Japan International Cooperation Agency (JICA)
The Ministry of Public Works and Regional Planning
The Municipality of Bucharest
Romania

The Study on the Solid Waste Management System
for Bucharest Municipality in Romania

Final Report

Volume 4

Feasibility Study
on
the Development of the 3 Sanitary Landfill Sites in Balaceanca, Cretuleasca and Glina

December 1995

EX Corporation
Yachiyo Engineering Co., Ltd.

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Table of Contents

Chapter 1

Project Background, Objective and Necessity

CHAPTER 1 PROJECT BACKGROUND, OBJECTIVE AND NECESSITY

1.1 Background

This project "Development of the 3 sanitary Landfill Sites in Balaceanca, Cretuleasca and Glina" was identified through the formulation of master plan for solid waste management for Bucharest.

At present, Bucharest has one landfill site in Glina, which has been used since the mid 1970's. The site is managed and operated by RASUB, a public service providing company controlled by the Bucharest municipality. (This company was a state company in the former regime).

Open dumping is practiced on the site. There are no facilities to control environmental pollution. Naturally, the current open dumping practice in the Glina site has been causing environmental pollution and public health risks to local citizens living nearby the site. About 12,000 local people live in 2 villages adjacent to the landfill site: Popesti-Leordini village and Glina village. It is observed that surface water is polluted by leachate (waste water generated by waste deposit), uncovered dumped waste generates bad smell and smoke, and causes nuisance to the local people. Uncovered waste provides breeding bed for fly, dogs and crows.

The Glina landfill site has no water supply and no toilet facilities which leads to bad working conditions for the site workers.

At present, it is estimated that annual waste disposal quantity at the Glina site is 490,000 tons. It is projected that in 2010, the disposal quantity will increase to 820,000 tons. The cumulative quantity from 1995 till 2010 will be 10 million tons. A land of 167 ha in addition to the existing Glina landfill site will have to be acquired to dispose of the waste of this quantity.

1.2 Objectives

The major objective of the project is:

1. to develop final disposal sites in the 3 areas; Balaceanca, Cretuleasca and Glina which have capacity to dispose of all solid waste (except for hazardous waste) collected from the Bucharest municipal area, in sanitary and environmentally sound manner without causing significant public health risks to local citizens.

   This major objective will be achieved through the following activities:

   a. to secure landfill sites to satisfy future landfill needs
   b. to upgrade waste disposal standards by applying sanitary landfill

Other objectives of the project are:

2. to serve as a national model of landfill
3. to diffuse sanitary landfill technology to other localities

1.3 Project Components

The project "Development of Landfill Sites in Balaceanca, Cretuleasca and Glina" has the following 4 construction components:

1. Construction of a sanitary landfill site in Balaceanca
2. Construction of a sanitary landfill site in Cretuleasca
3. Improvement of the existing landfill site in Glina

Locations of the 3 sites are shown in Fig. 7.1-1 Necessary engineering services are included in the project. In addition, the project has the following component:

4. Diffusion of sanitary landfill technology to other localities

1.4 Executing Agencies and Beneficiaries

1.4.1 Executing Agencies

The executing agency for the first 4 components showing in Section 1.3 will be the Bucharest Municipality. Public Service Department of the municipality is a key department responsible for the project implementation.

Ministry of Public Works and Regional Planning will be responsible for the 4th component (diffusion of sanitary landfill technology to other localities).

1.4.2 Beneficiaries

Beneficiaries for the first 3 components (construction of the 3 landfill sites) are the citizens of Bucharest.
Beneficiaries of the 4th component is the local residents in Popesti-Leordeni village living adjacent to the Glina landfill site. Local residents living in villages situated to the east of the planned Balaceanca landfill site in the Agricultural Sector will be beneficiaries of a new access road which is included in the Balaceanca site construction component.

Beneficiaries of the 5th component (diffusion of landfill technology to localities) will be persons involved in landfill design and operation both in local governments and in disposal service providing organizations.

1.5 Necessity and Benefits

1.5.1 Necessity and Benefits of New Landfill Sites

It is estimated that the Bucharest Municipality must obtain land of 167 ha in total (other than the remaining area of the existing Glina landfill site) to dispose of solid waste collected until the year 2010. Through this project, the Bucharest Municipality will obtain 2 new sites (Balaceanca and Cretuleasca) having a total area of 68 ha, a 41 % of the required area.

The current Glina site will be full in several years if no new landfill sites are provided. The implementation of this project is necessary for the municipality to secure new

landfill sites. If no landfill sites are secured, the following situation may be caused in the near future:

1. Bucharest Municipality has to use incineration as a means of waste treatment, which is 8 times costlier than the planned sanitary landfill method. (Acquisition of some landfill sites are still necessary to dispose of incineration ash even if the incineration is applied.)
2. Sanitary condition of Bucharest will extremely deteriorate if there are no means of disposal of collected waste.

Only way to avoid the above situation is to secure new landfill sites through this project.

1.5.2 Necessity and Benefits of Upgrading Disposal Standards

The implementation of this project will provide the Bucharest municipality with an opportunity to upgrade landfill standard from the current open dumping to the sanitary landfill. The upgrading of landfill standards will bring about the following benefits:

1. Reduction of public health risks to local citizens living nearby landfill sites
2. Reduction of environmental pollution of the surrounding areas
3. Increases in people's acceptability of future landfill sites (It is likely that more people accept construction of landfill sites if it proves that the sites cause less problems to them.)

It is expected that a project component (diffusion of landfill technology to other localities) will lead to the upgrading of the disposal standards in other localities, which will bring about the same benefits for other Romanian cities.

Chapter 2

Options of Waste Disposal

CHAPTER 2 OPTIONS OF WASTE DISPOSAL

2.1 Alternative Methods

It is considered that the following two alternative methods are worth studying their applicability as a major means of waste disposal in Bucharest:

Alternative 1 Sanitary landfill
Alternative 2 Incineration

Theoretically, composting is another disposal alternative. However, the composting is not considered feasible as a major means of waste disposal in Bucharest judging from the fact that the composting was carried out in Bucharest but several years ago stopped because compost product contained heavy metals and there was not sufficient demand for the product.

2.2 Criteria for Evaluation

Cost and environmental soundness are two major criteria used in evaluation of disposal alternatives.

