11) North Shuneh FDS

Table 2-3-2-12 summarizes present state of this FDS.
The following sections describe the general, the state of landfill and the state of influence on environment

(A) General

Managed by North Gohl CSC, North Shuneh FDS is located about 4 km south of Shamaria City, about 8 km from the Governorate north border and about 45 km from the south border (see Fig. 2-3-2-22), in a mildly hilly terrain. There are no adjacent houses nor public facilities, but small rivers on both sides of this FDS. Ground is composed of sandy soil equivalents on the surface and limestones thereunder.
This FDS has an area of 89,000 m^2 and a capacity of landfill year of 43 years (1983-2025) including the future plan, and is provided with a control office and access and in-site roads.
Wastes received are municipal wastes and medical wastes, quantity amounting to 72 t/day by 1995 record. But, this time survey resulted in the quantity of 36 t/day, about a half of the value obtained by 1995 record. Visual observation gave waste composition: food waste of about 70%, papers of 10%, plastics and rubbers of 10%, and others.

(B) State of landfill

Landfill adopts the open dumping method which uses trenches and applies only the final cover soil, without daily cover. Landfill efficiency is low.
Wastes carried in by dump trucks are dumped on the dumping stage and, then, dropped down into the trench, cut beforehand. No leveling nor compacting by landfill equipment are executed. When the trench is filled up, the final cover is applied. At the time of our site survey, wastes were left on the dumping stage as heaped.

(C) State of influence on environment

No traffic jams are seen and no influence public facilities can occur because there are no houses nor public facilities in the periphery. Air pollution, noise and vibration are also out of any problem.
Water is also supposed not to be polluted, because leachate is hardly

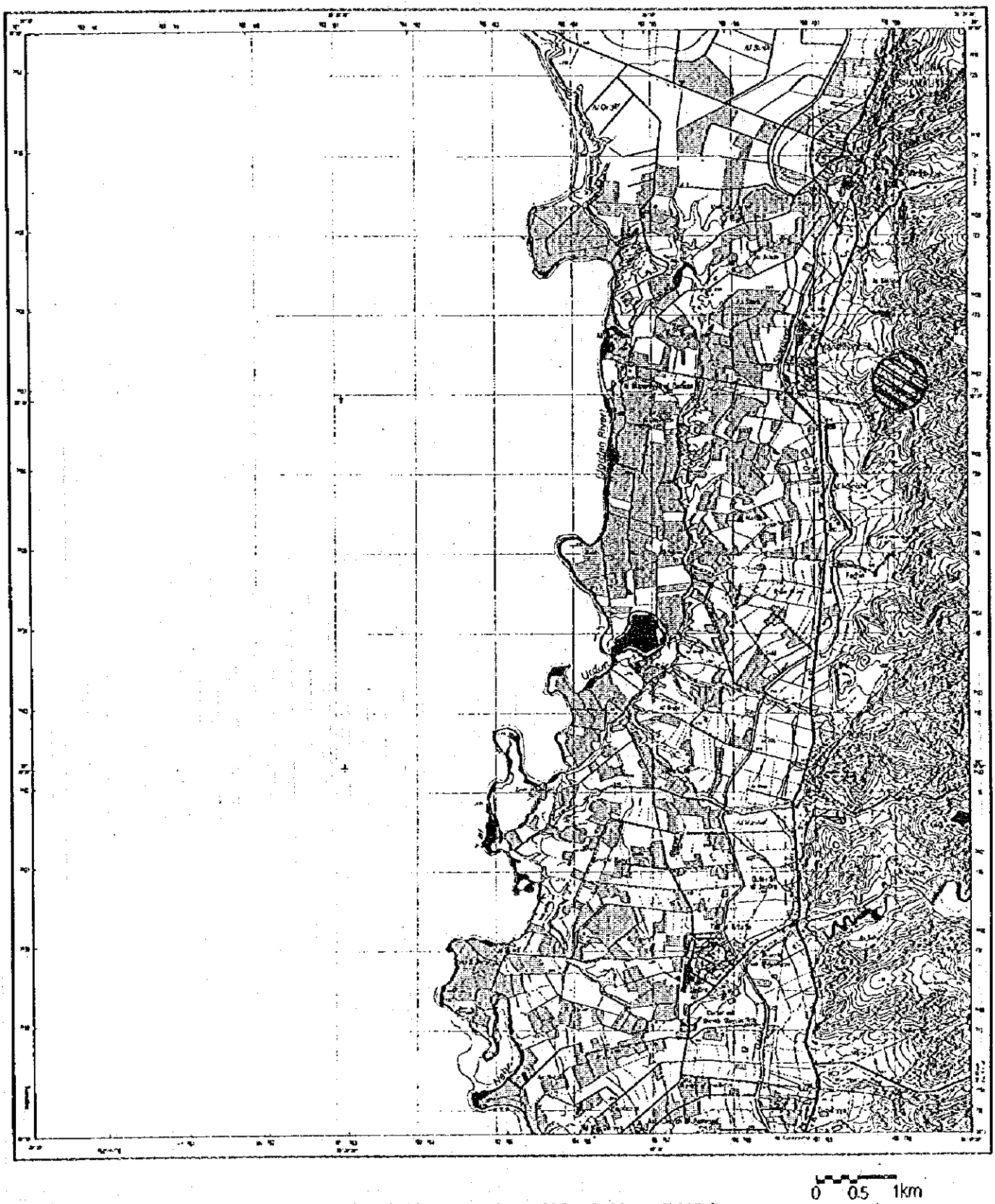


Fig. 2-3-2-22 Location of North Shuneh FDS

generated under the environment where precipitation is small (360mm/yr) and evaporation effect is active.

Table 2-3-2-12 Present State of North Shuneh FDS (1/4)

Item / Contents
1. Outlines of the final disposal site
(1) Location: About 45 km south of Shamaria City about 8 km from North Gohl Governorate north border and about 45 km from the south border
(2) Geographical configuration: Hilly land surrounded by a desert and farmyards with no houses nor public facilities but small rivers on both sides
(3) Soil quality: Sandy soil equivalents on the surface and limestones thereunder
(4) Ground-water: approx. 680 m under the surface
(5) Area: 67,000 m^2 initially and 89,000 m^2 at the present (an adjacent 12,000 m^2 purchased additionally)
(6) Volume capacity: 210,000 m^3 by the initial plan and 75,000 m^3 still available (excluding the expansion portion)
(7) Term of landfill: 1983-1998 (15 years) by the initial plan, but 43 years including the expansion portion
(8) Types of received wastes: municipal and medical wastes
(9) Quantity of wastes: 72 t/day (1995); 36 t/day (by our survey)

Table 2-3-2-12 Present State of North Shuneh FDS (2/4)

Item / Contents	
(10) Component of wastes	(by visual observation):
① papers	: 10%
② plastics and rubbers	: 10%
③ food waste	: 70%
④ glasses and porcelains	: -- %
⑤ metals	: -- %
⑥ woods	: -- %
⑦ fibers	: -- %
⑧ others	: 10%
(11) Equiped facilities:	
* control office	
* access and in-site roads	
2 State of landfill	
(1) Method of landfill:	
The open dumping method only with the final cover	
(2) Plan of landfill sequence:	
No plan	
(3) Method of leveling and compacting:	
No leveling nor compacting after dropping wastes into the trench	
(4) Plan and actual state of cover	
Plan: ① thickness of waste layer	: 200-300 cm
② thickness of daily cover soil	: -- cm
③ thickness of intermediate cover soil	: -- cm
④ thickness of final cover soil	: 50 cm
⑤ procurement of cover soil	: excavation soil obtained in the site
	Actual state
Actual state:	
* A trench is dug, wastes are dumped open into it and, when it is filled up, the final cover is applied.	
* The ratio of thickness of waste layer to that of cover soil is random since the trench depth is irregular.	
* In some cases of taking cover soil, wastes buried previously are dug out since it is not systematically planned where the soil should be taken.	

Table 2-3-2-12 Present State of Shuneh FDS (3/4)

Item / Judgment / Contents
3. State of influence on peripheries
(1) Traffics and life facilities :D * No traffic jams because of few number of trucks. * No problem due to traffics because of no houses nor public facilities near the roads.
(2) State of sanitation and health :A * Flies and harmful insects are generated. (In summer, chemicals are sprayed once every week.) * Light wastes are scattered near the rivers. * A lot of birds are seen.
(3) Ground-water :D * Ground-water is pumped up at about 400 m downstream of this FDS. * Periodical quality test there detects no pollution.
(4) State of lakes and rivers :D * One of the rivers (running on both sides of this FDS) has water. * The water shows no pollution by leachate.
(5) Air pollution :D * No smoke pollution because no open-burn is executed. * No problem of exhaust gas because of few number of dump trucks. * No problem of dusts generated by dumping since houses are about 2 km apart.
(6) Water pollution :D * One of the rivers(running on both sides of this FDS) has water. * The water shows no pollution by leachate.
(7) Soil pollution :D * No problem since most of the received wastes are general wastes.
(8) Noise and vibration :D * No problem caused by dump trucks because they are few. * No problem caused by operation of construction machines such as bulldozers on the site because facilities such as houses are about 2 km away.
(9) Offensive odor :A * There are some offensive odor because open dumping is executed.

Table 2-3-2-12 Present State of Shuneh FDS (4/4)

Other remarks * Good access since the site is near to main road and access roads are paved. * Whereas there are no scavengers, some people earn livelihood by pasturage near this FDS. * Soil cut on the site is available for cover. * This FDS can be properly controlled by executing systematic landfill.
< Judgment classification > A: serious influence presumed B: some influence presumed C: influence unknown D: no influence

View of FDS from the entrance.

View from the bottom of FDS. Two little rivers are running along FDS.
(the one of them dries out now)

View of disposed wastes without any treatment.

Trench to throw wastes.

Fig. 2-3-2-23 Views of North Shunch FDS

Here, the field study results (see Table 2-3-2-13) shall be summarized before examining the respective FDS improvement plans.

- There are no private houses or public facilities adjacent to any of the FDS except for the Madaba FDS.

- According to the data of the rain gauge stations near the FDS, the annual precipitation is quite low, being 42-560mm/year or approximately 1/4th that of Japan.

- Although the quantities of MSW vary widely from 34 to 316t/day, the quantity hauled per day is low in general. Daily cover and final cover are applied according to the execution plan for covering at the Ma'an and Al-Akaider FDS. At the other FDS, only the final cover is applied or cover is applied only sporadically. The exposure of waste was noted in a significant number of FDS.

- With regard to the impacts of FDS on the surrounding environment, none of the FDS had any problems in terms of impacts on transportation and living facilities, groundwater pollution, conditions of flow into lakes, marshes, and rivers, water pollution, soil pollution, and noise and vibration.

Meanwhile, though the levels differ from case to case, health and sanitation problems due to the scattering of waste, proliferation of flies and other unsanitary pests, etc., air pollution (especially air pollution by smoke) due to open burning, and offensive odors are notable as problems of the FDS.

Table 2-3-2-13 FDS Field Survey Results (1/2)

ITEM \ FDS		Al-Akaider	Mafraq	Humra	Tafila	Ma'an	Lojoon	Aqaba	Kufrinja existing	Kufrinja new	Madaba	North Shuneh
1. Topography of the Site		Hilly land with a gradual relief	Earthy desert. flatland	Steeply sloping area in a mountain area	Hilly land with a gradual relief	Flatland	Hilly land with a gradual relief	Hilly land with a gradual relief	Flatland	Relatively Steeply sloping area in a mountain area	Flatland	Hilly land with a gradual relief
2. Circumstances of Infrastructure Development at the FDS	Access road	Fully furnished with a paved road for exclusive use	Same as the left	Same as the left	Furnished with an unpaved road for exclusive use	Fully furnished with a paved road for exclusive use	A paved road for exclusive use is currently under construc-tion	Fully furnished with a paved road for exclusive use	Fully furnished with a paved road which is used in common as a public road	The const-ruction of paved road used in common as public road is under planning (already appropri-ated for in the budget)	Furnished with an unpaved road for exclusive use	Fully furnished with a paved road for exclusive use
	Electrical power	None	None	Available	None	None	None	None	None	-	Available	None
	Water system	None	None	Available	None	None	None	None	None	-	Available	None
3. Ground Conditions		Sandy soil with limestone in parts	Sandy soil	Clayish soil and sandy limestone	Sandy soil with limestone in parts	Sandy soil with gravel	Same as the left	Sandy soil	Sandy soil with limestone in parts	Calcareous clayish soil (marl)	Sandy soil	Same as the left
4.Private houses or public facilities in neighboring areas		None	None	None	None	None	None	None	None	None	Some wi-thin 100m	None
5.MSW Quantity (results of study on hauled quantity. t/day)		316	82	125	52 m3/d	34	96	62	38	-	63	36

Table 2-3-2-13 FDS Field Survey Results (2/2)

ITEM \ FDS	Al-Akaider	Mafraq	Humra	Tafila	Ma'an	Lojoon	Aqaba	Kufrinja existing	Kufrinja new	Madaba	North Shuneh
6. Landfill Conditions											
(1) Landfilling method	Sandwitch method	ODM/FCO *1	ODM/WIC *2	ODM/FCO *1	Sandwich method	Sandwich method	Open dumping method	Open dumping method	-	Sandwich method	ODM/FCO *1
(2) Landfilling sequence plan	YES	YES	YES	YES	YES	YES	NO	NO	-	YES	NO
(3) Leveling-surface compaction method	By:*3 tamping roller	By:*4 bulldozer etc.	DBWL:*5	NO	BB:*4	BB:*4	NO	NO	-	BB:*4	NO
(4) Circumstances of covering	GCOAP *6	NCOAP *7	NCOAP *7	NCOAP *7	Carried out as planned	-	NCOAP *7	No cover soil	-	NCOAP *7	NCOAP *7

Legend 1:

*1: ODM/FCO= Open dumping method:final cover only *2: ODM/WIC= Open dumping method with irregular covering *3: BTR= By tamping roller, etc.

*4: BB= By bulldozer, etc. *5: DBWL= Dumping by wheel loader, etc. *6: GCOAP= Generally carried out as planned

*7: NCOAP= Not carried out as planned.

ITEM \ FDS	Al-Akaider	Mafraq	Humra	Tafila	Ma'an	Lojoon	Aqaba	Kufrinja existing	Kufrinja new	Madaba	North Shuneh
7. Impacts on the surrounding environment											
(1) Transportation and living facilities	D	D	D	D	D	D	D	D	D	D	D
(2) Health and sanitation	A	D	B	B	D	C	B	A	C	B	B
(3) Groundwater	D	D	D	D	D	D	D	D	D	D	D
(4) Lakes, marshes, and rivers	D	D	C	D	D	D	D	C	B	C	D
(5) Air pollution	D	B	D	D	D	D	D	A	D	D	D
(6) Water pollution	D	D	C	D	D	D	D	D	B	D	D
(7) Soil contamination	C	D	D	D	D	D	C	D	D	C	D
(8) Noise and vibration	D	D	D	D	D	D	D	D	D	D	D
(9) Offensive odors	D	D	B	D	D	C	D	A	C	B	A

Legend 2:

A : a large impact is presumed/ B : some impact is presumed/ C : unknown/ D : no impact

(3) Fundamental Concepts of Design

Purpose of waste disposal is to remove wastes from living zone, reduce their volume, stabilize them, and turn them harmless. Waste treatment process are usually divided into collection / transfer stage, intermediate treatment stage, and final disposal stage. Since the final disposal is the process to return wastes to nature, the sole possible process is landfill in principle.

Purpose of landfill, is to store wastes in a suitable manner, and stabilize them utilizing natural metabolism to turn them harmless without damaging environment. Therefore, the final disposal site must be such a place where landfilled wastes can be stored safely and leachate gives no direct pollution to peripheral environment. Besides, landfilled wastes should not scatter and issue offensive odor. Additionally, leachate should be reduced in quantity, improved in quality, and issue nothing like methane gas.

The fundamental concepts of landfill plans, based on this field study, are listed below.:

1) The objective wastes of landfill should be restricted to municipal solid wastes, excluding industrial and medical wastes which should be controlled by Jordan government.

2) The daily cover and the final cover should be surely executed for sanitation purpose to prevent wastes from be scattered and generation of flies and harmful insects, and offensive odor.

3) Method and sequence of landfill and equipment employed should be determined considering geographical configuration, soil quality, precipitation and evaporation, quantity and quality of wastes at the objective FDS, and influences on peripheral environment.

4) Facilities such as leachate collecting and draining pipe ducts and leachate treating equipment are not necessary in Jordan since

① annual precipitation is small and evaporation effect is active and

② ground bed is impermeable.

However, in Kufrinja FDS, which is to be constructed on rather a steep slope, equipment such as the leachate collecting and draining pipe, the leachate regulating reservoir and the leachate circulating pump should be installed as a consideration against influences on peripheral environment.

5) Additionally, periodical monitoring should be executed in all FDS's to grip whether peripheral water areas are polluted by leachate.

6) Fences should be installed along the entire length of border to prevent illegal dumping, scavengers' invasion and flying out of wastes.

7) Access and in-site roads should be installed to prevent cars and equipments from traffic accident and to maintain the efficiency of optimal landfill.

(4) Fundamental Design

1) Fundamentals for execution of sanitary landfill

(A) Definition and construction of sanitary landfill

The American Civil Engineering Institute defines sanitary landfill as "the method of waste disposal which protect health and safety of citizens against public hazard by executing leveling and compacting waste to minimize its volume and applying soil-cover over the landfilled wastes at the end of each day's work or more frequently if needed."

Construction of landfill in Japanese FDS's can be classified into five as shown in Table 2-3-2-14:

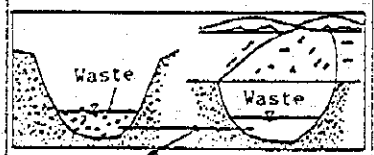
① anaerobic construction of landfill,
② anaerobic sanitary construction of landfill with daily cover soil.
③ modified anaerobic sanitary construction of landfill with leachate collecting and draining pipe duct on the bottom,
④ Semi-aerobic construction of landfill with ventilating, water collecting and draining equipment, and
⑤ aerobic construction of landfill with air blowing-in equipment.

Most of new Japanese FDS's employ ④ semi-aerobic construction from the aspect of improving properties of gas generated from leachate.
But, in Jordan, adoption of ④ semi-aerobic construction is questionable for reasons of climatic and geological conditions, and gradual improvement of FDS facilities is believed to recommend. Reasons include the facts that annual precipitation is much less than in Japan and evaporation effect is well expectable, there is no problem of peripheral water pollution by leachate, and ground bed at the FDS is impermeable. Therefore, adoption of ② anaerobic sanitary construction, shown in Table 2-3-2-14, is considered suitable for the first stage FDS's in Jordan.

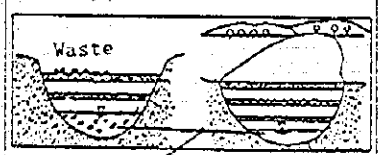
Table 2-3-2-14 Types and Features of Landfill Constructions

Landfill construction	Features	Advantage	Disadvantage
① Anaerobic landfill [Fig. 1]	Wastes are simply dumped in an excavated or natural hollow.	No investment of FDS construction needed.	Many kinds of pollution have happened.
② Anaerobic sanitary landfill [fig. 2] Soil cover applied at end of each day's landfill work	Wastes are dumped in an excavated or natural hollow, and applied with soil cover at end of each day's landfill work.	No investment of FDS construction needed.	Leachate may cover wastes at a place with a large precipitation. Stabilization rate is very slow because the bottom of a hollow is anaerobic.
③ Modified anaerobic sanitary landfill [Fig. 3] Leachate collecting and draining pipe laid on the bottom :LCDP	Leachate collecting and Draining pipe is laid to remove leachate, and impermeable layer is constructed on the bottom of landfill to prevent contamination of groundwater. Thus, the main design concept is control of leachate.	Sanitary landfill without any contamination of ground-water is possible by daily cover soil and suitable treatment of leachate with the collecting and draining pipe laid on the site bottom to collect leachate in the pit.	This design is disadvantageous for rapid stabilization of landfilled wastes since landfilled wastes are put under aerobic conditions only in the initial stage of landfill.
④ Semi-aerobic landfill [Fig. 4] Leachate collecting and draining pipe, associated with ventilating and collecting / draining equipment laid on the bottom :LCDP+VCDㅌ	Fresh air goes easily down inside the landfill utilizing lowering water level there due to draining of leachate. And air can be led into the site bottom portion through the empty leachate collecting pipe when precipitation is small, thus ventilation in the bottom portion is secured naturally.	Aerobic portion is expanded in the landfilled layers, activating aerobic microorganisms there. This promotes decomposition of organic wastes, reducing satbilization term of landfill. Additionally, leachate properties are largely improved with substances such as ammoniacal nitrogen in comparison with the leachate in anaerobic landfill.	Nothing especially.
⑤ Aerobic landfill [Fig. 5] Air forced in	Excusive air letting-in pipe is laid together, without using the leachate collecting and draining pipe to let air in, and air is activelyfed in by a blower installed outside of the landfill portion. Air Letting In Pipe : ALIP	Stabilization of landfill is drastically accelerated since aerobic fermentation is promoted in landfilled wastes. Leachate is reduced in quantity, and methane gas generation can also be reduced. This process issues less bad odor.	Too high a cost needed, and the objective wastes are wet refuse mainly.

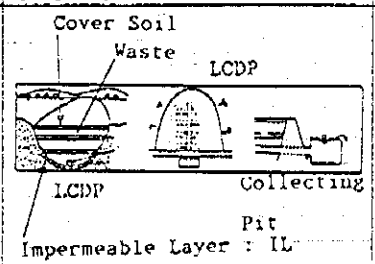
[Fig. 1]



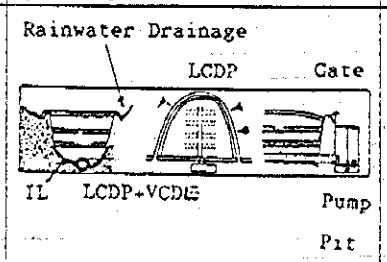
[Fig. 2]



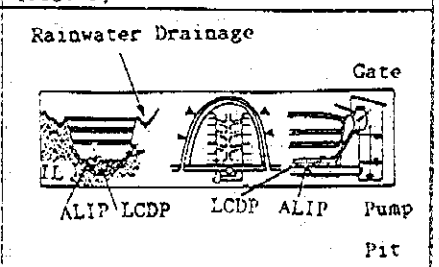
[Fig. 3]



[Fig. 4]



[Fig. 5]



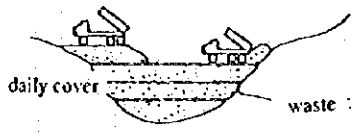
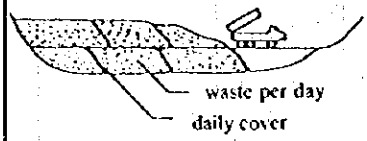
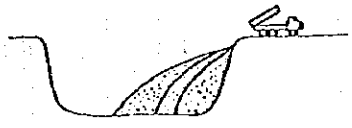
Figures extracted from : National City Cleaning Conference : Explanation on Guidelines for Final Disposal Site of Waste Supervised by Water Sypply and Environmental Sanitation Department, Ministry of Health and Welfare, Japan

(B) Types of landfill method

Landfill methods include three methods as shown in Table 2-3-2-15.

Out of these, the cell method is employed for sanitary landfill considering quantity of wastes accepted daily by the objective FDS's and the geographically flat configuration of the sites.

Table 2-3-2-15 Types and Features of Landfill Methods

Landfill method	Features
Sandwich method:  	Levels wastes horizontal, and stacks wastes layer and cover soil alternately. Used in a narrow mountainous site. When area of landfill is large, dumping area for one day must be restricted to assure the thickness of wastes required to apply soil cover. This inevitably makes slopes of waste layer.
Cell method:  	Applies cover soil on the landfill wastes and slopes to finish it cell-like. Used popularly in Japan. The cell size is automatically determined by the daily quantity of landfill. Each cell forms an independent waste landfill layer. This is effective in prevention of fire outbreak and propagation, scattered wastes, offensive odor and harmful insect generation.
Dumping method: 	Only dumps wastes into the place without leveling or compacting. This method is not expected to form ground with good dynamic properties and prevent scattered wastes, offensive odor generation, harmful insect generation and the like. This method is not suitable to landfill wastes sanitarily and systematically.

Figures extracted from; National City Cleaning Conference; Explanation on Guidelines for Final Disposal Site of Wastes; Supervised by Water Supply and Environmental Sanitation Department, Ministry of Health and Welfare, Japan

(C) Cover soil

A) Effects and necessity of cover soil

Cover soil is very effective for prevention of offensive odor, scattering and flowing out of wastes, increase of sanitarily harmful insects and animals, and outbreak and propagation of fire as well as preservation of peripheral environment.

Additionally, it is effective also for control of landfill ground such as carrying-in, leveling and compacting of wastes, and prevention of rainwater penetration (reduction of leachate).

Table 2-3-2-3 Types and Effects of Cover Soil

Type	Daily cover	Intermediate cover	Final cover
Definition	Applied when land-filled wastes have reached a specific thickness,or at the end of the day's landfill work.	Applied on the part of the site which will be left for a long time after daily cover is executed.	Applied on the top when landfill work has finished.
Main effects	* prevention of flying wastes * prevention of bad odor generation * sanitary measure to flies, etc. * prevention of harmful insect generation etc.	* road ground for hauling trucks * rainwater blocking in landfill portion left standing for rather a long time	* sight improvement * ground application * leachate reduction
Material	* soil taken on the site	* soil taken on the site	* soil taken on the site

B) Determination of cover soil thickness

Thickness of cover soil should be determined suitable for purpose of cover, type and shape of landfilled wastes, type of cover soil, and peripheral environmental conditions. The thickness should be generally as shown in Fig. 2-3-2-24 for each type of coverings. The reasons;

① Daily cover

A thickness of 30~50cm would be suitable because of the following reasons.

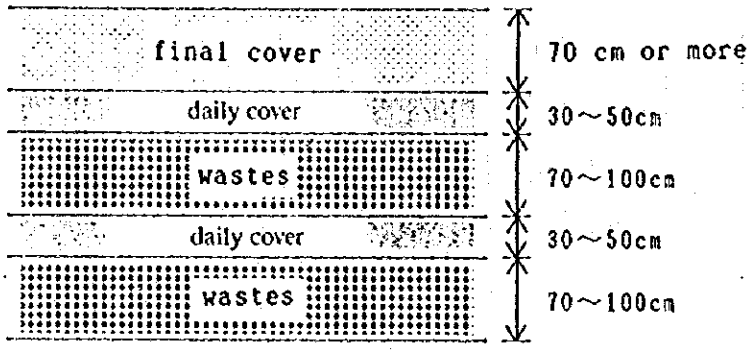
- A thickness of soil cover for crushed wastes and incinerator residue is 15~20cm as standard in Japan. However, 50~60% of landfilled waste is food wastes, main factors of offensive odor, and cover soil is mostly permeable sandy soil in Jordan. Thus, the standard thickness of cover soil should be thicker than the one in Japan.
- From the fact that Ma'an FDS. which applies daily cover of a thickness of 30~50cm, is successful in giving no influence on peripheral environment.

② Intermediate cover

Thickness of intermediate cover, when applied, is considered sufficient if determined nearly same as the upper limit of daily cover to bear weight of dump trucks and block rainwater permeation.

③ Final cover

When to consider planting of young trees on the final cover to improve visual sight, thickness of final cover should not be less than 70 cm (total thickness of cover soil comes to 100-120 cm as final cover is added to the daily cover (t=30~50) laid beneath).



(*) Thickness of intermediate cover, if applied, should be about 50 cm.

Fig. 2-3-2-24 Thickness of waste and cover soil

(D) Methods of leveling and compacting

Methods of leveling and compacting on the landfill wastes include that dropping down the wastes unloaded from the truck with a bulldozer or other equipment, and that pushing the wastes up, as shown in Fig. 2-3-2-25.

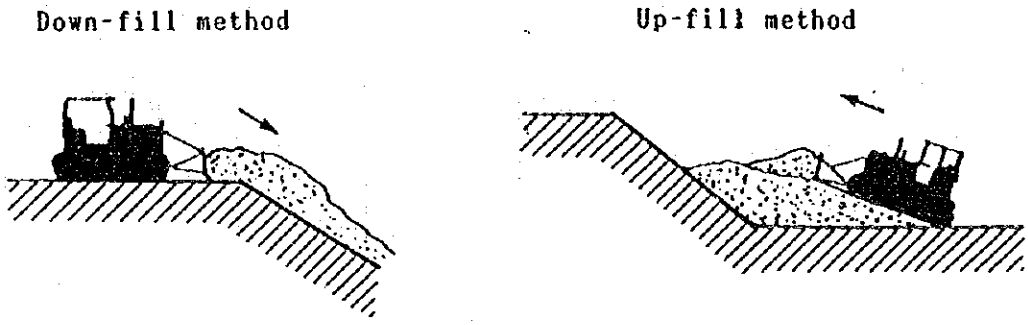


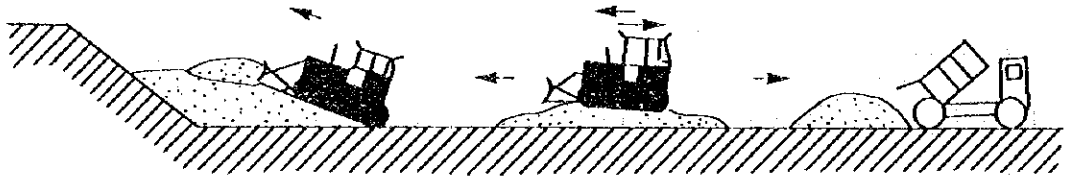
Fig. 2-3-2-25 Method of bedding and compaction

The method dropping down is hard to hold waste layer uniform, tending to "the lower the thicker," and compact wastes sufficiently. The method pushing up is easy to hold a uniform waste layer and compact wastes sufficiently.

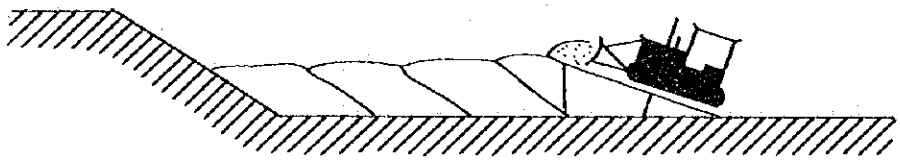
In leveling and compacting, the following points should be particularly cared for in order to increase landfill capacity, stabilize waste layer, and preserve applicability of landfill and peripheral environment.

- Leveling thickness should not be too large. It is said that the thickness of sand and soil to which compacting effect reaches is 30-50 cm with an ordinary leveling machine.
- Therefore, the leveling machine will be efficient to compact the layer of waste which consists two to three layers of the whole day thickness 70-100 cm.
- Wastes should be leveled and pressed by pushing up along a slope to have a thickness as uniform as possible. The slope should be about 20 deg. preferably.

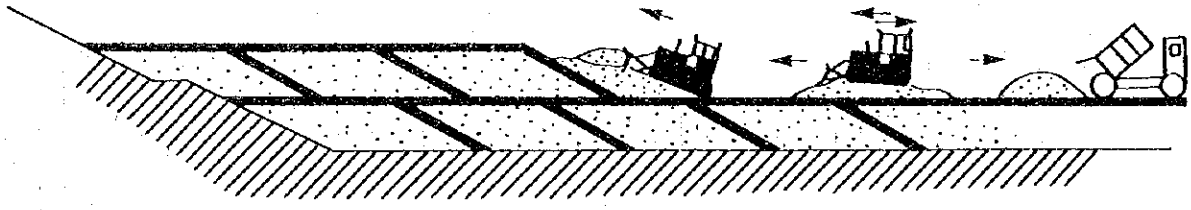
The concept of leveling and compacting is given in Fig. 2-3-2-26.



Preparation of a unit of cell with the up-fill method



Preparation of cells with the up-fill method



Typical landfill by cell method

Fig. 2-3-2-26	Typical Landfill by Cell Method

B) Landfill machines

For landfill, suitable machines should be chosen considering configuration and scale of the final disposal site, method of landfill, type of wastes, etc.

To classify landfill machines functionally;

① machines to level and press wastes to a uniform thickness,

② machines used to cut soil for cover and apply coverings, and

③ machines required to execute landfill work smoothly.

Out of these, types and performances of machines belonging to ① and ② above are listed in Table 2-3-2-17. Machines belonging to ③ include vehicles that have equipment to spray water or disinfectant.

2) Improvement plan for the FDS targeted in the study

In formulating the improvement plan for the FDS targeted in the study, it is essential to grasp the current circumstances of landfill, the impacts on the surrounding environment, etc. In this section, FDS improvement plans for each FDS are examined. Meanwhile, The staff, the maintenance costs, the equipment owned, etc, of the FDS shall be discussed in detail in Section 2-3-3, "Equipment Plan."

Table 2-3-2-17 Performances of Landfilling Machines

Work Machine	Capacity	Wastes		Cover soil					Scale of Landfilling	Features
		Leveling	Compacting	Cutting	Loading	Transport	Leveling	Compacting		
Buildozer	weight: 3.5-40 t running speed: 0-14 km/h earth-moving plate: 0.5-10 m3	◎	○	△	×	×	◎	○	large-small	* good leveling performance * suitable for compacting and usable even for soft ground * not so good mobility * giving a good compacting effect to hard ground * the most versatile machine
Dozer-shovel	bucket capacity: 0.2-4 m3 running speed: 0-14 km/h	○	△	◎	◎	×	○	△	large-small	* suitable for cutting and loading * leveling and compacting performance a little inferior to the bulldozer
Wheel loader	bucket capacity: 0.2-9 m3 running speed: 0-40 km/h	○	×	△	◎	×	○	×	large-small	* unsuitable for compacting * good mobility * mainly used for loading
Excavator	bucket capacity: 0.2-9 m3	×	×	◎	◎	×	△	×	large-small	* most suitable for cutting and loading * used to take cover soil by cutting natural ground
Landfill compacter	weight: 20-34 t tooth height: 15 cm	◎	◎	×	×	×	○	○	large-small	* high crushing and compacting effect but, effect reduced if used on ground not hard * usually suitable for landfilling uncrushed wastes

Nomenclature: ◎: most suitable, ○: good performance, △: usable but performance not so good, ×: unsuitable

(A) Al-Akaider FDS

A plan view and cross-sectional view of the FDS landfill plan are shown in Figs. 2-3-2-27 to 2-3-2-29. The FDS improvement plan is described below.

A) Consideration of the landfill method

Currently at this FDS, the sandwich method of landfill is carried out in view of the topography, geology, etc. of the landfill site. However, since there is proliferation of flies and other unsanitary pests as well as scattering of wastes, it is essential that daily cover be carried out thoroughly through a cell method.

B) Consideration of the working sequence and the equipment used

The embankment erection work and landfill operation shall be carried out according to the flow shown in Table 2-3-2-18.

The following equipment shall be used in consideration of the procurement source of cover soil, etc., working efficiency, and solid waste classification, etc.

Natural ground excavation, loading, transportation	: bulldozer, wheel loader, dump truck
Leveling and surface compaction of embankment and cover soil	: bulldozer
Leveling and surface compaction of solid waste:	: bulldozer

The reasons for adopting such combinations of equipment and work are as follows:

- Since the sandy soil (which partly includes landfill waste) of the natural ground is planned to be used for embankment and cover soil, a bulldozer, which is excellent for excavating in layers at flat areas, is suitable.

- A wheel loader, which excels in working efficiency, is optimal for the loading of the excavated natural ground soil. A dump truck is most suitable for the transportation of excavated natural ground soil in view of the transportation distance.

- A buildozer, which excels in workability and can provide surface compaction effects, is most suitable for the leveling and surface compaction of solid waste, embankment, and cover soil.

- Since food wastes comprise a large part of the waste and there are hardly any bulky wastes, etc. that require crushing, leveling and surface compaction by a buildozer should be adequate.

