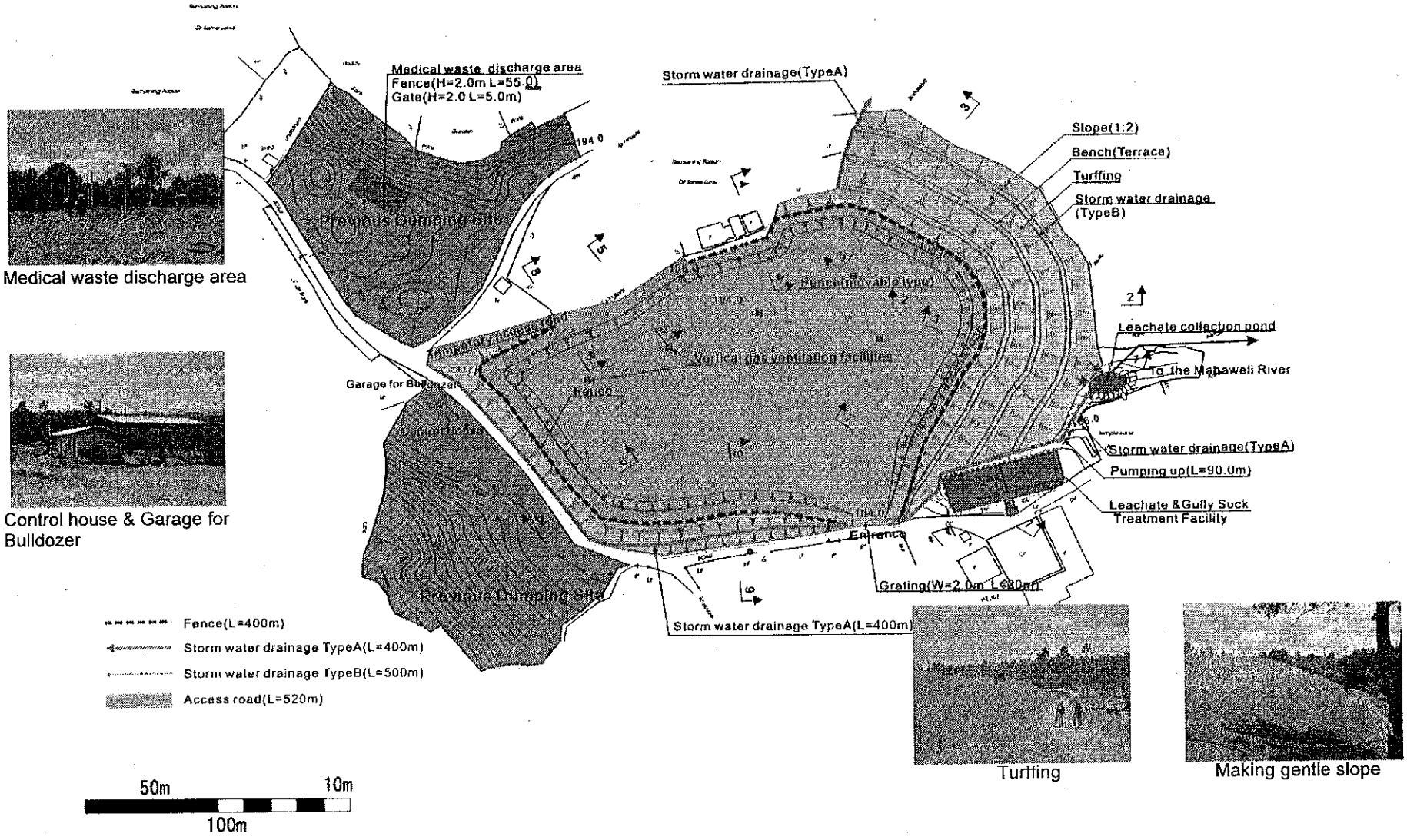
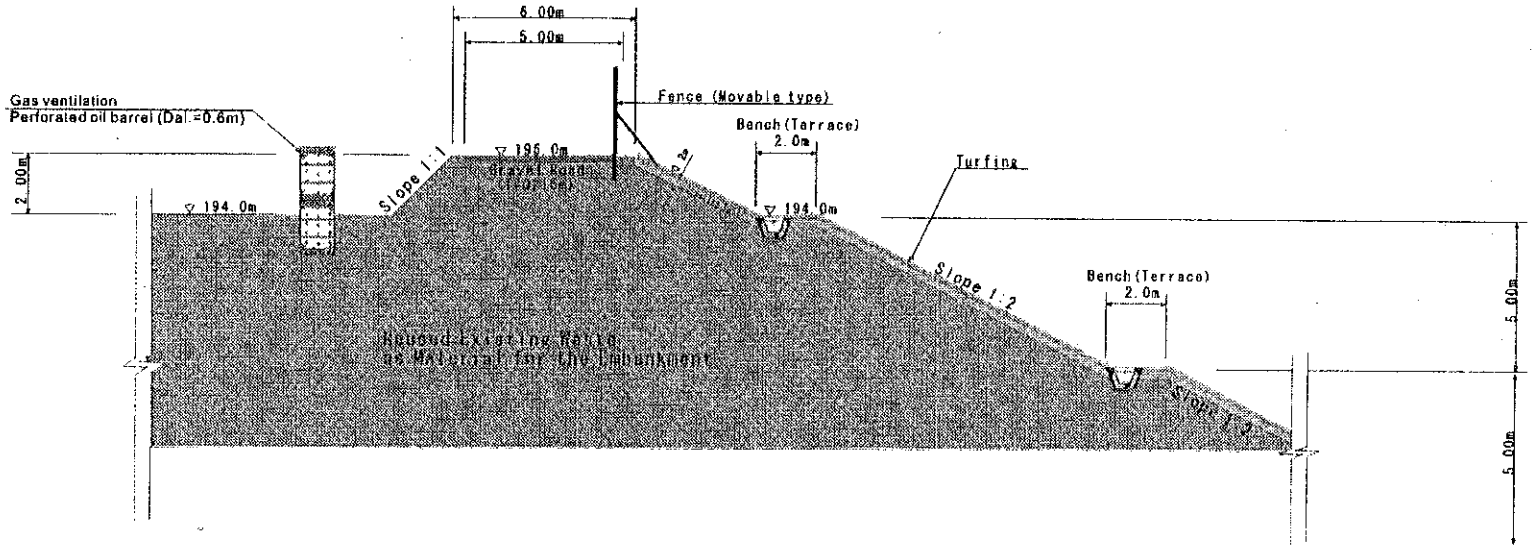


Figure 1-2: Layout of Improved Gohagoda Landfill Site

Typical Section A



Typical Section B

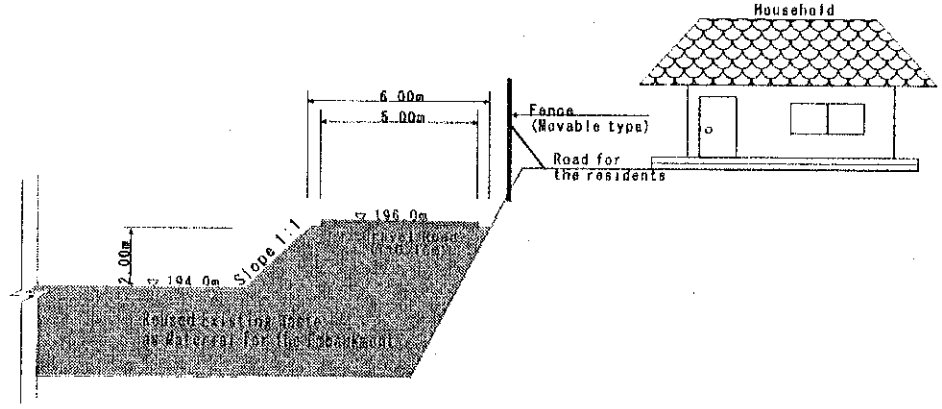


Figure 1-3: Typical section after improvement

Table 1-1: Conceptual Design of Improved Gohagoda Landfill Site

Item		Unit	Qty
Total area of improved landfill site		Ha	Approx. 2.5
Extent Capacity		M^3	80,000
Life span		Years	2-3
Type of landfill method		-	Semi-Aerobic
Administration	Control office	No.	1
	Garage for bulldozer	No.	1
Security and safety facility	Fence (Fixed type)	L.S.	1
Sanitary waste disposal facility	Access road (gravel) for short term use	L.S.	1
Leachate collection Pond		L.S.	1
Modification of Gully suck and leachate treatment facility – System consist of mechanical aerators that fixed to the existing gully suck tanks		No.	1
Storm water drainage	Rip rap type on final slope (type "B")	L.S.	1
	Rip rap type drain along the road (type "A")	L.S.	1
Gas ventilation facility –Perforated oil barrel filled with rubble stone		Nos.	5
Disposal pit for medical waste		No.	1

b.2 Leachate Collection Pond

A leachate collection pond was constructed at the lowest point of the fill in order to collect leachate seep from the bottom of the landfill. The facility was excavated pit supported with sand bags. Electrical pump and pipeline installed to divert collected leachate to the modified gully suck- Leachate treatment facility.