2.3 Evaluation

2.3.1 Specifications of Facilities Assumed for Evaluation

Cost of sanitary landfill and incinerator vary greatly depending on level (specifications) of respective facilities. For the purpose of meaningful comparison, environmentally-sound facilities of minimum cost were assumed. Outlines of assumed landfill facility and incinerator are shown below.

Table 2.3-1 Outline of Landfill Facilities Assumed for Evaluation

Facilities	Functions	Specifications
1. Embankment	to prevent garbage from flowing out of the site and to also prevent rainfall from flowing in.	Soil bank of 7 m height around site.
2. Lining	to avoid seepage of leachate and contamination of ground water	Artificial liner Thickness = 1.2 mm
3. Leachate Collection Facility	to collect leachate quickly	Crushed stone
4. Rain Water Drain Facility	to prevent water from flowing into the site	Concrete drain ditch (Width= depth=300mm) are constructed around the site
5. Leachate Treatment Facility	to treat leachate and improve quality of water to be discharged outside the site	Generated leachate will be transported to Glina sewage treatment facilities through leachate transmission pipes.
6. Gas Exhaust Facility	to collect and release the gas generated from decomposed waste	Old drum

Table 2.3-2 Outline of Incinerator Assumed for Evaluation

	Description
Type	24 hours operation stoker type
Facilities included	1. Refuse receiving and feeding system 2. Combustion system 3. Ash treatment system 4. Waste waster treatment system 5. Air supply system 6. Flue gas draft system 7. Dust collection system 8. Surplus heat utilization system 9. Instrumentation - Automatic control system 10. Stack 11. Building

2.3.2 Cost Comparison

Both sanitary landfill and incineration assumed for comparison are considered environmentally sound and acceptable. Therefore a meaningful evaluation of the two alternatives can be made in terms of unit cost. The unit cost is defined as follows:

Unit cost = a + b where,

a: Sum of investments and all costs of operation and maintenance needed during entire operation period

b. Total quantity of waste to be disposed of during entire operation period

Estimated net unit costs of the sanitary landfill and incinerator are $ 5.17/ton and $ 42.05/ton respectively as shown in Table 2.3-1 and Fig. 2.3-1. The unit incinerator cost of $42.05 is a net cost obtained by deducting heat sales ($ 7.83/ton) from the gross cost ($ 48.88/ton). ($ 48.88/ton - $ 7.83/ton = $ 42.05/ton

The unit cost of the sanitary landfill was estimated based on estimated costs of the planned landfill sites in Balaceanca and Cretuleasca.

The incineration is of continuous operation stoker type with systems of heat recovery. Its construction cost is assumed to be around US $ 185,000/ton, which is considered a minimum level as a modern incinerator.

Table 2.3-3 Estimated Unit Costs of Sanitary Landfill and Incineration

Unit: US $/ton in 1995 price

Cost Items	Sanitary Landfill	Incineration
1. Depreciation of Investment Cost	4.46	36.97
2. Operation & maintenance	0.53	12.91
3. Total cost (1 +2)	5.17	48.88
4. Sales of heat	-	7.83
5. Net cost (3 - 4)	**5.17**	**42.05**
6. Index of net cost	100	813