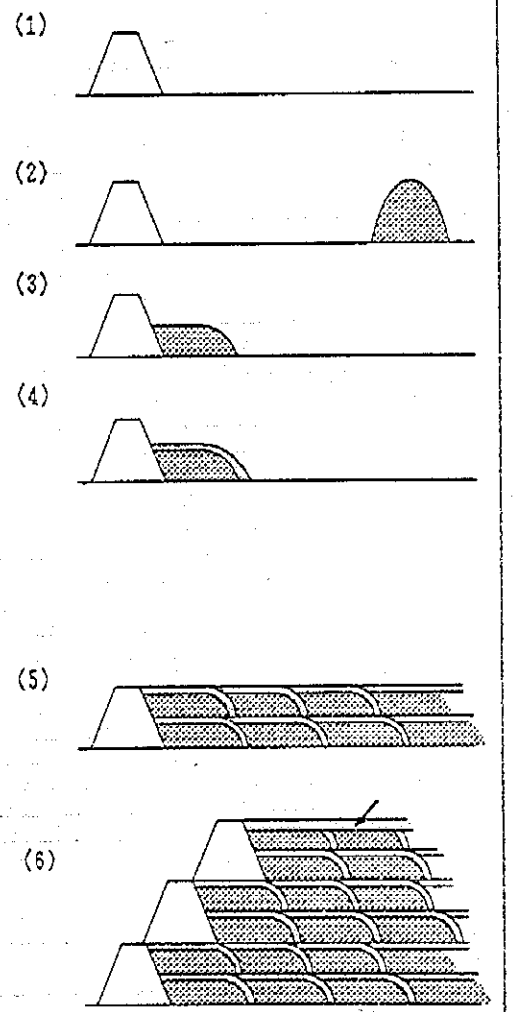
Besides the landfill operation equipment indicated above, an excavator is needed for constructing the water channel for directly connecting the four settling ponds for night soil treatment. Also, although the supernatant after night soil treatment is supplied to the tree-planting plant, a tractor head is needed for excavation and improvement work between the trees and for prevention of proliferation of flies and other unsanitary pests.

C) Maintenance facility plan

The monitoring well shall have the structure shown in Fig.2-3-2-30 as standard.
The purpose of monitoring the groundwater in the surroundings of the FDS by means of a monitoring well is to monitor the degree of diffusion of pollutants that flow out from the FDS in the groundwater and the level of impact on the living environment for people.
A monitoring well must thus be provided at one location along the direction of flow of the groundwater directly below the FDS. The depth of the monitoring well shall be set so that the pollution of the aquifer adjacent the FDS can be detected.

Table 2-3-2-18 Work Flow and Equipment Used: AL-AKAIDER

Work Flow	Equipment Used
START (1) Erection of embankment (2) Hauling of solid waste into site (3) Leveling and compaction of solid waste (4) Application of daily cover [NO] Has landfill been performed up to the height of the embankment? [YES] (5) Completion of one process [YES] Continue with further landfill? [NO] (6) Application of final cover END	(1) Excavation : Bulldozer Loading : Wheel loader Transport : Dump truck Leveling/ Surface compaction : Bulldozer (3) Bulldozer (4) Bulldozer (6) Excavation : Bulldozer Loading : Wheel loader Transport : Dump truck Leveling/ Surface compaction : Bulldozer



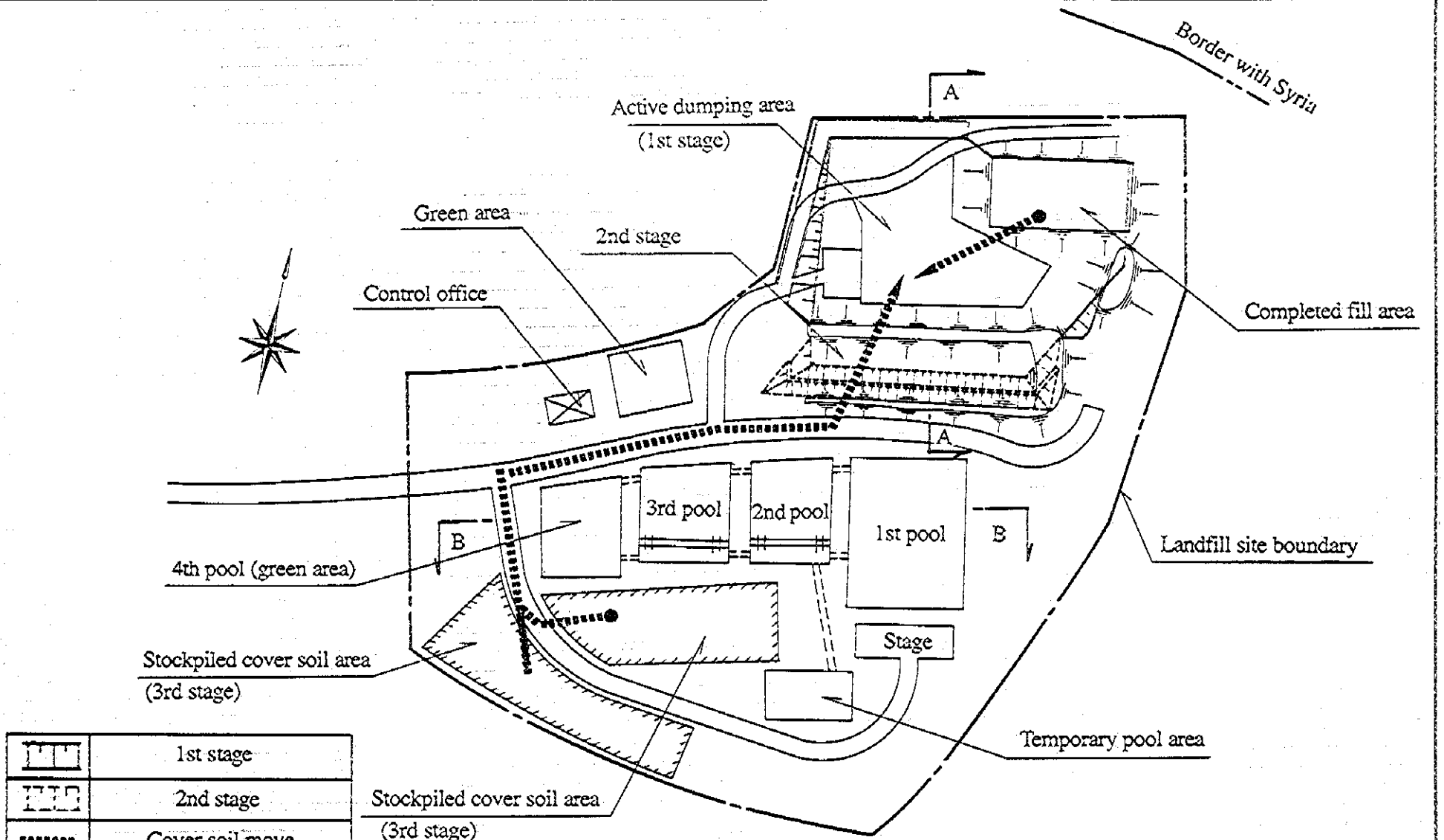
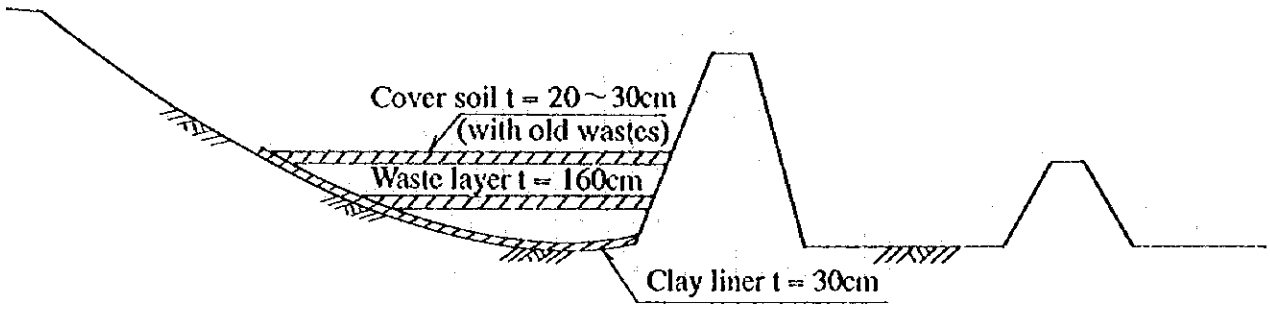
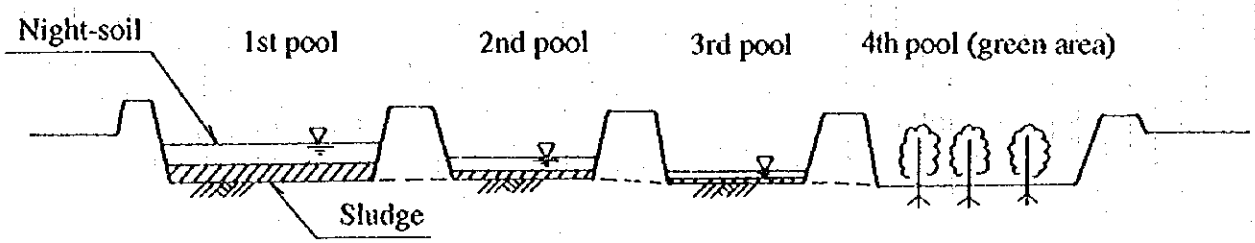


Fig. 2-3-2-27 Ground plan of Al-Akaider FDS

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



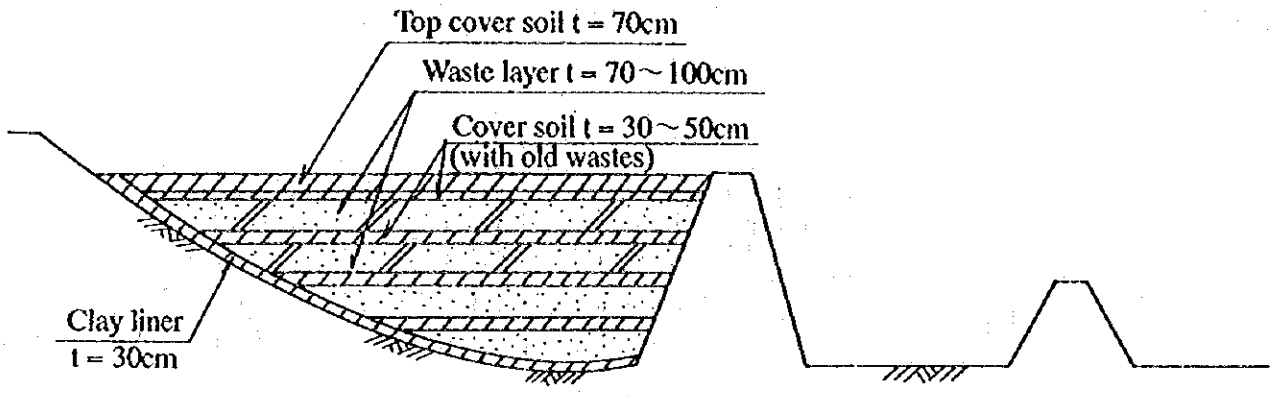
Section A-A



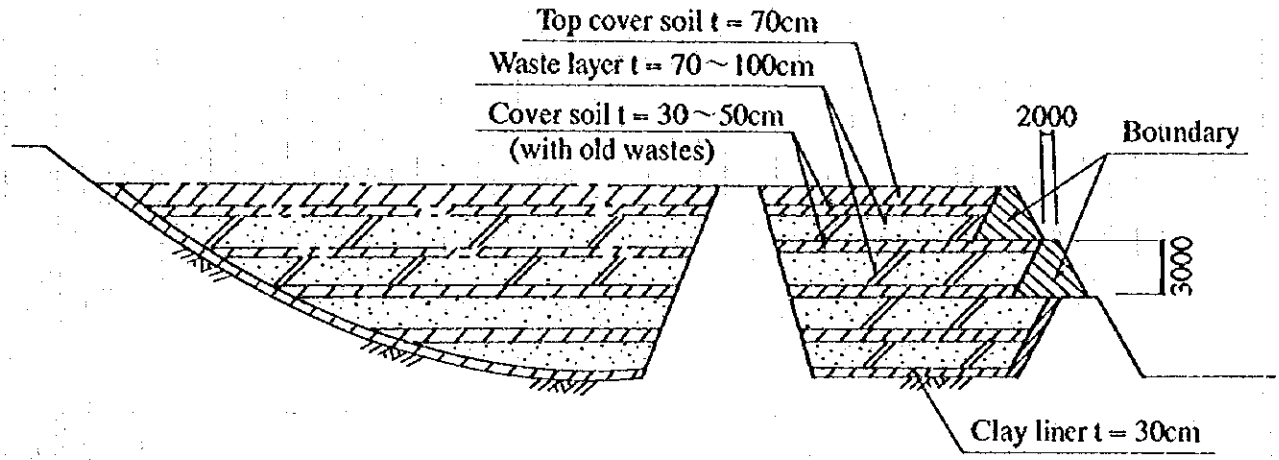
Section B-B

Fig. 2-3-2-28	Cross section of Al-Akaider FDS (1/2)

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Section A-A
1st stage



Section A-A
2nd stage

Unit: mm

Fig. 2-3-2-29	Cross section of Al-Akaider FDS (2/2)

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

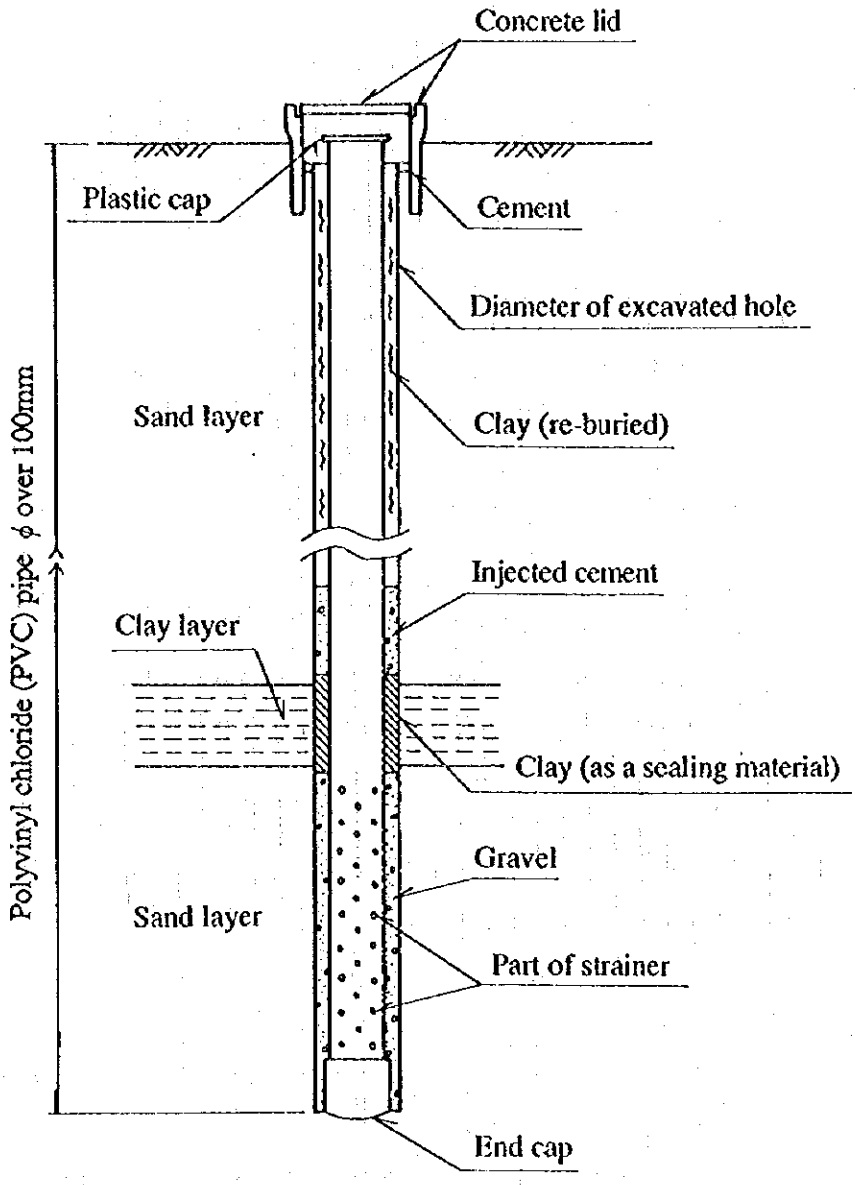


Fig. 2-3-2-30	Standard of monitoring well

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

(B) Mafraq FDS

A plan view and cross-sectional view of the FDS landfill plan are shown in Figs. 2-3-2-31 to 2-3-2-33. The FDS improvement plan is described below.

A) Consideration of the landfill method

Sanitary landfill using trenches shall be carried out at this FDS in view of the circumstances of landfill, the topography, geology, etc. of the landfill site, the procurement source of cover soil, the ultimate use of the completed landfill, etc. This method shall be adopted for the following reasons.

- With the current landfill method, sections in which landfill has been completed cannot be distinguished clearly from sections in which landfill has not been completed and the landfill efficiency is poor. Furthermore, open burning, open dumping, etc. are unfavorable in terms of environmental sanitation.

- Since the landfill site has a nearly flat topography and the surface layer is comprised of sandy soil at depths of 3.0-4.0 m on the average (7.0 m maximum) and bedrocks at further depths, the workability of the site is good for trench excavation.

- Trenches can be excavated according to the unevenness of the bedrock and cover soil can be procured on-site.
- Since there are plans for using the completed landfill as a park with trees, etc., the embankment cannot be made higher than necessary due to restrictions in terms of current circumstances and foundation height.

B) Consideration of the working sequence and the equipment used

The trench excavation work and landfill operation shall be carried out according to the flow shown in Table 2-3-2-19.

The following equipment shall be used in consideration of the excavated foundation, the topography, the working efficiency, and the solid waste classification.

Trench excavation	: excavator
Leveling and surface compaction of solid waste and cover soil	: bulldozer

The reasons for adopting such combinations of equipment and work are as follows:

- Since the surface layer is comprised of a sandy soil layer to depths of 3.0-4.0 m on the average (7.0 m max.), an excavator, which excels in working efficiency, is most suitable for trench excavation.

- A bulldozer, which excels in workability and can provide surface compaction effects, is most suitable for the leveling and surface compaction of solid waste and cover soil.

- Since food wastes comprise a large part of the solid waste and there are hardly any bulky wastes, etc. that require crushing, leveling and surface compaction by a bulldozer should be adequate.

Besides the landfill operation equipment indicated above, a tractor head for spraying chemicals is needed for the purpose of preventing the proliferation of flies and other unsanitary pests.

C) Maintenance facility plan

a. On-site road

An on-site road shall be installed to facilitate the passage of the solid waste transporting vehicles to be provided in the FDS. Since the on-site road must thus enable safe passage of solid waste transporting vehicles without jams, a road having the structure shown in Fig. 2-3-2-34 shall be installed within the boundaries of the site.

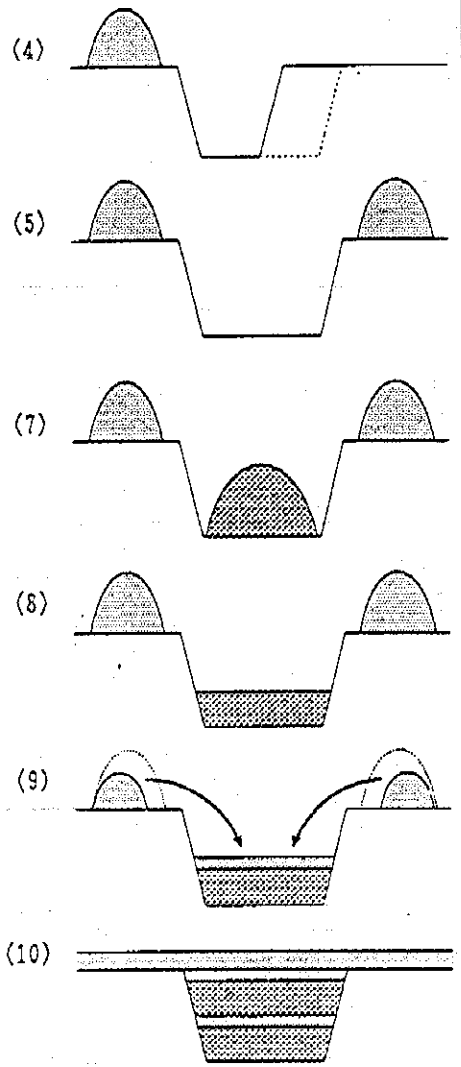
b. Peripheral fence

A peripheral fence, such as that shown in Fig. 2-3-2-35 shall be installed about the entire perimeter of the site. Though this peripheral fence shall be provided mainly to prevent unnecessary entry of persons inside the FDS and for safety management, it shall also provide the effects of preventing illegal waste dumping and shutting off the view and serve a facility for preventing the scattering of solid waste.

c. Monitoring well

The monitoring well shall have the structure shown in Fig. 2-3-2-36 as standard. The purpose of monitoring the groundwater in the surroundings of the FDS by means of a monitoring well is to monitor the degree of diffusion of pollutants that flow out from the FDS in the groundwater and the level of impact on the living environment for people. A monitoring well must thus be provided at one location along the direction of flow of the groundwater directly below the FDS. The depth of the monitoring well shall be set so that the pollution of the aquifer adjacent the FDS can be detected.

Table 2-3-2-19 Work Flow and Equipment Used: MAFRAQ

Work Flow	Equipment Used
START Trench Excavation Work (1) Installation of fence for preventing unwanted entry (2) Furnishing of peripheral road (3) Positioning of excavation range by line marker (4) Trench excavation (one side) (5) Trench excavation (one side) (6) Completion of trench Landfill Operation (7) Hauling of solid waste into site (8) Leveling and compaction of solid waste (9) Application of daily cover [YES] Continue with further landfill? [NO] (10) Application of final cover END	 (4): Excavator (5): Excavator (8) Bulldozer (9) Bulldozer (10) Bulldozer

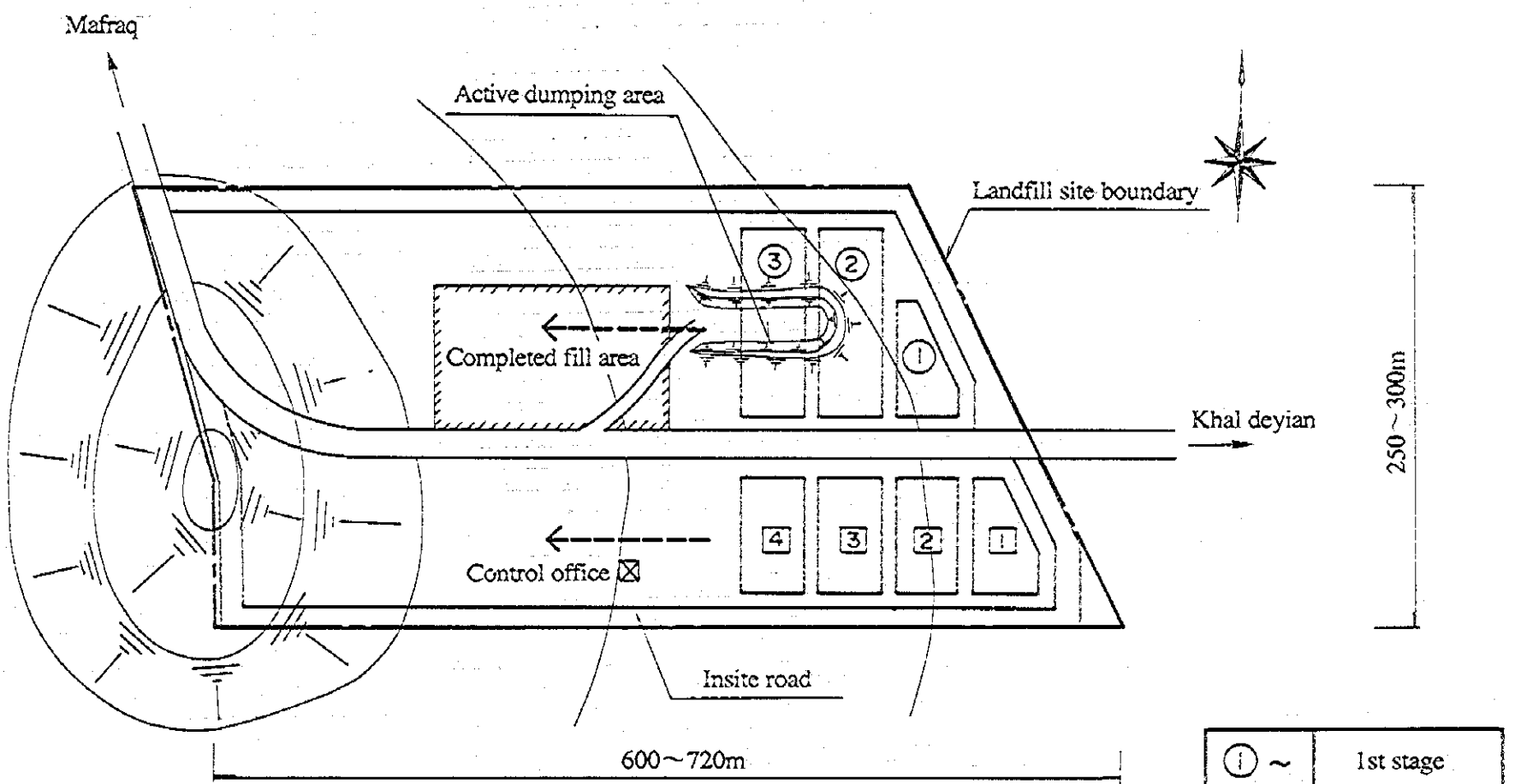
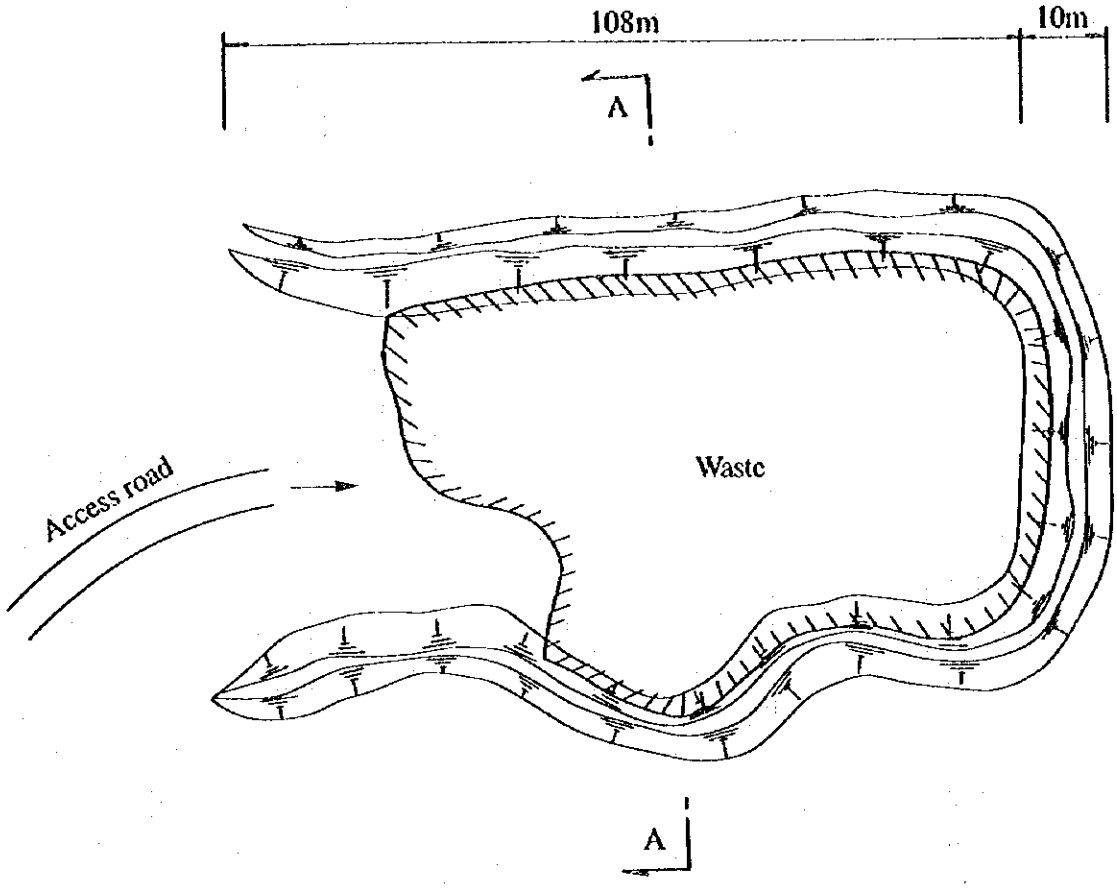
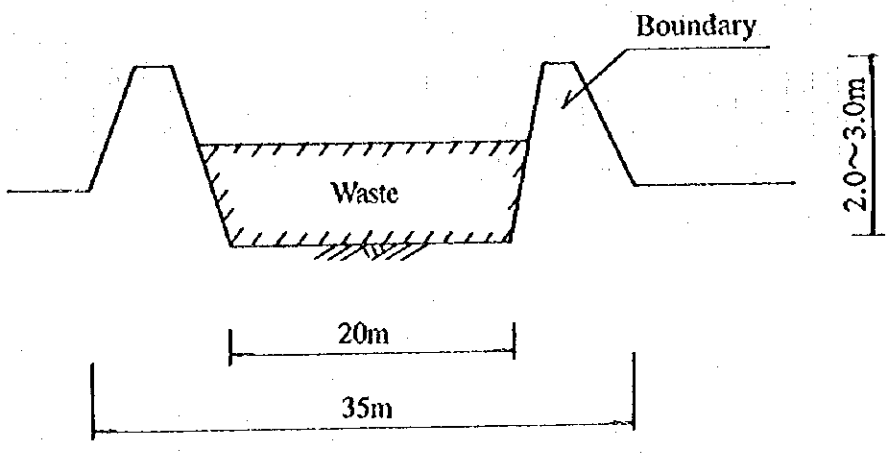


Fig. 2-3-2-31 Ground plan of Mafraq FDS

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



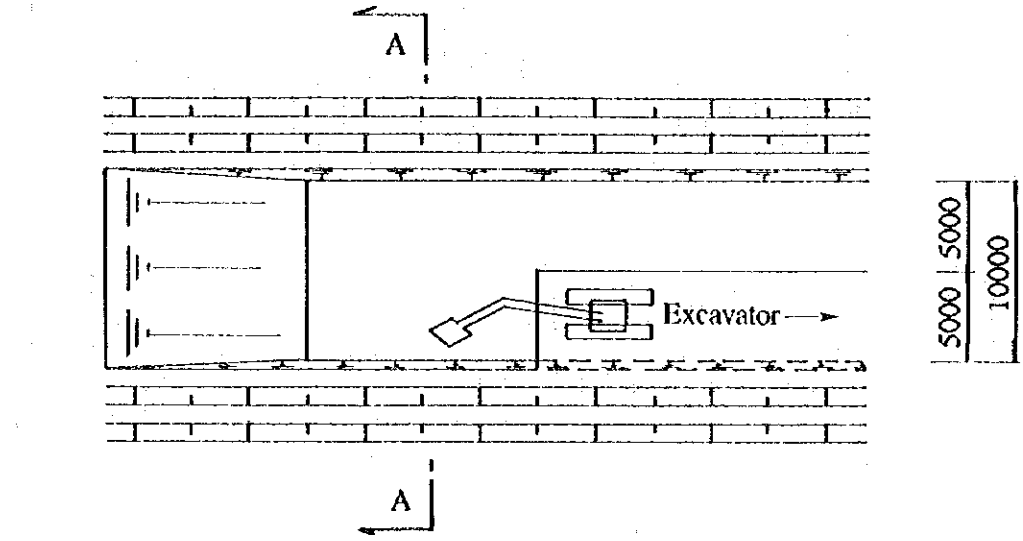
Active dumping area

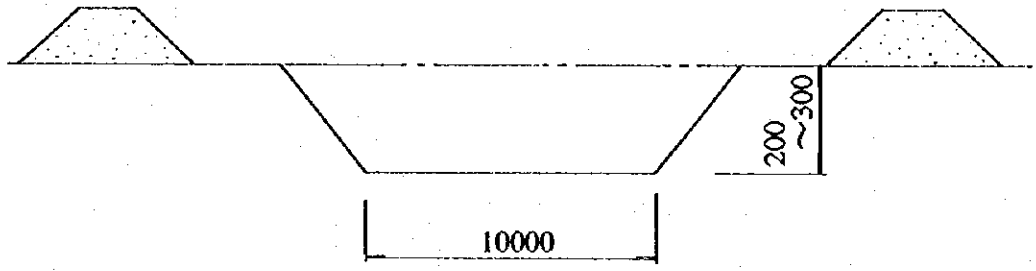


Section A-A

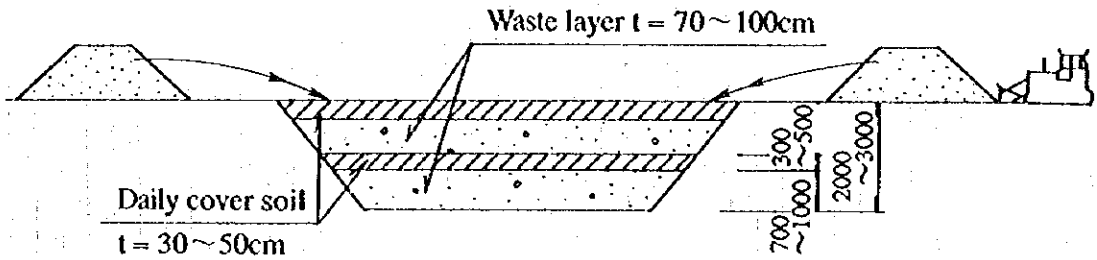
Fig. 2-3-2-32	General drawing of Mafraq FDS

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

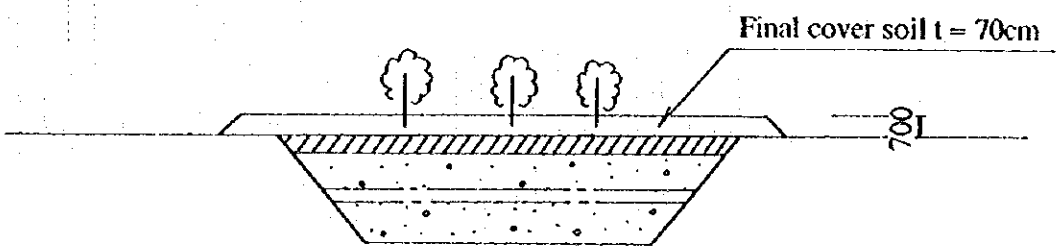




Section A-A (before dumping)



Section A-A (during dumping)

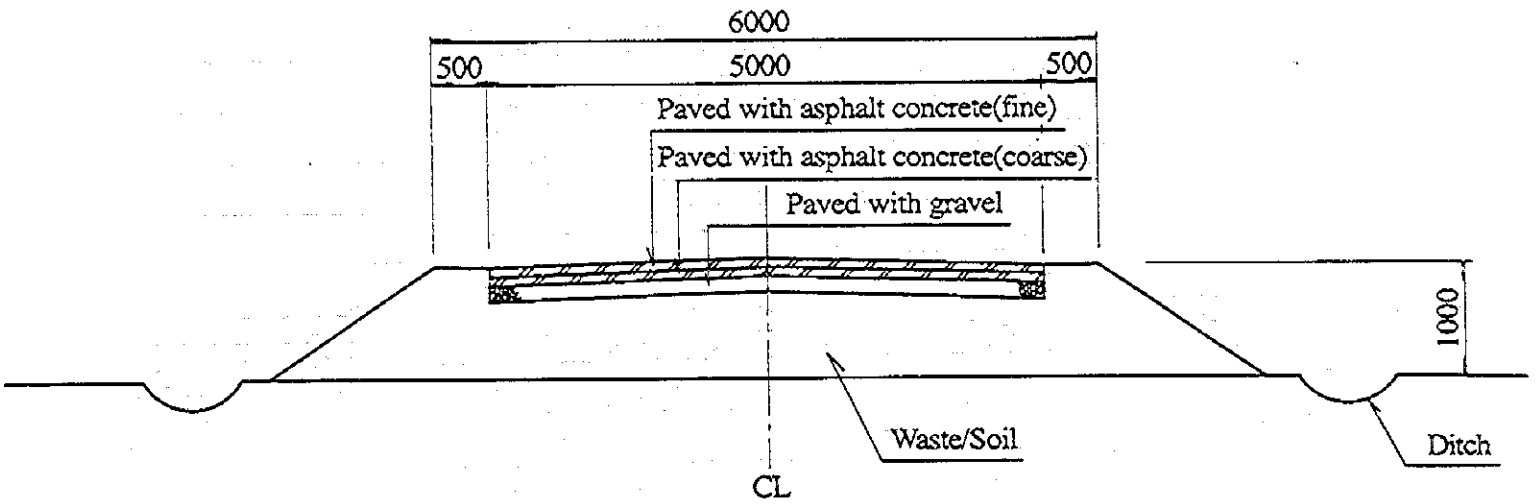


Section A-A (after dumping)