b.3 Modification of Gully suck and leachate treatment facility

The existing gully suck disposal tanks were modified in order to treat leachate and gully suck. The tank receives approximately $23m^3$ of gully suck, which collected from the septic tanks. The quality of gully suck waste shows that it has already decomposed most of BOD but further treatment is needed to reduce the BOD before release to the inland water bodies. In addition to gully suck, the facility receives leachate that pumped out from the leachate collection pond after modifications. Four aerators were installed in primary tank to enhance the degradation process and secondary tank was designed as settlement tank & temporary storage prior to discharge. The treated effluent is discharge to small stream flowing below the landfill facility.

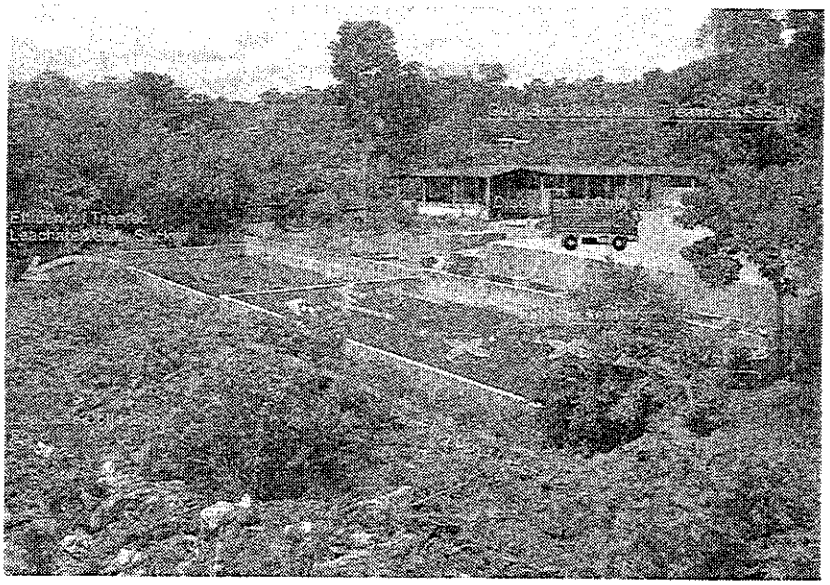


Figure 1-4: Concept of Treatment Facility for Leachate and Gully Suck

b.4 Bench (terrace)

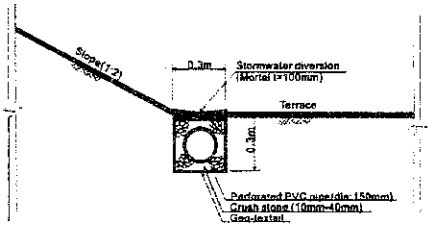
The purpose of bench was as follows.

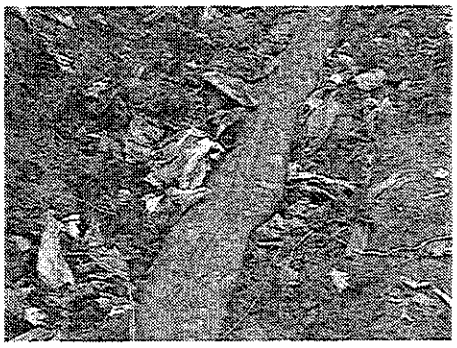
1) To protect the slope by intercepting runoff water flowing on the slope.
2) To provide the enough space for the interceptor drain on benches.
3) To provide the enough working space for the slope maintenance.
4) To keep the waste filling slope stable.

The bench plan was as follows.

- Every 5 meters in height.
- 2 meters in bench width.

The purpose of leachate collection facility on the bench was to collect seeping leachate from the relocated landfill site.

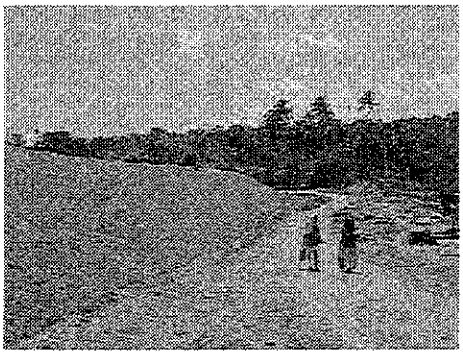


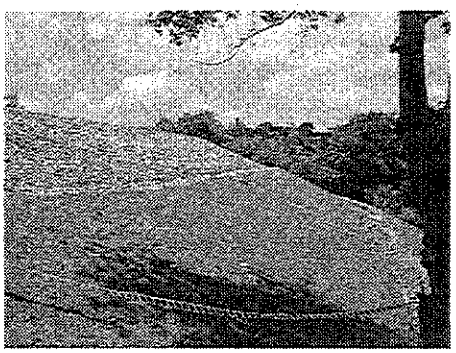


b.5 Turffing

The outside of slope of the waste filling was turffed for the following purposes.

5) Protection of the slope from erosion by runoff water.
6) Maintenance of the good view.





b.6 Storm water Drain

The storm water drain on the bench terrace and along the foot of the landfill was installed for the following purposes.

1) Minimization of leachate generation amount by intercepting runoff water into the site.
2) Maintenance of access road

Type "A" drain will be constructed along the road to collect storm water coming from surrounding area and slope of the fill. The collected water will be diverted to the small stream at the bottom of landfill.

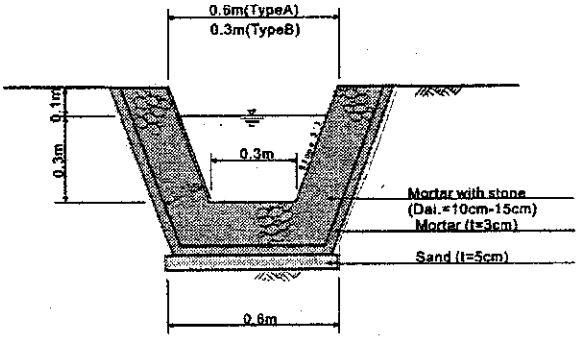


Figure 1-5: Riprap drain

b.7 Gas Ventilating Facility

The gas ventilating facility was provided to exhaust landfill gas generated in the landfilled waste to minimize the risk of gas explosion

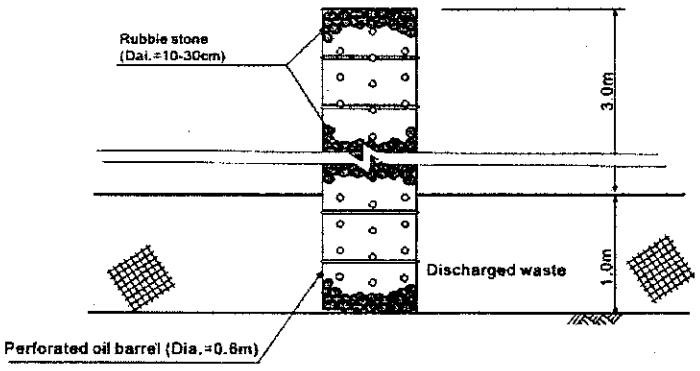


Figure 1-6: Gas Ventilating Facility

b.8 Medical Waste Discharge Area

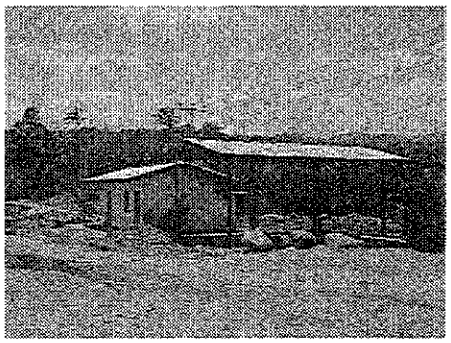
The Medical Waste Discharge Area was constructed separately on the old dumping area. It receives the following wastes which require special care for handling.