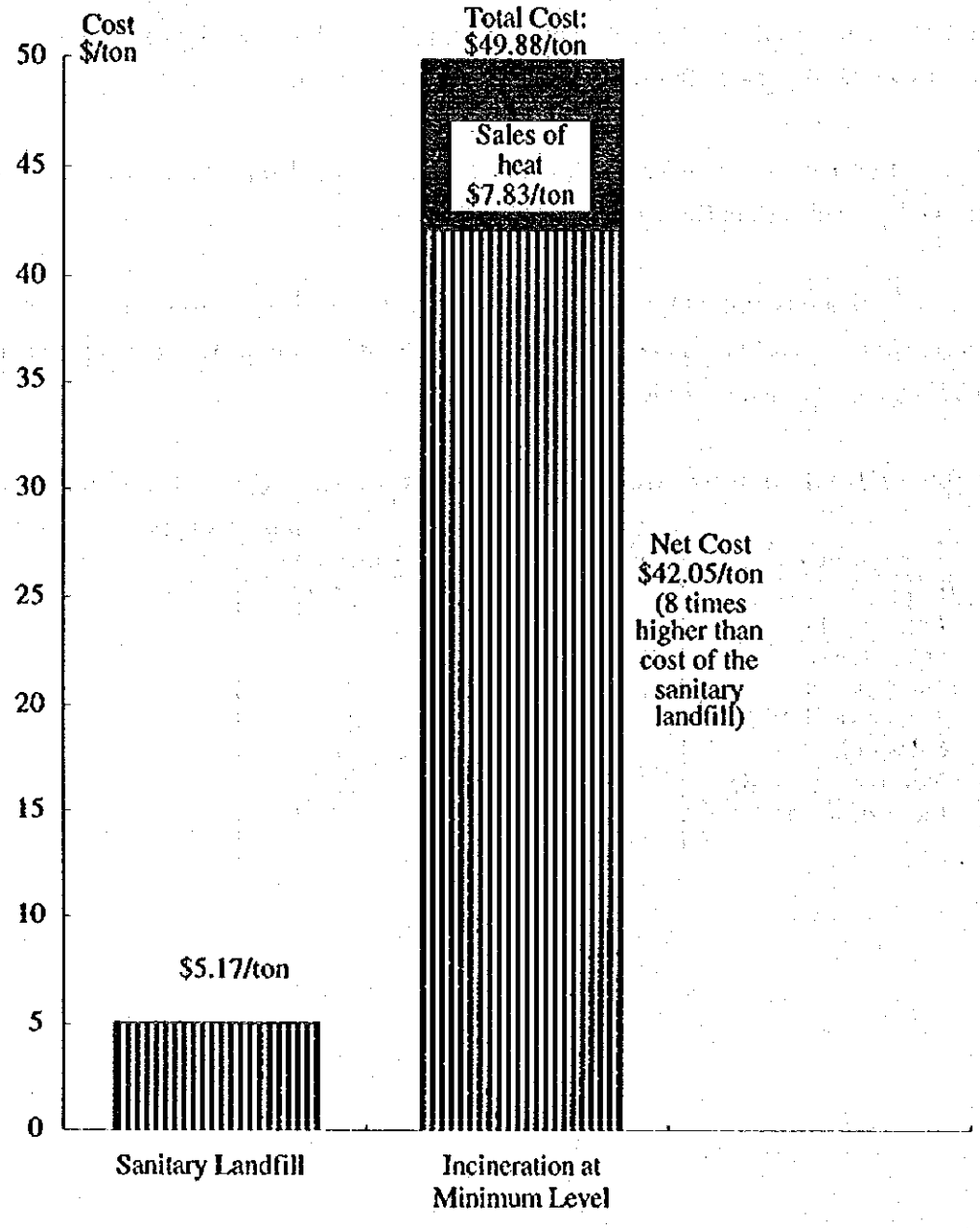


Fig. 2.3-1 Comparison of Unit Costs of Sanitary Landfill and Incinerator

2.3.3 Major Assumptions Used for the Estimation of Sanitary Landfill Cost and Incineration Costs

A. Assumptions Used for Estimation of Sanitary Landfill Cost

A1 Unit Construction Cost: $ 4.64/ton

Calculation:
a ÷ b = $ 46,368,680 ÷ 9,995,000 ton = $4.64/ton
where,
a: Estimated total cost of construction of the 5 sanitary landfill sites in Balaceanca, Cretuleasca, Afumati and Berceni: $ 62,246,866
b: Estimated total waste quantity to be disposed of at the 5 sanitary landfill sites in Balaceanca, Cretuleasca, Afumati and Berceni: 9,995,000 ton

A2 Unit operation and maintenance cost: $ 0.53/ton

Calculation:
a ÷ b = $ 256,786 ÷ 9,995,000 ton = $ 0.53/ton
where,
a: Estimated total cost of operation and maintenance of the 5 sanitary landfill sites in Balaceanca, Cretuleasca, Afumati and Berceni: $ 5,256,786
b: Estimated total waste quantity to be disposed of at the 5 sanitary landfill sites in Balaceanca, Cretuleasca, Afumati and Berceni: 9,995,000 ton

A3 Unit total cost of sanitary landfill: $ 5.17/ton

Calculation:
$ 4.64/ton (Unit construction cost) + $ 0.53/ton (Unit operation & maintenance costs) = $ 6.23/ton

See Appendix for further details.

B. Unit Incineration Cost

B1 Unit Construction Cost

B1.1 Construction cost per capacity: US $ 185,236/ton/day capacity

This costs was estimated based on an Austrian incinerator manufacturer's price quotation which is US $ 185,236/ton/day capacity. Further assumptions used are as follows: 1) building work shares 30 % of the original Austrian price. 2) building work in Romanian is one third of the Austrian price. 3) imported equipment cost in Romania is subject to 5 % import duty, 4) total incinerator price is subject to 18 % value added tax.

Calculation:
- Equipment cost before value added tax (a) = US $ 188,000/ton/day capacity x 70 % (equipment portion) x 1.05 (import tax: 5%) = $ 138,180/ton/day capacity
- Building work cost before valued added tax (b) : $ 188,000/t/d capacity x 30 % (building work portion) x 1/3 (ratio of Romanian building cost to Austrian cost) = $ 18,800/t/d capacity
- Total incinerator cost = (a + b) x 1.18 (value added tax: 18%)
= ($ 138,180 t/d + $ 18,800 t/d) x 1.18 = $ 156,980 t/d capacity x 1.18
= $ 185,236 t/d capacity

B1.2 Quantity of waste to be incinerated per capacity through life period: 5,010 ton

Calculation:
a x b x c = 1 t/d x 334 days/year x 15 years = 5,010 ton where
a: Waste incineration quantity per one t/d capacity: 1 t/24 hours (by definition)
b: Operation day: 334 day/year (11 months/year)
c: Useful period: 15 years

B1.3 Unit construction cost = $ 36.97/ton

Calculation:
$ 185,236 (unit construction cost per ton capacity) ÷ 5,010 ton (total waste quantity to be incinerated per ton capacity through life period) = $ 36.97/ton

B2. Unit Operation & maintenance costs: $ 12.91/ton

Calculation:
(a x b) + (c x d) = ($ 18.5/ton x 25 %) + ($ 25.1/ton x 33 %)
= $ 4.63/ton + $ 8.28/ton = $ 12.91/ton
where,
a: Typical Japanese operation cost of a 300 ton/day capacity incinerator: $ 18.5/ton
b: Ratio of Romanian operation cost to Japanese operation cost: 0.25
c: Typical Japanese maintenance cost of a 300 ton/day capacity incinerator: $ 25.1/ton
d: Ratio of Romanian maintenance cost to Japanese maintenance cost: 0.33

B3. Unit heat sales: $ 7.83/ton

Calculation: a ÷ b = $ 68,268/year ÷ 8,720 ton/year = $ 7.83/ton
where
a: Total heat sales of Militari incinerator (owned by RADET in Bucharest) in 1993: 122,882,000 lei/year = $ 68,268/year (at exchange rate: 1,800 lei/$)
b: Total waste quantity incinerated by the Militari incinerator in 1993: 8,720 ton/year

B4. Net incineration cost: $ 42.05/ton

Calculation: a + b - c = ($ 36.97/ton + $ 12.91/ton) - $ 7.83/ton =
$ 49.88 - $ 7.83 = $ 42.05
where,
a: Unit construction cost
b: Unit operation maintenance cost
c: Unit heat sales

2.4 Conclusion

1. Incineration is 8 times costlier than Sanitary landfill.

2. Feasibility of sanitary landfill crucially depends on land availability. Judging from the land use condition of Bucharest, it is likely that the Bucharest municipality can obtain, in the agriculture sector, land of area required for landfill up to the year 2010 (167 ha in total).

3. Therefore, it is judged that sanitary landfill is more economical, suitable and recommendable for Bucharest than incineration.

4. and specifications of sanitary landfill depend on such conditions as 1) geographical Appropriate level and geological conditions of sites, 2) distance from site to the nearest human settlement area, and 3) national environmental standards and regulation.

5. Development Strategy for Incineration

Although the incineration is not feasible at present, it may become feasible for Romania some time in the future as there will be changes in the Romanian socio economic conditions which will affect waste composition and land availability. Therefore, the incineration should not be excluded from a future option.

It may be an appropriate strategy for Bucharest to have a pilot incinerator to develop incineration technology suitable for conditions of the Romanian waste. It took about 10 years for the Japanese local governments to develop incineration technology suitable to Japanese waste conditions after they first imported modern incinerators from European countries.