Unit: mm

Fig. 2-3-2-33	Cross section of Mafraq FDS

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

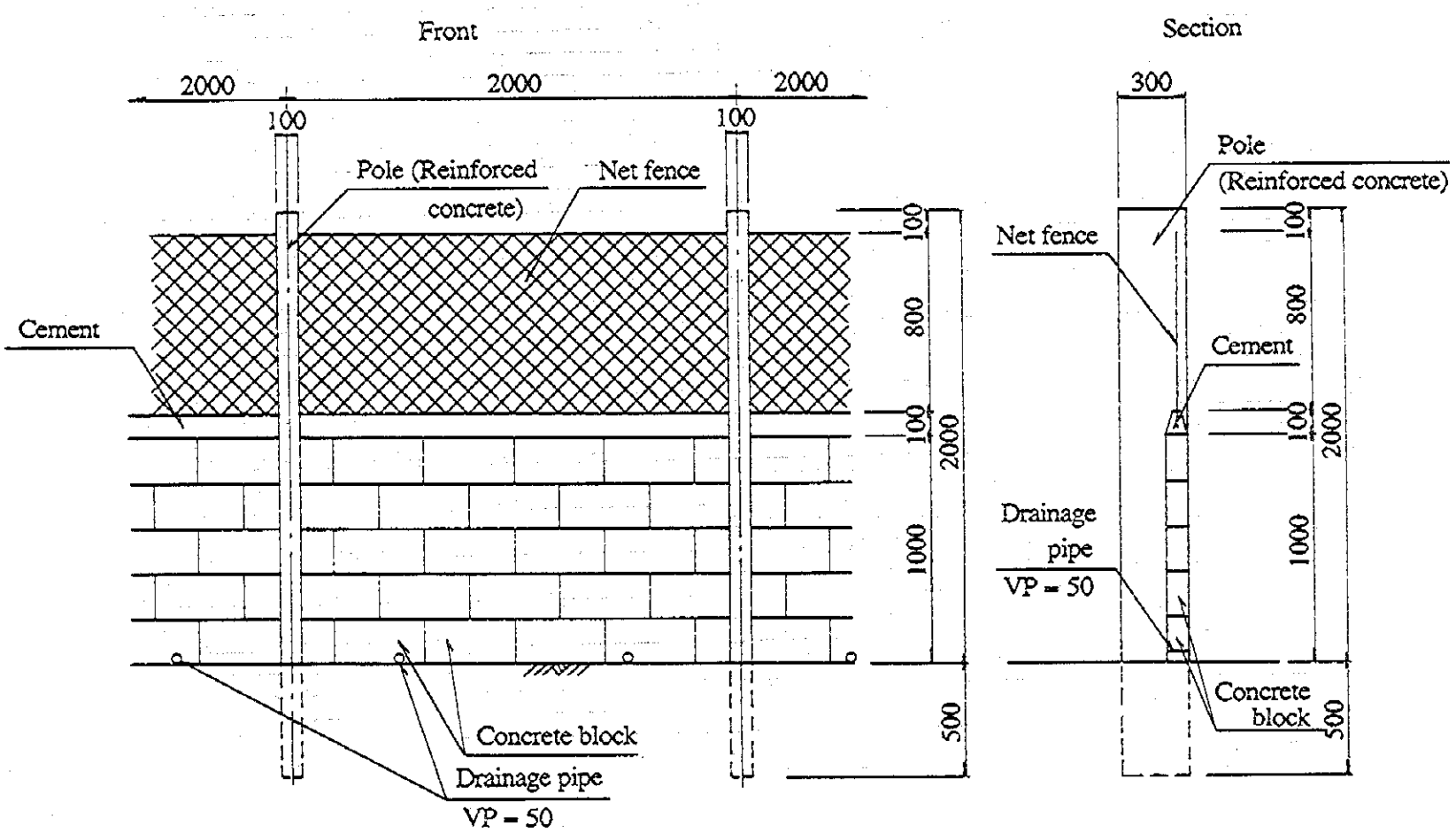


Unit: mm

Fig. 2-3-2-34	Cross section of access / insite road

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

Guard fence S = 1 : 20



Unit: mm

Fig. 2-3-2-35	General drawing of guard fence

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

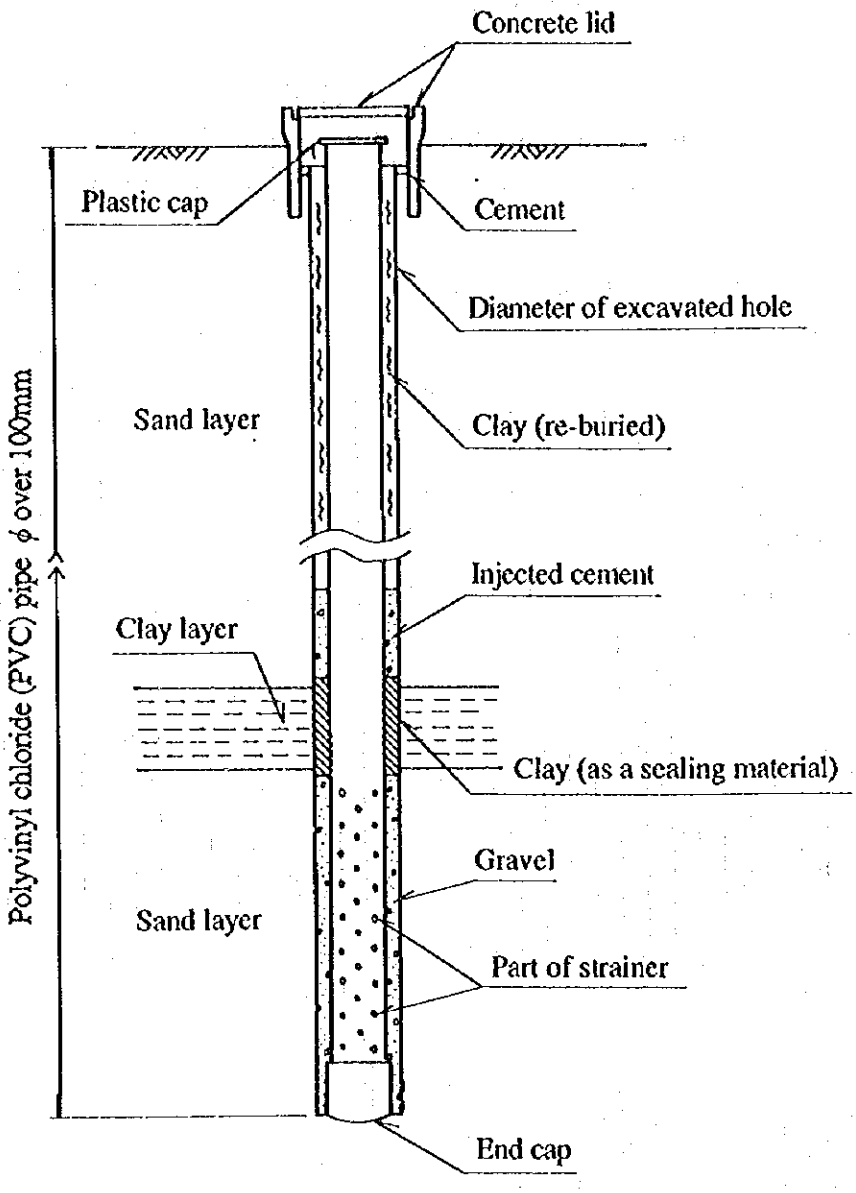


Fig. 2-3-2-36	Standard of monitoring well

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

(C) Humra FDS

A plan view and cross-sectional view of the FDS landfill plan are shown in Figs. 2-3-2-37 and 2-3-2-38. The FDS improvement plan is described below.

A) Consideration of the landfill method

Sanitary landfill with erection of embankments shall be carried out at this FDS in view of the circumstances of landfill, the topography of the landfill site, etc. This method shall be adopted for the following reasons.

- Although daily covering is carried out on an irregular basis, since the solid waste is currently dumped with a dumping stage, the compaction is inadequate and there is scattering of solid waste.

- Since the slope of a hill is used at this FDS, the lifetime of the landfill site can be extended by carrying out landfill upon making effective use of the landfill space through the erection of embankments along the boundary of the site.

B) Consideration of the working sequence and the equipment used

The embankment erection work and landfill operation shall be carried out according to the flow shown in Table 2-3-2-20.

The following equipment shall be used in consideration of the excavated foundation, the topography, the working efficiency, and the solid waste classification.

Natural ground excavation, loading, transportation	: tractor shovel, dump truck
Erection of embankment	: bulldozer
Leveling and surface compaction of solid waste and cover soil	: bulldozer

The reasons for adopting such combinations of equipment and work are as

follows:

- Since the natural ground is a hard ground comprised of clayish sandstone and sandy limestone and has a steep inclination, the excavation of the natural ground must be carried out with a tractor shovel with ripper.

- Since the excavated natural ground soil must be transported over a long distance, a dump truck will be most suitable for transportation.

- A bulldozer, which is excellent for leveling and surface compaction, is most suitable for the erection of embankments.

- Since kitchen garbage comprise a large part of the solid waste and there are hardly any bulky wastes, etc. that require crushing, leveling and surface compaction by a bulldozer should be adequate.

Besides the landfill operation equipment indicated above, a tractor head for spraying chemicals is needed for the purpose of preventing the proliferation of flies and other unsanitary pests.

C) Maintenance facility plan

a. On-site road

Although an on-site road with a steep gradient is provided as an existing facility, concrete walls, etc. shall be erected at dangerous locations along the on-site road in consideration of the safety of solid waste transporting vehicles.

Also, although the on-site road is furnished up to the intermediate point of the FDS, a road having the structure shown in Fig. 2-3-2-39 shall be furnished in consideration of the muddying of the ground surface during the rainy season and the transporting of solid wastes to the most remote point of the FDS.

b. Peripheral fence

A peripheral fence, such as that shown in Fig. 2-3-2-40 shall be installed about the entire perimeter of the site. Though this peripheral fence shall be provided mainly to prevent unnecessary entry of persons inside the FDS and for safety management, it shall also provide the effects of preventing illegal waste dumping and shutting off the view and serve as a facility for preventing the scattering of solid waste.

c. Monitoring well

The monitoring well shall have the structure shown in Fig. 2-3-2-41 as standard.
The purpose of monitoring the groundwater in the surroundings of the FDS by means of a monitoring well is to monitor the degree of diffusion of pollutants that flow out from the FDS in the groundwater and the level of impact on the living environment for people.

A monitoring well must thus be provided at one location along the direction of flow of the groundwater directly below the FDS. The depth of the monitoring well shall be set so that the pollution of the aquifer adjacent the FDS can be detected.

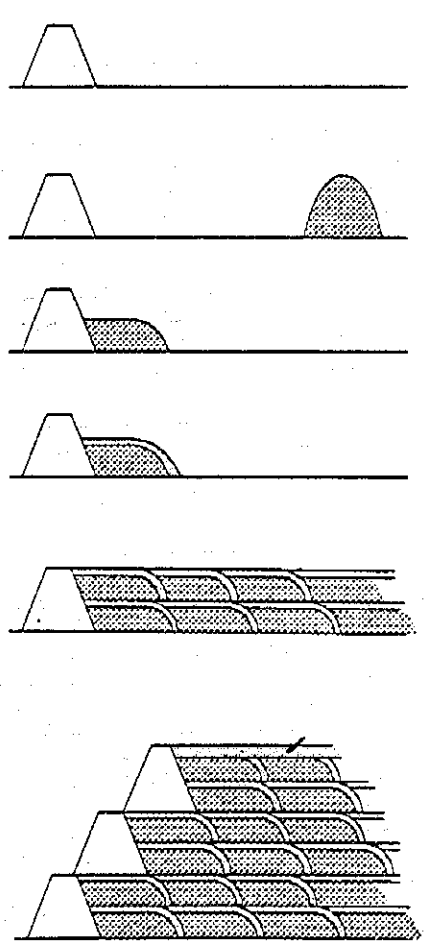
d. Leachate circulation pumping facility

Fig. 2-3-2-42 is a standard drawing of a leachate circulation pump facility.

The water quantity can be reduced and the water quality can be improved by circulating the leachate of the existing simple settling pond to the landfill section by means of a pump.

Table 2-3-2-20 Work Flow and Equipment Used: HUMURA

Work Flow	Equipment Used
START (1) Furnishing of on-site road (2) Erection of embankment (3) Hauling of solid waste into site (4) Leveling and compaction of solid waste (5) Application of daily cover [NO] Has landfill been performed up to the height of the embankment? [YES] (6) Completion of one process [YES] Continue with further landfill? [NO] (7) Application of final cover END	(2) Excavation : Dozer-shovel Loading : Dozer-shovel Transport : Dump truck Leveling/ Surface compaction : Bulldozer (4) Bulldozer (5) Excavation : Dozer-shovel Loading : Dozer-shovel Transport : Dump truck Leveling/ Surface compaction : Bulldozer (7) Excavation : Dozer-shovel Loading : Dozer-shovel Transport : Dump truck Leveling/ Surface compaction : Bulldozer



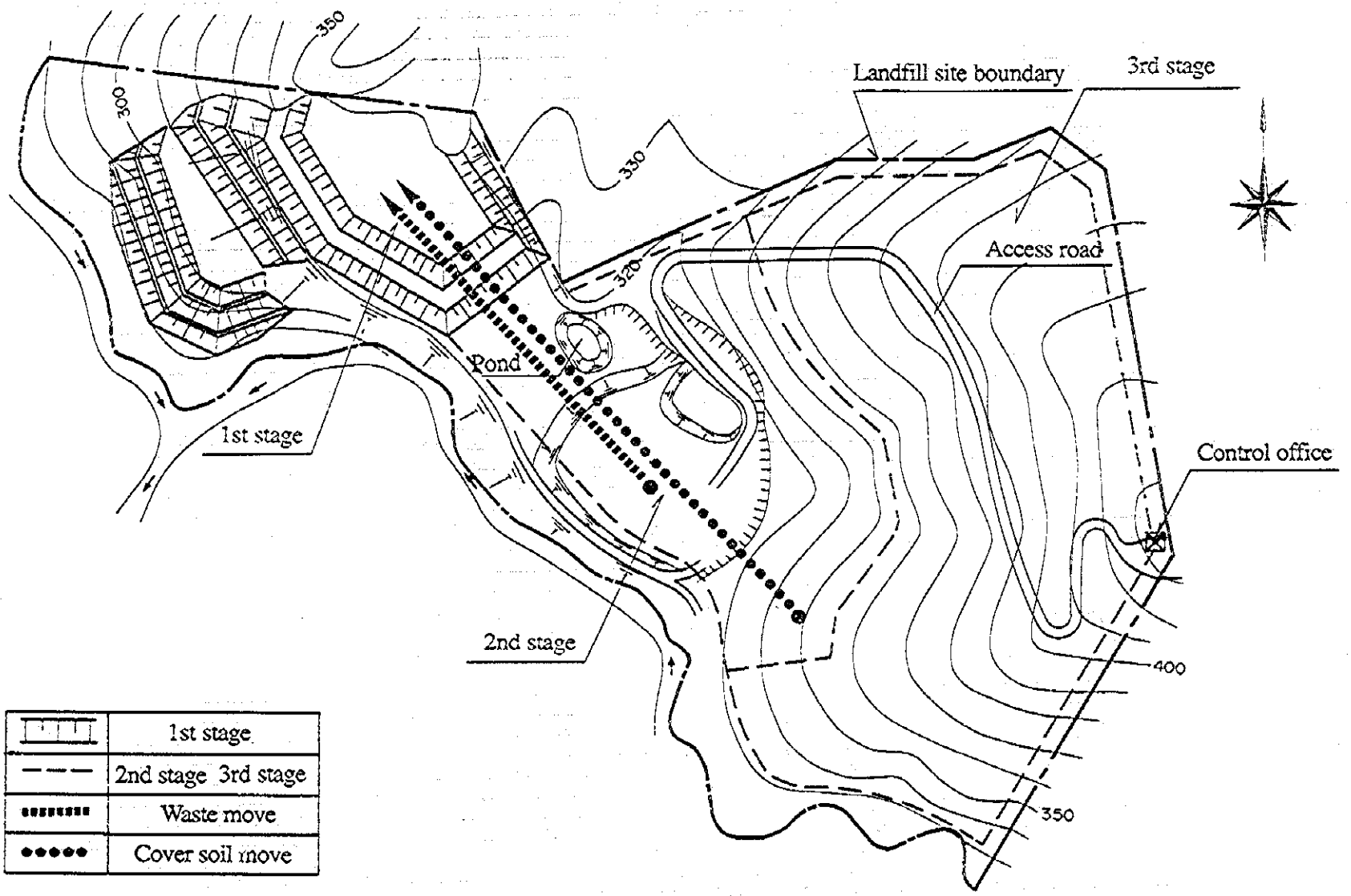
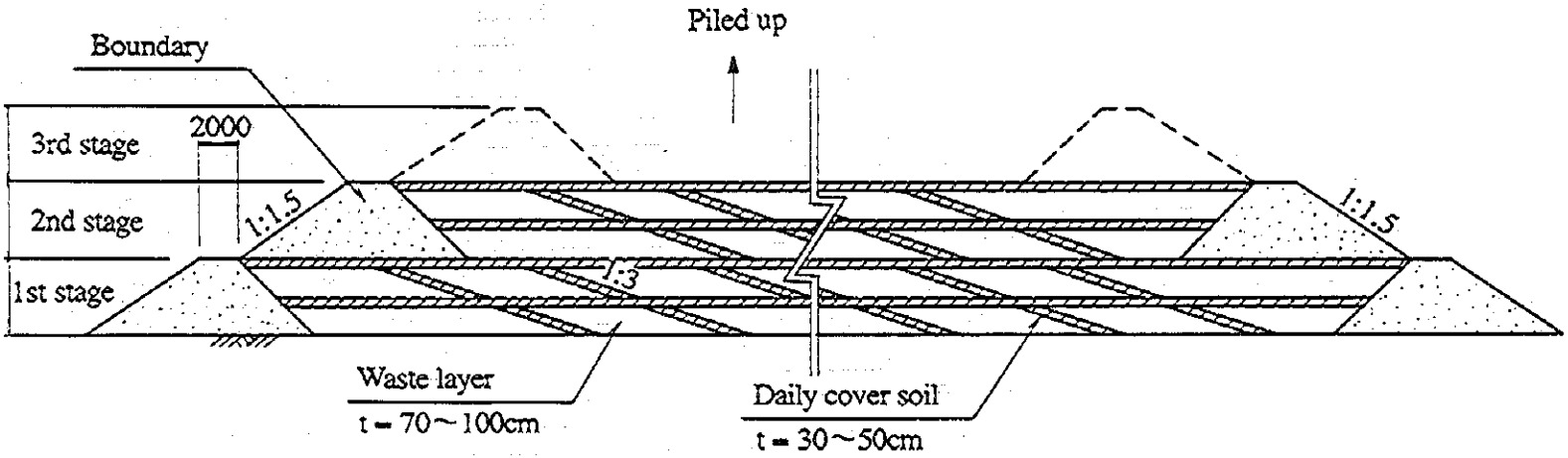


Fig. 3-3-2-37 Ground plan of Humra FDS

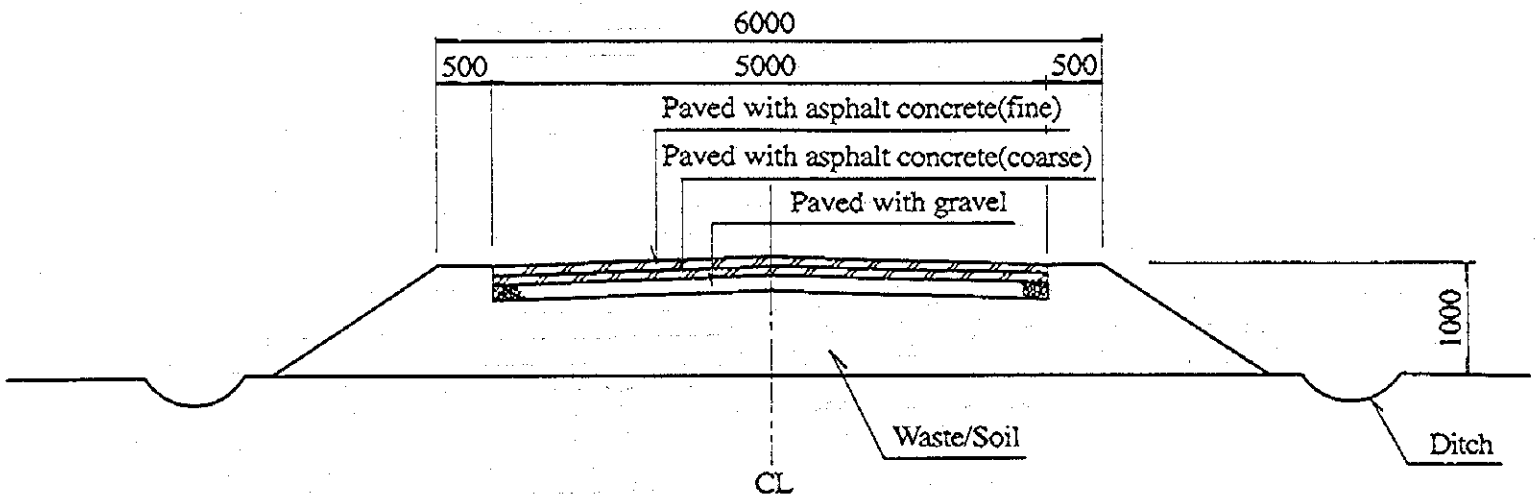
BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Unit: mm

Fig. 2-3-2-38	Cross section of Humra FDS

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

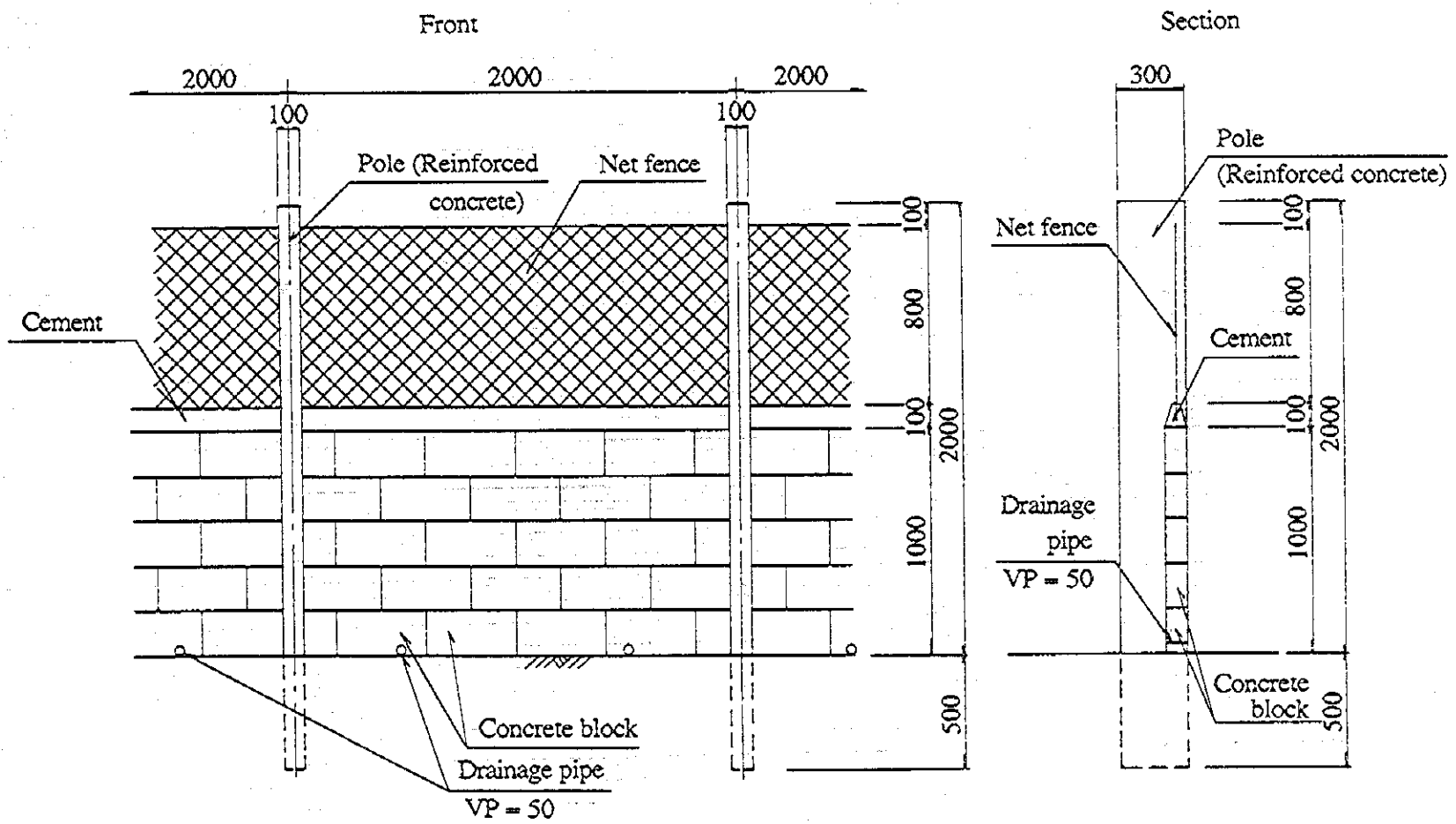


Unit: mm

Fig. 2-3-2-39 Cross section of access / insite road

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

Guard fence S = 1 : 20



Unit: mm

Fig. 2-3-2-40 General drawing of guard fence

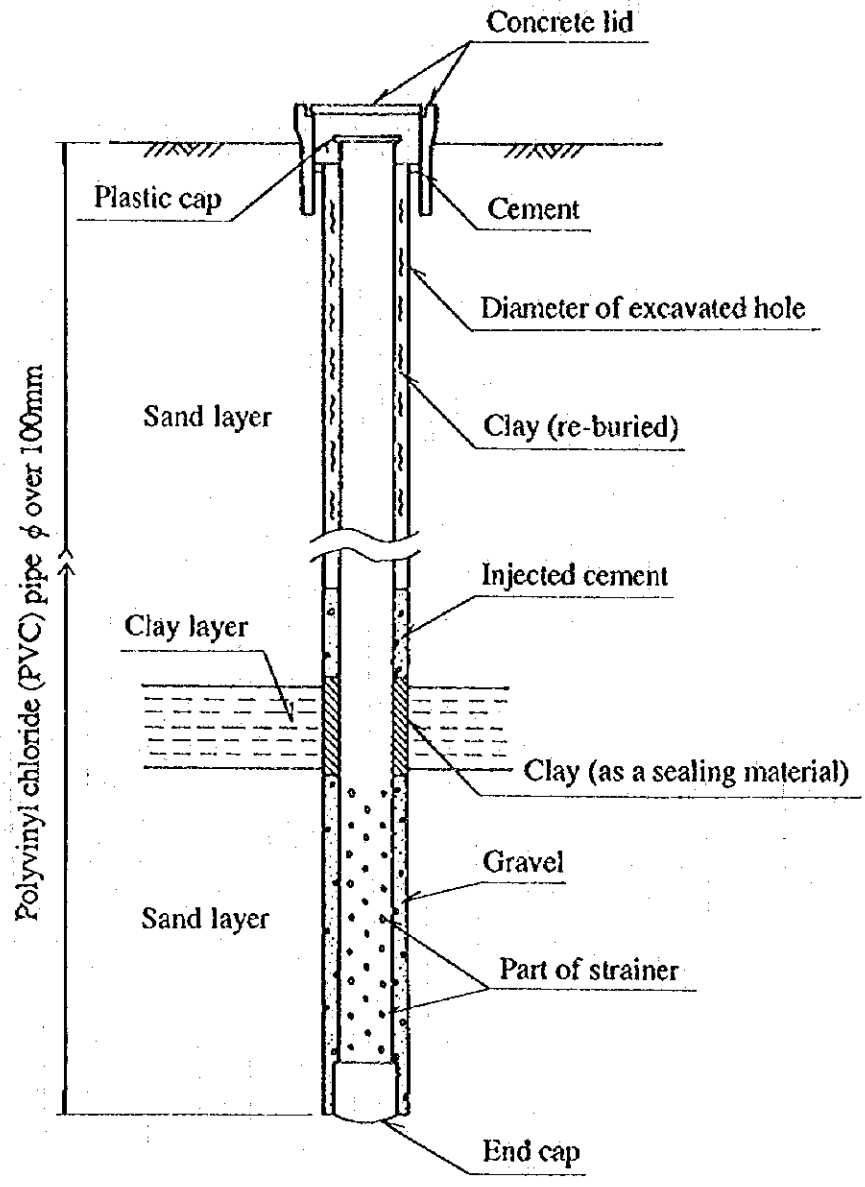
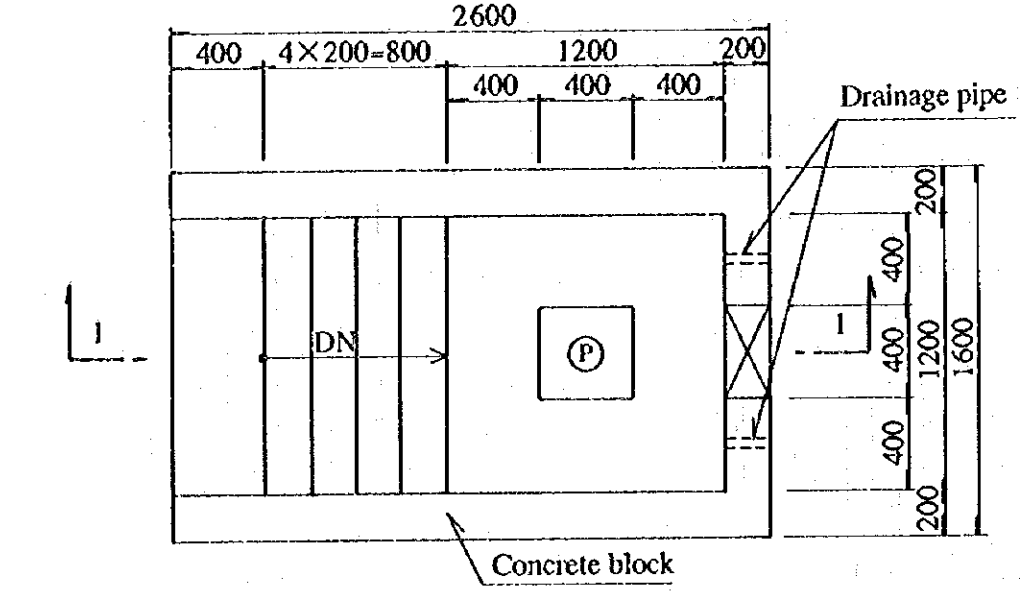
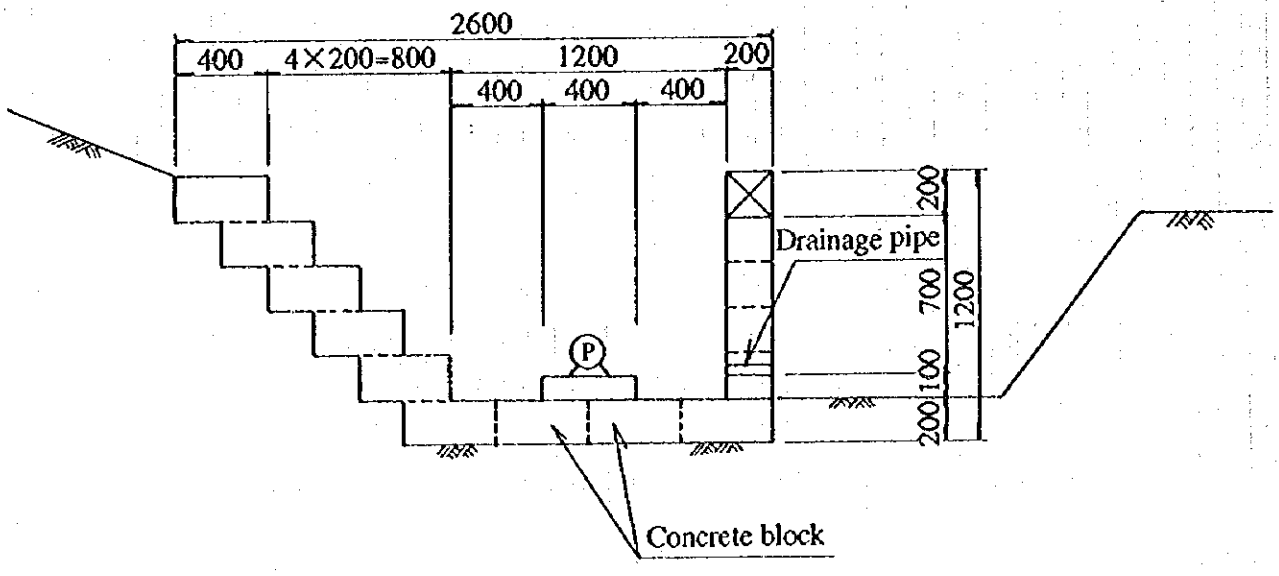


Fig. 2-3-2-41	Standard of monitoring well

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Ground plan



Section

Unit: mm

Fig. 2-3-2-42	General drawing of night-soil pit

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

(D) Tafila FDS

A plan view and cross-sectional view of the FDS landfill plan are shown in Figs. 2-3-2-43 and 2-3-2-44. The FDS improvement plan is described below.

A) Consideration of the landfill method

At this FDS, sanitary landfill using trenches shall be carried out at the stage aimed at the current landfill section in view of the circumstances of landfill, the topography, geology, etc. of the landfill site, the procurement source of cover soil, on-site road furnishing circumstances, etc.

At the subsequent stage, sanitary landfill with erection of embankments shall be carried out. The development shall be carried out in a stage wise manner for the following reasons.

- Landfill is currently being carried out from the central part of the landfill site, which is lowest in altitude in topographical terms. However, since the natural ground at the most remote part of the FDS can be used as cover soil, it is best in terms of landfill efficiency and procurement of cover soil to excavate this natural ground and prepare a flat landscape.

- Since the on-site road is paved completely, this road should be used in a semi permanent manner to provide a highly efficient means of access for transporting vehicles.

- The lifetime of the landfill site can be extended by erecting embankments according to the progress of landfill from the end of the on-site road onwards and by using landfill space in the vertical direction.

B) Consideration of the working sequence and the equipment used

The landfill methods can largely be classified into two methods.

In the initial stage, the present landfill section shall be excavated in a trench-like manner with a tractor shovel and land preparation shall be carried out up to the current foundation after performing sanitary landfill of solid wastes. In the subsequent stage, the natural ground shall be excavated with a tractor shovel to prepare a flat landscape.
Thereafter, sanitary landfill of solid wastes shall be carried out upon erecting embankments.
Such work shall be carried out according to the flow shown in Table 2-3-2-21.
The following equipment shall be used for trench excavation, natural ground excavation, landfill operation, etc. in consideration of the foundation to be excavated, the topography, the working efficiency, and the solid waste classification.

Trench excavation	: tractor shovel
Natural ground excavation, loading, transportation : tractor shovel,	: dump truck
Erection of embankment	: bulldozer
Leveling and surface compaction of solid waste and cover soil	: bulldozer

The reasons for adopting such combinations of equipment and work are as follows:

- Since the section at which trenches shall be excavated (central part of the landfill site) is comprised of sandy soil, excavation can be carried out with an excavator. However, since the bedrock of the natural ground is hard, the excavation of the natural ground must be carried out with a tractor shovel with ripper. The use of a tractor shovel, which is excellent for both trench excavation and natural ground excavation, is thus optimal.

- Since the excavated natural ground soil must be transported over a long distance, a dump truck will be most suitable for transportation.

- A bulldozer, which is excellent for leveling and surface compaction, is most suitable for the erection of embankments.
- Since food waste comprise a large part of the solid waste and there are

hardly any bulky wastes, etc. that require crushing, leveling and surface compaction by a bulldozer should be adequate.

Besides the landfill operation equipment indicated above, a tractor head for spraying chemicals is needed for the purpose of preventing the proliferation of flies and other unsanitary pests.