- Syringes
- Medical tools and goods which contacted blood

The disposal pit was completely surrounded by a gate and a fence to ensure nobody except the landfill staff can enter.

b.9 Relocation of Control House and Garage for Bulldozer

The existing site office and garage for the bulldozer were demolished during the construction of landfill. Those facilities were relocated outside the landfill.



b.10 Security facilities

A Movable fixed type fence was installed along the temporary access road on the embankment to prevent waste scattering from active filling area.

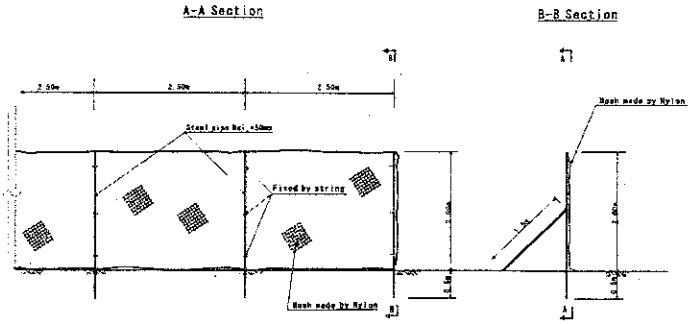


Figure 1-7: Movable type fence

b.11 Construction of new Access roads

New access road was constructed around the landfill facility. The collection vehicles to dump its waste to the filling area use the constructed access road. The access road is located 2 m above the active filling area. The road was established by filling old waste on the Embankment and finished with compacted soil and gavel to easy access of collection vehicle.

1.9.3.2 Transfer the appropriate operation method for sanitary landfill operation

To improve the faculties at the landfill site is easy by construction, however to maintain the sustainable maintenance and operation is always very difficult. One of the reasons why sustainable maintenance is difficult is the staffs in charge of landfill operation does not know the operation method for sanitary landfill operation.

During the pilot projects, the counterparts who belong to Kandy Municipal Council and Nuwara Eliya Council were involved to the supervision of construction in order to transfer the method of construction of sanitary landfill site. After the completion of the improvement constructions, technical transfer, such as compress of discharged waste and covering soil, was conducted with the bulldozers donated by JICA to Nuwara Eliya Municipal Council and Kandy Municipal Council. Further, the operation manual for sanitary landfill site was prepared in order to maintain the sustainable appropriate operation. The manual include following items.

a. The Cell and Layer Operation with Daily Soil Cover

The term cell is described the volume of material placed in a landfill during one operating period, usually one day (See Figure 1-8). A cell includes the solid waste deposited and the daily cover material surrounding it.

The advantages of using daily cover are primarily in preventing windblown litter and odours, birds and vermin and in improving the site's visual appearance. It is also advocated as a means of shedding surface water during the filling sequence, thereby leachate management by reducing infiltration. At sites where daily covered is spread by bulldozer, a thickness less than 200mm is not be feasible, keeping in view the uneven surface of the waste.

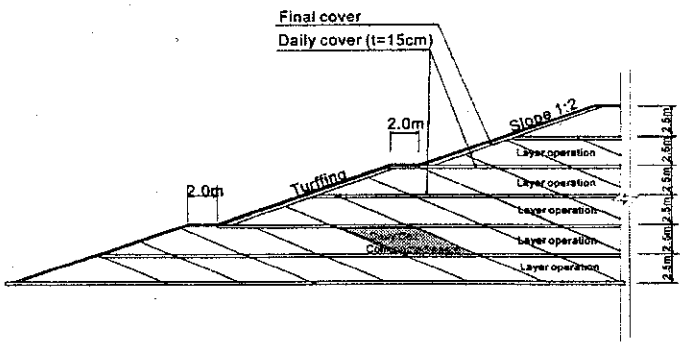


Figure 1-8: Daily Cell and Daily Soil Cover

A layer is a complete cell over the active area of the landfill.

b. Leachate Treatment

The leachate treatment facility requires the following O&M works.

1) Replacement of coconuts fibre every five years and to be discharged to the landfill site (Nuwara Eliya Moon Plains Landfill Site)

2) Replacement of charcoal filter periodically and to be discharged to the landfill site whenever necessary. (Nuwara Eliya Moon Plains Landfill Site)

3) Removing of sludge periodically and to be discharged to the landfill site whenever necessary

c. Turfing on the Finished Slope

Turfing on the finished slope is required for protection of the slope and mitigation of landscape.

d. Extension of Gas Ventilation Facility

The gas ventilations will be placed at a spacing of 30m to 50m on the landfill cover. The gas ventilation pipes will be extended every layer of operation. The height of each layer is 2.0m-2.5m; therefore the length of each extended gas is required 3.0m.

e. Maintenance of Installed Facilities

Fence, access road will be maintained when these are damaged. The drain will be cleaned every one month in order to prevent from blocking.

f. Reception of Visitors

The site will welcome visitors because this will be the model sanitary landfill site for Sri Lanka. Municipal Council staff will explain the design, operation and maintenance system for the landfill operation.

g. Required Resources for O & M

- Manpower
  - Supervisor (not full time): 1 person
  - Operator of Bulldozer: 1 person
  - Foreman: 1 person
  - Guard & record keeping: 1 person
  - Labour: 2 persons
- Heavy equipment
  - A bulldozer (full time) 1 unit
- Diesel and lubricant oil for a bulldozer
- Soil for covering waste: 1 to 2 loads per day.
- Electricity for a water pump & Floating aerators (Kandy Gohagoda Landfill Site)
- Material for gas venting facility
- Turfing on the sloping side

1.9.3.3 Establishment of the necessary public consideration and monitoring system for operation of the sanitary landfill site

The monitoring committee was established for the following purpose.

- to ensure the landfill operation in compliance with the method stated in the landfill operation manual.
- to keep the transparency of the landfill operation.

The monitoring committee holds meeting periodically and makes the monitoring results available to the public.

a. Proposed member of the monitoring committee

The proposed monitoring committee members are as follows.

Table 1-2: Proposed Monitoring Committee Members

Position	Eligibility
Chairman	Chairman of the health committee
Member 1	a municipal council member elected from the ward near the landfill site
Member 2	a municipal council staff in Health Department
Member 3	a municipal council staff in Works Department
Member 4, 5	representatives of neighbourhoods
Member 6	a Central Environmental Authority staff
Member 7	a staff in local environmental NGO

b. Monitoring frequency

Period	Frequency
Before the construction The first monitoring will be executed before the commencement of the construction work in order to understand and to keep record the original condition.	1 time
During the first six months	every month
After six months If the monitoring committee judges that the monthly monitoring is not necessary, the monitoring frequency will be reduced after the six months landfill operation. However, the monitoring has to be done at least every three months.	every three months

c. Monitoring check list

JICA Study Team prepared the check list of the monitoring for the landfill operation. The monitoring committee shall execute according to the monitoring check list.

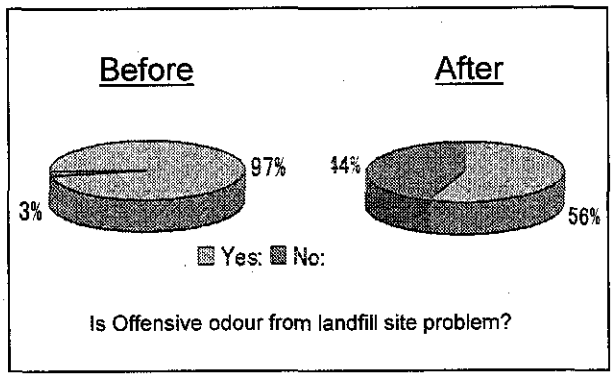
Table 1-3: Draft Check List for the Landfill Operation