It is generally said that if a local government wishes to apply incineration as major means of waste disposal without causing a serious economic load on the citizens, GDP per capita of $ 4,000 or more would be needed.

It would be beyond the financial capability of the Municipality of Bucharest to entirely finance even a pilot incinerator with the capacity of 200 ton/day within 10 years time. (Minimum construction cost would be $ 40 million.). In view of the possibility of diffusion of the incineration technology to other local governments, it makes a sense that the central government should finance a major portion of the cost of construction of such pilot incinerator. Timing of the construction of such pilot incinerator depends mainly on availability of funds and speed of changes in socio economic conditions. The appropriate timing would not be before the year 2000.

Part D of Report 8 Other Studies shows technical information on incinerators.

Chapter 3

Existing Institutions and Laws Concerning Solid Waste Management

CHAPTER 3 EXISTING INSTITUTIONS AND LAWS CONCERNING SOLID WASTE MANAGEMENT

3.1 Institutions Involved in Solid Waste Management

3.1.1 Central Government Level

At central government level, the following 4 ministries are involved in solid waste management:

1) Ministry of Public Works and Regional Planning (MLPAT)
2) Ministry of Water, Forests, and Environmental Protection
3) Ministry of Health
4) Ministry of Industry

MLPAT is responsible for formulation of policy and planning, appropriation of state budget to local governments, and formulation of guidance, education/training.

Ministry of Water, Forests and Environmental Protection is responsible for drafting environmental laws, and a law regulating environmental aspects of solid waste management. This ministry receives environmental impact assessment (EIA) from project proponents, and give environmental permits through its provincial branches. (EIA is required for landfill projects.) Responsibilities of this ministry include also control of trans-boundary movement of waste, and monitoring of waste disposal operation.

Ministry of Health sees waste management from view point of public health. This ministry's responsibilities include policy development, drafting laws, and granting permits and licenses. The ministry has Inspectorate for Salburity (Cleansing) and Preventive Medicine in each province. Each inspectorate is responsible for assessing solid waste management activities from public health view point.

Ministry of Industry is responsible for promotion of recycling. Under the ministry, there is National Commission for Material Recycling - NCMR. Its activities include promotion of recycling through development of technology, and drafting laws. This commission grants recycling business permissions to companies which apply for them.

3.1.2 Local Government Level

Local Government's Responsibility for Solid Waste Management (SWM)

According to the Romanian Laws including Law 4/1981, local governments have ultimate duty of care and accountability for SWM to the public.

The Bucharest Municipality's main responsibilities for SWM may be summarized as follows:

1. an ultimate duty of care and accountability for SWM to the public
2. planning and policy formulation
3. financing SWM services including the contracting out of services
   Note: The municipality has a power to give private companies a franchisee authorization and license to collect solid waste.
4. setting SWM standards and issuing norms
5. monitoring services for compliance.

Actual Providers of SWM Services

In the former regime, all the public services including solid waste management were provided by state service providing companies in each locality. According to Law 15/1990, these companies have been transformed into Autonomous Regies, which continue to provide solid waste management service at present. Autonomous regies are closely monitored and regulated by local governments.

3.1.3 Solid Waste Management in Bucharest

Provision of SWM Services

At present, in Bucharest, collection service of municipal waste except for street waste is provided by two organizations, i.e., the Autonomous regie called RASUB and a private company called RGR (a joint venture company formed by a German power company, German cleansing company, RASUB and RADET). RASUB collect municipal waste from 5 sectors (Sectors 1 - 5), while RGR collect waste from Sector 6. Street waste is collected by ADP (public service department in each sector government). Non-municipal waste such as industrial waste, demolition waste are collected under the responsibility of waste generators.

Relationship between the Bucharest Municipality and Service Providers

The municipality have granted both RASUB and RGR an authorization to collect household waste, and a license to collect business waste. However, they have no contractual relationship with the Bucharest Municipality. RASUB and RGR have waste collection service contracts with the service recipients, and collect the service fees from them. It is considered that they are franchisees. RASUB (must obtain approvals from both the municipality and Ministry of Finance if it wants to change the service fee rates, while RGR can change the rates without obtaining approval from them.

The Bucharest Municipality intends 1) to introduce waste tax and collect it, and 2) to use RASUB, RGR and other companies as contractors through tenders, and remunerate them based on the service contracts.

Introduction of Waste Tax

The municipality's councilors meeting did not approve the introduction of the waste tax mainly in view of possible difficulty in collection of such tax by the municipality. The municipality requested Ministry of Finance (MoF) to collect the tax for the municipality. However, MoF refused it as MoF does not have enough manpower for the tax collection. A possible solution may be that the municipality pay MoF some fees for the tax collection service. The municipality has been negotiating with MoF.

Transformation of RASUB into a Commercial Enterprise

The municipality's councilors meeting decided that RASUB should be transformed into an commercial company according to Ordinance 69/1994. However, the Bucharest prefect (appointed by the Government) turned down the municipal decision possibly due to a problem related to the ownership of assets (buildings, workshop facilities, waste trucks, etc.). Note: The municipality thinks that most of the assets such as workshops and waste trucks used by RASUB belong to the Municipality, while RASUB is of the option that these assets belong to RASUB. It seems that the prefect supports the option of RASUB.

Establishment of Municipal Waste Administration

According to Law 69/1991, a local government has 2 institutional choices with respect to management of waste disposal, i.e. either to use autonomous regies or to establish a municipal organization (Waste Disposal Administration). At present, in Bucharest, the autonomous regie provide disposal services. Bucharest municipality has a plan to establish Municipal Waste Disposal Administration. It is expected newly constructed landfill sites in Balaceanca and Cretuleasca as well as the existing Glina site will be

managed by the Municipal Waste Disposal Administration. (Proposed organization of this administration is shown in Section 1.8 of this report.)

3.2 Laws Concerning Solid Waste Management

In Romanian, there is not a comprehensive law concerning solid waste management. Ministry of Water, Forests and Environment has an initiative to draft a law which regulates environmental aspects of solid waste management.

The same ministry has drafted a new Environmental Protection Law. It was passed by the lower chamber of the parliament in the spring session 1995. This law may be passed by the upper chamber by the end of this year or next year 1996. This new law will replace the existing environment law (Law 9/1973).