C) Maintenance facility plan

a. Monitoring well

The monitoring well shall have the structure shown in Fig. 2-3-2-45 as standard. The purpose of monitoring the groundwater in the surroundings of the FDS by means of a monitoring well is to monitor the degree of diffusion of pollutants that flow out from the FDS in the groundwater and the level of impact on the living environment for people. A monitoring well must thus be provided at one location along the direction of flow of the groundwater directly below the FDS. The depth of the monitoring well shall be set so that the pollution of the aquifer adjacent the FDS can be detected.

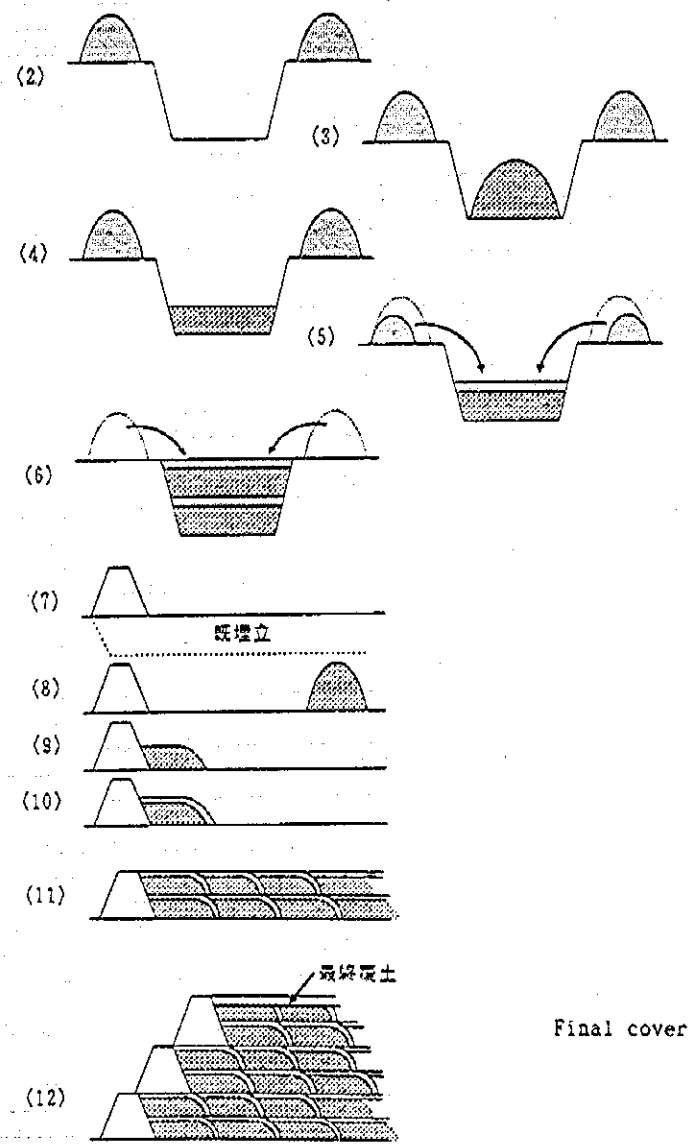
b. Transporting road

Since the road for transporting solid waste from the main road to the FDS is presently unpaved, it must be furnished immediately in consideration of the safety of the passage of vehicles.

c. Night soil treatment water pumping facility

Fig. 2-3-2-46 is a standard drawing of a night soil treatment water pump facility. The greening of the FDS can be promoted by supplying the night soil treatment water of the existing settling pond to the tree-planting plant, etc.

Table 2-3-2-21 Work Flow and Equipment Used: TAFILA

Work Flow		Equipment Used
START First Stage (1) Positioning of excavation range by line marker (2) Trench Excavation (3) Hauling of solid waste into site (4) Leveling and compaction of solid waste (5) Application of daily cover [YES] Has all of the above been completed? [NO] (6) Completion of first stage Second Stage (7) Erection of embankment (8) Hauling of solid waste into site (9) Leveling and compaction of solid waste (10) Application of daily cover [YES] Has landfill been performed up to the height of the embankment? [NO] (11) Completion of one process [YES] Continue with further landfill? [NO] (12) Application of final cover END		(2) Dozer-shovel (4) Bulldozer (5) Bulldozer (7) Excavation : Dozer-shovel Loading : Dozer-shovel Transport : Dump truck Leveling/ Surface compaction : Bulldozer (9) Bulldozer (10) Excavation : Dozer-shovel Loading : Dozer-shovel Transport : Dump truck Leveling/ Surface compaction : Bulldozer Final cover (12) Excavation : Dozer-shovel Loading : Dozer-shovel Transport : Dump truck Leveling/ Surface compaction : Bulldozer

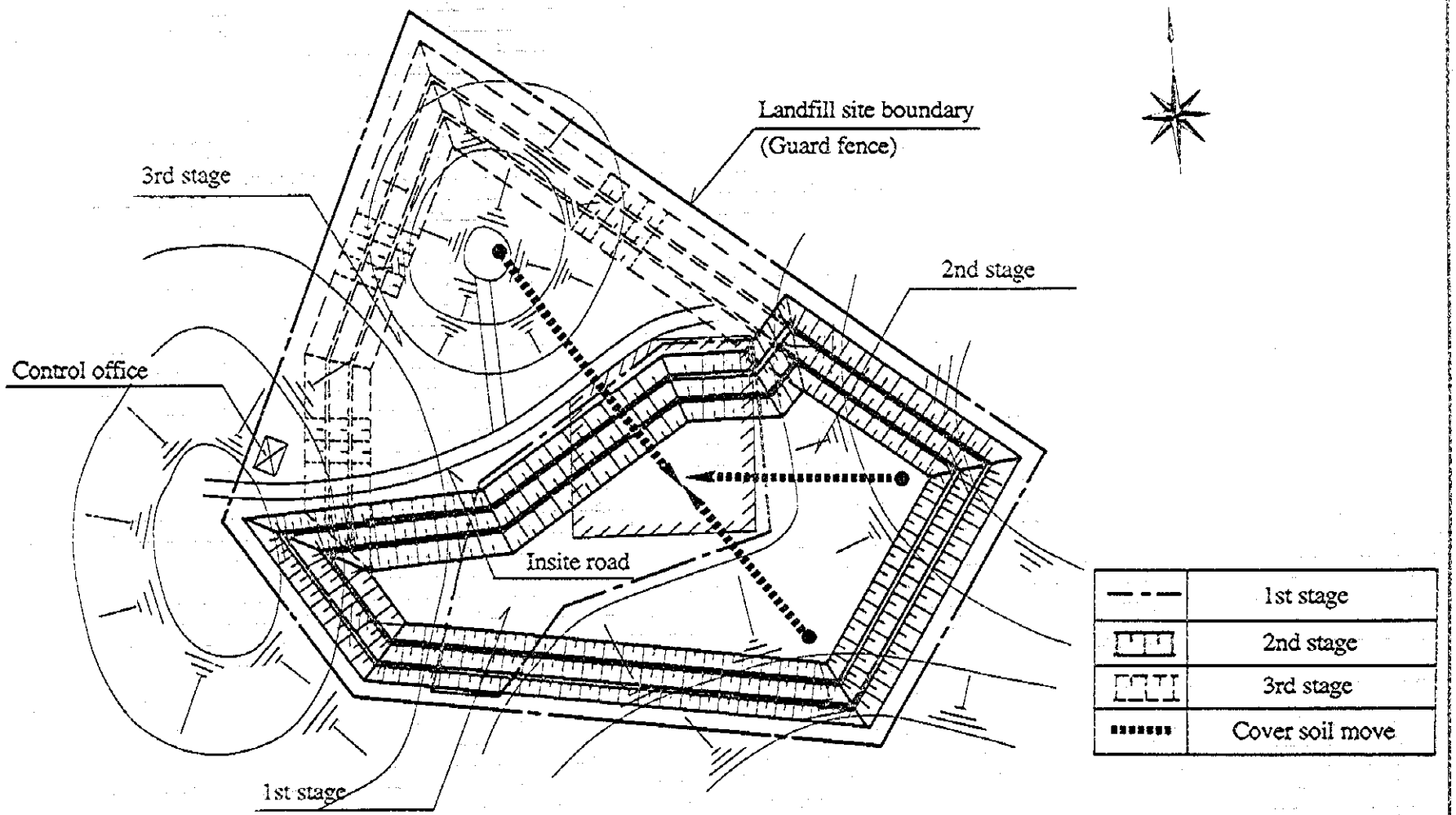
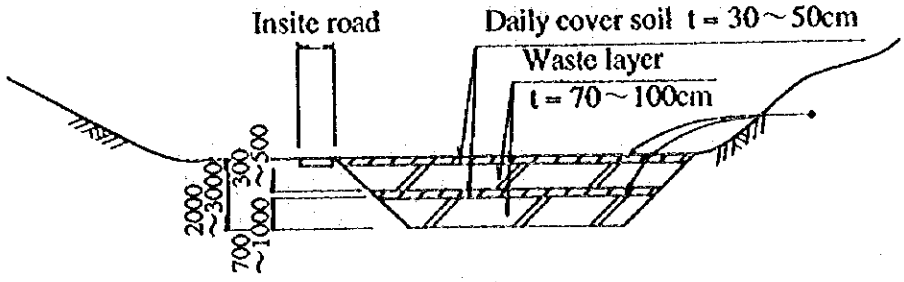
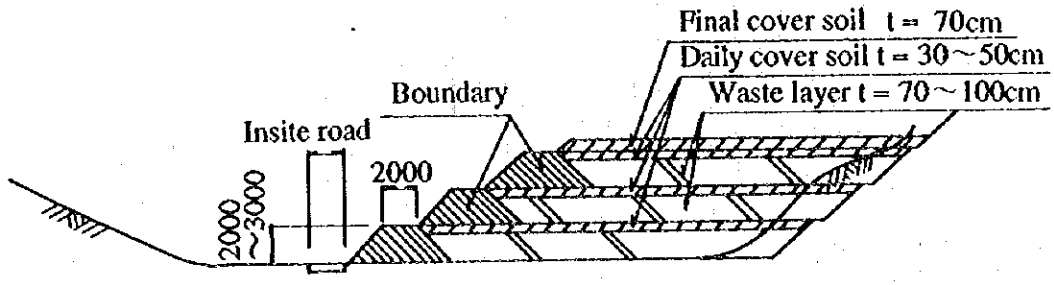


Fig. 2-3-2-43	Ground plan of Tafila FDS

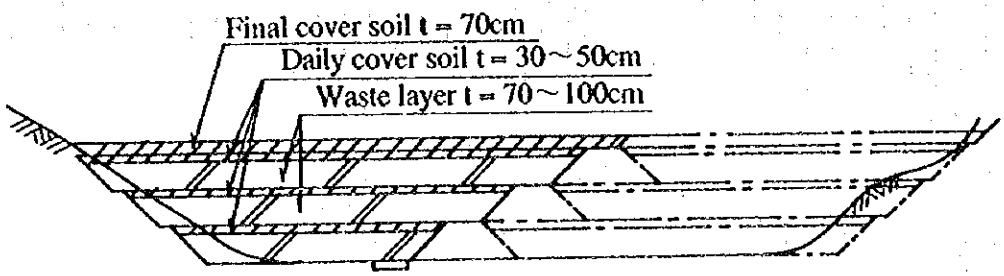
BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



1st stage



2nd stage



3rd stage

Unit: mm

Fig. 2-3-2-44	Cross section of Tafila FDS

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

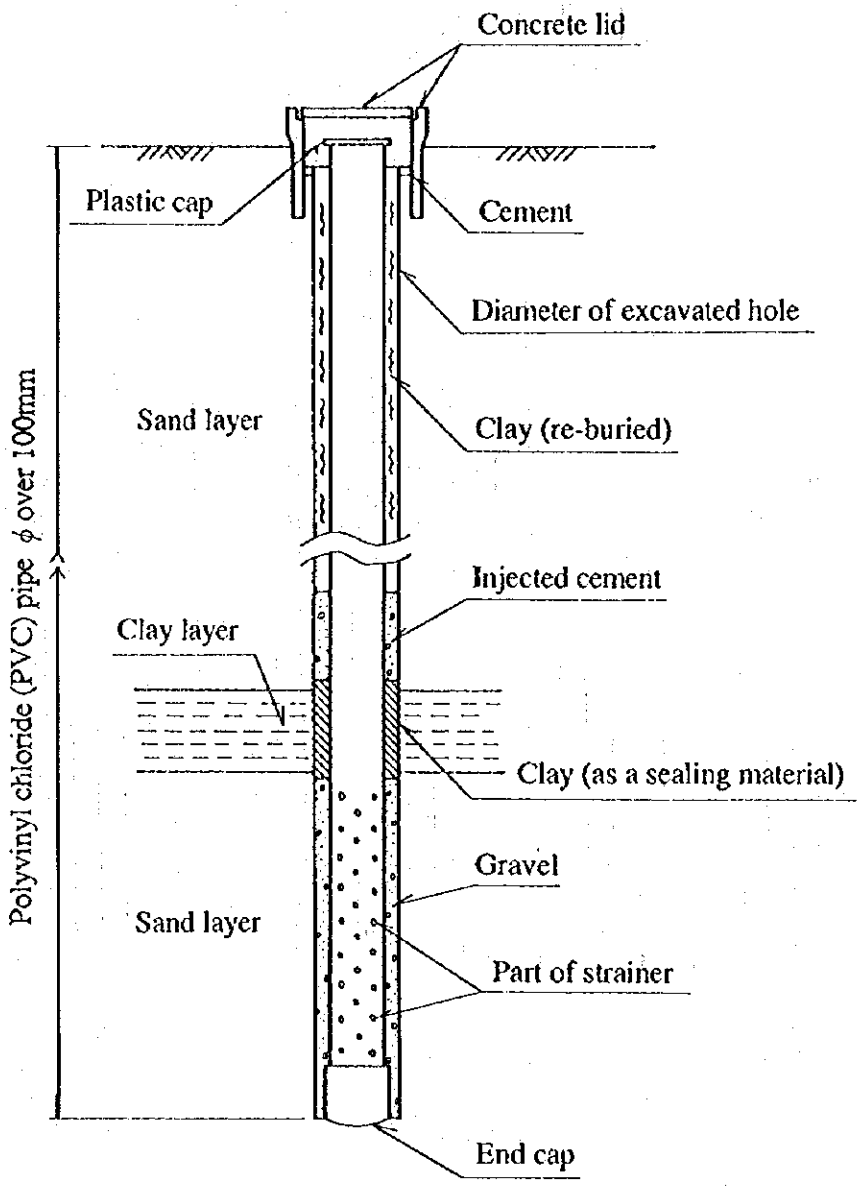
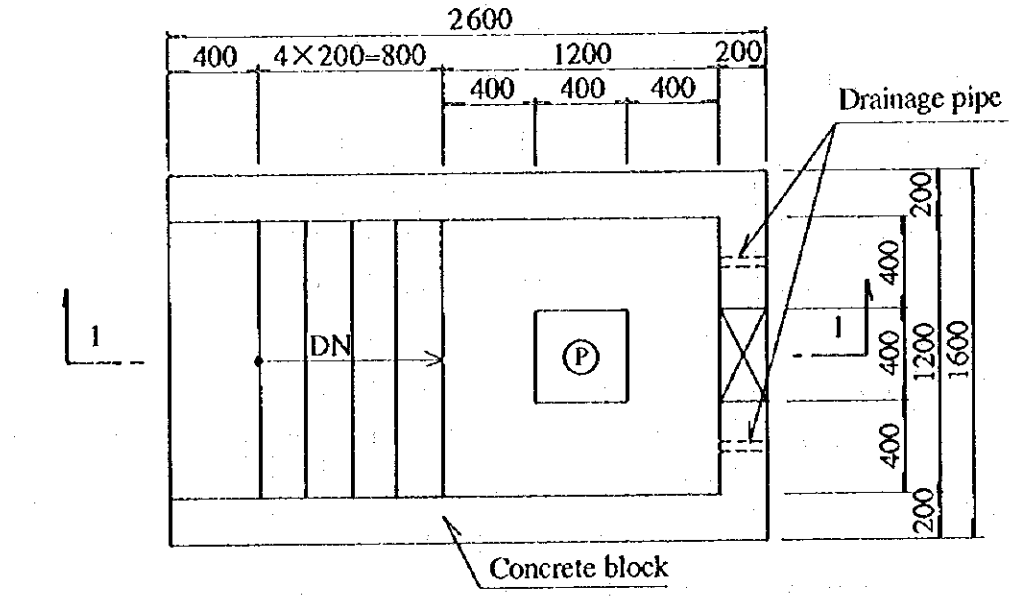
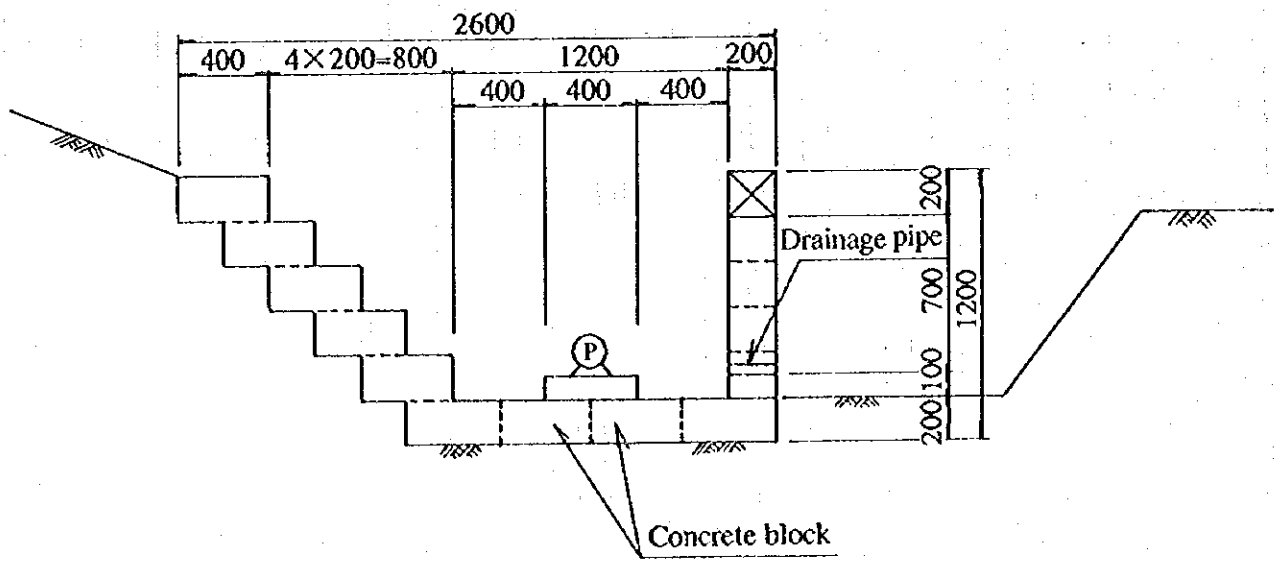


Fig. 2-3-2-45	Standard of monitoring well

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Ground plan



Section

Unit: mm

Fig. 2-3-2-46	General drawing of night-soil pit

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

(E) Ma'an FDS

A plan view and cross-sectional view of the FDS landfill plan are shown in Figs. 2-3-2-47 and 2-3-2-48. The FDS improvement plan is described below.

A) Consideration of the landfill method

The technical level of the manager of this FDS is high and he adequately recognizes the importance of retaining solid waste in the landfill site and promoting stabilization of the solid waste layer through methods that make the most efficient use of the limited landfill space without damaging the surrounding environment.
Sanitary landfill using trenches is thus being carried out presently in view of the topography, geology, etc. of this landfill site and it is best that this landfill method be continued in the future.

B) Consideration of the working sequence and the equipment used

The trench excavation work and landfill operation shall be carried out according to the flow shown in Table 2-3-2-22.
The following equipment shall be used in consideration of the excavated foundation, the topography, the working efficiency, and the solid waste classification.

Trench excavation : excavator
Leveling and surface compaction of solid waste and cover soil : bulldozer

The reasons for adopting such combinations of equipment and work are as follows:

- Since the excavated foundation is comprised of consolidated sandy soil containing gravel, ripping work must be carried out using a bulldozer.

- Since the excavation depth will be 4.0-4.5m and since ripping work is carried out in advance, the adoption of an excavator is most suitable since it enables the piling of the soil on both sides of a trench while excavating

at the same time and is thus excellent in working efficiency.

- Since the excavated foundation is comprised of consolidated sandy soil containing gravel and since the site is flat, a buildozer, which can provide surface compaction efficiency, is most suitable for leveling and surface compaction of solid waste and cover soil.

- Since food wastes comprise a large part of the solid waste and there are hardly any bulky wastes, etc. that require crushing, leveling and surface compaction by a buildozer should be adequate.

C) Maintenance facility plan

a. On-site road

An on-site road shall be installed to facilitate the passage of the solid waste transporting vehicles to be provided in the FDS. Since the on-site road must thus enable safe passage of solid waste transporting vehicles without jams, a road having the structure shown in Fig. 2-3-2-49 shall be installed within the boundaries of the site.

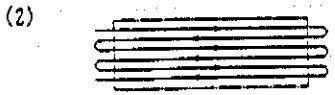
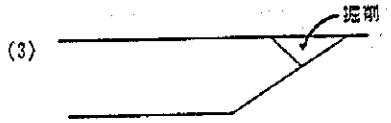
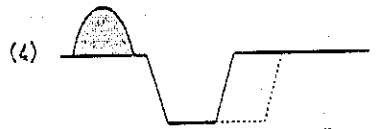
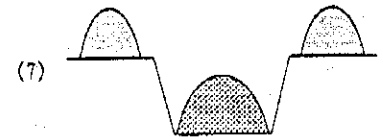
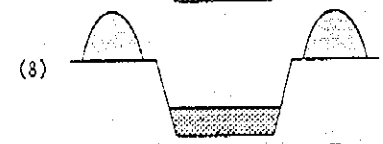
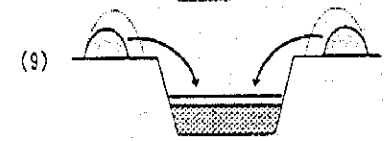
b. Monitoring well

The monitoring well shall have the structure shown in Fig. 2-3-2-50 as standard. The purpose of monitoring the groundwater in the surroundings of the FDS by means of a monitoring well is to monitor the degree of diffusion of pollutants that flow out from the FDS in the groundwater and the level of impact on the living environment for people. A monitoring well must thus be provided at one location along the direction of flow of the groundwater directly below the FDS. The depth of the monitoring well shall be set so that the pollution of the aquifer adjacent the FDS can be detected.

c. Night soil treatment water pumping facility

Fig. 2-3-2-51 is a standard drawing of a night soil treatment water pump facility. The greening of the FDS can be promoted by supplying the night soil treatment water of the existing settling pond to the tree-planting plant, etc.

Table 2-3-2-22 Work Flow and Equipment Used: MA'AN

Work Flow		Equipment Used
START		
Trench Excavation Work		
(1) Positioning of excavation range by line marker		
(2) Ripping work (2-3 reciprocations)		(2) Bulldozer
(3) Excavation of the end sections of the trench		(3) Bulldozer
(4) Trench excavation (one side)		(4) Excavator
(5) Trench excavation (one side)		(5) Excavator
(6) Completion of trench		
Landfill Operation		
(7) Hauling of solid waste into site		
(8) Leveling and compaction of solid waste		(8) Bulldozer
(9) Application of daily cover		(9) Bulldozer
[NO] Continue with further landfill?		
[YES] (10) Application of final cover		(10)Bulldozer
END		

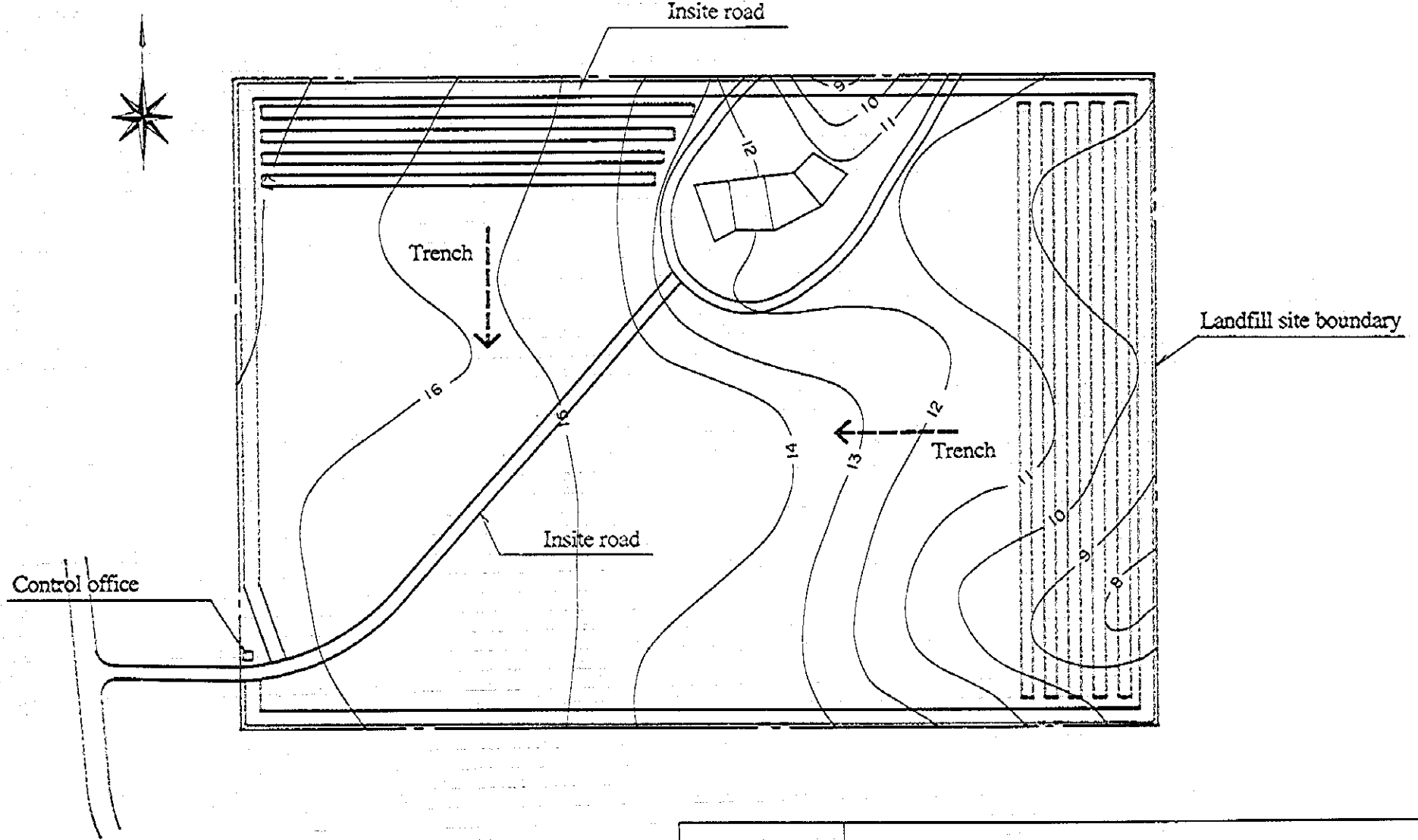
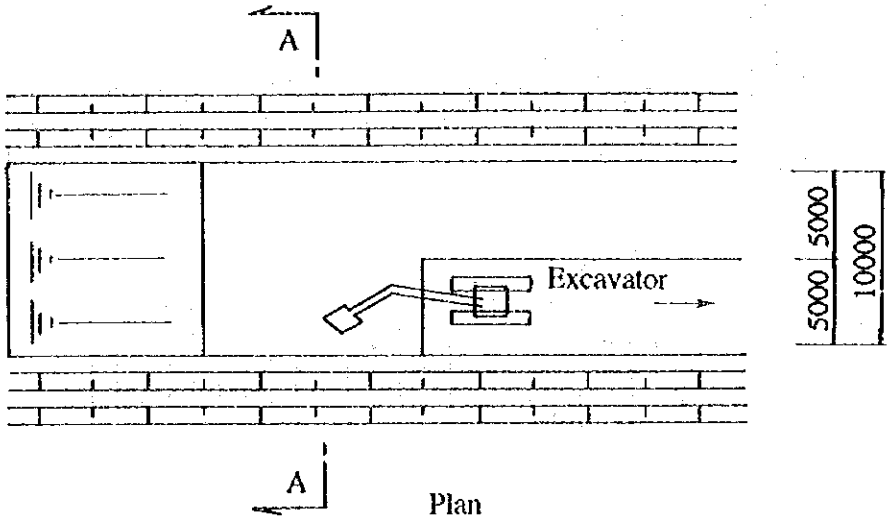
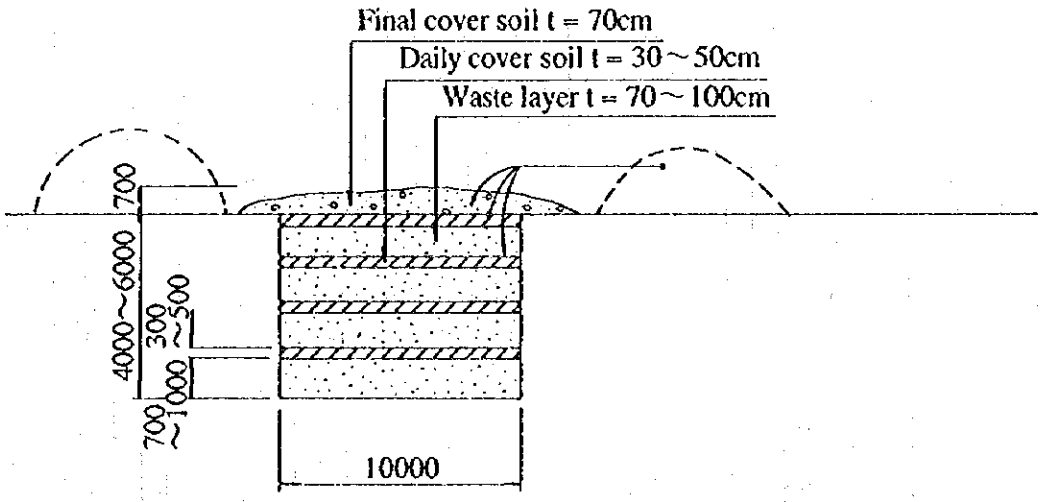


Fig. 2-3-2-47 Ground plan of Ma'an FDS

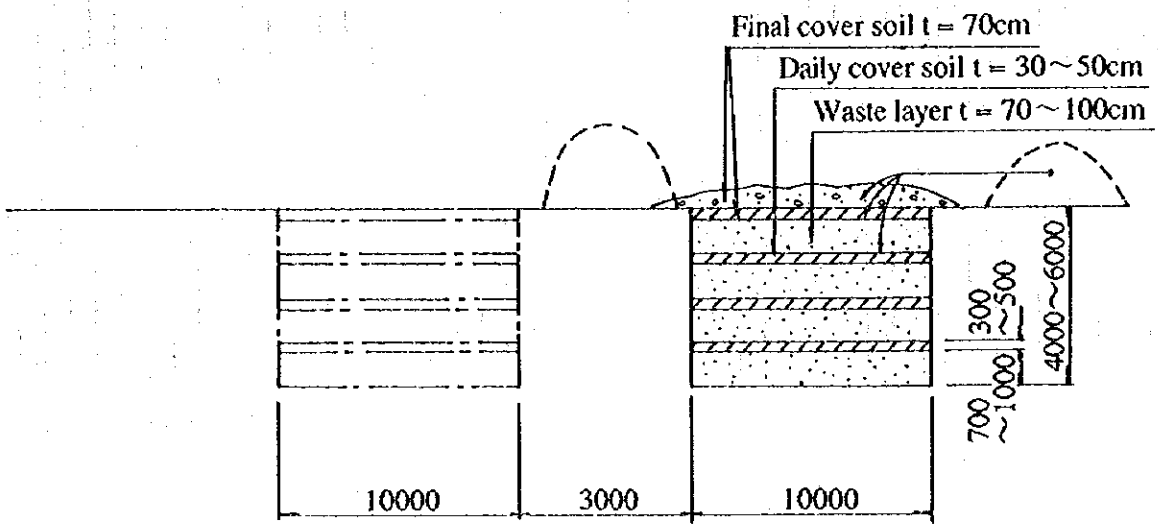
BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Plan