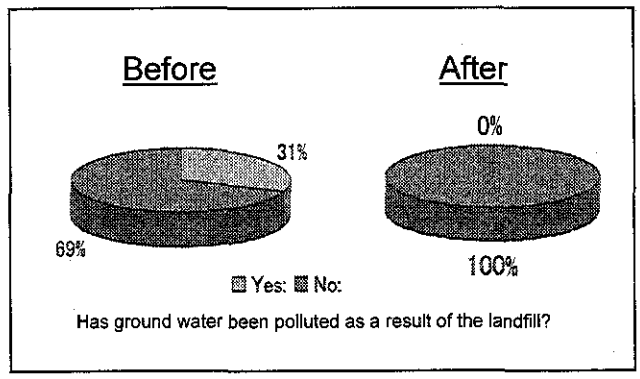
Check list Monitoring Committee for the Moon Plains Landfill Site					Date: Time:	
Category A: Environmental effect (Before and after construction)						
No	Items	Acceptable	Medium	Terrible	Score	Notes
A1.	Fire & Smoking	0	1	2		
A2.	Offensive dour	0	1	2		
A3.	Waste water	0	1	2		
A4.	Withering of trees caused by discharged waste	0	1	2		
A5.	Waste scattering	0	1	2		
A6.	Animals (Dogs, monkeys, birds etc.)	0	1	2		
A7	Vermin (Flies etc.)	0	1	2		
A8.	View	0	1	2		
A9.	Entry of scavenger (If no scavenger is the site : select "0")	0	-	2		
	Total of Category A					
Category B : Function of facilities (After finishing of construction)						
No	Items	Functioning	Medium	No functioning	Score	Notes
B1.	Drainage system					
	B1-1.Rip pap	0	1	2		
	B1-2.Earth drain	0	1	2		
B2.	Leachate collection & treatment system	0	1	2		
B3.	Gas ventilation system	0	1	2		
B4.	Discharge pit for the health care	0	1	2		
B5.	Gully suck treatment facility	0	1	2		
B6.	Access road					
	B6-1.Asphalt road	0	1	2		
	B6-2.Gravel road	0	1	2		
B7.	Tire wash pit	0	1	2		
B8.	Security facilities					
	B8-1.Gate	0	1	2		
	B8-2.Fence	0	1	2		
	B8-3.Guardrail	0	1	2		
B9.	Waste scattering prevention net fence	0	1	2		
B10.	Turffing	0	1	2		
	Total of Category B					
Comment: Name & Signature						

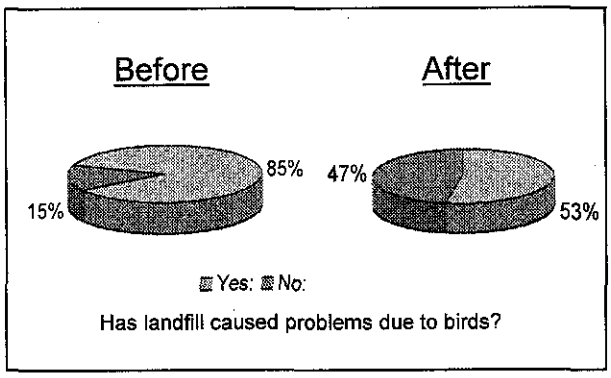
1.9.4 Assessment

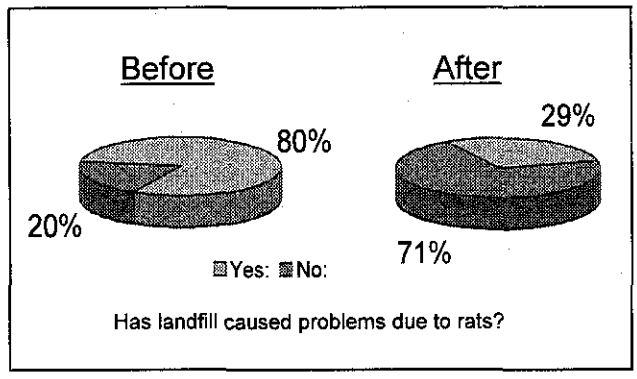
1.9.4.1 Improvement of Gohagoda landfill site in Kandy

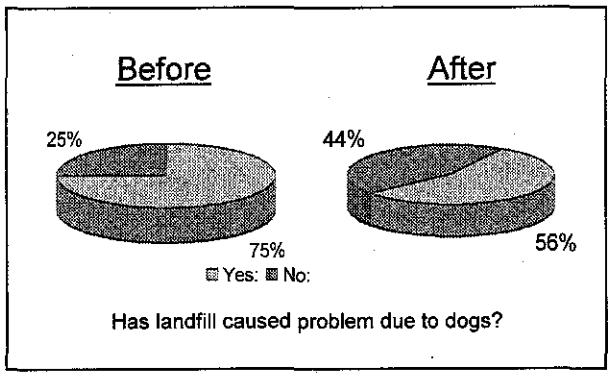
The study team organized the interview survey on the surrounding households at Thekkawatte village and Powatte village before and after improvement of the landfill site. The first interview was conducted in June 2002 and the other was conducted in October 2003. The number of samples for each interview is fifty. The results of the interview surveys are as follows:

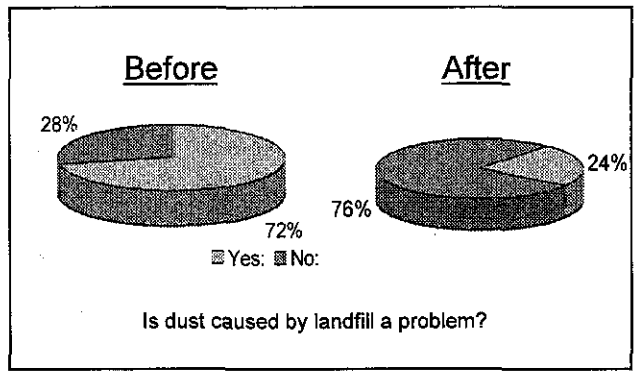


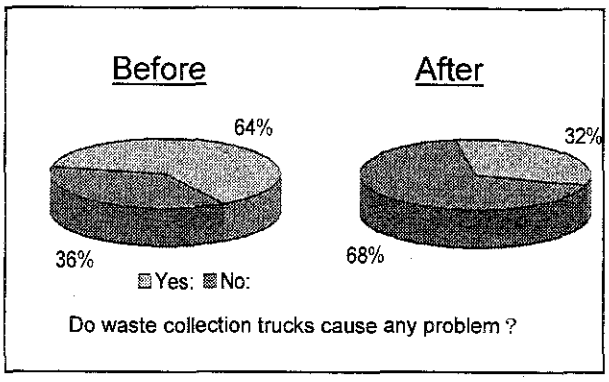


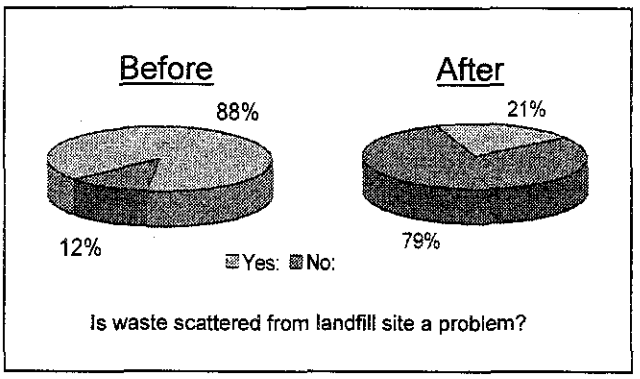


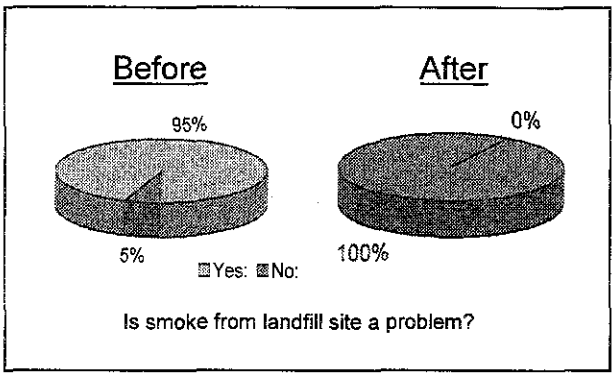


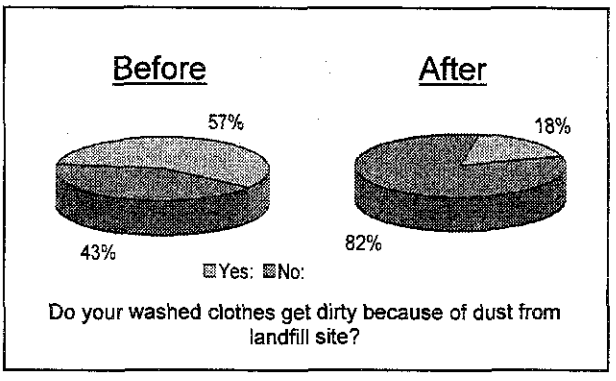


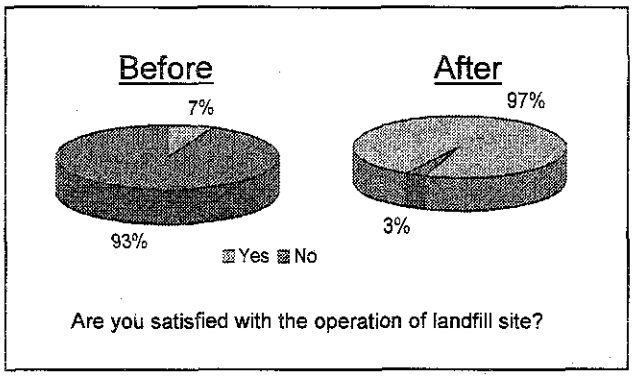












According to the results of the interview surveys, the improvement of Gohagoda landfill site and its operation has had a favorable impression on the local residents. The main improvement works of Gohagoda landfill site consist of the relocation of existing waste, covering soil, turfing and the installation of fencing. Most of the improvement works do not require rare and/or expensive material or special technology. This proves that simple methods for improvement of the landfill site with cheap, domestic material can easily satisfy the local residents.