In Romanian there is not a national standards or guidelines with respect to 1) criteria for selection of landfill sites, 2) required facilities, and 3) required standard on treatment of leachate (waste water generated in the deposit of landfill) though some requirements are shown in Law 5/1989, Order 59/1976 by Ministry of Public Works, and Order 981/1994. Ministry of Public Works has started formulation of a national standard concerning landfill.

The Bucharest Sanitation Norm enforced by the municipality in April 1994 is a principle norms concerning environmental protection and solid waste management.

The proposed landfill facilities are designed in such a manner as to comply with all the existing laws and regulations, guidelines, and norms.

The following paragraphs list laws and regulations concerning selected issues:

1) *Local governments are responsible for organizing solid waste management.*

This is stipulated in:

- Law 4/1981 on Municipal Services (Articles 6,7 & 12)
- Law 10/1982 "Obligation and responsibilities of local councils, socialist institutions and the population for organizing, maintaining, and cleaning of all localities, the maintaining of public order and discipline"
- Law 9/1973 on Protection of Environment (Article 35 Item b and Article 37 Item c)

- Law 69/1991 Local Public Administration (Article 21 Item 1)

2) *Local government can use autonomous regies or private companies that provide solid waste management services.*

This is stipulated in:

- Law 69/1991 on Local Public Administration (Articles 21 Item h)
- Law 15/1990 on Restructuring of State Owned Enterprises into Autonomous Regies and Commercial Companies (Article 3 2nd paragraph) (This law was amended by Ordinance 69, 1994)

  Note: Autonomous regies were established according to this law 15/1990.

3) *Hazardous waste management*

a. Generators' responsibility for hazardous waste management
   - Law 9/73 (Articles 19 and 22)
   - Bucharest Sanitation Norms (Articles 3, 14 and 4 Item b)

b. Hazardous waste without being treated may not be brought into municipal disposal sites
   - Law 9/1973 (articles 19 and 22 paragraph 2)
   - Bucharest Sanitation Norm/1994 (Articles 13 Item b and 14 item c)

c. Import of hazardous was
   - Law 88/1992
   - Government Ordinance 340/1992 amended by Government Ordinance 437/1992

4) *Penalty imposed on those who did not comply with laws regarding management of hazardous waste*

This is stipulated in:

- Government Decision No. 127/1994 "Penalties for inadequate waste management affecting the environment and public health"
- Law 10/1982
- Bucharest Sanitation Norms/1994 (Articles 13 and 21)

5) *Landfill*

a. Criteria for site selection:

- Ordinance 59/1976 on Domestic and street waste management issued by Ministry of Public Work (Article 31)
- Order 981/1994 Hygiene Norms on People's Life Environment (Article 10)
- Law 5/1989 Article 12
- Romanian Standard (R-07) Urban salbrity, Salbrity of communities, Terminology

b. Types of waste that municipal disposal sites may accept
   - Bucharest Sanitation Norms/1994 (Article 2)

c. Landfill operation method:
   - Ordinance 59/1976 Articles 32 and 33

d. Facilities required:
   - Orientation Principles for domestic waste landfill site equipment issued by Ministry of Waster, Forests, and Environmental Protection
   - Romanian Standard (R-07)
   - Ordinance 59/1976 Article 34

6) *Recycling*

A new law has been proposed by Ministry of Industry to replace the existing Law 469/1979.

Chapter 4

Sites Selection, Conditions and Environmental Evaluation

CHAPTER 4 SITES SELECTION, CONDITIONS AND ENVIRONMENTAL EVALUATION

4.1 Site Selection

4.1.1 Identification of Candidate Landfill Sites

Through the Master Plan Study, the Study Team in collaboration with the Romanian counterparts have identified 11 candidate disposal sites as shown in Fig 4.1-1 and Table 4.1-1 in the Agricultural Sector that surrounds the area under the Bucharest Municipality.

Those sites were identified and preliminary evaluated based on economic, environmental other criteria that cover the following:

- Efficiency of collection and transport (locations should be within 20 km from the center of Bucharest.)
- Compliance with related urban planning regulations
- Area of sufficient size (one site area should be larger than 10 ha.)
- Suitable topographical conditions to ensure landfill capacity efficiency
- Sites should be located more than 200 m away from the property lines of premises such as residences and stores.
- The landfill site should be located at least 200 m away from rivers or lakes
- Approach road and access road should be available.

Technical Guidelines for Selection of Landfill Sites shown in the Attachment to the Master Plan was also used by the Study Team for the identification of candidate landfill sites.

4.1.2 Selection of Sites

After 11 candidates disposal sites were identified and preliminary evaluated by the Study Team and the counterparts, the Bucharest Municipality sent letters to each villages councils where the candidates sites are located to check possibility of using the candidates sites for waste disposal. Of the 11 the village councils, 3 village councils, i.e., Cernica council (for Balaceanca site), Stefanesti de Jos council (for Cretuleasca