1st stage

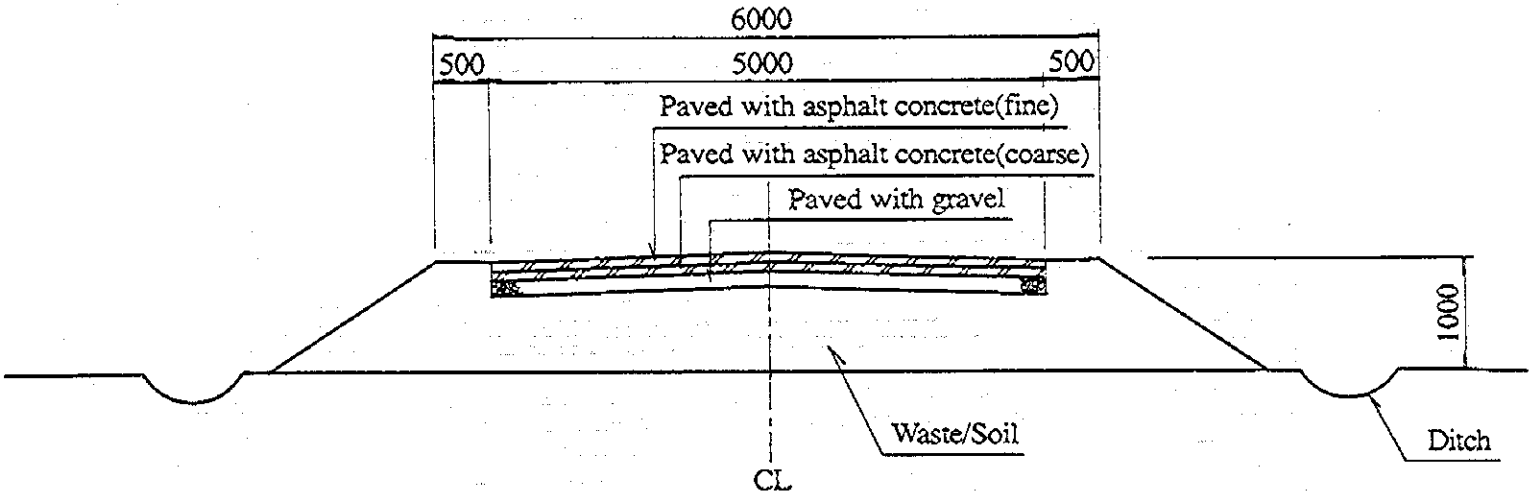


2nd stage

Unit: mm

Fig. 2-3-2-48	Cross section of Ma'an FDS

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Unit: mm

Fig. 2-3-2-49 Cross section of access / insite road

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

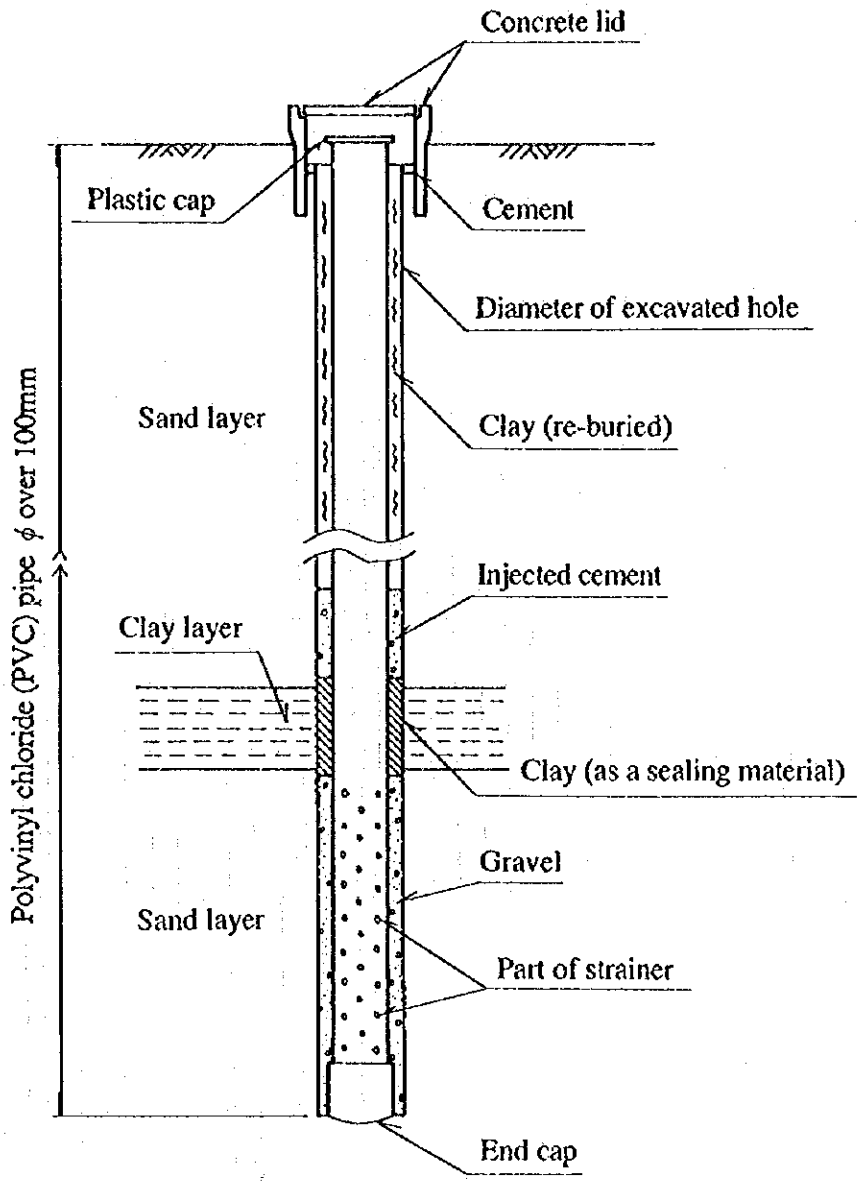
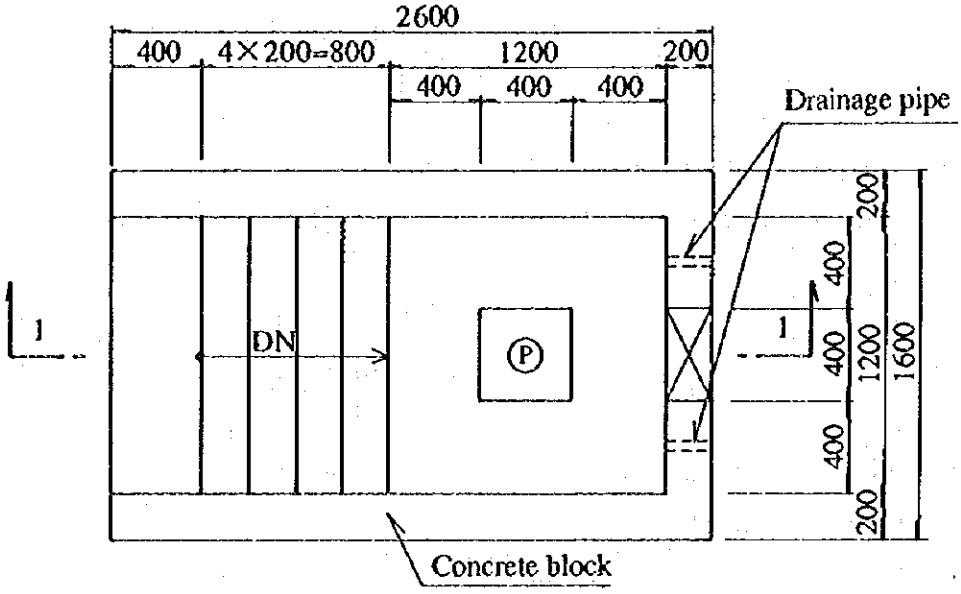
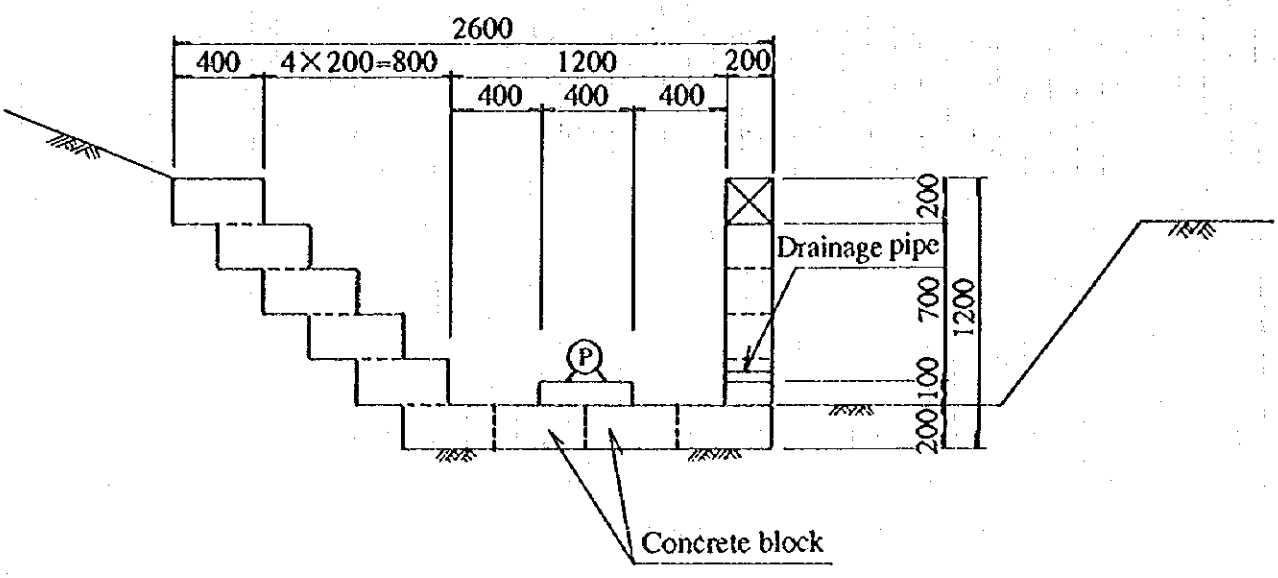


Fig. 2-3-2-50	Standard of monitoring well

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Ground plan



Section

Unit: mm

Fig. 2-3-2-51	General drawing of night-soil pit

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

(F) Lojoon FDS

A plan view and cross-sectional view of the FDS landfill plan are shown in Figs. 2-3-2-52 and 2-3-2-53. The FDS improvement plan is described below.

A) Consideration of the landfill method

Landfill was started in 1996 at this FDS which is projected to be the most exemplary FDS in Jordan. Sanitary landfill with preparation of embankments, which enable maximization of landfill efficiency and effective use of landfill space, shall thus be adopted for this site.

B) Consideration of the working sequence and the equipment used

The embankment erection work and landfill operation shall be carried out according to the flow shown in Table 2-3-2-23.
The following equipment shall be used in consideration of the procurement source of cover soil, etc., working efficiency, and solid waste classification, etc.

Natural ground excavation, loading,: bulldozer, wheel loader, dump truck
transportation:
Leveling and surface compaction of : bulldozer
embankment and cover soil
Leveling and surface compaction of : bulldozer
solid waste

The reasons for adopting such combinations of equipment and work are as follows:

- Since the sandy soil of the natural ground is planned to be used for embankment and cover soil, a bulldozer, which is excellent for excavating in layers at flat areas, is suitable.

- A wheel loader, which excels in working efficiency, is optimal for the loading of excavated natural ground soil. A dump truck is most suited for transportation of excavated natural ground soil in view of the transporting

distance.

- A buildozer, which excels in workability and can provide surface compaction effects, is most suitable for the leveling and surface compaction of solid waste, embankment, and cover soil.

- Although the details on the solid waste classification are unclear, since kitchen garbage comprise the majority of the waste and there are hardly any bulky wastes, etc. that require crushing, leveling and surface compaction by a buildozer should be adequate.

Besides the landfill operation equipment indicated above, a tractor head for spraying chemicals is needed for the purpose of preventing the proliferation of flies and other unsanitary pests.

C) Maintenance facility plan

a. On-site road

An on-site road shall be installed to facilitate the passage of the solid waste transporting vehicles to be provided in the FDS. Since the on-site road must thus enable safe passage of solid waste transporting vehicles without jams, a road having the structure shown in Fig. 2-3-2-54 shall be installed within the boundaries of the site.

b. Monitoring well

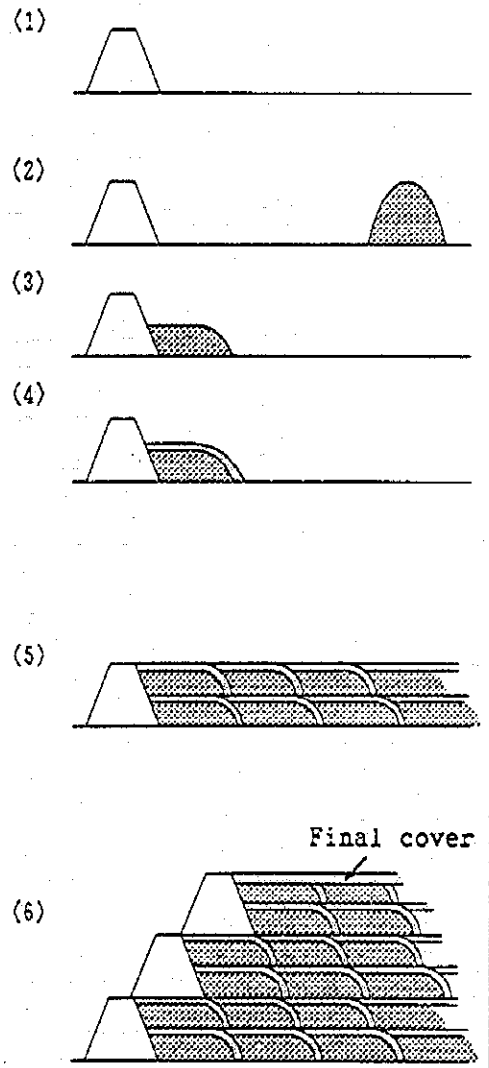
The monitoring well shall have the structure shown in Fig. 2-3-2-55 as standard.

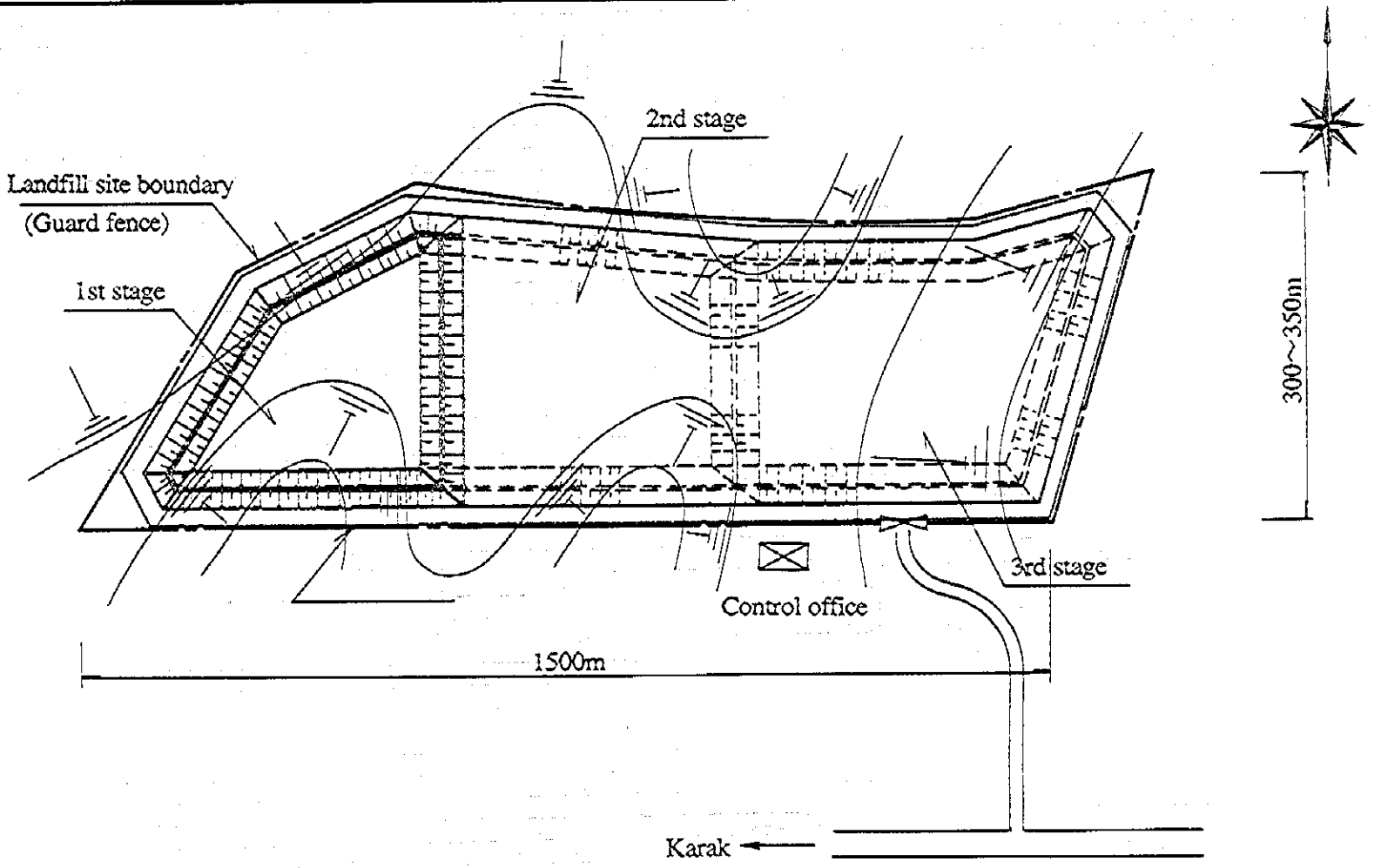
The purpose of monitoring the groundwater in the surroundings of the FDS by means of a monitoring well is to monitor the degree of diffusion of pollutants that flow out from the FDS in the groundwater and the level of impact on the living environment for people.

A monitoring well must thus be provided at one location along the direction of flow of the groundwater directly below the FDS. The depth of the monitoring well shall be set so that the pollution of the aquifer adjacent the FDS can be detected.

Table 2-3-2-23 Work Flow and Equipment Used: LOJOON

Work Flow	Equipment Used
START (1) Erection of embankment (2) Hauling of solid waste into site (3) Leveling and compaction of solid waste (4) Application of daily cover [NO] Has landfill been performed up to the height of the embankment? [YES] (5) Completion of one process [YES] Continue with further landfill? [NO] (6) Application of final cover END	(1) Excavation : Bulldozer Loading : Wheel loader Transport : Dump truck Leveling/ Surface compaction : Bulldozer (3) Bulldozer (4) Bulldozer (6) Excavation : Bulldozer Loading : Wheel loader Transport : Dump truck Leveling/ Surface compaction : Bulldozer

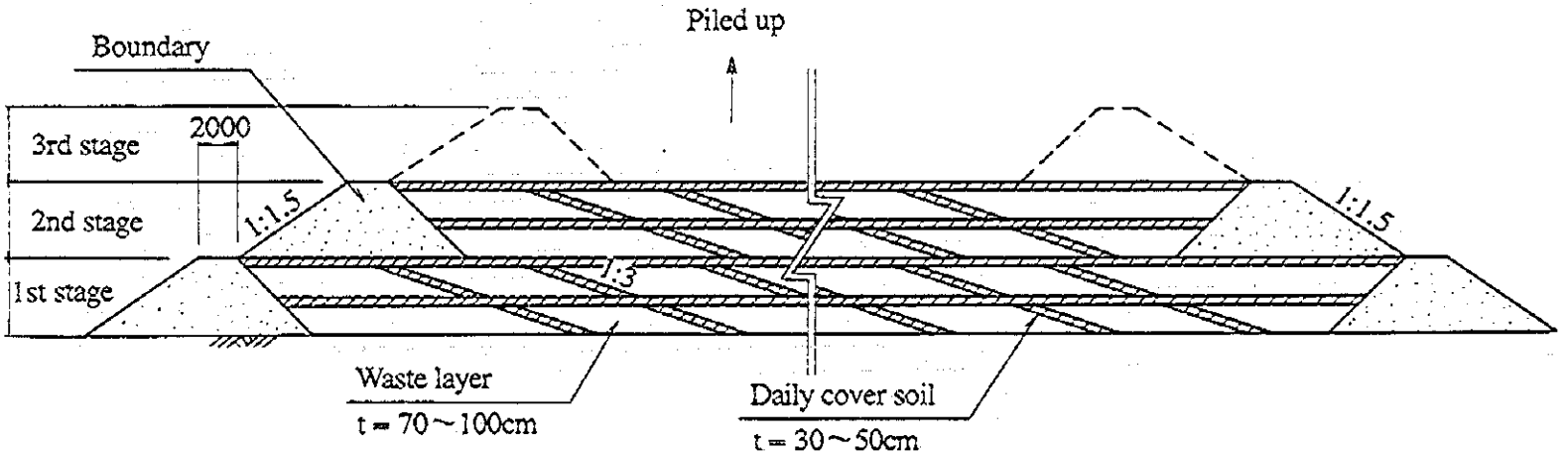




	1st stage
	2nd stage 3rd stage

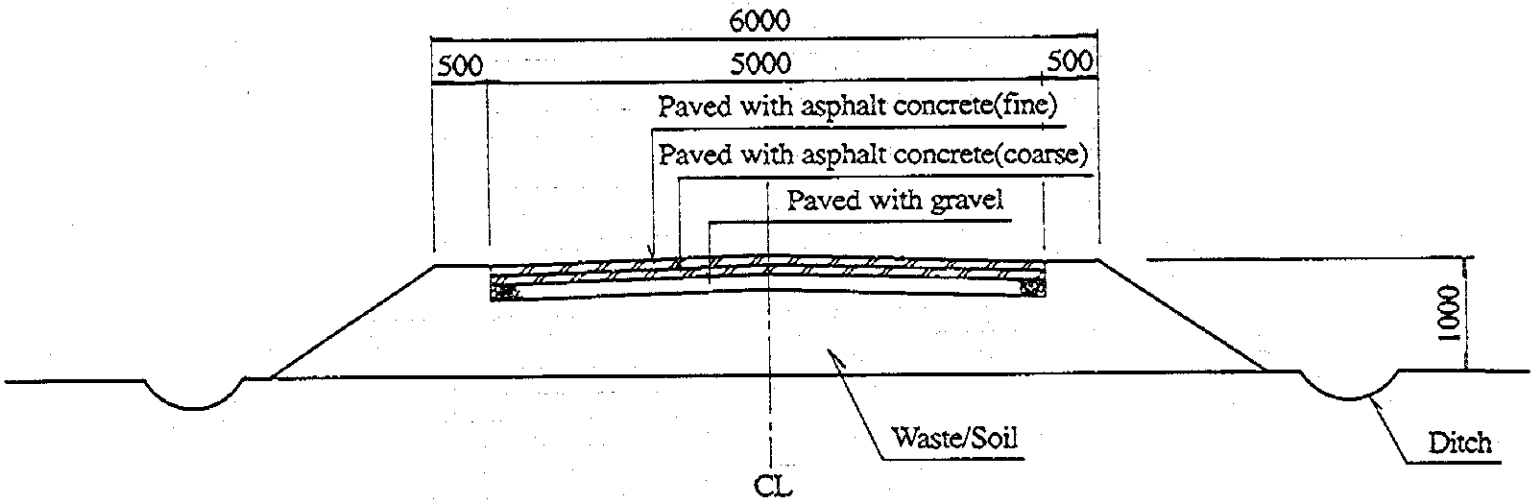
Fig. 3-3-2-52 Ground plan of Lojoon FDS

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Unit: mm

Fig. 2-3-2-53	Cross section of Lojoon FDS



Unit: mm

Fig. 2-3-2-54 Cross section of access / insite road

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

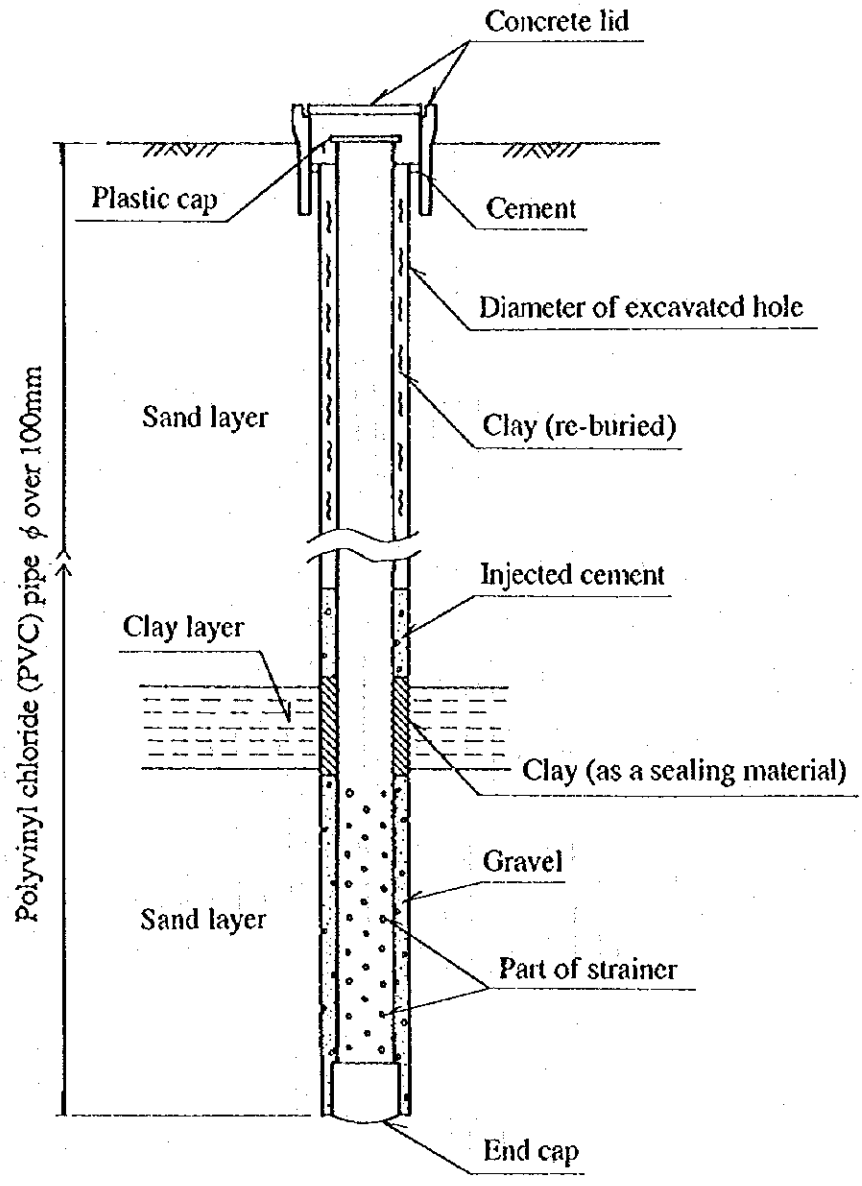


Fig. 2-3-2-55	Standard of monitoring well

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

(G) Aqaba FDS

A plan view and cross-sectional view of the FDS landfill plan are shown in Figs. 2-3-2-56 and 2-3-2-57. The FDS improvement plan is described below.

A) Consideration of the landfill method

Sanitary landfill using trenches shall be carried out at this FDS in view of the circumstances of landfill, the topographical and geological conditions, the procurement source of cover soil, etc.
This method shall be adopted for the following reasons.

- Presently, open burning is carried out along with open dumping landfill. Although the impact of open burning on the surrounding environment is small, it is essential to carry out sanitary landfill with application of daily cover in terms of conservation of the surrounding environment.

- Trenches can be excavated next to the existing landfill waste and such trenches can be used efficiently for filling with residue.

- Excellent procurement efficiency of cover soil can be provided by reusing the trench excavation material as cover soil.

- By disposing of the existing landfill waste appropriately, new landfill space can be secured and the lifetime of the landfill site may be extended.

B) Consideration of the working sequence and the equipment used

The trench excavation work and the landfill of incineration residue and solid waste shall be carried out according to the flow shown in Table 2-3-2-24.

The following equipment shall be used in consideration of the excavated foundation, the topography, the working efficiency, and the solid waste classification.

Trench excavation	: excavator
Transfer of incineration residue	: bulldozer
Leveling and surface compaction of solid waste, incineration residue, and cover soil	: bulldozer

The reasons for adopting such combinations of equipment and work are as follows:

- Since the surface layer is comprised of sandy soil, an excavator, which excels in working efficiency, is most suitable for trench excavation.

- Since the trench is excavated adjacent the incineration residue, the distance for transferring incineration residue will be short. A bulldozer will thus be adequate for moving the incineration residue.

- Since the foundation is bedrock and the site is a flat area, a bulldozer, which excels in workability and can provide surface compaction effects, is most suitable for the leveling and surface compaction of solid waste and cover soil.

- Since kitchen garbage and incineration residue comprise a large part of the solid waste and there are hardly any bulky wastes, etc. that require crushing, leveling and surface compaction by a bulldozer should be adequate.

Besides the landfill operation equipment indicated above, a tractor head for spraying chemicals is needed for the purpose of preventing the proliferation of flies and other unsanitary pests.

C) Maintenance facility plan

a. On-site road

An on-site road shall be installed to facilitate the passage of the solid waste transporting vehicles to be provided in the FDS. Since the on-site road must thus enable safe passage of solid waste transporting vehicles without

jams, a road having the structure shown in Fig. 2-3-2-58 shall be installed within the boundaries of the site.

b. Peripheral fence

A peripheral fence, such as that shown in Fig. 2-3-2-59 shall be installed about the entire perimeter of the site. Though this peripheral fence shall be provided mainly to prevent unnecessary entry of persons inside the FDS and for safety management, it shall also provide the effects of preventing illegal waste dumping and shutting off the view and serve as a facility for preventing the scattering of solid waste.

c. Monitoring well

The monitoring well shall have the structure shown in Fig. 2-3-2-60 as standard. The purpose of monitoring the groundwater in the surroundings of the FDS by means of a monitoring well is to monitor the degree of diffusion of pollutants that flow out from the FDS in the groundwater and the level of impact on the living environment for people. A monitoring well must thus be provided at one location along the direction of flow of the groundwater directly below the FDS. The depth of the monitoring well shall be set so that the pollution of the aquifer adjacent the FDS can be detected.

Table 2-3-2-24 Work Flow and Equipment Used: AQABA

Work Flow

START

Landfill of Residue by Open Burning

(1) Positioning of excavation range by line marker

(2) Trench Excavation

(3) Completion of trench

(4) Excavation, transfer and hauling of residue

(5) Leveling and compaction of residue

[NO] Has the trench become full?

[YES]

(6) Application of final cover

[NO] Has all of the residue been filled?

[YES]

Landfill of Hauling Solid Waste

(7) Positioning of excavation range by line marker

(8) Trench excavation (one side)

(9) Trench excavation (one side)

(10) Completion of trench

(11) Hauling of solid waste into site

(12) Leveling and compaction of solid waste

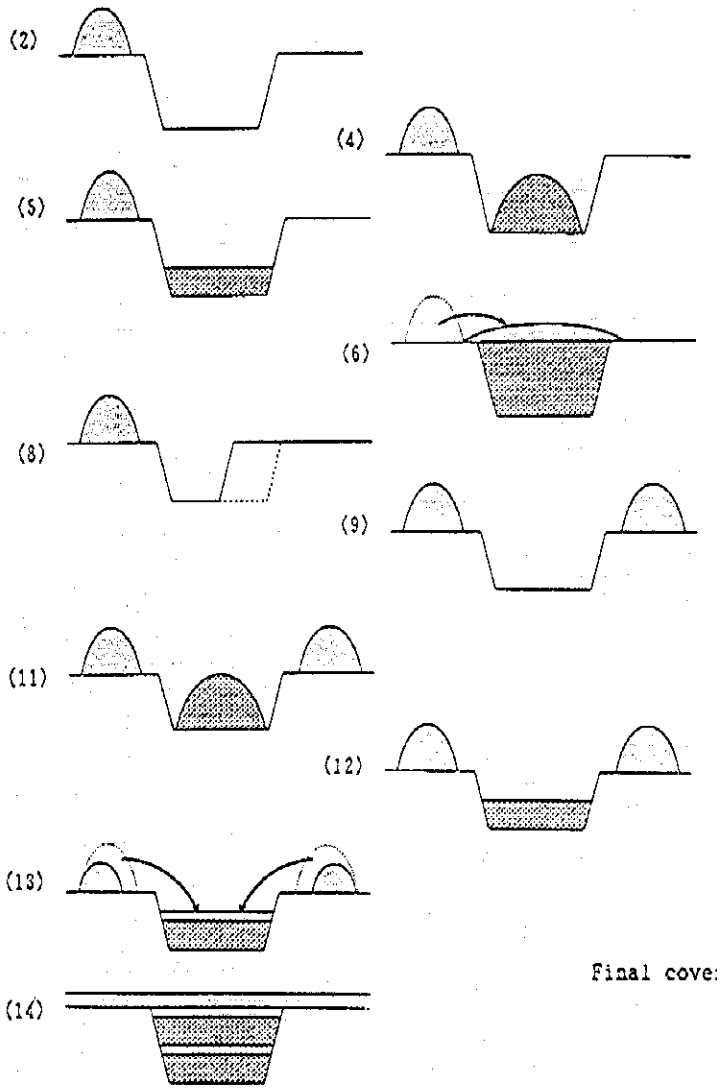
(13) Application of daily cover

[YES] Continue with further landfill?

[NO]

(14) Application of final cover

END



Equipment Used

(2) Excavator

(4) Bulldozer

(5) Bulldozer

(6) Bulldozer

(8) Excavator

(9) Excavator

(12)Bulldozer

(13)Bulldozer

(14)Bulldozer

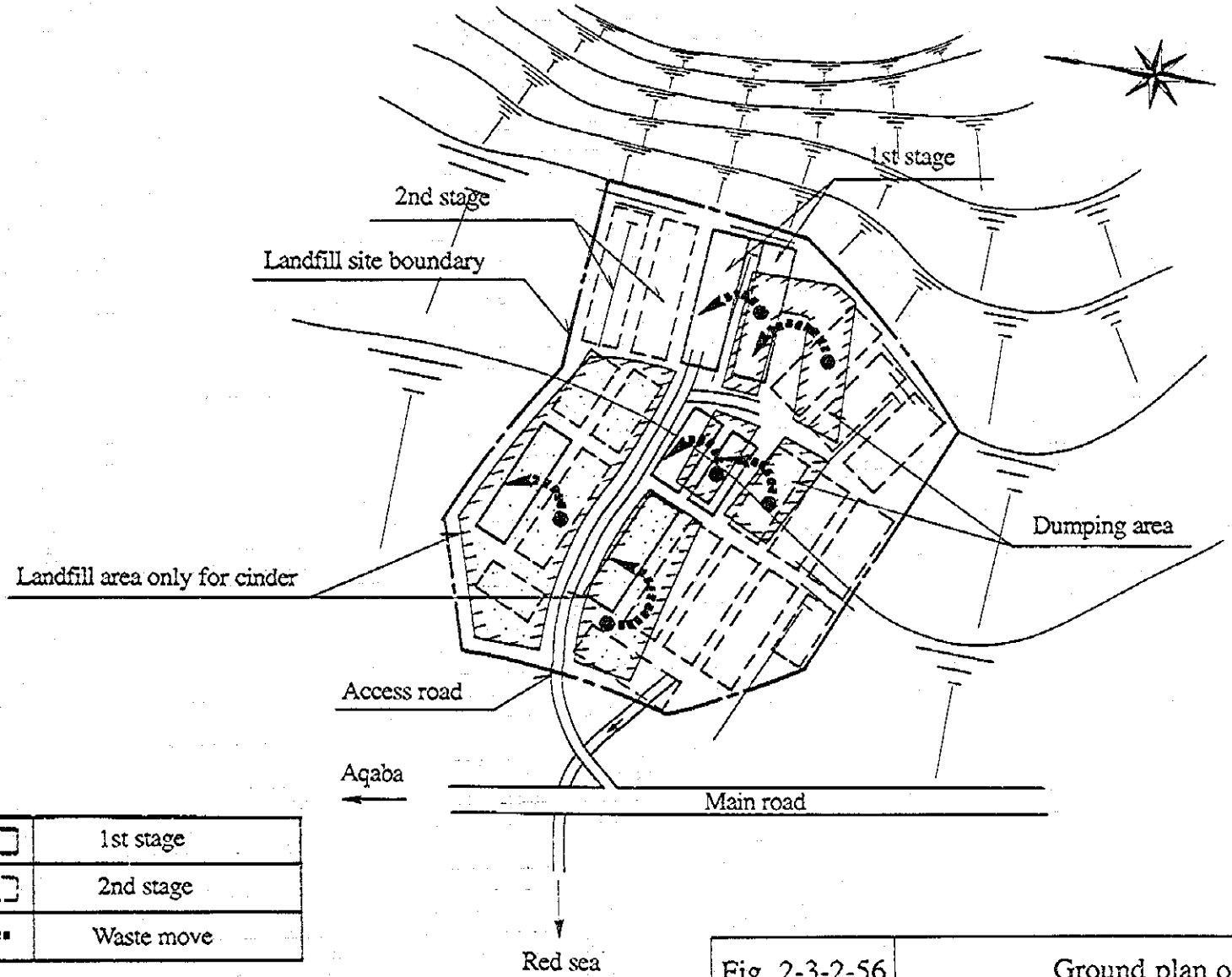
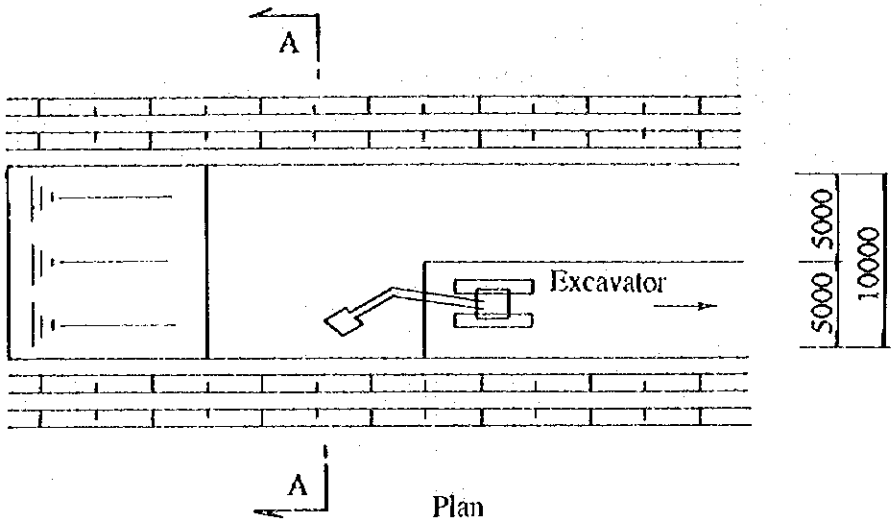
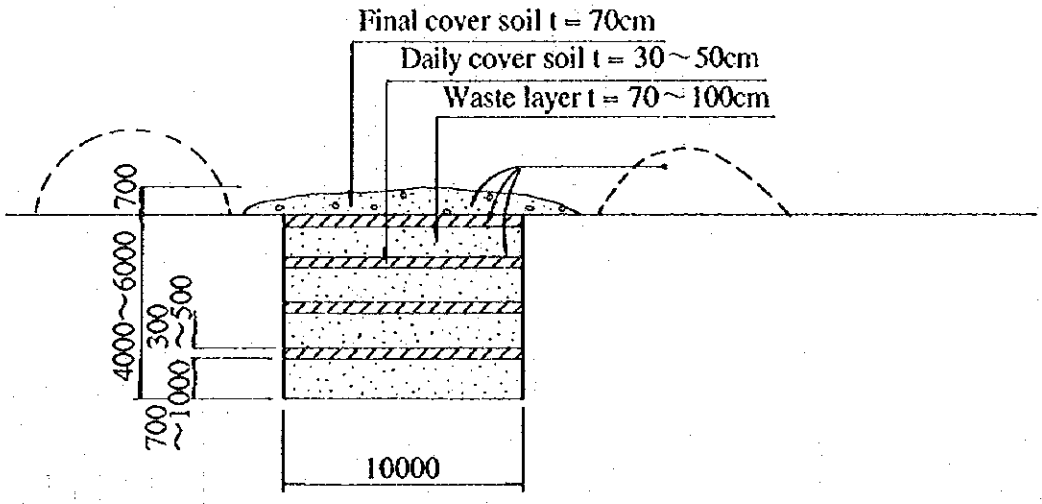


