increased, perhaps by supplying it at no charge. Market research would be needed to identify uses for the material, the price that users would be willing to pay, and the requirements of potential customers in terms of quality and delivery service.
- ◊ The coarse reject material could be used as fill material, or, if the recyclable materials were removed, it should be very suitable for the construction and maintenance of site roads. It is worth paying careful attention to the condition of the site roads on a disposal site, because poor roads lead to extra vehicle wear, delays (if the trucks become stuck), extra dust, and unloading in unauthorised places (if the drivers think that it is too difficult or uncertain to unload the waste in the correct place because of the poor site roads).
- ◊ Good records of site operations are useful in that they help the site operator to know the age and depth of waste, to enable excavation of the waste after it has had sufficient time to decompose and stabilise.

◊ Mumbai has a heavy rainfall each year, and so there is ample opportunity for the waste to receive sufficient moisture to allow its decomposition. In an arid zone the decomposition may proceed at a slower rate, so more care should be taken to ensure that the waste is decomposed before it is extracted. Preliminary results in Gaza (Palestinian Territories), which has a fairly arid climate, suggest that the moisture in the waste is sufficient to promote rapid decomposition, but in arid areas where the waste has a low moisture content, it would be wise to be aware of this possibility.

E-1.6 RAG-PICKERS AT DEONAR DISPOSAL SITE

by Dr P K Makwana and Adrian Coad

a) Environmental conditions at the site

Many of the rag-pickers who sort through the deposited wastes at Deonar live within the perimeter of the site, in temporary shelters made with plastic sheeting, and without any sanitation facilities.

A preliminary survey was undertaken amongst twenty rag-pickers who were living at the edge of the Deonar site, and amongst five of the municipal workers employed to work at the site, to gain some understanding of their perceptions of the health and environmental situation at the disposal site.

Air pollution was said to be the main problem; both the dust and the smoke were complained about. It must be remembered that the fires were started illegally by the rag-pickers, so if some of their community are concerned about the smoke, a public education campaign might have some effect. A report from the local health centre claimed that 90% of the population in this area suffered from respiratory infections, particularly in the winter.

All those interviewed complained about the noise, especially the noise of vehicles operating on the site at night. All of the sample also complained about the presence of large numbers of flies in the area.

Injuries from discarded sharps from hospital wastes were mentioned by two of those interviewed.

The other problems that caused complaints and the percentage mentioning each problem are shown in the list below:

Rats	80%
Smell	20%
Insect and dog bites	16%

In addition the site staff complained about a lack of safety precautions.

Doctors at the local health centre claimed that 80% of the children of the area had been immunised against TB, polio, typhoid, tetanus and diphtheria and measles. The main health problems among the slum dwellers were said to be malnutrition, anaemia, drug addiction and alcoholism. In addition to the health centre, a Rotary club was also working amongst the slum dwellers of the area.

b) Control of unauthorised people at Deonar disposal site

Many of the problems associated with the Deonar disposal site are related to the activities of the rag-pickers. It is easy to recommend measures such as fencing to keep rag-pickers off the site, but in practice fences would not keep them out because they depend on the waste for their livelihood and so would take whatever measures that seemed necessary to ensure that they have access to the waste deposited at the disposal site every day. Even armed police had not been a sufficient deterrent. It was reported that a truck driver had been attacked by a rag-picker with a knife because he was not prepared to drive his truck to the place where the rag-picker wanted him to do stop for unloading.

The problem of rag-pickers needs to be solved, and perhaps the first step is to understand their perspectives and situation. Prof. Sneha Palnitkar of the All-India Institute of Local Self Government in Mumbai has done some useful work in this field. Municipal officials are reluctant to employ rag-pickers as municipal workers, even on a casual basis, because labour laws are such that they might try to claim all the rights and privileges of municipal employees. In Zimbabwe there was a scheme in which contractors were engaged to collect recyclable materials from disposal sites, and they employed people who were already working illegally at the sites, providing them with uniforms and

identification without which they were not allowed on the sites. In this way the contractor takes some of the responsibility for the conduct of the rag-pickers. A long-term, and possibly utopian, solution to the problem of rag-pickers on disposal sites is to segregate recyclables so thoroughly at the source that there is nothing of any value left in the waste when it reaches the disposal site. It is good to start working hard for this ideal, but it is not realistic to expect such widespread co-operation from the households of India within a decade, unless there is a national movement led by someone with the stature of Mahatma Gandhi.

The problems of land disposal of wastes in Mumbai are not easy - possible shortage of land area, air pollution, unhygienic practices, and others - but many of the problems can be solved and conditions can be improved if there is the political will at a high level and if there are enthusiastic engineers working at the sites.