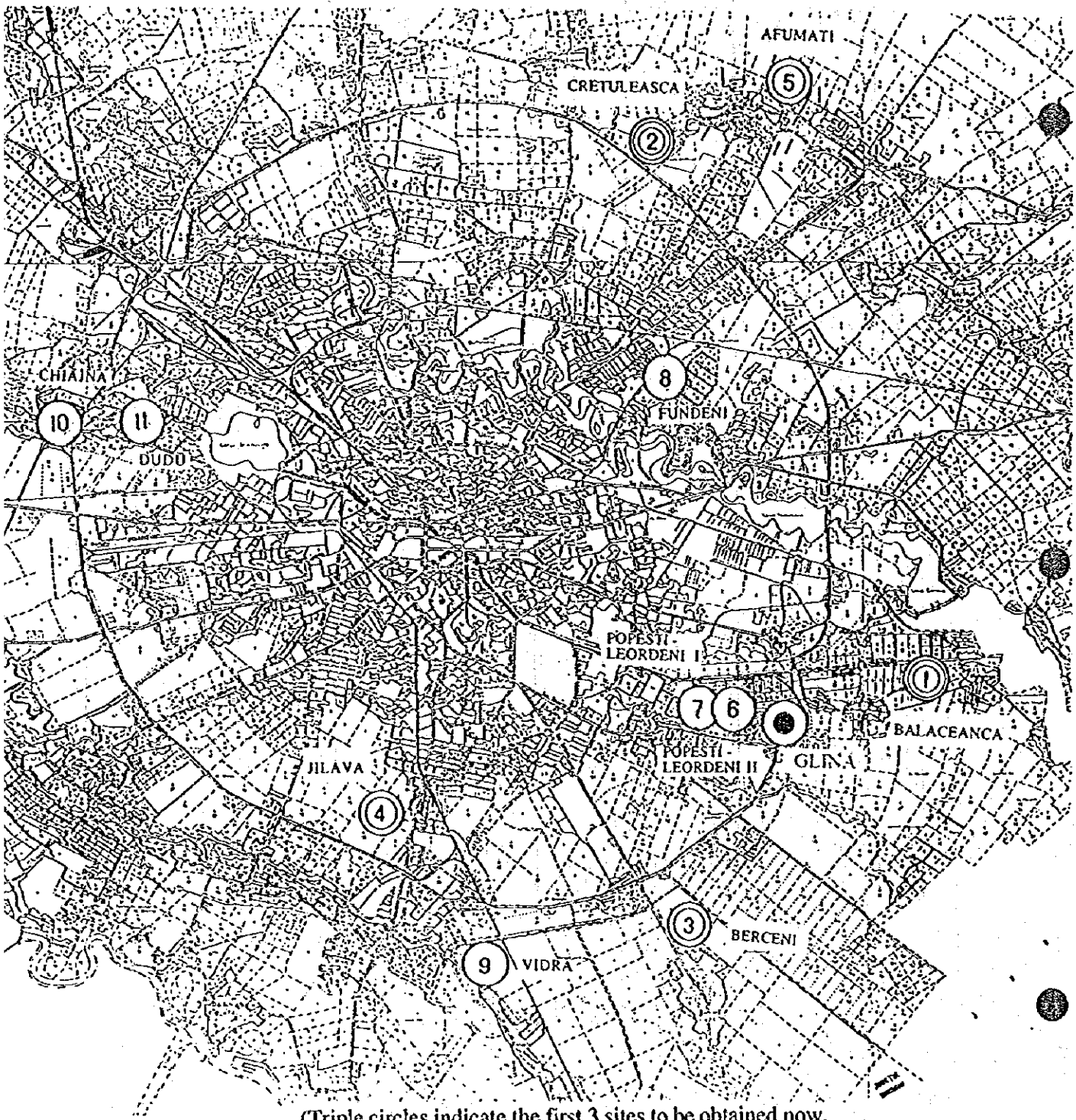
site) and Vidra council (for Vidra site) agreed that the Study Team would carry out a feasibility study for construction of disposal sites.

Of the 3 sites (Balaceanca, Cretuleasca and Vidra), the first 2 sites, i.e., Balaceanca and Cretuleasca sites have been selected for feasibility study because 1) it was estimated that the construction cost of Vidra site is higher than the other 2 sites, 2) Balaceanca site construction cost was estimated to be the lowest among all the 11 candidate sites, and 3) through the Master Plan study, it was considered advisable for the Bucharest Municipality to acquire 2 new sites as soon as possible in addition to the existing Glina site for economical waste haulage.

The Master Plan proposes that the Bucharest Municipality should acquire 3 more sites for waste disposal in Berceni, Afumati and Jilava so that these sites can be used after filling up the planned sites in Balaceanca and Cretuleasca as well as the existing Glina site.

Table 4.1-1 Description of the Candidate Disposal Sites

No.	NAME	LOCATION & Distance from the city center	AREA (Landfill area)	CAPACITY (Mil. m^3)	LAND USE	NOTE
1	BALACEANCA	SOUTH - EAST 10.0 km	50 ha (45 ha)	4.0	Swampy land	• New access road 1.5 km should be constructed • Excavation work is needed
2	CRETULEASCA	NORTH - EAST 12.0 km	24 ha (20 ha)	1.2	Field	• The site is located nearby Balta river (150 m) • Excavation work is needed • New access road 0.8 km should be constructed • There is an institute nearby the site
3	BERCENI	SOUTH 9.0 km	20 ha (16 ha)	0.8 (4m Height = 1.6)	Field	Same as above
4	AFUMATI	NORTH - EAST 12.0 km	36 ha (30 ha)	1.2 (4m Height = 2.4)	Field	• New access road 1.0 km should be constructed • Excavation work is needed
5	JILAVA	SOUTH 9.0 km	43 ha (35 ha)	1.4 (4m Height= 2.8)	Field	• New access road 0.6 km should be constructed • Excavation work is needed
6	POPESTI - LEORDENI II	SOUTH - EAST 10.0 km	58 ha (50 ha)	7.2	Field	• The site is located nearby Glina existing site and residential area • New access road 1.6 km should be constructed • There is not cover soil material
7	POPESTI - LEORDENI I	SOUTH - EAST 7.0 km	25 ha (21 ha)	3.0	Field	• The site is located nearby Glina existing site and residential area • New access road 1.2 km should be constructed • There is not cover soil material
8	FUNDENI	NORTH - EAST 15.0 km	41 ha (30 ha)	1.2 (4m Height = 2.4)	Field	• New access road 0.3 km should be constructed • Excavation work is needed
9.	CHIAJNA	WEST 11.5 km	50 ha (42 ha)	3.0	Reed plain	• New access road 0.8 km should be constructed • The site located nearby the residential area (100 m) and Dimbovita river (200 m) • There is not cover soil material
10.	DUDU	WEST 9.0 km	25 ha (21 ha)	1.5	Open Pit	• New access road 2.0 km should be constructed • The site is located near by Dimbovita river (150 m) • There is not cover soil material
11.	VIDRA	SOUTH 110 km	90 ha (57 ha)	5.1	Field	• New access road 0.6 km should be constructed • Excavation work is needed



(Triple circles indicate the first 3 sites to be obtained now.
Double circles indicate the other 3 sites to be constructed later.)

Fig. 4.1-1 Location of Candidate Sites

4.2 Conditions of the Initial Sites

4.2.1 Description of the Project Sites

1) Cretuleasca Project Site

The Cretuleasca project site is within the Stefanesti commune, on the right bank of the Pasarea river. Cretuleasca, Stefanesti de Jos and Stefanesti de Sus are at a short distance downstream on the river banks. Proximity of the water front and Cretuleasca village (500m) makes this location not very favorable from the environmental point of view.

The project site is almost classified as pasture land, but actual informal use is crops (maize). It seems that about 7ha of the land within the limits of the project site could be privately owned by 4 households of Cretuleasca. The bottom of the site depression is used for informal and illegal dump of waste.