Fig. 2-3-2-56 Ground plan of Aqaba FDS

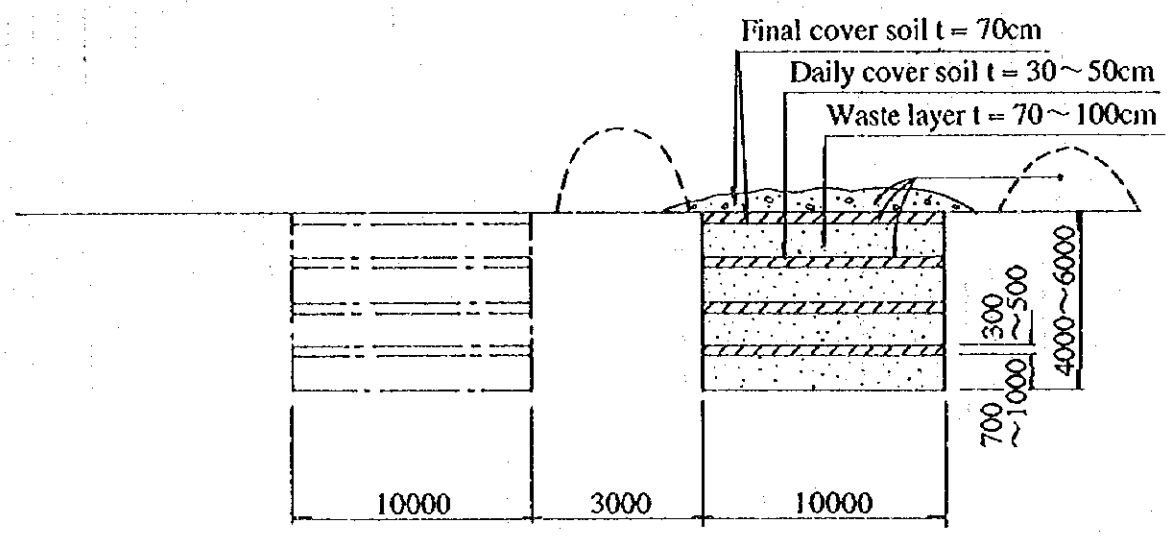
BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Plan



1st stage

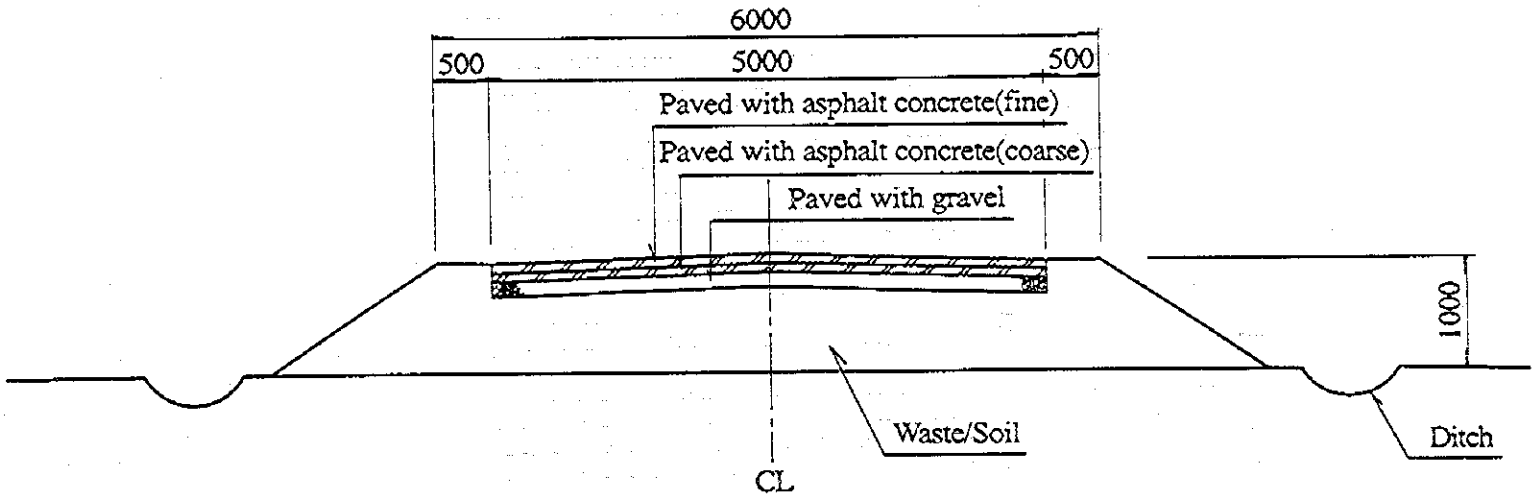


2nd stage

Unit: mm

Fig. 2-3-2-57	Cross section of Aqaba FDS

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

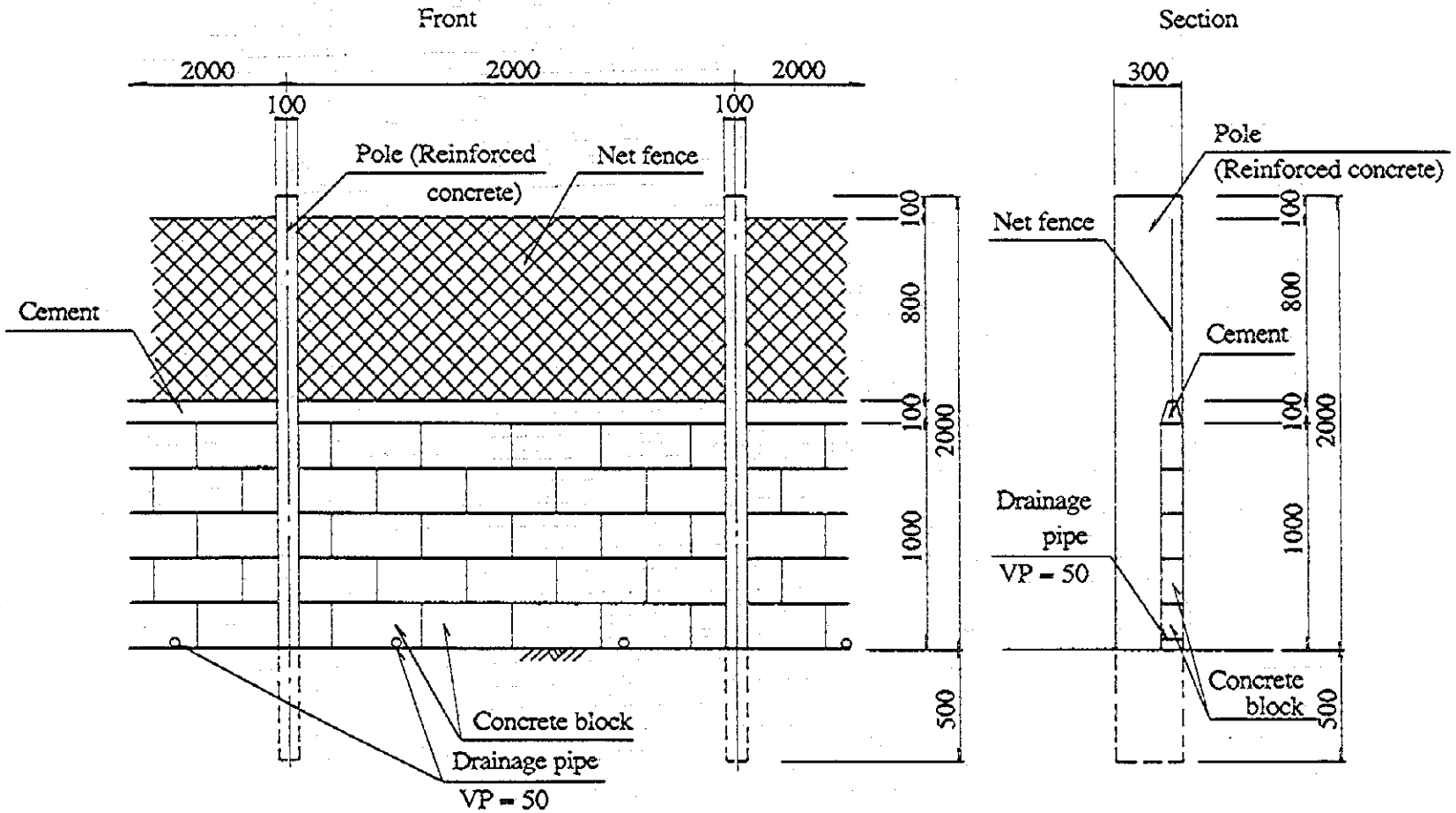


Unit: mm

Fig. 2-3-2-58 Cross section of access / insite road

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

Guard fence S = 1 : 20



Unit: mm

Fig. 2-3-2-59	General drawing of guard fence

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

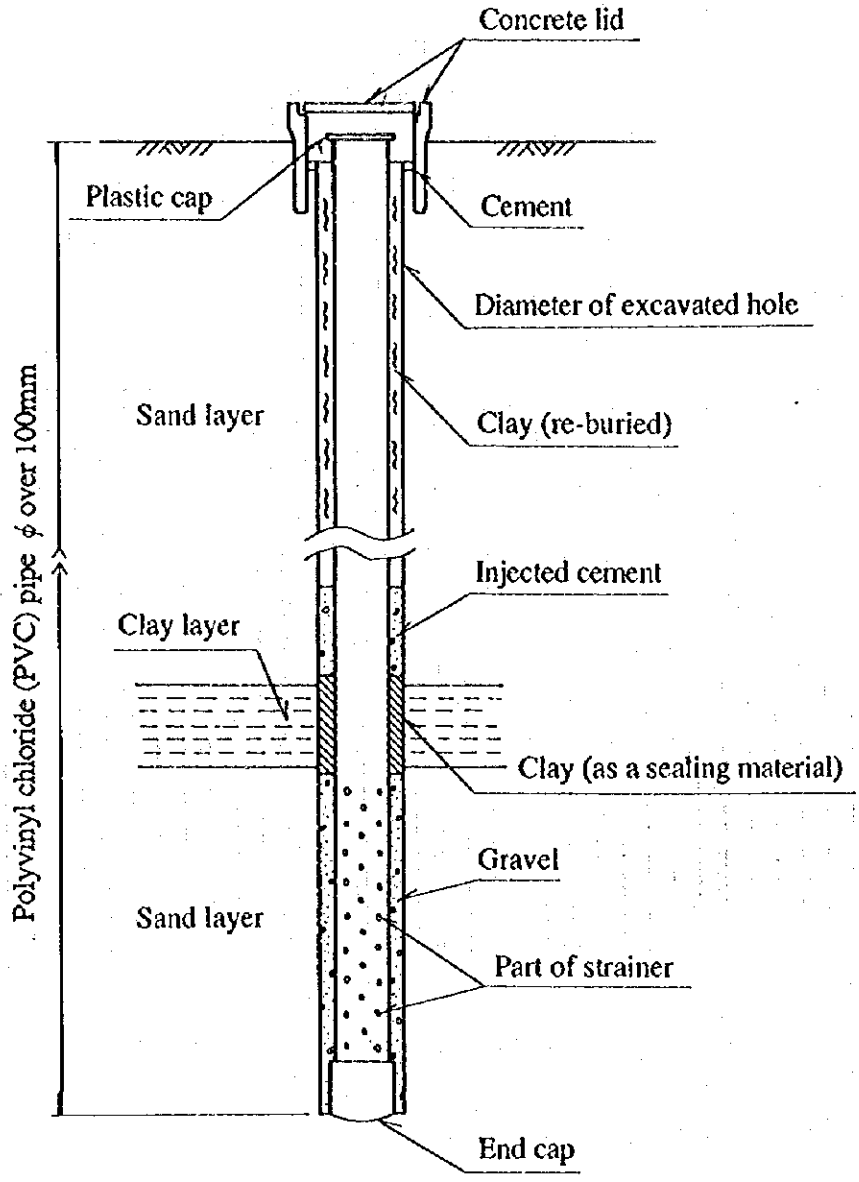


Fig. 2-3-2-60 Standard of monitoring well

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

(H) Existing Kufrinja FDS

A plan view and cross-sectional view of the FDS landfill plan are shown in Figs. 2-3-2-61 and 2-3-2-62. The FDS improvement plan is described below.

A) Consideration of the landfill method

The biggest problem with this FDS is the impact on the surrounding environment due to open dumping accompanied with open burning.

The formulation and execution of immediate countermeasures are essential. Since rocks can be procured within the grounds at this FDS, it is best to install rock-fill dam type structures along the entire perimeter and to carry out sanitary landfill of the open burning residue and the hauled solid waste.

B) Consideration of the working sequence and the equipment used

The dam (rock-fill type) erection work and landfill operation shall be carried out according to the flow shown in Table 2-3-2-25.

The following equipment shall be used in consideration of the excavated foundation, the topography, the working efficiency, and the solid waste classification.

Natural ground excavation, loading, transportation	: tractor shovel, dump truck
Leveling and surface compaction of solid waste and cover soil	: bulldozer

The reasons for adopting such combinations of equipment and work are as follows:

- Since the surface of the natural ground is hard limestone and the landscape is hilly, excavation by a tractor shovel is suitable in terms of working efficiency.

- Since an on-site road (public road) crosses the central part of the grounds, a dump truck will be best for the transport of excavated natural ground material.

- Since kitchen garbage comprise a large part of the solid waste and there are hardly any bulky wastes, etc. that require crushing, leveling and surface compaction by a bulldozer should be adequate.

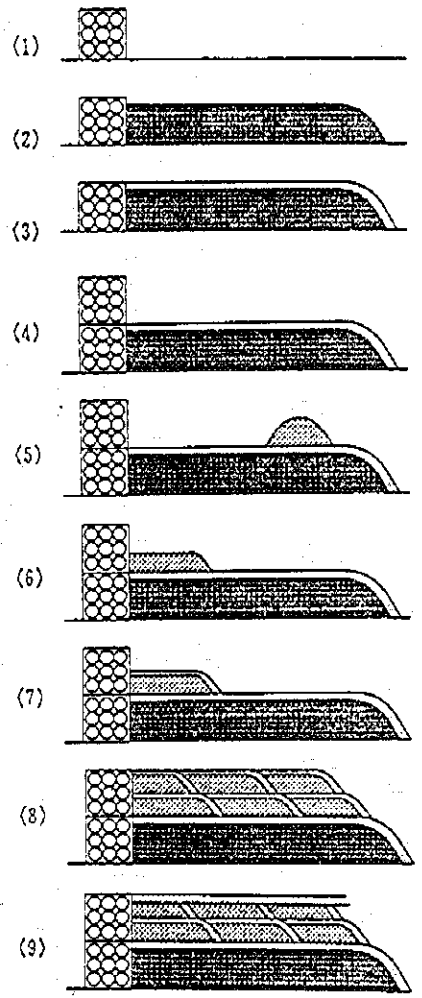
Besides the landfill operation equipment indicated above, a tractor head for spraying chemicals is needed for the purpose of preventing the proliferation of flies and other unsanitary pests.

C) Maintenance facility plan

The monitoring well shall have the structure shown in Fig. 2-3-2-63 as standard.
The purpose of monitoring the groundwater in the surroundings of the FDS by means of a monitoring well is to monitor the degree of diffusion of pollutants that flow out from the FDS in the groundwater and the level of impact on the living environment for people.
A monitoring well must thus be provided at one location along the direction of flow of the groundwater directly below the FDS. The depth of the monitoring well shall be set so that the pollution of the aquifer adjacent the FDS can be detected.

Table 2-3-2-25 Work Flow and Equipment Used: KUFRINJA/ EXISTING

Work Flow	Equipment Used
START Landfill of Existing Landfill Solid Waste (1) Erection of rock-fill structure (2) Collection and transfer of landfill solid waste (3) Application of cover soil Landfill of Hauling Solid Waste (4) Erection of rock-fill structure (5) Hauling of solid waste into site (6) Leveling and compaction of solid waste (7) Application of daily cover [NO] Has all of the landfill been completed? [YES] (8) Completion of one process [NO] Has landfill been performed up to the height of the embankment? [YES] (9) Application of final cover END	(1) Excavation : Dozer-shovel Loading : Dozer-shovel Transport : Dump truck (2) Bulldozer (3) Excavation : Dozer-shovel Loading : Dozer-shovel Transport : Dump truck Leveling/ Surface compaction : Bulldozer (4) Excavation : Dozer-shovel Loading : Dozer-shovel Transport : Dump truck (6) Bulldozer (7) Excavation : Dozer-shovel Loading : Dozer-shovel Transport : Dump truck Leveling/ Surface compaction : Bulldozer (9) Excavation : Bulldozer Loading : Wheel loader Transport : Dump truck Leveling/ Surface compaction : Bulldozer



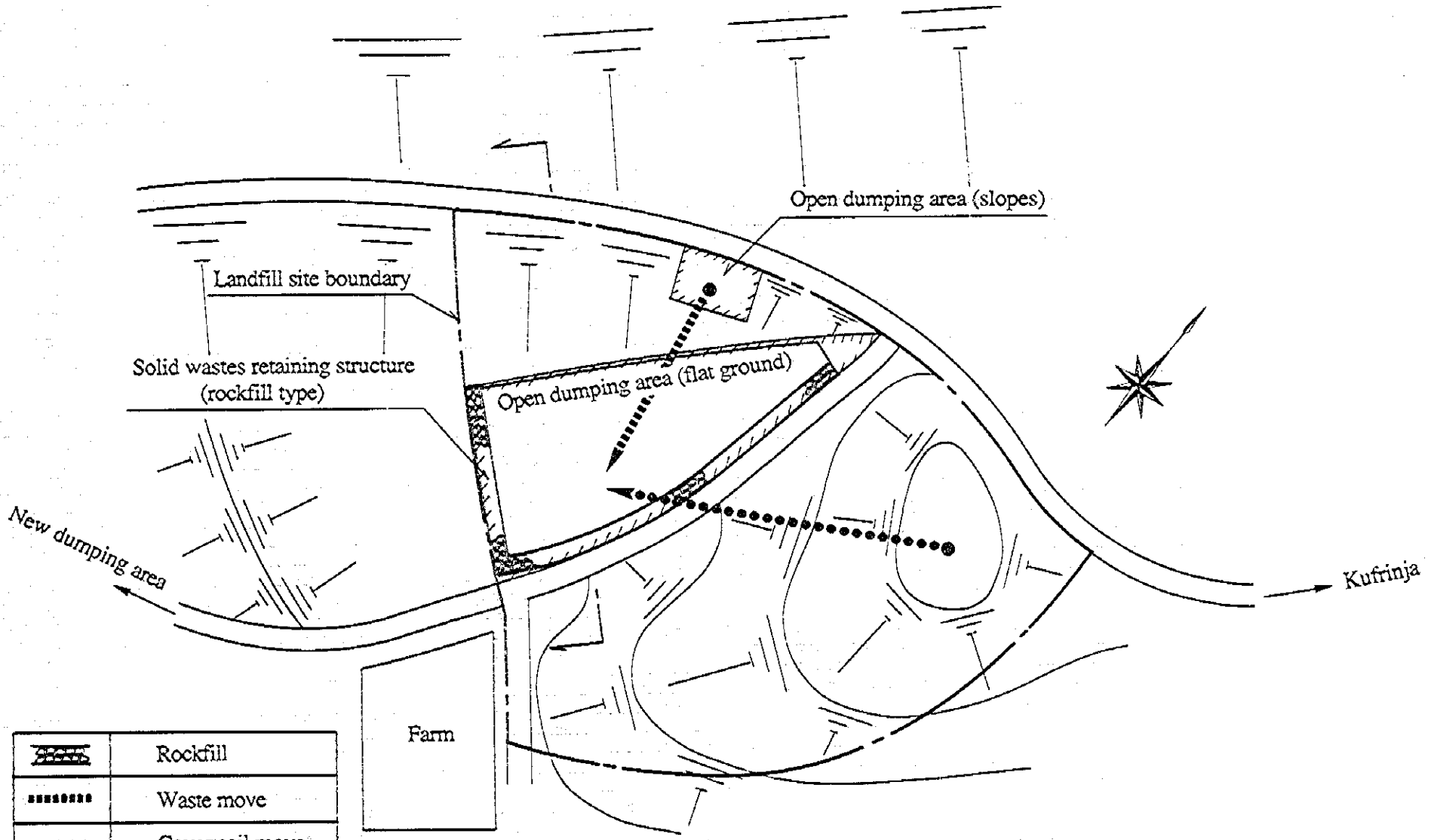
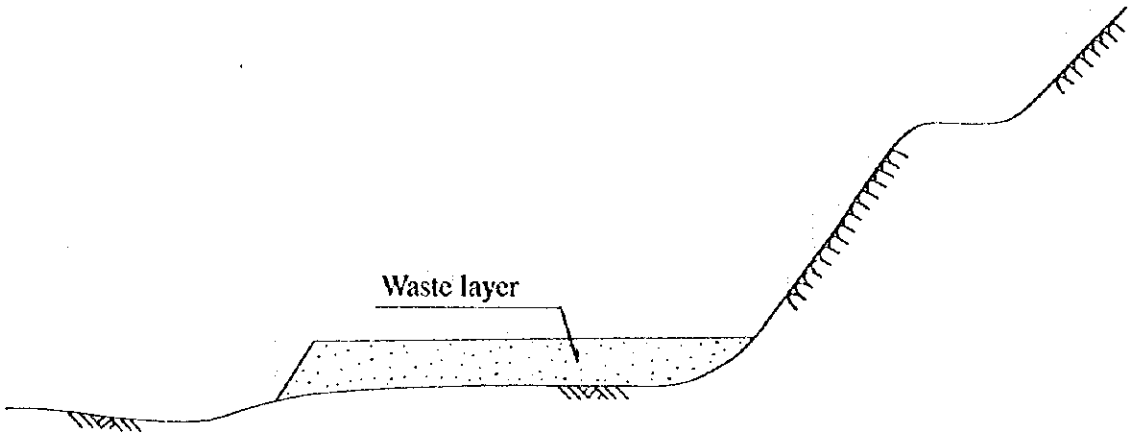
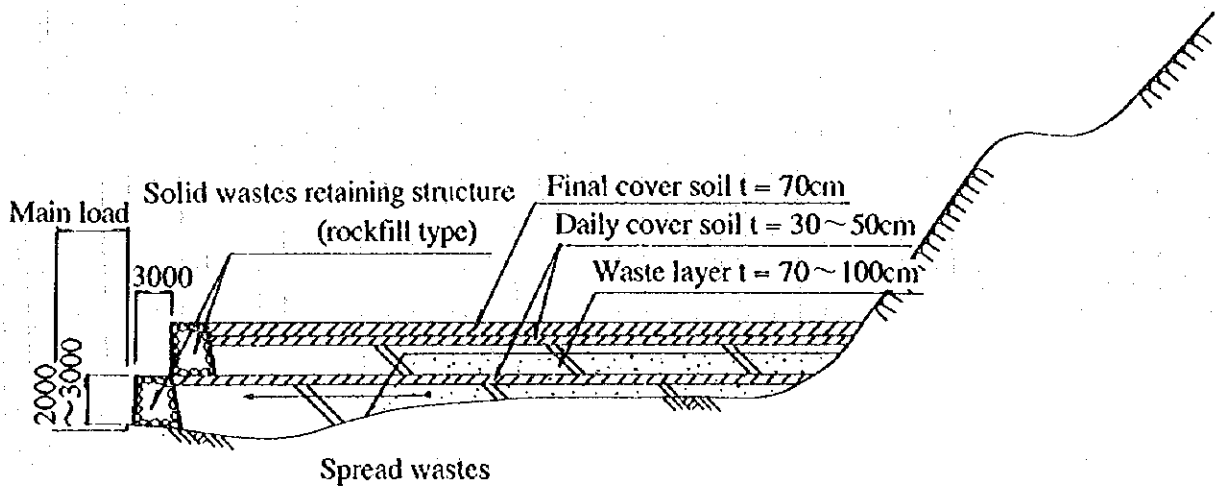


Fig. 2-3-2-61 Ground plan of Old Kufrinja FDS

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Section A-A
(before dumping)



Section A-A
(after dumping)

Unit: mm

Fig. 2-3-2-62	Cross section of Old Kufrinja FDS

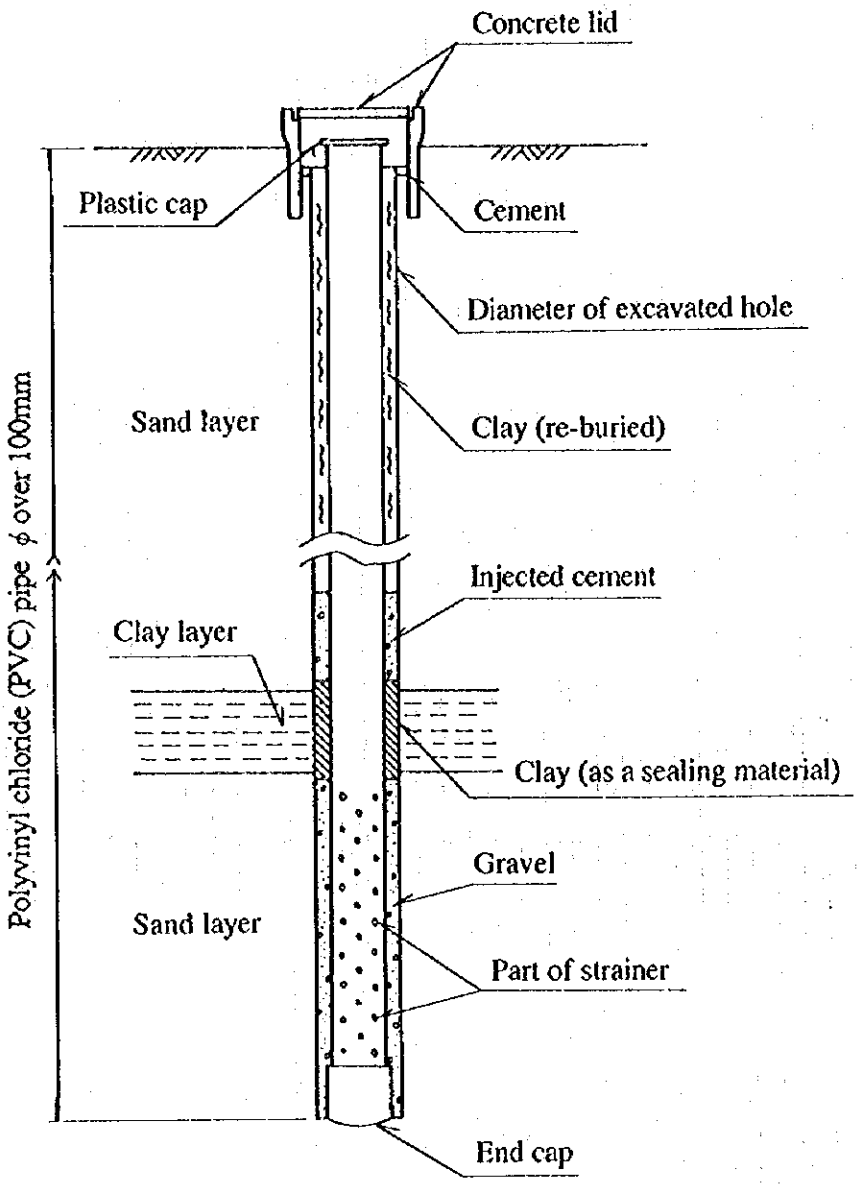


Fig. 2-3-2-63 Standard of monitoring well

(I) New Kufrinja FDS

A plan view and cross-sectional view of the FDS landfill plan are shown in Figs. 2-3-2-64 and 2-3-2-65. The FDS improvement plan is described below.

A) Prerequisites for FDS construction

The Department of Environment has indicated the following conditions for FDS construction to the CSC.

a. FDS preparation work
   ① The hauling road and on-site road shall be paved.
   ② Structures for preventing soil erosion and scattering prevention fences for preventing the scattering of solid waste shall be installed along the perimeter of the FDS.
   ③ A control building and a guardhouse shall be installed.
b. Sanitary landfill shall be performed and open dumping shall be avoided.
c. Technical staff shall be placed for maintenance of the disposal site.
d. Equipment necessary for carrying out sanitary landfill shall be arranged and these equipment shall be used continuously at the FDS.
e. The planned construction site shall be used for solid waste disposal. Since 100 dunam of government property shall be allocated, discussions shall be held with the Department of Land and Survey.

B) Consideration of the landfill method

Since the slope of a hill is used at this FDS, sanitary landfill shall be carried out along with erection of embankments from the lower side of the slope in order to make effective use of the landfill space.

C) Consideration of the working sequence and the equipment used

The embankment erection work and landfill operation shall be carried out according to the flow shown in Table 2-3-2-26.
The following equipment shall be used in consideration of the excavated foundation, the topography, the working efficiency, and the solid waste

classification.

Natural ground excavation, loading, transportation : tractor shovel,	: dump truck
Erection of embankment	: bulldozer
Leveling and surface compaction of solid waste and cover soil	: bulldozer

The reasons for adopting such combinations of equipment and work are as follows:

- Since the topography is one with a steep inclination, excavation by a tractor shovel is appropriate in terms of safety and working efficiency.

- Since the excavated natural ground soil must be transported over a long distance, a dump truck will be most suitable for transport.

- A bulldozer, which is excellent for leveling and surface compaction, is most suitable for the preparation of embankments.

- Since kitchen garbage comprise a large part of the solid waste and there are hardly any bulky wastes, etc. that require crushing, leveling and surface compaction by a bulldozer should be adequate.

Besides the landfill operation equipment indicated above, a tractor head for spraying chemicals is needed for the purpose of preventing the proliferation of flies and other unsanitary pests.

D) Maintenance facility plan

a. On-site road

An on-site road shall be installed to facilitate the passage of the solid waste transporting vehicles to be provided in the FDS. Since the on-site road must thus enable safe passage of solid waste transporting vehicles without jams, a road having the structure shown in Fig. 2-3-2-66 shall be installed within the boundaries of the site.

b. Peripheral fence

A peripheral fence, such as that shown in Fig. 2-3-2-67 shall be installed about the entire perimeter of the site. Though this peripheral fence shall be provided mainly to prevent unnecessary entry of persons inside the FDS and for safety management, it shall also provide the effects of preventing illegal waste dumping and shutting off the view, and serve a facility for preventing the scattering of solid waste.

c. Monitoring well

The monitoring well shall have the structure shown in Fig. 2-3-2-68 as standard. The purpose of monitoring the groundwater in the surroundings of the FDS by means of a monitoring well is to monitor the degree of diffusion of pollutants that flow out from the FDS in the groundwater and the level of impact on the living environment for people. A monitoring well must thus be provided at one location along the direction of flow of the groundwater directly below the FDS. The depth of the monitoring well shall be set so that the pollution of the aquifer adjacent the FDS can be detected.

d. Gas venting facilities

Fig. 2-3-2-69 is a standard drawing of a gas venting facility. The purpose of a gas venting facility is to vent the gas within the landfill solid waste layer rapidly to thereby prevent impacts on the working and surrounding environments. Gas venting facilities shall be installed, as a rule, at 50m intervals in accordance with the progress of landfill.

e. Leachate circulation pumping facility

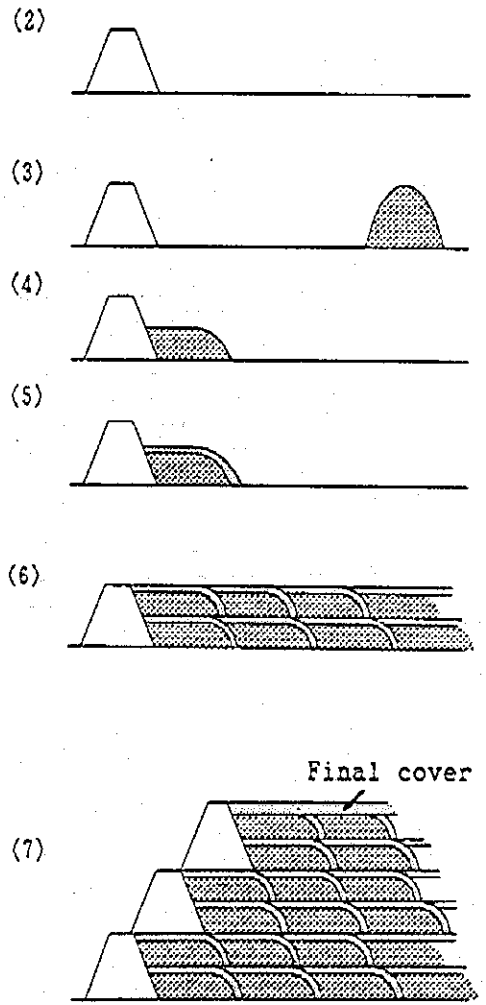
Fig. 2-3-2-70 is a standard drawing of a leachate circulation pump facility. The water quantity can be reduced and the water quality can be improved by circulating the leachate of the existing simple settling pond to the landfill section by means of a pump.

f. Leachate collection pipe

Fig. 2-3-2-71 is a standard drawing of a leachate collection line.
The purpose of the leachate collection line is to rapidly discharge the rainwater and leachate that seep into the landfill layer and to promote the activation of microorganisms and the stabilization of the landfill site through expanding the aerobic area.