Reference 2

Operation and Maintenance Manual

for

Controlled Landfill Site at Gohagoda in Kandy

Contents

Reference 2 Operation and Maintenance Manual for Controlled Landfill Site at Gohagoda in Kandy

2.1 Waste discharging and covering soil

The waste shall be discharged to the landfill site from the three platforms. The waste discharging procedure is as follows.

1) The waste shall be discharged to the down at the landfill site from platforms.
2) Bulldozer shall move and compact the waste. The waste must not be scattered and it must be minimize as less as possible in order to decrease the amount of covering soil.
3) When the dimension of compacted waste is approximately two (2) meter height, twenty (20) meter width and twenty (20) meter length, it covered by soil.
4) The thickness of covering soil is approximately twenty (20) cm and it shall be done twice or three times a week.
5) The area where is covered soil on the waste will become temporary access road for collection vehicle, therefore it must be compacted well by Bulldozer.
6) The steel plates can be utilised for the travelling of collection vehicle, when it is rain.

The following figures show the operation procedure of discharging waste and covering soil.

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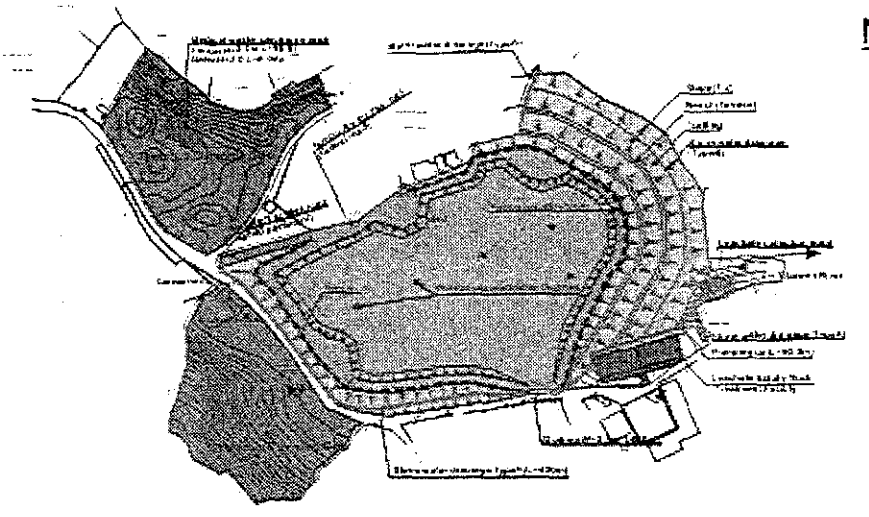

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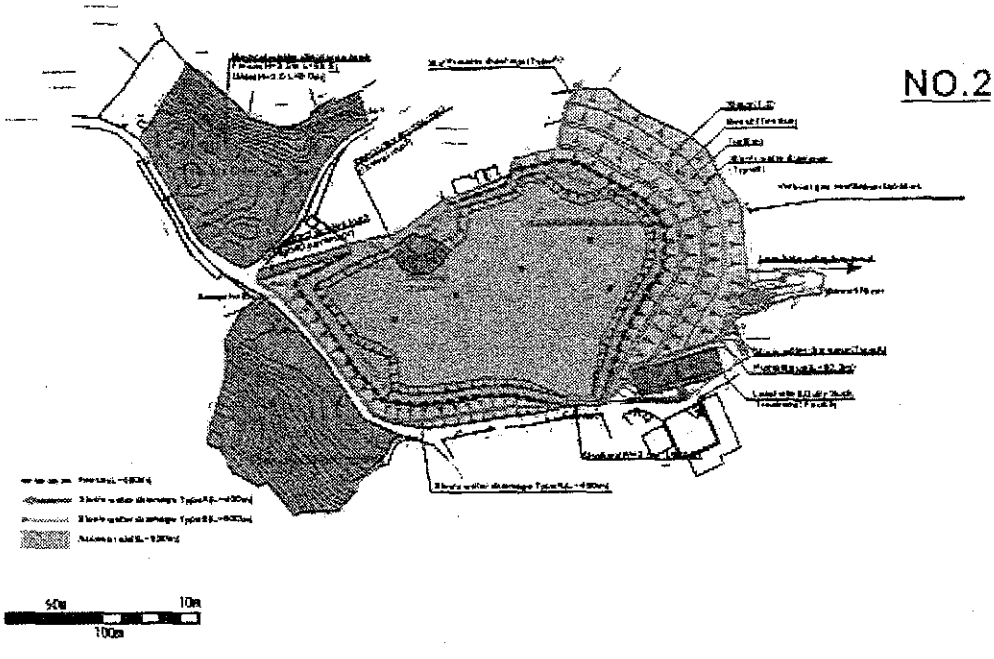

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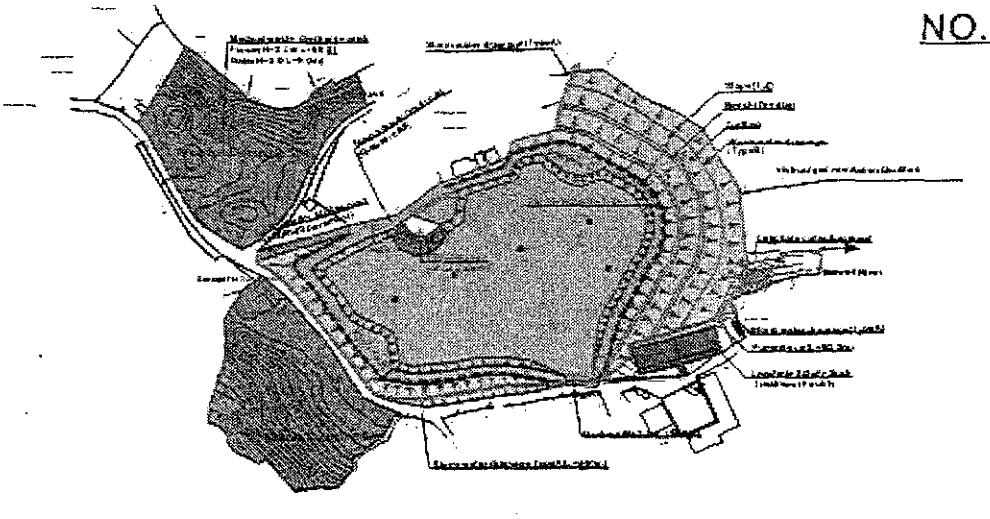

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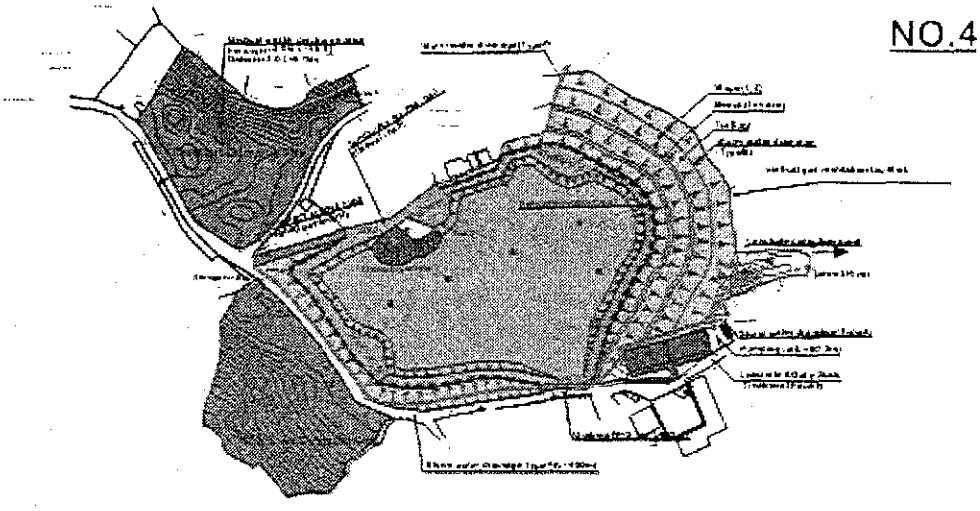