2) Balaceanca Project Site

The Balaceanca project site is within the Cernica commune, on the right bank of the Dimbovita river, and between 2 villages at equal distance: Glina and Balaceanca. Distance to these villages is about 1km. Distance to the actual waste disposal site is about 3 km, to the west.

The project site is a part of the communal and natural pasture land of the Balaceanca village. Within the site, 6 households pay land use rights for individual cultivation of maize crops. Pasture land is mainly used by cattle owners of the western part of Balaceanca, but this pasture is secondary for its quality and location in comparison with other pasture land sites, and for Balaceanca people on a whole. Pasture land users pay an annual land use fee to the commune.

The site is also used for informal and illegal dump of solid waste. A small part of the project site is still remaining as swamp, with natural vegetation and water surface.

The western escarpment of the project site is an important historical site of the Glina culture (2600 - 1900 BC). The site covers a period from 3000BC (neotlithic) to the first century (Dacic settlements). The project must obtain the approval of the National Commission of Historical Monuments (Ministry of Culture). Protection must be considered.

3) Glina Project Site

The Glina project site is almost within the Popesti Leordeni commune, just at the limit with the Glina commune. The project site is shared by both communes, since 1.7% of the land area of Popesti Leordeni, and 0.36% of the land area of Glina commune are registered as landfill. The site is immediately surrounded by the villages of Popesti Leordeni and Glina, and the Ring Road of Bucharest. Natural conditions are similar to those of the Balaceanca site project. The site has been used for 30 years, and the impact on the social environment is critical.

Actual use also includes informal uses like individual cultivation of crops (maize) and herding of cattle on pasture land. A small part of the project site is still remaining as swamp, with natural vegetation and stagnant water.

4.2.2 Natural Environment Conditions

1) Cretuleasca Site

a. Topographical and Geological Conditions

The Cretuleasca site is on a plateau at about 88m above sea level and has a dyke formed by rainwater which drained through it from the plateau. The dyke is about 6m deep.

The site is located on the layers whose base is diluvium. Over the base lay alluvium of maximum 5m thick and diluvium again on top. In this top layer, sandy soil spreads upto 65m high, a thick clay layer of about 11m on the soil, a sandy soil layer of 2 to 6 m at 76 to 81 m high, and again an 8m plus thick clay layer to the top. In the bottom part of alluvium stretches out a thick sandy soil layer, and over which clay mainly lays, whose N value is 3 to 4. Geological maps are shown in Appendix Chapter 1 Section 1.3.

b. Hidorological Conditions

Superficial groundwater table is at 1 to 7m depth and is subject to important vertical variations (3 to 5m). The Colentina aquifer is only at 5 to 7m depth, and the Mostitea aquifer at 20 to 25m (only 10m depth under the Pasarea river). Superficial groundwater is discharging into the Pasarea river. In case of contamination of the superficial aquifer,

river water quality can be affected. Colentina and Mostitea aquifers are important aquifers for drinking water.

Surface water is almost stagnant and its quality is then highly sensitive to any contamination.

The aquatic environment of the Pasarea valley is well preserved since it is isolated from accesses, and there is no pressure on the environment. There is no any important protected species within the habitual birds population. Quality of the aquatic ecosystem depends on the water quality of the Pasarea river and, more globally, on the land use of the catchment area.

2) Balaceanca Site

a. Topographical and Geological Conditions

The Balaceanca site consists of a plateau at about 65m above sea level and a lowland, which had been eroded by river flow and developed, at about 51m above sea level. The site shows a typical topographic feature of a river terrace along the river.

The site is located on the layers, whose base is diluvium. Alluvium of 10m sits on the base. A clay layer partially exists in the base but was identified discontinuous. A sandy soil layer of about 5m spreads on the clay layer. Another clay layer of 3m also spreads over the sandy soil layer. This clay layer is scarce in the lowland, and the sandy soil layer beneath and the alluvium contact each other. Sandy soil layer spreads over this clay layer.

Clay and sands alternate in the lowland's alluvium. The clay layer is solid for alluvium and its N value is 3 to 11. Geological maps are shown in Appendix Chapter 1 Section 1.3.

b. Hidorological Conditions

Water table is at about 2 to 10m depth in the Dimbovita flood plain, including the project site. On the terrace, wells depth is at about 20m. Important aquifers are the Colentina aquifer at only 15 to 20m depth on the terrace, and the Mostistea aquifer at about 40m depth.

Phreatic aquifer is very superficial (swamps), and Colentina strata is directly in contact with the project site, which makes groundwater very sensitive to the project.

Dimbovita river is at 300m from the project site. Confinement of the riverbanks (but not the bottom) has created conditions of water stagnation during rainy periods. There is a significant water exchange between Dimbovita river and phreatic aquifers.

Groundwater quality is seriously contaminated by the infiltration of Dimbovita river water at 15m depth. Upper groundwater (swamp area) is of better quality.

Dimbovita river water is degraded due to upstream discharge of Bucharest wastewater. Swamp water is polluted (nitrate, ammonia).

The swamp environment within the site as well as the flood plain has been reduced to very small units of land. It is not a significant habitat for wildlife species, which are not protected species in Romania. Bird species are in small number and only of passage.

3) Glina site

a. Topographic and Geological Conditions

The Glina site consists of a plateau at about 75m above sea level and a lowland, which had been eroded by river flow and developed, at about 56m. The site shows a typical topographic feature of a river terrace along the river.

The site is located on layers, whose base is diluvium. Alluvium of maximum 10m lays over the base in the lowland.

The base of the site contains a clay layer of over 6 m at about 50m or higher, which forms the base of alluvium of the lowland. A 9m sand layer containing gravel exists over this clay layer. A clay layer over the sand layer.

Alluvium in the lowland containing 1m of a thin sand layer, comprises of mainly clay and its N value is 2 to 6. Geological maps are shown in Appendix Chapter 1 Section 1.3.

b. Hidorological Conditions

Phreatic aquifer appears at surface in the swamp site. Groundwater flow is from the terrace to the swamp, and from the swamp to the Dimbovita river. The Colentina strata is directly in contact with the project site, which makes groundwater very sensitive to the project.

Wells groundwater quality is chemically contaminated on the W and NW side of the Glina landfill, while it is within the required limits all around excepted for bacteriological pollution. Link with the Glina disposal site is not evident. Contamination by nitrates is general. Drill water analysis of superficial aquifer within the project site has shown contamination from the landfill.