Table 2-3-2-26 Work Flow and Equipment Used: KUFRINJA/ NEW

Work Flow	Equipment Used
START (1) Furnishing of on-site road (2) Erection of embankment (3) Hauling of solid waste into site (4) Leveling and compaction of solid waste (5) Application of daily cover [NO] Has landfill been performed up to the height of the embankment? [YES] (6) Completion of one process [YES] Continue with further landfill? [NO] (7) Application of final cover END	(2) Excavation : Dozer-shovel Loading : Dozer-shovel Transport : Dump truck Leveling/ Surface compaction : Bulldozer (4) Bulldozer (5) Excavation : Dozer-shovel Loading : Dozer-shovel Transport : Dump truck Leveling/ Surface compaction : Bulldozer (7) Excavation : Dozer-shovel Loading : Dozer-shovel Transport : Dump truck Leveling/ Surface compaction : Bulldozer



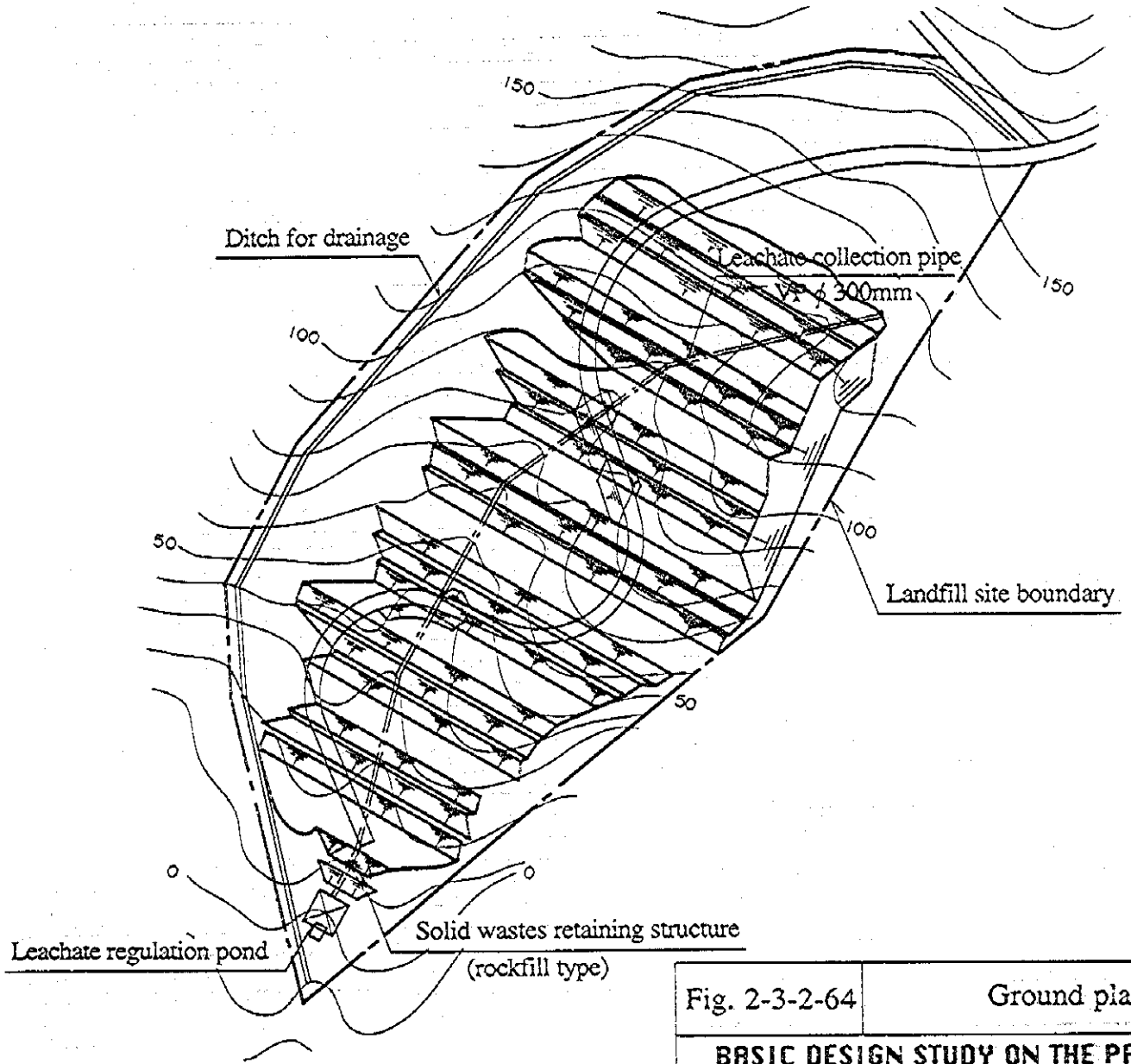
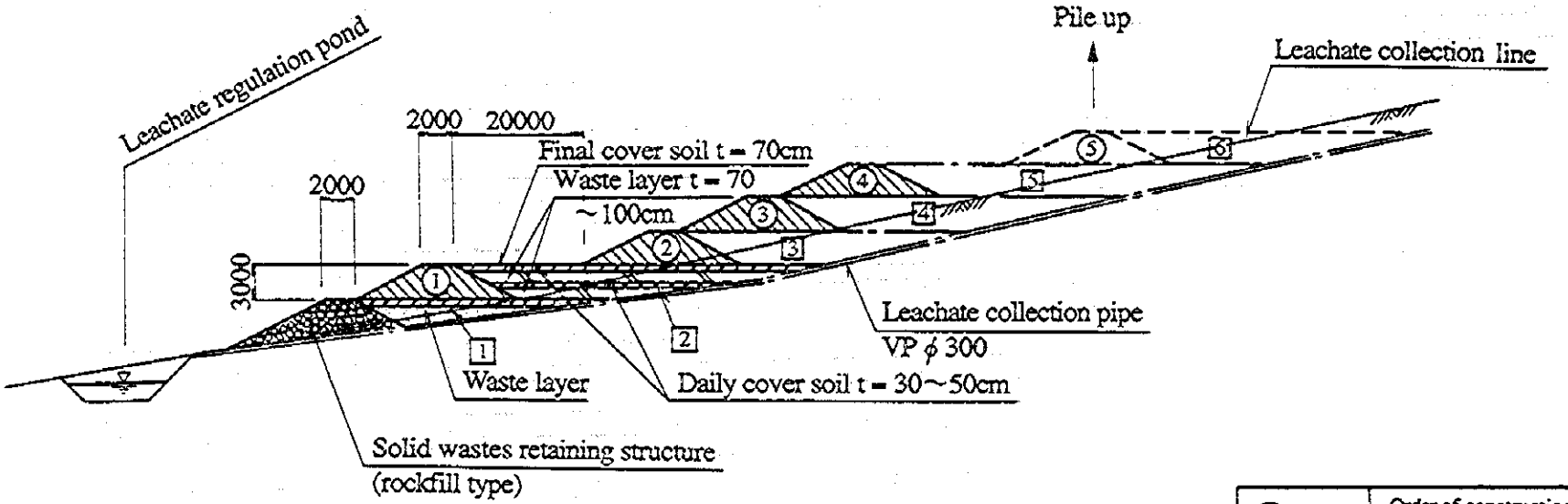


Fig. 2-3-2-64 Ground plan of New Kufrinja FDS

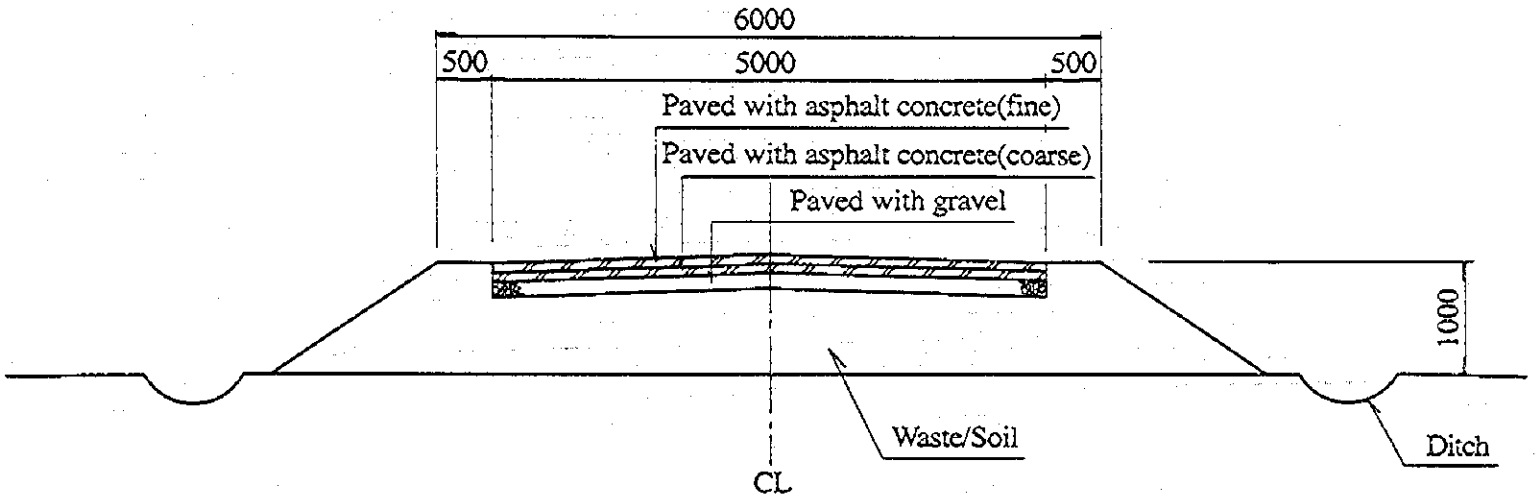
BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Unit: mm

Fig. 2-3-2-65 Cross section of New Kufrinja FDS

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

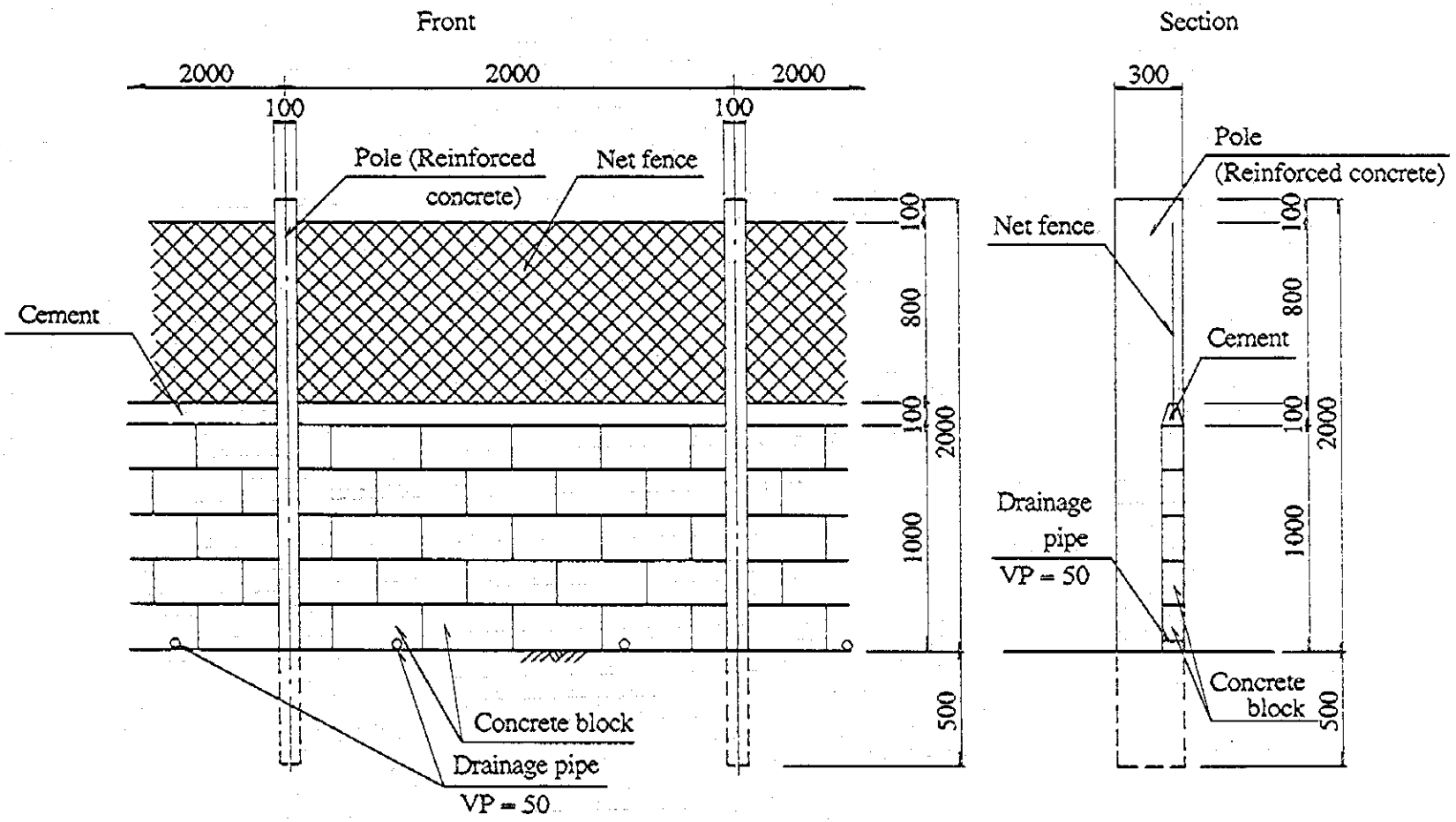


Unit: mm

Fig. 2-3-2-66 Cross section of access / insite road

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

Guard fence S = 1 : 20



Unit: mm

Fig. 2-3-2-67	General drawing of guard fence

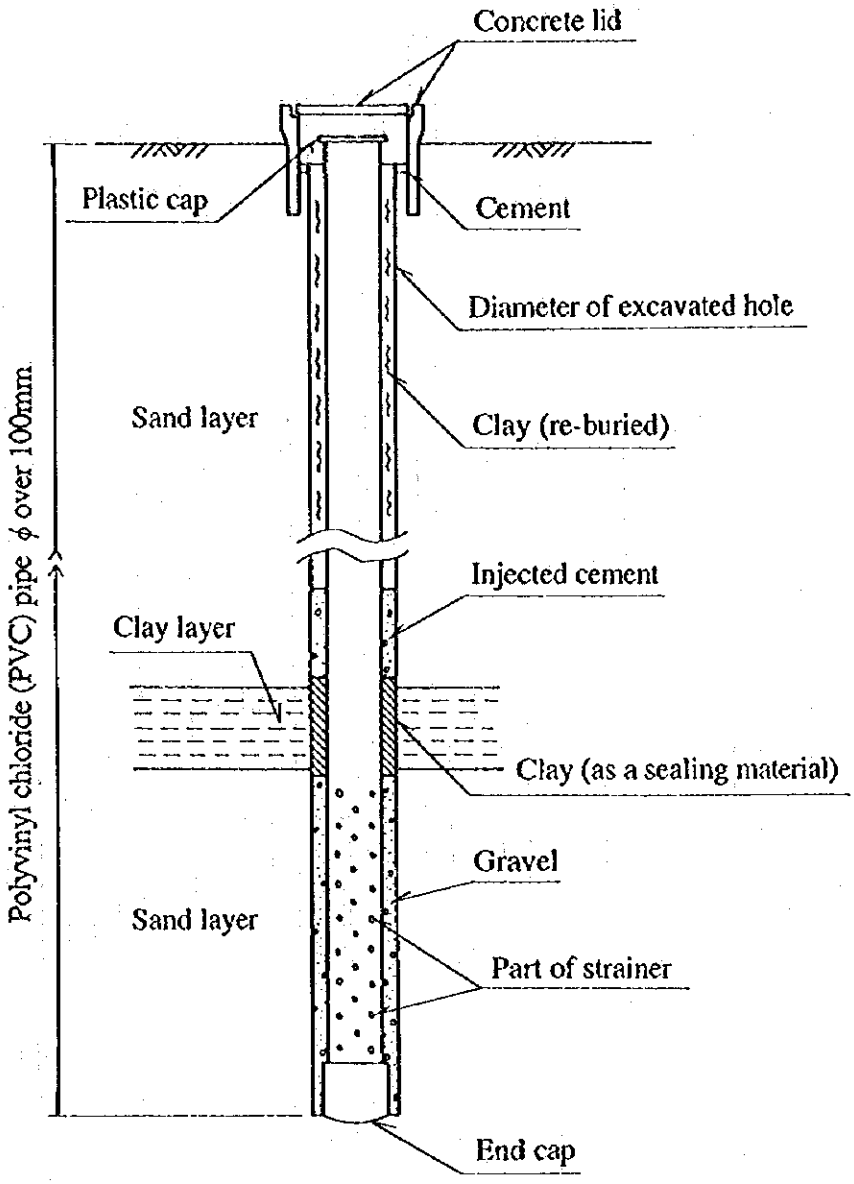
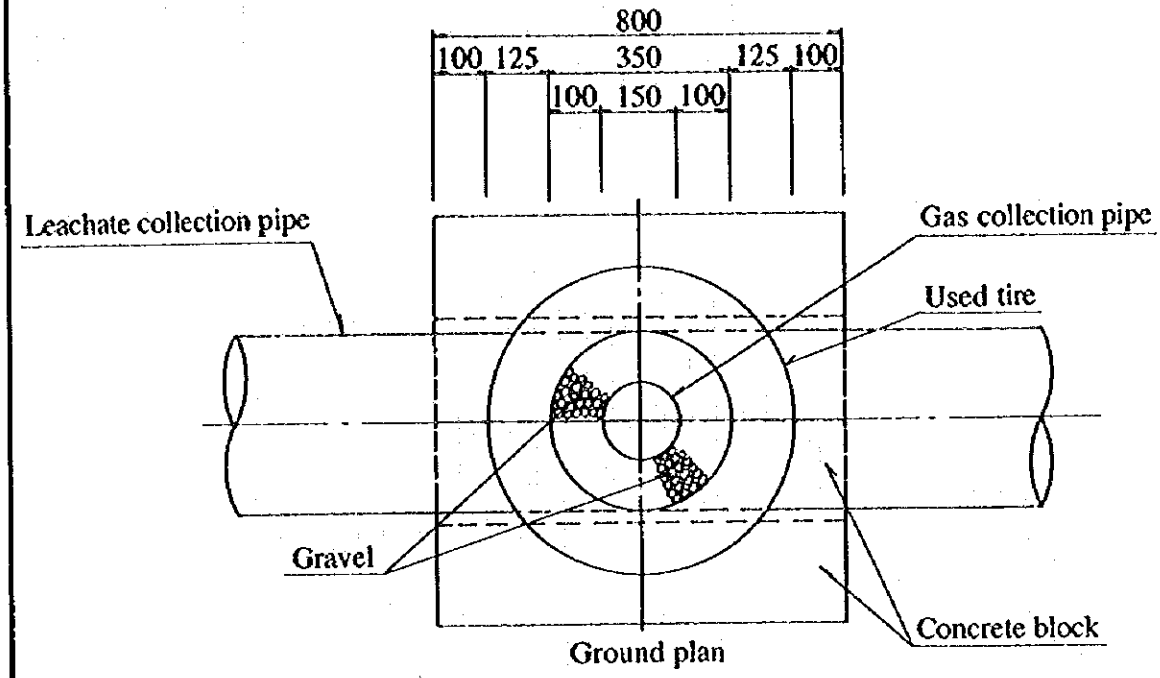


Fig. 2-3-2-68	Standard of monitoring well

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



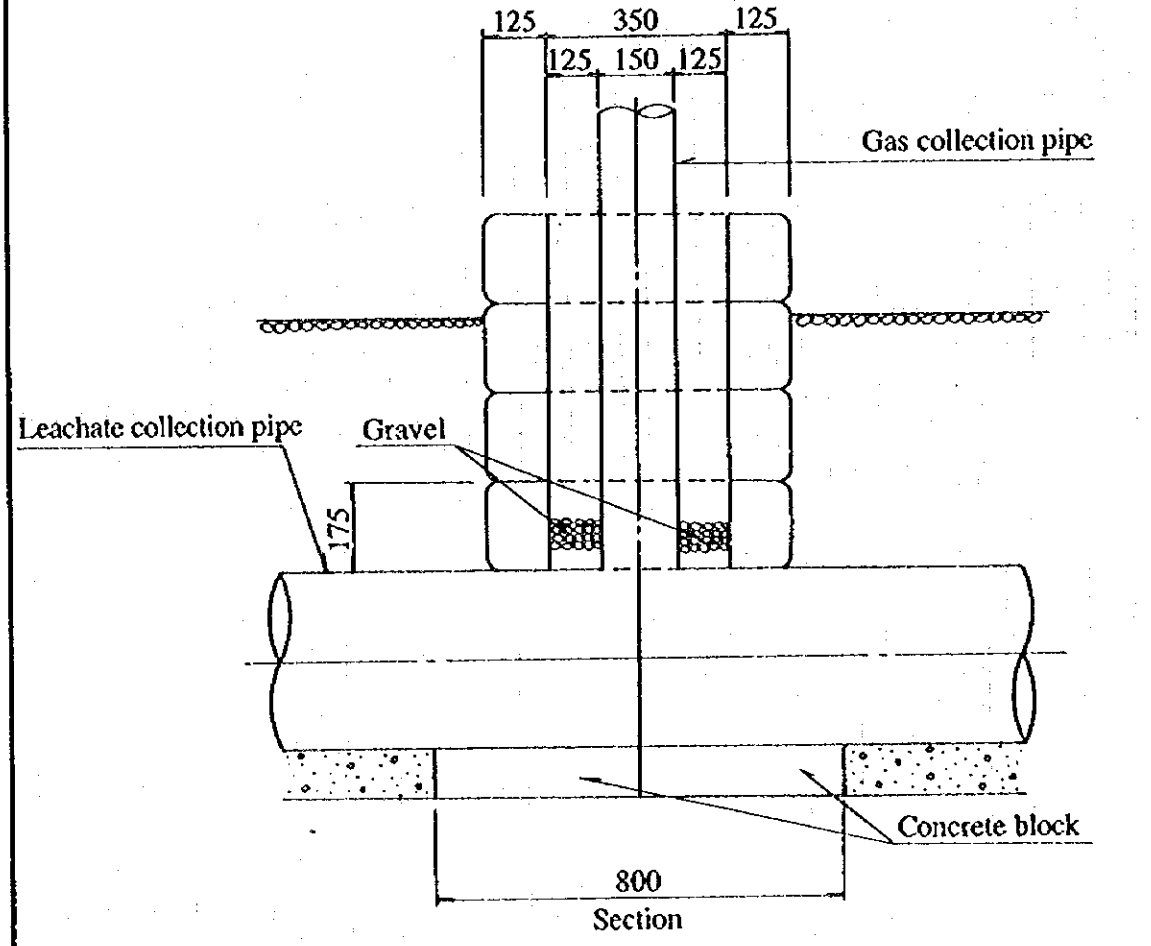
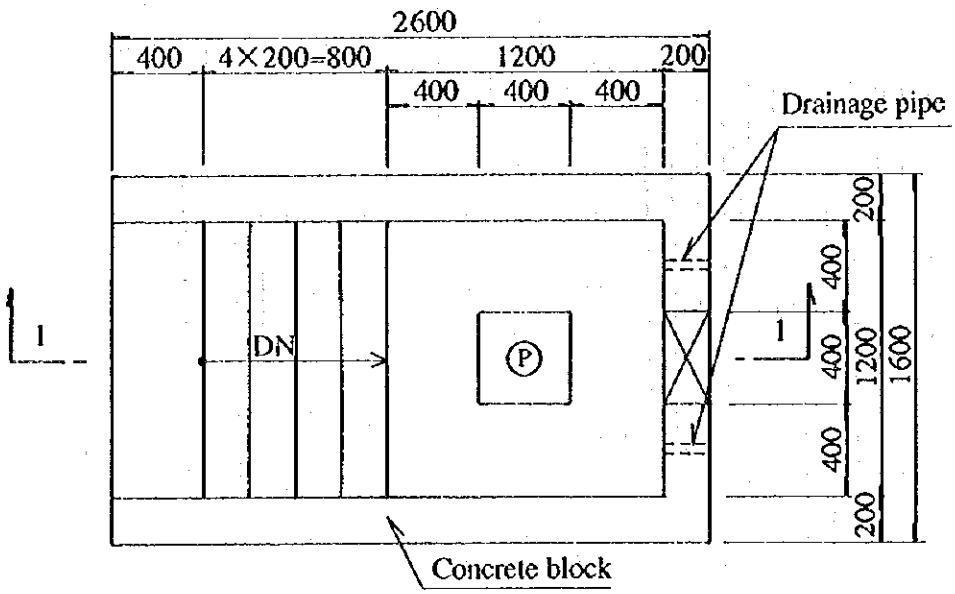
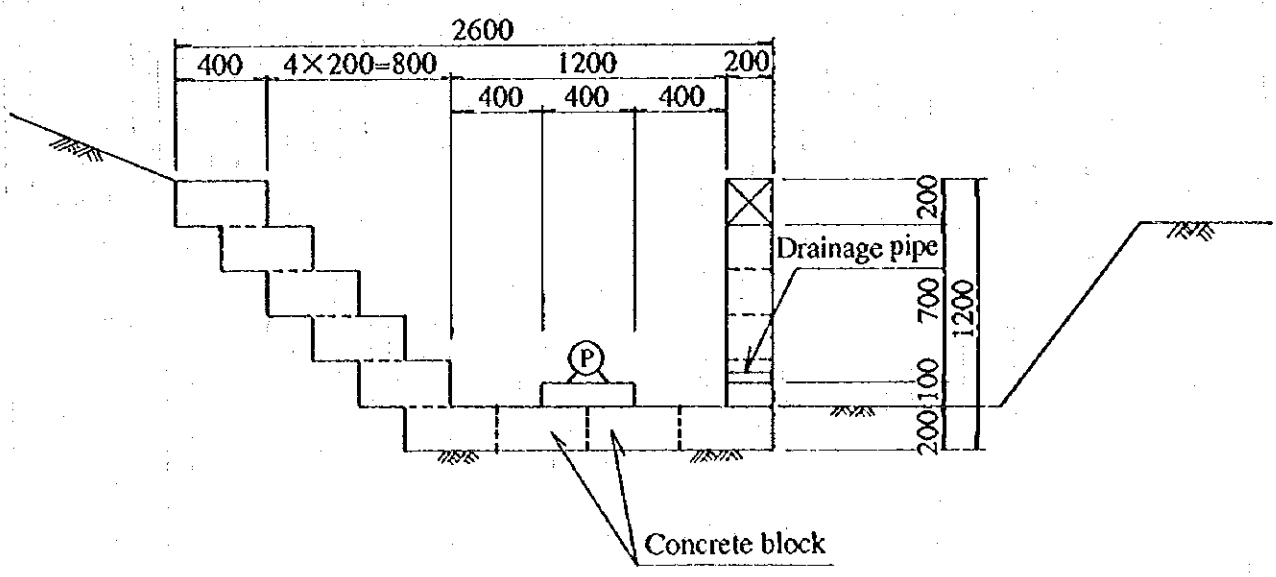


Fig. 2-3-2-69	General drawing of gas collection pipe

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Ground plan

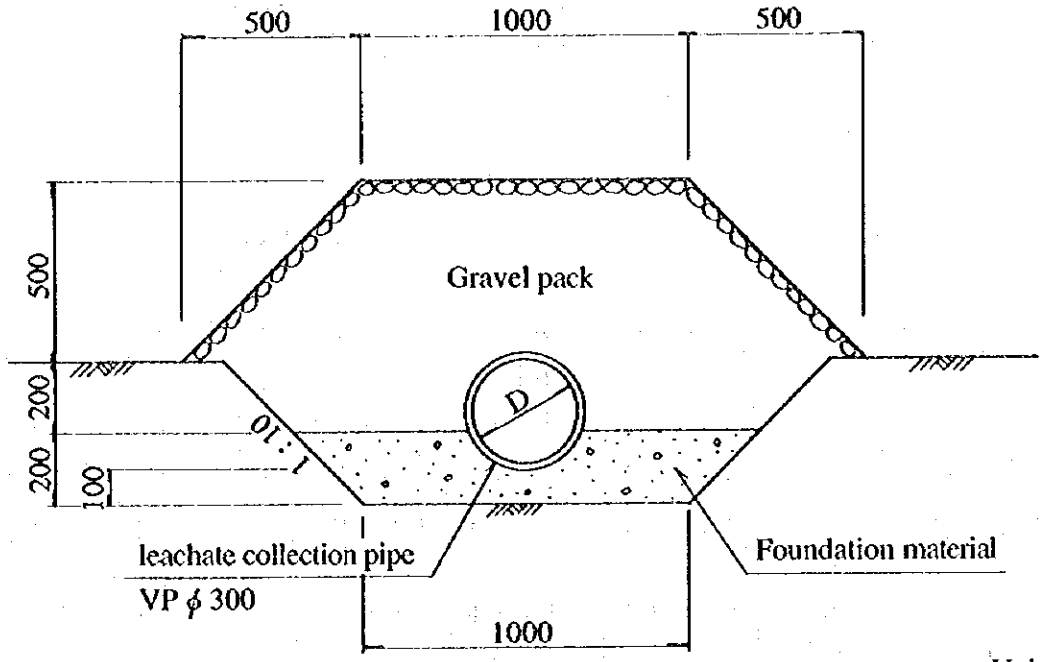


Section

Unit: mm

Fig. 2-3-2-70	General drawing of night-soil pit

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Unit: mm

Fig. 2-3-2-71	Cross section of leachate collection pipe

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

(J) Madaba FDS

A plan view and cross-sectional view of the FDS landfill plan are shown in Figs. 2-3-2-72 and 2-3-2-73. The FDS improvement plan is described below.

A) Consideration of the landfill method

Since this FDS is not imposing any significant impacts on the surrounding environment presently, sanitary landfill with preparation of embankments, which enables maximization of landfill efficiency and effective use of landfill space through current landfill methods, shall be adopted for this site.

B) Consideration of the working sequence and the equipment used

The embankment erection work and landfill operation shall be carried out according to the flow shown in Table 2-3-2-27.

The following equipment shall be used in consideration of the procurement source of cover soil, etc., working efficiency, solid waste classification, etc.

Natural ground excavation, loading, transportation : bulldozer, wheel loader, dump truck
Leveling and surface compaction of embankment and cover soil : bulldozer
Leveling and surface compaction of solid waste : bulldozer

The reasons for adopting such combinations of equipment and work are as follows:

- Since the sandy soil of the natural ground is planned to be used for embankment and cover soil, a bulldozer, which is excellent for excavation in layers at flat areas, is suitable.

- A wheel loader, which excels in terms of working efficiency, is optimal for the loading of the excavated natural ground soil. A dump truck is most suitable for the transportation of excavated natural ground soil in view of the transporting distance.

- A bulldozer, which excels in workability and provide surface compaction effects, is most suitable for the leveling and surface compaction work for the waste, the embankment, and the cover soil.

- Since kitchen garbage comprise the majority of the waste and there are hardly any bulky wastes, etc. that require crushing, leveling and surface compaction by a bulldozer should be adequate.

Besides the landfill operation equipment indicated above, a tractor head for spraying chemicals is needed for the purpose of preventing the proliferation of flies and other unsanitary pests.

C) Maintenance facility plan

a. On-site road

An on-site road shall be installed to facilitate the passage of the solid waste transporting vehicles to be provided in the FDS. Since the on-site road must thus enables safe passage of solid waste transporting vehicles without jams, a road having the structure shown in Fig. 2-3-2-74 shall be installed within the boundaries of the site.

b. Peripheral fence

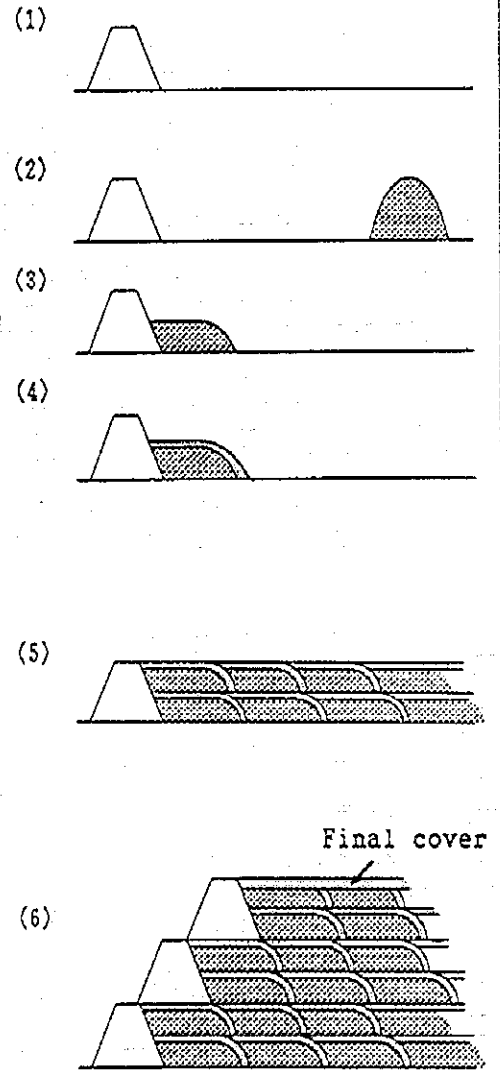
A peripheral fence shall be installed along the entire perimeter of the site (Fig. 2-3-2-75). Though this peripheral fence sahll be provided mainly to prevent unnecessary entry of persons inside the FDS and for safety management, it shall also provide the effects of preventing illegal waste dumping and shutting off the view and serve as a facility for preventing the scattering of solid waste.

c. Monitoring well

The monitoring well shall have the structure shown in Fig. 2-3-2-76 as standard. The purpose of monitoring the groundwater in the surroundings of the FDS by means of a monitoring well is to monitor the degree of diffusion of pollutants that flow out from the FDS in the groundwater and the level of impact on the living environment for people. A monitoring well must thus be provided at one location along the direction of flow of the groundwater directly below the FDS. The depth of the monitoring well shall be set so that the pollution of the aquifer adjacent the FDS can be detected.

Table 2-3-2-27 Work Flow and Equipment Used: MADABA

Work Flow	Equipment Used
START (1) Erection of embankment (2) Hauling of solid waste into site (3) Leveling and compaction of solid waste (4) Application of daily cover [NO] Has landfill been performed up to the height of the embankment? [YES] (5) Completion of one process [YES] Continue with further landfill? [NO] (6) Application of final cover END	(1) Excavation : Bulldozer Loading : Wheel loader Transport : Dump truck Leveling/ Surface compaction : Bulldozer (3) Bulldozer (4) Bulldozer (6) Excavation : Bulldozer Loading : Wheel loader Transport : Dump truck Leveling/ Surface compaction : Bulldozer



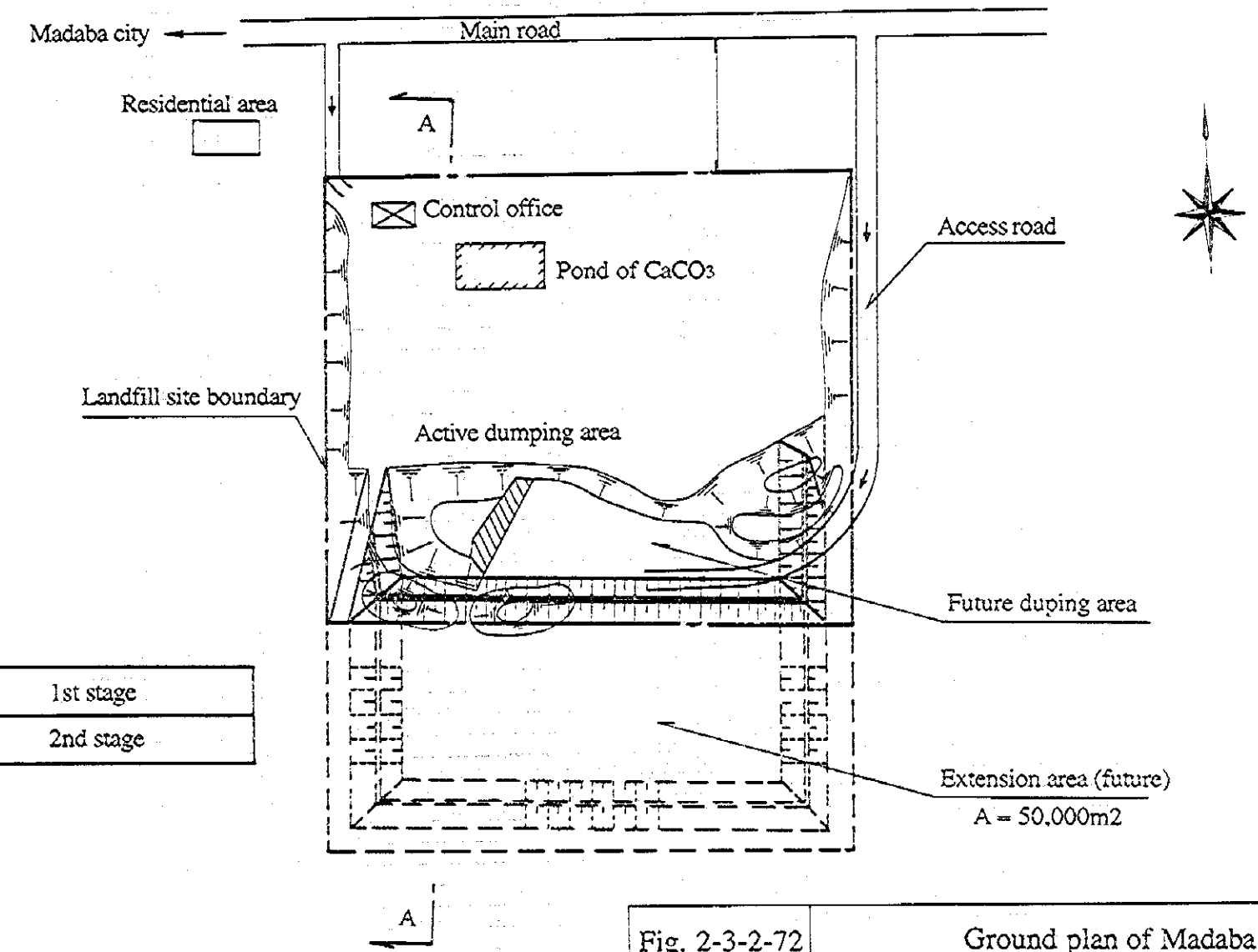
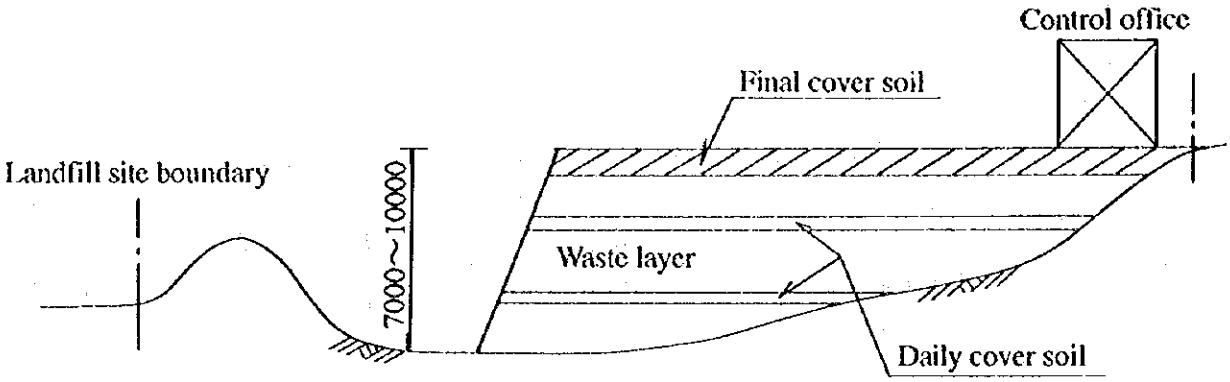
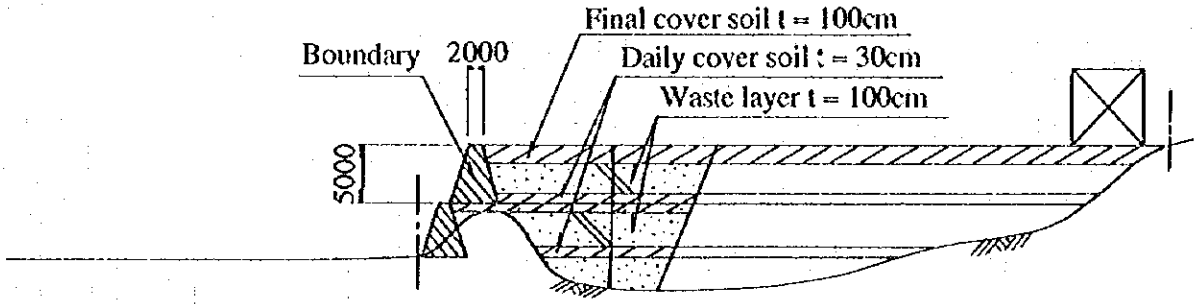