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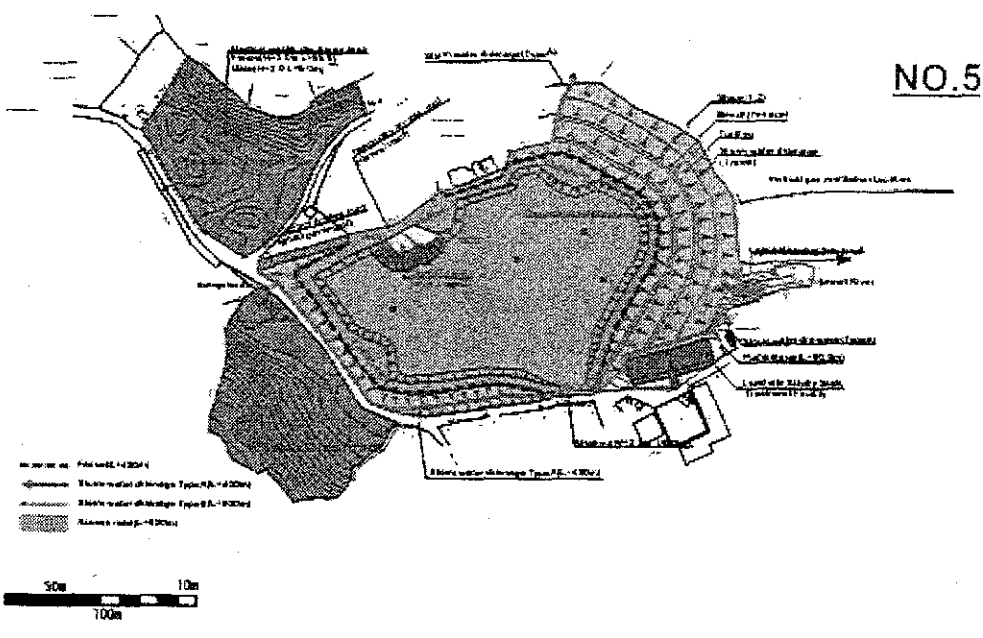

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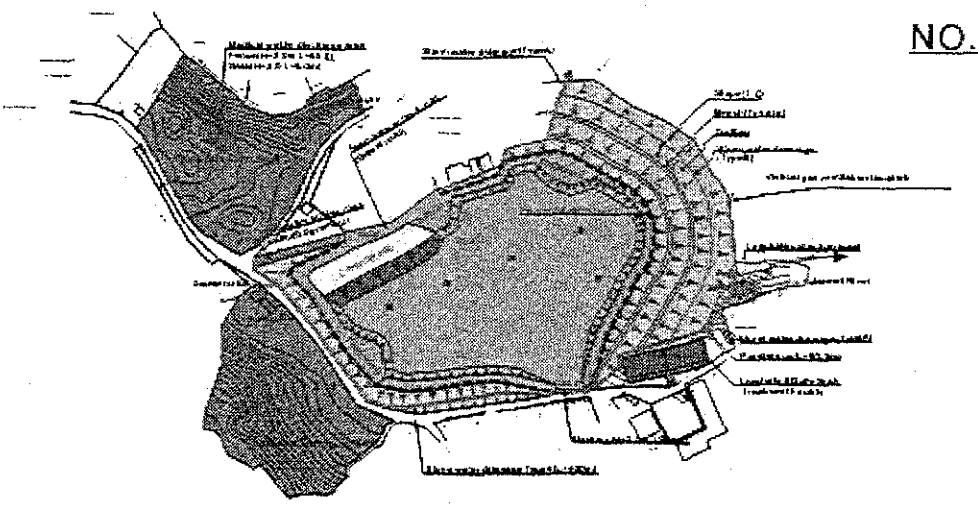

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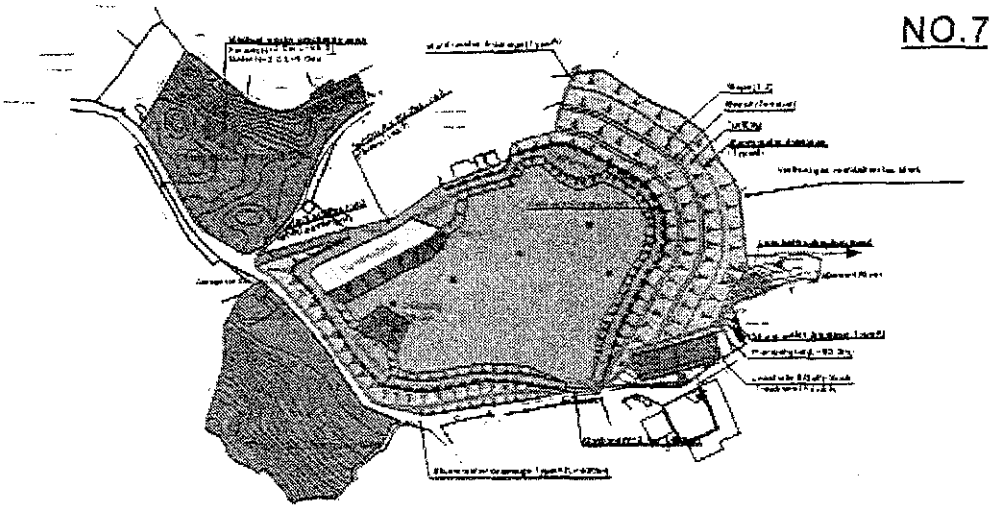

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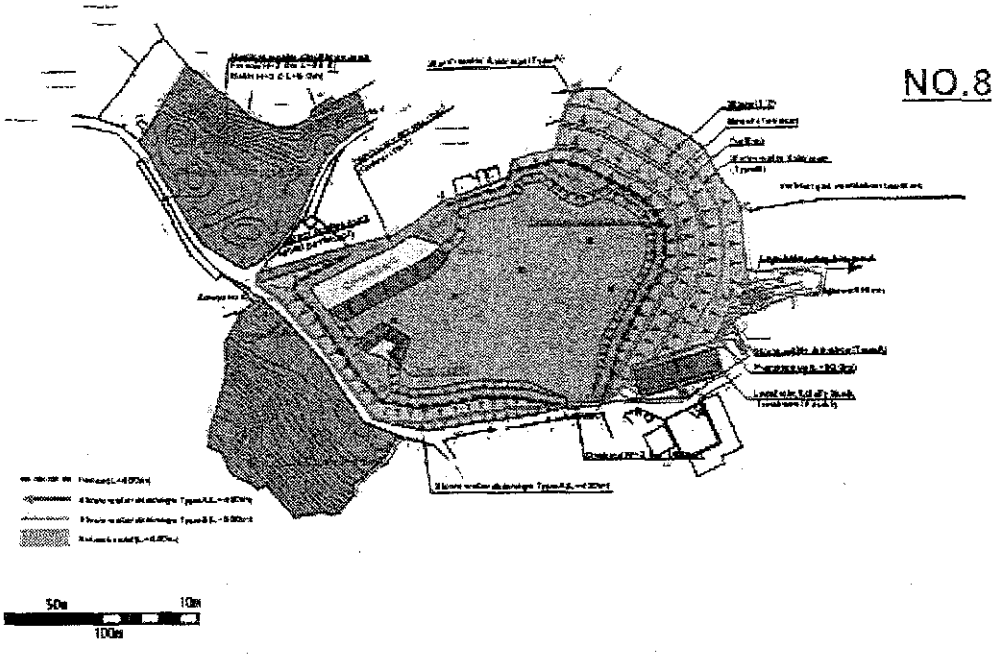

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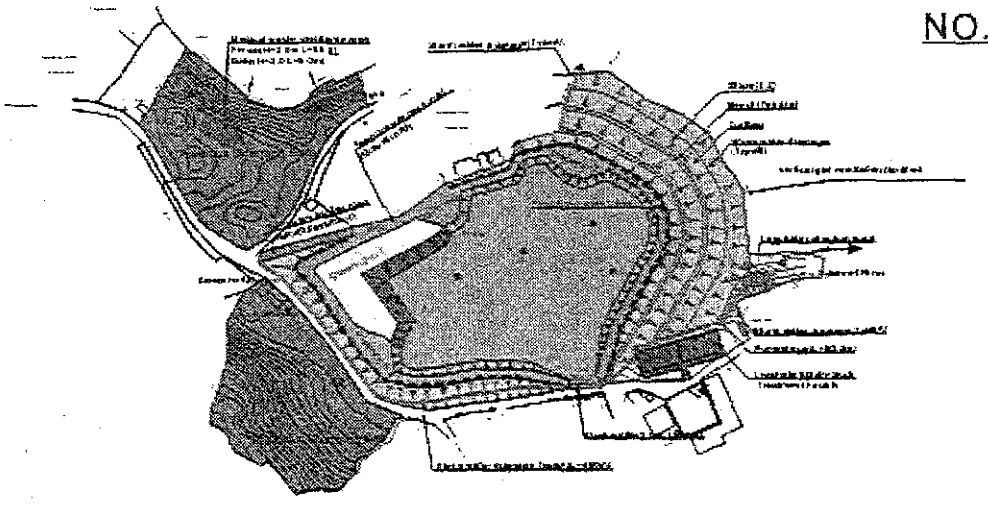

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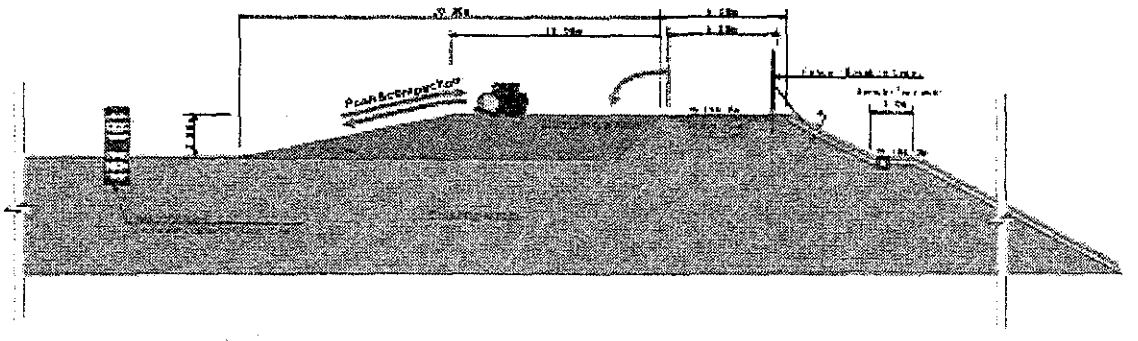

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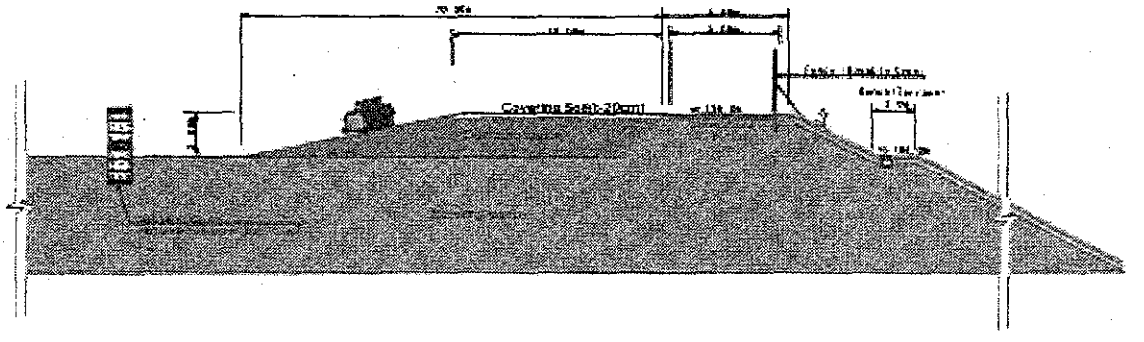

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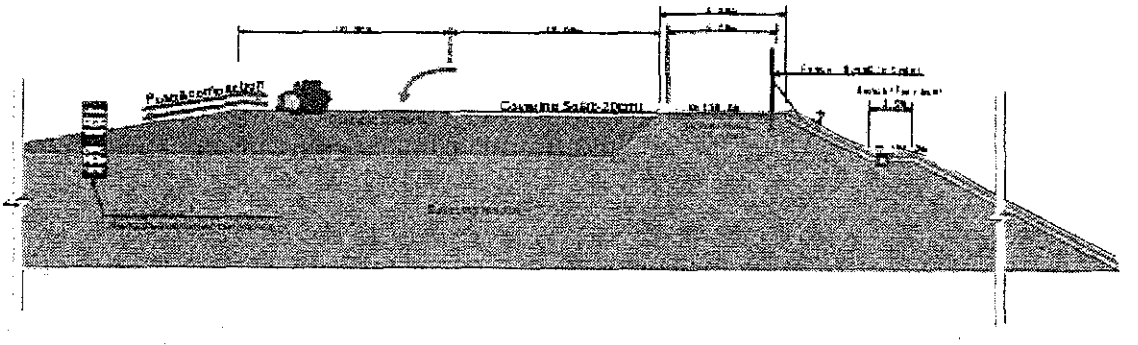
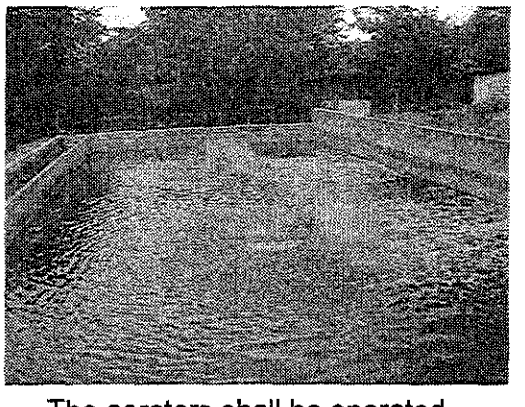


2.2 Leachate Treatment

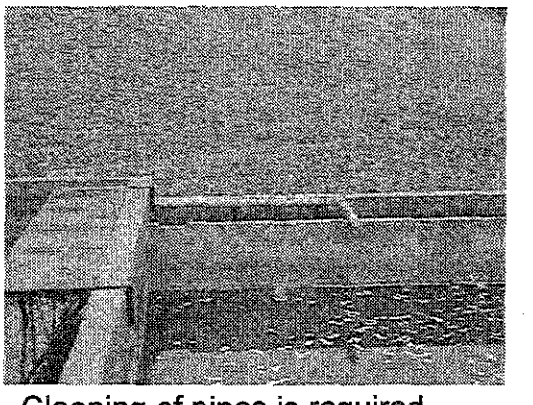
2.2.1 Leachate and gully suck tanks

The operation and maintenance of leachate and gully suck tanks is as follows

- The aerators shall be operated two hours in the morning and two hours in the evening everyday.
- The leachate treatment facility requires removing of sludge periodically and to be discharged to the landfill site whenever necessary
- Connection pipe between upper tank and lower tank and effluent pipe from lower tank shall be clean once a week.
- Removing of floating materials (shopping bags, paper and so on) and bulky waste (Tire, wood and so on)
- Add grease and service aerators every three months