Fig. 2-3-2-72 Ground plan of Madaba FDS

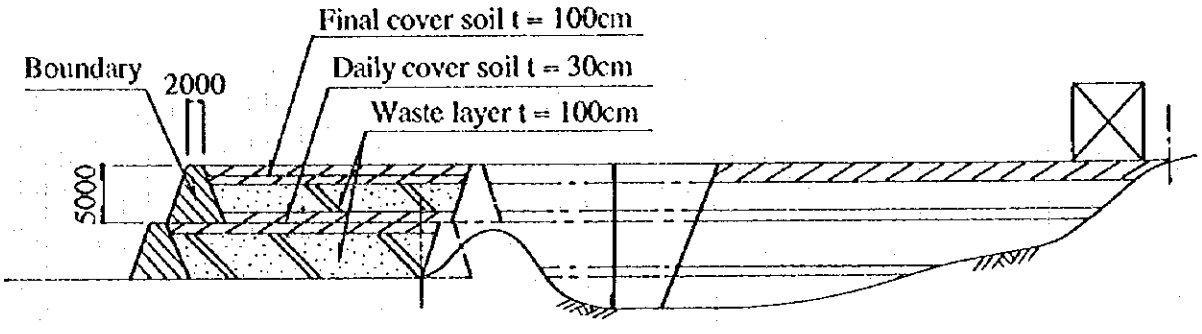
BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Section A-A



Section A-A
1st stage

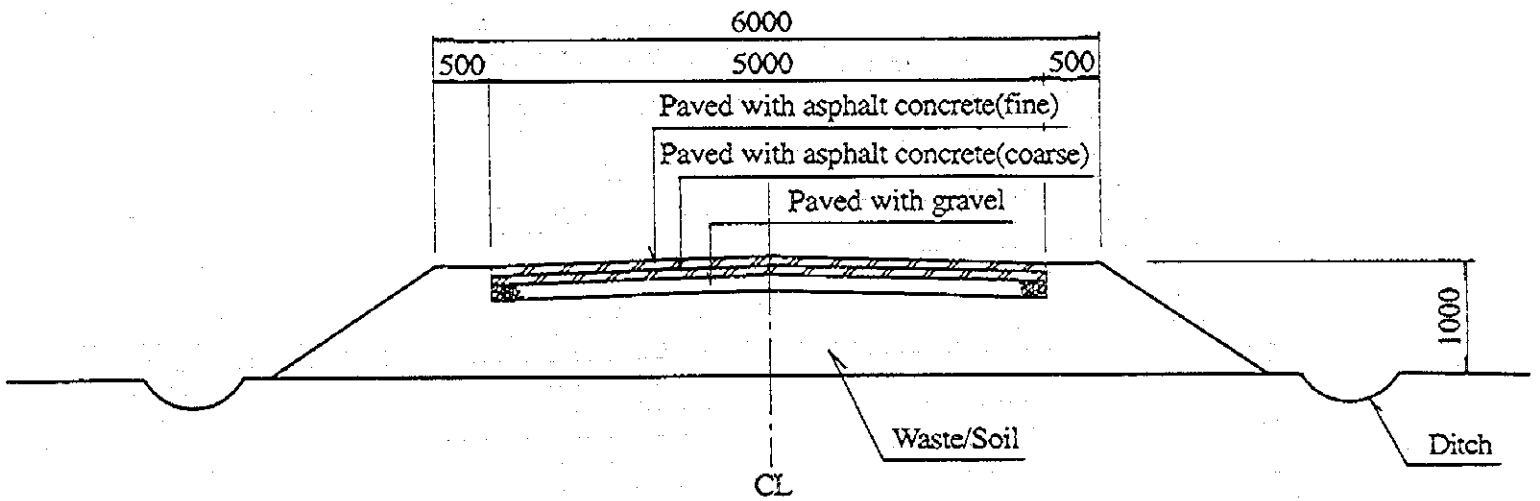


Section A-A
2nd stage

Unit: mm

Fig. 2-3-2-73	Cross section of Madaba FDS

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

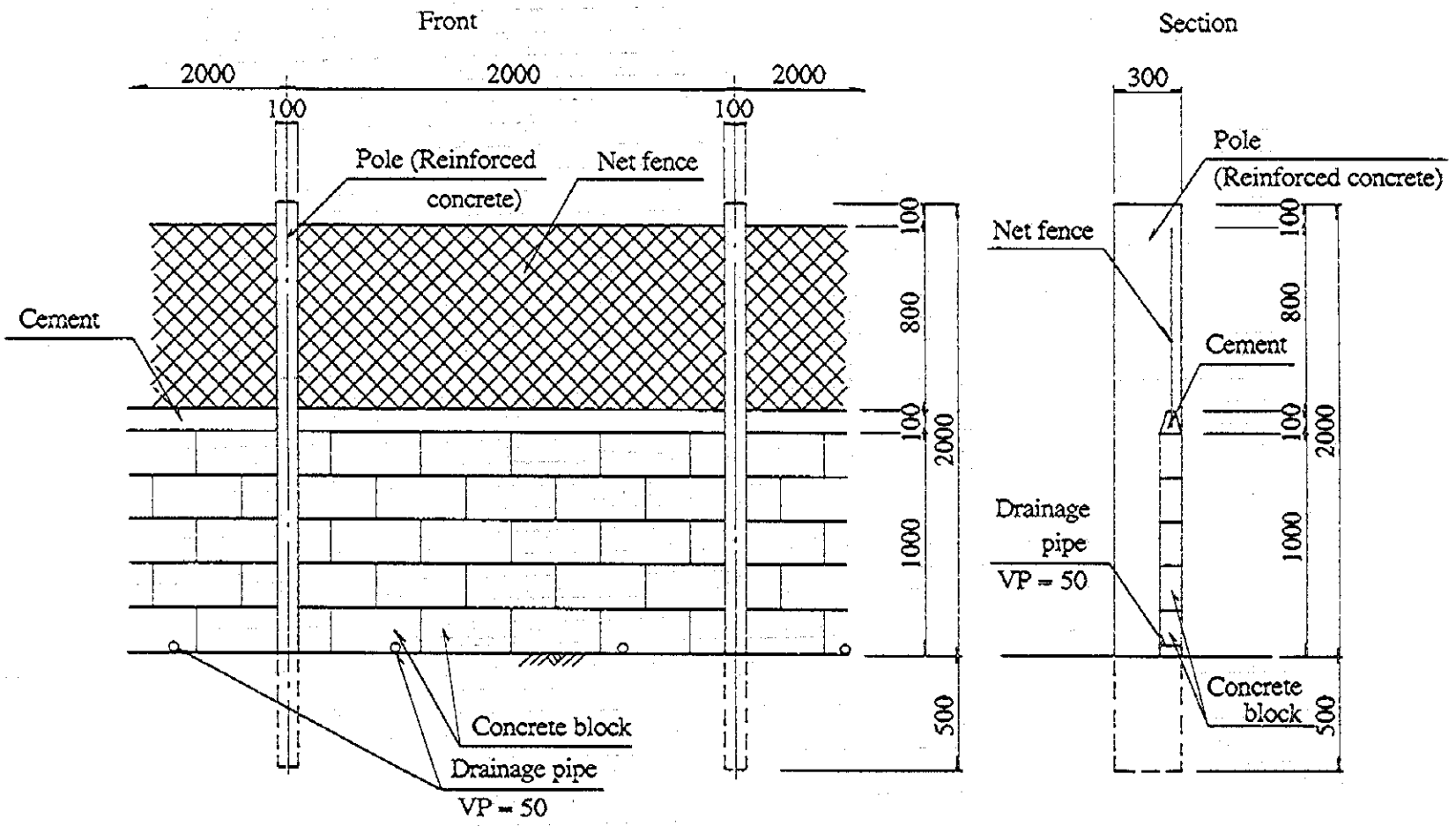


Unit: mm

Fig. 2-3-2-74 Cross section of access / insite road

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

Guard fence S = 1 : 20



Unit: mm

Fig. 2-3-2-75 General drawing of guard fence

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

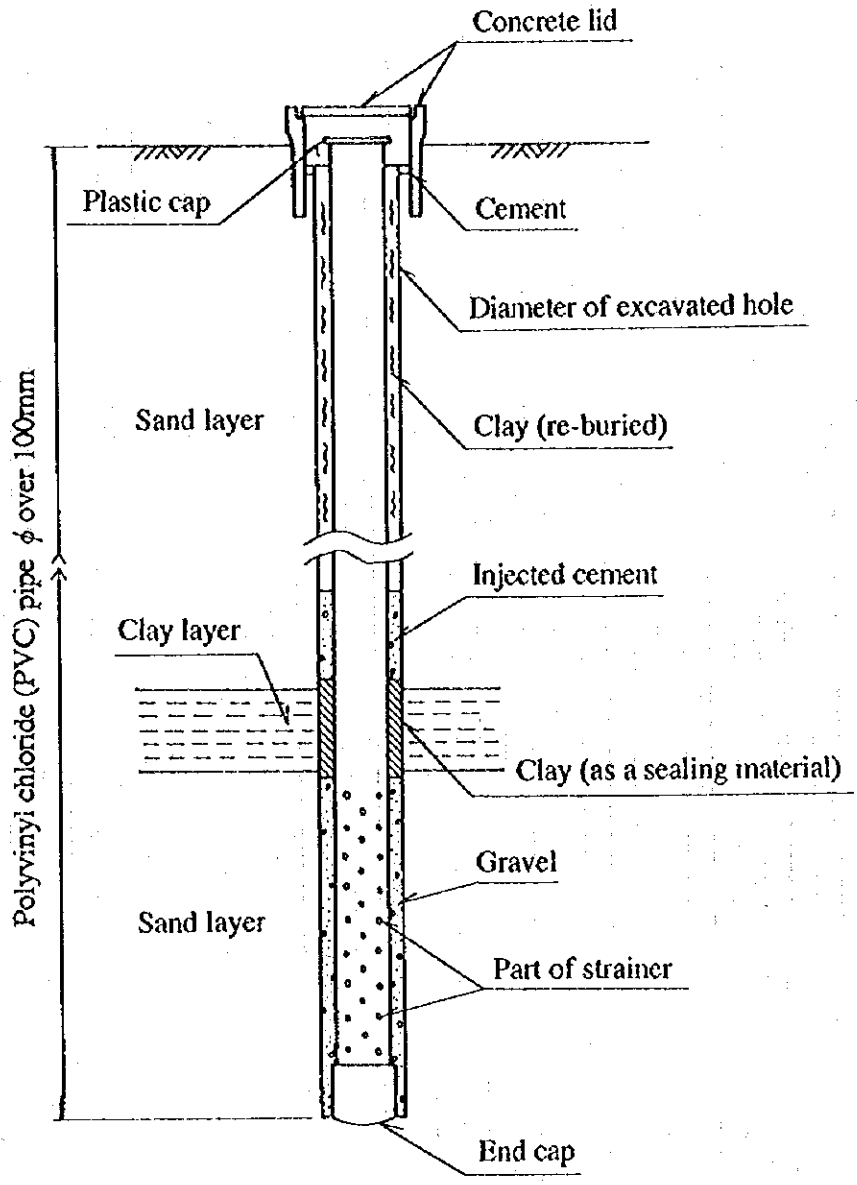


Fig. 2-3-2-76 Standard of monitoring well

(K) North Shuneh FDS

A plan view and cross-sectional view of the FDS landfill plan are shown in Figs. 2-3-2-77 and 2-3-2-78. The FDS improvement plan is described below.

A) Consideration of the landfill method

Sanitary landfill with preparation of embankments shall be carried out at this FDS in view of the circumstances of landfill, the topographical and geological conditions, the scale of the landfill site, the procurement source of cover soil, etc.

The advantages of this method are as follows.

- Landfill is currently being carried out by excavating trenches irregularly with a wheel loader and dumping the solid waste in such trenches. Since leveling, surface compaction, daily covering, and intermediate covering of the solid waste are not performed, the landfill efficiency is poor and there are impacts on the surrounding environment due to scattering of solid waste, etc.

- Embankments can be erected along the boundary of the site because of the gradually inclining landscape and the sandy soil which enable excavation.

- The landfill efficiency can be improved by erecting embankments in accordance with the progress of landfill.

- Since the scale of the landfill site is relatively small, the lifetime of landfill site can be secured by layering embankments and making use of the landfill space in the vertical direction.

- The excavation soil at the site can be used as cover soil.

B) Consideration of the working sequence and the equipment used

The embankment erection work and landfill operation shall be carried out according to the flow shown in Table 2-3-2-28.
The following equipment shall be used in consideration of the excavated foundation, topography, working efficiency, and solid waste classification.

Natural ground excavation, loading : bulldozer, wheel loader, dump truck and transporting
Erection of embankment : bulldozer
Leveling and surface compaction of solid waste : bulldozer

The reasons for adopting such combinations of equipment and work are as follows:

- Since the natural ground is comprised of sandy soil and slopes gradually, a bulldozer, which is excellent for excavation in layers at flat areas, is most suitable.

- A wheel loader, which excels in terms of working efficiency, is optimal for the loading of the excavated natural ground soil.

- A dump truck is most suitable for the transport of excavated natural ground soil since the transporting distance is long.

- A bulldozer, which is excellent for leveling and surface compaction, is most suitable for preparing embankments.

- Since kitchen garbage comprise the majority of the waste and there are hardly any bulky wastes, etc. which require crushing, leveling and surface compaction by a bulldozer should be adequate.

Besides the landfill operation equipment indicated above, a tractor head for spraying chemicals is needed for the purpose of preventing the proliferation of flies and other unsanitary pests.

C) Maintenance facility plan

a. On-site road

An on-site road shall be installed to facilitate the passage of the solid waste transporting vehicles to be provided in the FDS. Since the on-site road must thus enable safe passage of solid waste transporting vehicles without jams, a road having the structure shown in Fig. 2-3-2-79 shall be installed within the boundaries of the site.

b. Peripheral fence

A peripheral fence, such as that shown in Fig. 2-3-2-80 shall be installed about the entire perimeter of the site. Though this peripheral fence shall be provided mainly to prevent unnecessary entry of persons inside the FDS and for safety management, it shall also provide the effects of preventing illegal waste dumping and shutting off the view and serve as a facility for preventing the scattering of solid waste.

c. Monitoring well

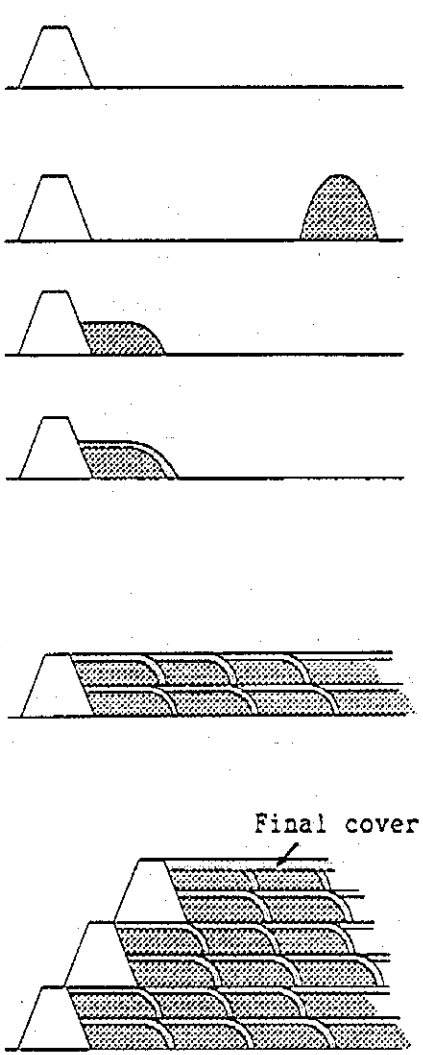
The monitoring well shall have the structure shown in Fig. 2-3-2-81 as standard.

The purpose of monitoring the groundwater in the surroundings of the FDS by means of a monitoring well is to monitor the degree of diffusion of pollutants that flow out from the FDS in the groundwater and the level of impact on the living environment for people.

A monitoring well must thus be provided at one location along the direction of flow of the groundwater directly below the FDS. The depth of the monitoring well shall be set so that the pollution of the aquifer adjacent the FDS can be detected.

Table 2-3-2-28 Work Flow and Equipment Used: NORTH SHUNEH

Work Flow	Equipment Used
START (1) Erection of embankment (2) Hauling of solid waste into site (3) Leveling and compaction of solid waste (4) Application of daily cover [NO] Has landfill been performed up to the height of the embankment? [YES] (5) Completion of one process [YES] Continue with further landfill? [NO] (6) Application of final cover END	(1) Excavation : Bulldozer Loading : Wheel loader Transport : Dump truck Leveling/ Surface compaction : Bulldozer (3) Bulldozer (4) Bulldozer (6) Excavation : Bulldozer Loading : Wheel loader Transport : Dump truck Leveling/ Surface compaction : Bulldozer



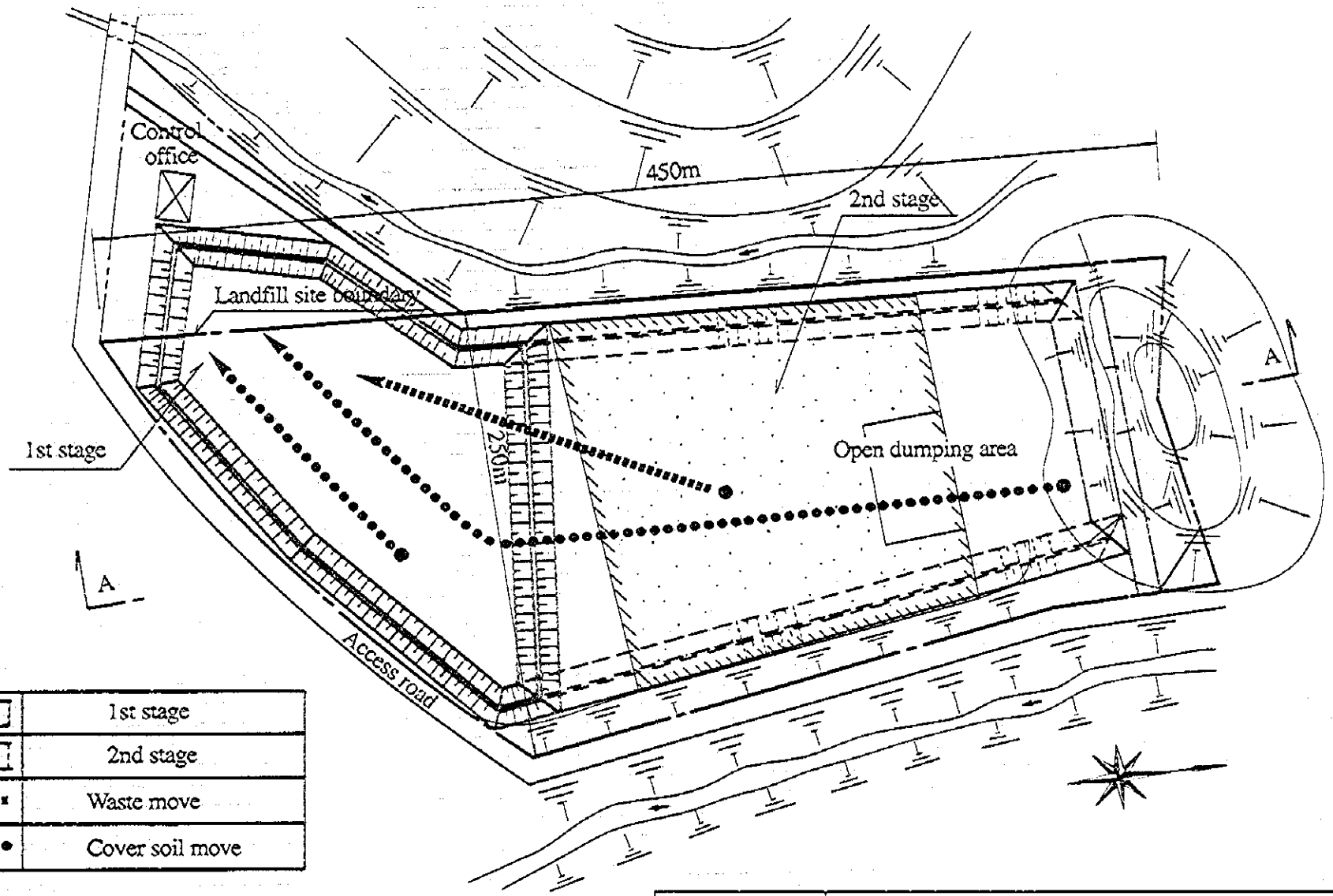
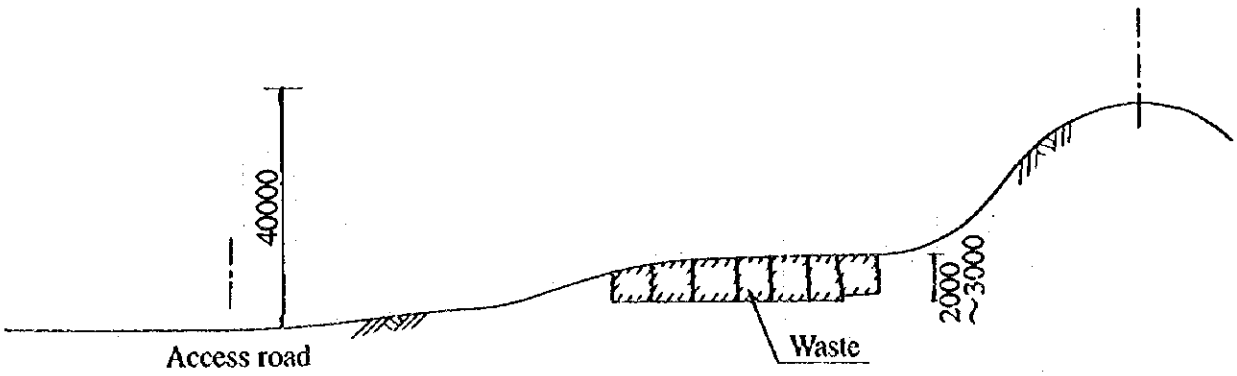
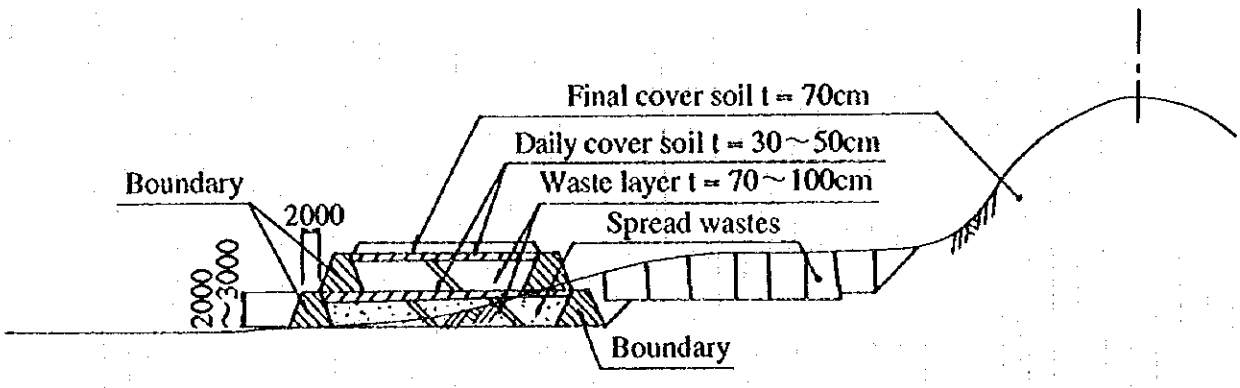


Fig. 2-3-2-77 Ground plan of North Shuneh FDS

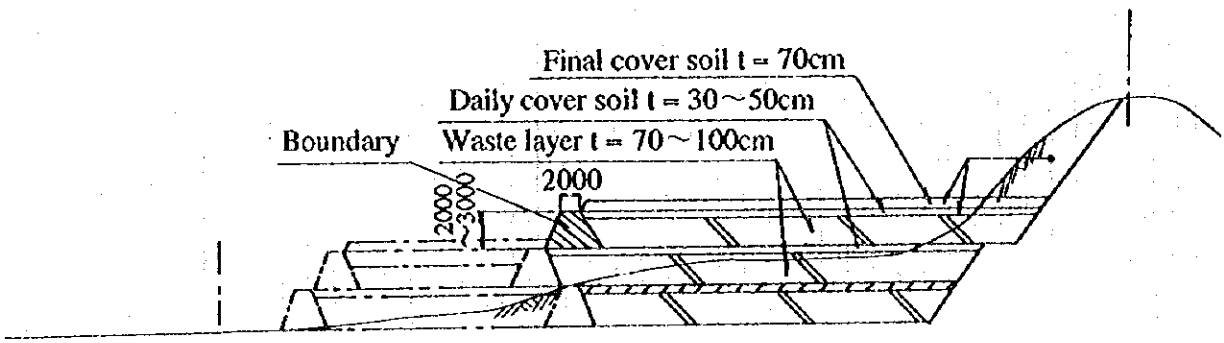
BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS



Section A-A



1st stage

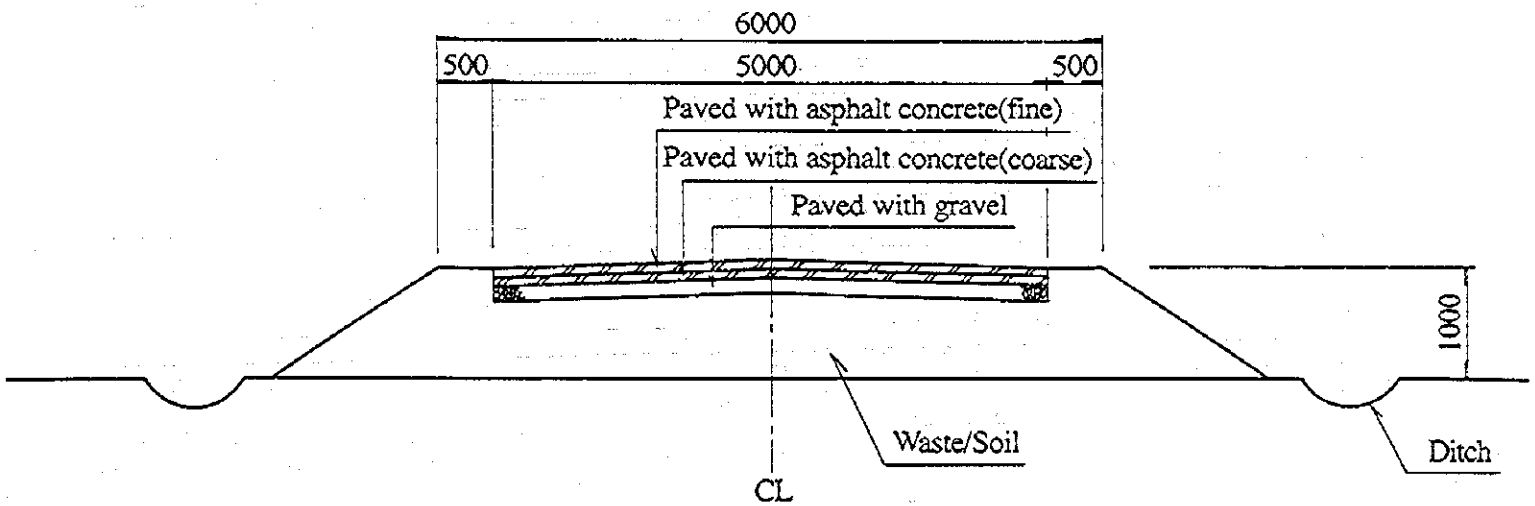


2nd stage

Unit: mm

Fig. 2-3-2-78	Cross section of North Shunch FDS

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

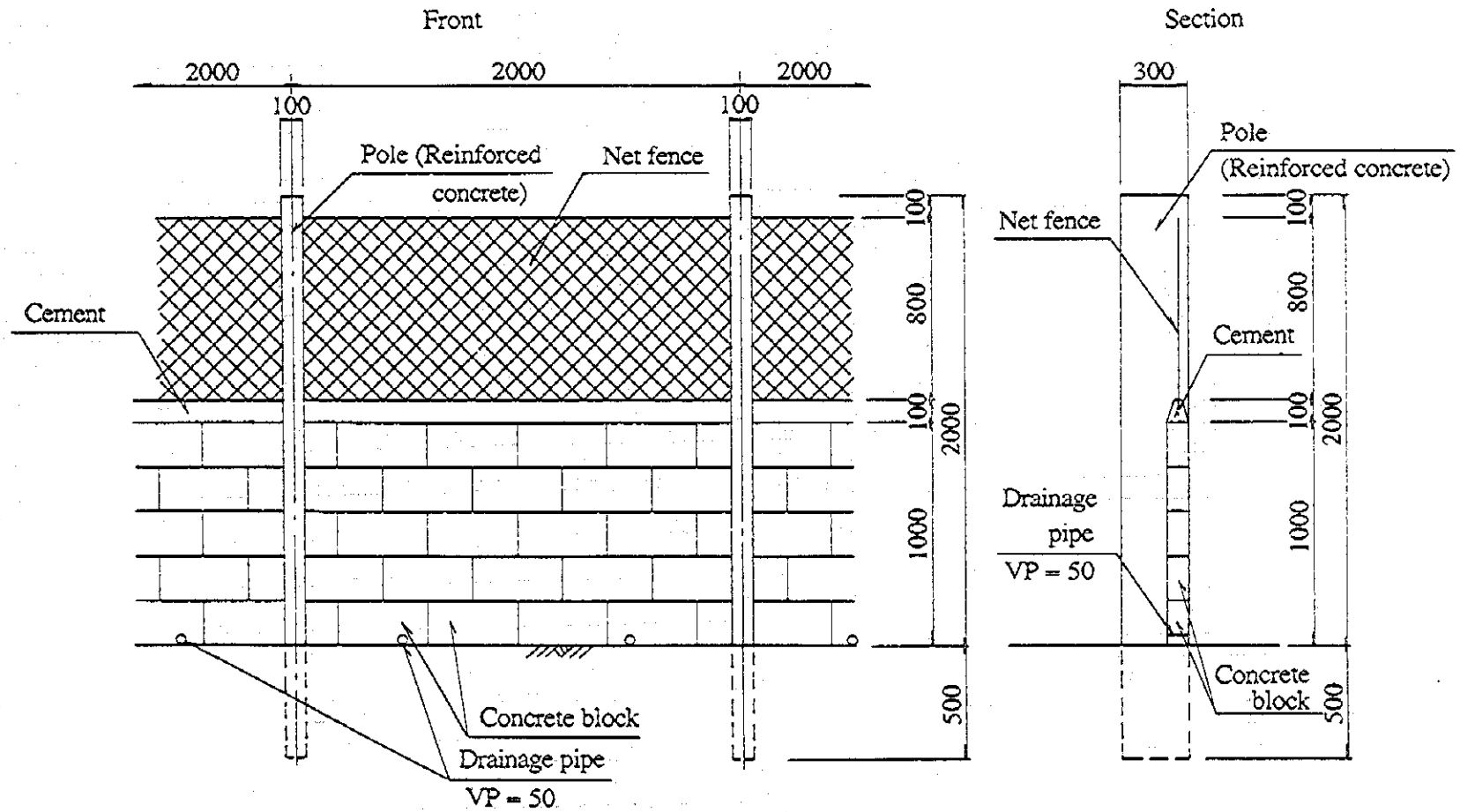


Unit: mm

Fig. 2-3-2-79 Cross section of access / insite road

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

Guard fence S = 1 : 20



Unit: mm

Fig. 2-3-2-80	General drawing of guard fence

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS

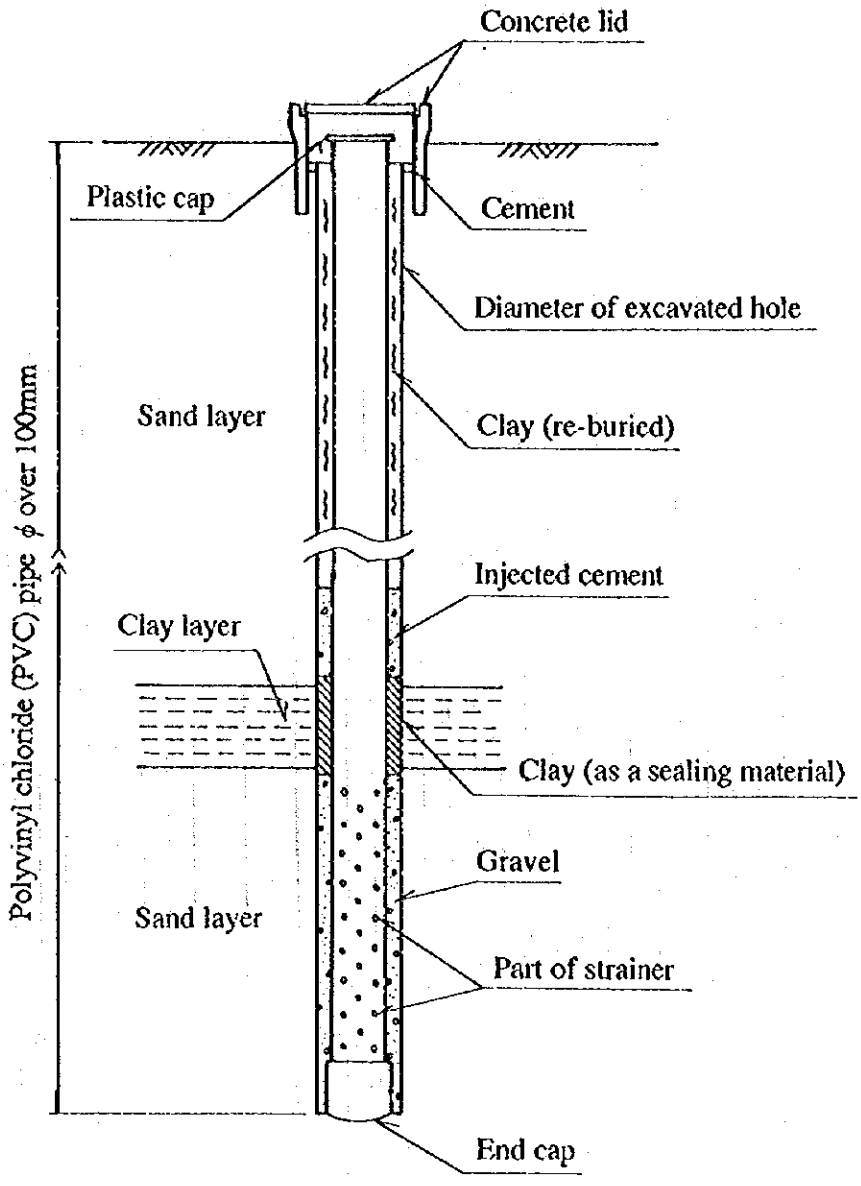


Fig. 2-3-2-81	Standard of monitoring well

BASIC DESIGN STUDY ON THE PROJECT FOR IMPROVEMENT OF SOLID WASTE MANAGEMENT IN MAJOR LOCAL AREAS