The aerators shall be operated for four hours per day

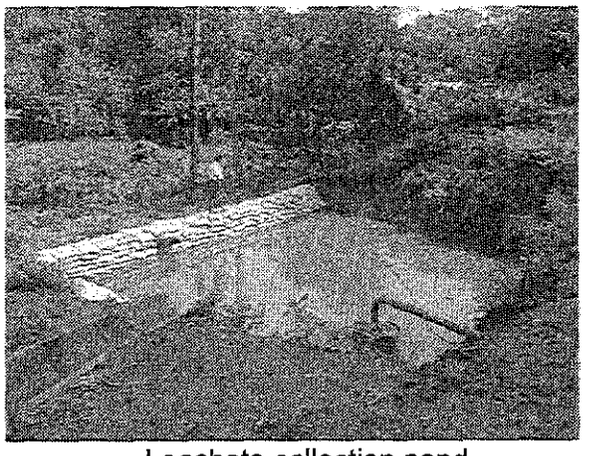


Cleaning of pipes is required once a week

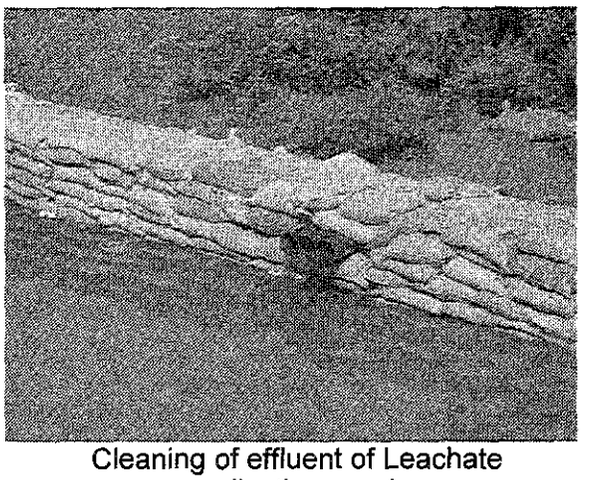
2.2.2 Leachate collection pond

The operation and maintenance of leachate collection pond is as follows

- Operate pump every morning
- To repair damaged sandbags
- To clean effluent pipe once a week
- To clean the inlet culvert once a week
- To remove the sedimentary soil every three months
- To check the function of pump and to remove the obstacles for the pump every day.



Leachate collection pond



Cleaning of effluent of Leachate collection pond

2.2.3 Leachate collection pipe on the terrace

The maintenance of leachate collection pipe is as follows

- To remove the obstacles at the effluent of leachate collection pipe
- When the seeping out of leachate is found on the terrace, the leachate collection pipe might be cloggy. The obstacles shall be removed in order to discharge the leachate properly.

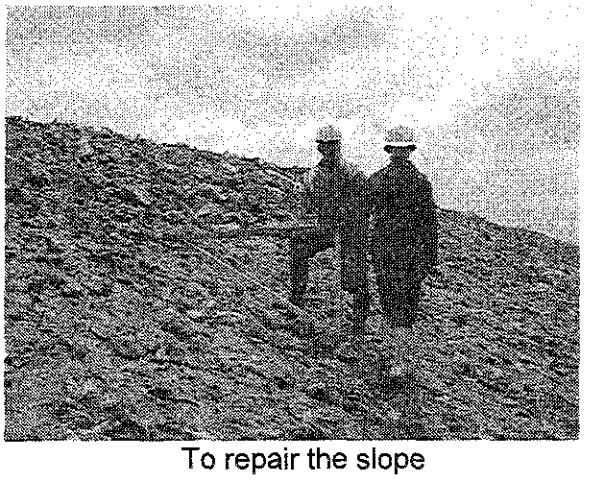
Removing the obstacles at the effluent

Removing of the obstacles of cloggy leachate collection pipe

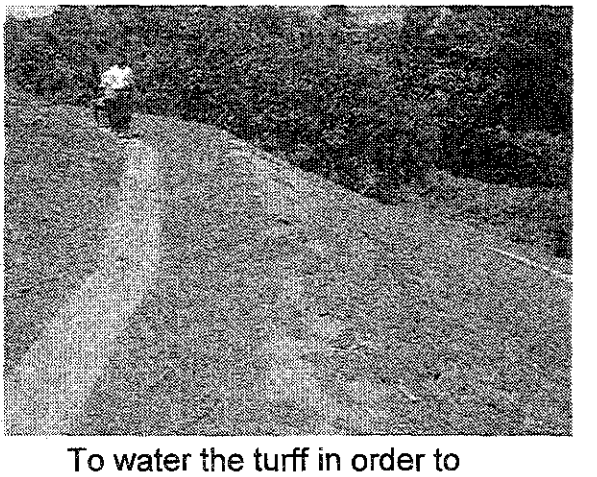
2.3 Finished slope

The maintenance of finished slope is as follows.

- To repair the damaged slope in accordance with 1:2 slope degree
- To water the turff at least every three days in order to protect the slope during dry season.
- To limit livestock to enter the landfill site. When the livestock is found, you must inform to MOH immediately.



To repair the slope

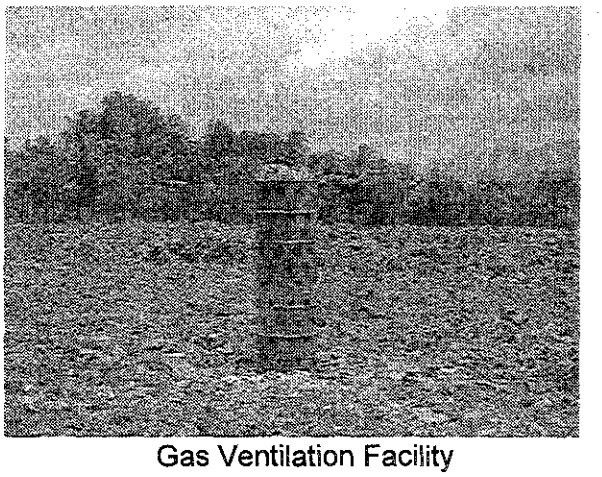


To water the turff in order to protect the slope

2.4 The other facilities

2.4.1 Extension of Gas Ventilation Facility

The role of gas ventilation facility is emission of methane gas which is generated through decomposing of discharged waste. The waste shall be discharged to surrounding of gas ventilation facility carefully.



Gas Ventilation Facility

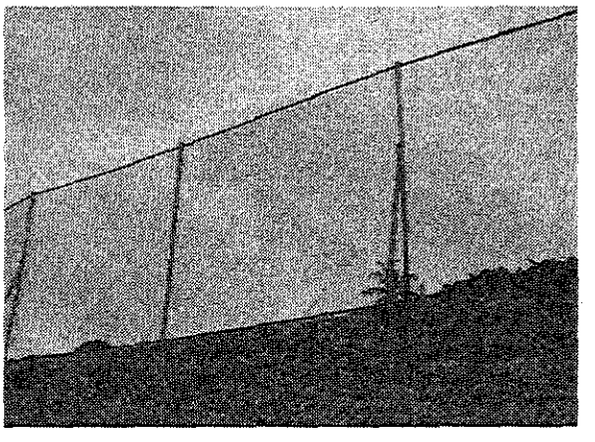
2.4.2 Storm water drainage

The role of storm water drainage is to divert the storm water from landfill site to outside. Storm water drainage shall be cleaned twice a month

Storm water drainage

2.4.3 Fence

The role of fence is to avoid the scattering waste. The fence shall be repaired when it is damaged by livestock and so on.

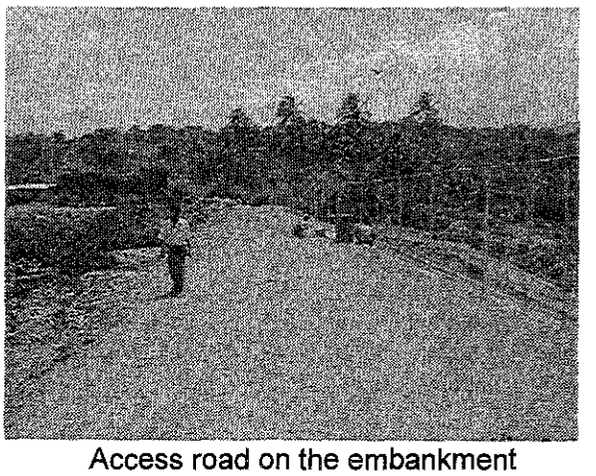


Repairing of damaged fence

2.5 Access road

The role of access road is to approach the place where the collection vehicles discharge waste.

The access road shall be repaired immediately when it is damaged.



Access road on the embankment

2.6 Medical waste discharge area

Medical waste discharge area in the Gohagoda landfill site is just temporary facility. Therefore all hospitals in Kandy have to establish the proper treatment system of medical waste as soon as possible.

2.7 Prohibited activity

The following activities are strictly prohibited.

- To discharge waste to back yard of control house
- To discharge gully suck to the landfill site or storm water drainage except for the gully suck treatment facility
- To discharge waste which comes from slaughter house to the outside of landfill site
- To discharge medical waste, which consists of mainly body parts, to the outside of medical discharge area.
- To sell waste which comes from slaughter house and gully suck as fertilizer
- To sell diesel of Bulldozer
- To permit entrance of livestock to the landfill site
- Burning of waste of any time
- Entrance of children to the landfill site

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