The project site is still partly occupied by a swamp habitat, which is frequented by few bird species. However, its ecological value is limited (small area, few number of species, absence of protected species).

c. Air Quality

Air quality is affected by industrial plants, traffic, and the Glina landfill site. Air pollutant levels are close to accepted limits on the landfill site. Proximity of dwellings is a factor of sensitivity of the air quality issue.

4.2.3 Social Environment Conditions

1) Cretuleasca Village

In the context of land ownership conflicts, land related transaction is a special sensitive issue.

Pasarea river is an essential element of the living environment, crossing the 3 villages of the commune.

The site is in the middle of 4 radius roads going from Bucharest to the countryside. 2 of them are restricted for trucks traffic (international roads). The other 2 roads are crossing the railway and the Ring Road at the same point. These crossing sites could create difficult conditions for the regular traffic of waste trucks.

Surface water and superficial phreatic water are important resources for the commune: Irrigation and fishing, actually under used, and drinking water.

Superficial aquifer is the main source of drinking water (individual wells), at a depth of about 7 or 8m. Drinking water quality is at the limit of acceptance for nitrates and ammonia, and compared with the Romanian standards.

Sanitary conditions (no sewage, no collection of waste, no water supply network) are factors of health risks in case of contamination of surface or groundwater.

The site is vulnerable to noise because of the favorable conditions of natural sound landscape (birds, water). Local people are probably not aware of the value of this amenity.

Conditions of life are similar to Romanian standards in Stefanesti commune, and under average for Cretuleasca village. Crops land is essential for the subsistence of Cretuleasca people. The standards of living at Cretuleasca means a great sensitivity to any change in land use pattern.

Landscape of Pasarea river is a potential amenity for the future. There are 3 factors of future potential for nature tourism: a) Rich flora and bird population of the aquatic environment. b) High quality of visual and sound landscape. c) Proximity of Bucharest with easy access.

Predominant wind is from E and NE, which means that there is no particular vulnerability as regards to the project location.

Local people expect that the project will give them advantages in terms of income / employment. They worry about possible health effects of the project.

2) Balaceanca Village

About 50 households do not have land property right at Balaceanca.

For the users of the crops land within the project site, the transfer of use rights to the available pasture land near Balaceanca should not be a problem.

The economic value of the site is limited to: a) Land use fees for crops and pasture land, which are collected by the Cernica commune; b) Herdsmen wage; c) Herding capacity

of a cattle of 50 cows heads, temporary, and used for commodity and as a custom. Pasture land of the project site is of minor importance, and loss due to implementation of the project should not seriously affect the actual users.

Lack of easy communication is a major problem for Balaceanca. In spite of the proximity of Glina, and of the large Dimbovita valley, the village is isolated. Only 1/10 of the village roads is asphalted.

The Colentina stratum, which is an important aquifer for drinking water, is very close to the surface all around the project site within the slopes of the escarpment.

Sanitary conditions (no sewage, no collection of waste, no water supply network) are factors of health risks in case of contamination of surface or groundwater.

Prevalent winds, which are from W and SW (more than 20% year total frequency) and E and NE (more than 28% year total frequency) are factors of vulnerability for Glina and Balaceanca villages.

Local people expect advantages in terms of commodity and communications: Roads, water supply, gas supply, telephone, sewage system.

3) Dwelling Area Around the Glina Project Site

The living conditions are affected by the landfill beyond the level of acceptability: Loss of the value of land, loss of normal living conditions outside (need to close windows, need to keep washing in the home, need to clean the fields scattered with solid waste materials), and unsanitary (water, solid waste dumps, pest and disease vectors).

Pestilential odors due to several sources are far beyond acceptable limits. Direct nuisances are daily and very severe, which makes these issues critical for the acceptance of the project. Bad traffic conditions are part of the effects of the landfill on the living environment of Glina village.

The Glina landfill is an important source of income for several households of gypsies.

Water resources of the Colentina aquifer are used for drinking purpose. Supply is by individual wells, at a depth of about 20-30m (on the river terrace).

Drinking water quality of Glina wells seems not to be contaminated by the landfill, but is influenced by other sources.

Colentina stratum is very close to the surface all around the project site, within the slopes of the escarpment.

People living around the landfill site have environmental diseases due to unsanitary conditions, like trichinosis (at least 25 cases in 1994), digestive illness, skin diseases, and breath diseases.

Conditions of life are at subsistence level for the people of Glina village. The scavengers population is more particularly sensitive to the conditions of the landfill site, in terms of income, and health.

4.3 Evaluation of the Impacts of the Projects

4.3.1 Receptors of the Impacts of the Project

The main receptors of the impacts of the Cretuleasca project are:

1. Aquatic environment of Pasarea river
2. Water quality of the Pasarea river
3. Superficial aquifer
4. Cretuleasca village people
5. Crops land use at the project site
6. Land property at the project site

The main receptors of the impacts of the Balaceanca project are:

1. Pasture land use at the project site
2. Crops land use at the project site
3. Colentina aquifer in the river terrace
4. Superficial aquifer in the Dimbovita flood plain
5. Balaceanca village people
6. Cultural assets at the project site

The main receptors of the impacts of the Glina project are:

1. Colentina aquifer in the river terrace
2. Superficial aquifer in the Dimbovita flood plain
3. Glina village and Popesti Leordeni commune people
4. Visual landscape
5. Working conditions in the landfill site

4.3.2 Main Negative Impacts of the Cretulaesca Project

Important negative and short term effects are:

1. Loss of birds population during operation of the site
2. Loss of amenities (visual and sound landscape) and loss of scenic value of the river area
3. Air pollution and air related nuisances
4. Generation of land property and land use conflicts with the project
5. Degradation of traffic conditions on the Ring Road

Important negative and long term effects are:

1. Change in the initial landscape
2. Contamination of superficial aquifer and Pasarea river water
3. Contamination of Colentina aquifer is possible
4. Degradation of sanitary conditions, contamination of the drinking water resources of Stefanesti, and impact on health
5. Loss of the aquatic environment in relationship with Pasarea river water quality
6. Loss of the resources potential of the Pasarea river: Irrigation, fishing, tourism

4.3.3 Main Negative Impacts of the Balaceanca Project

Important negative and short term effects are:

1. Air pollution and air related nuisances
2. Degradation of traffic conditions in Glina and Balaceanca villages
3. Degradation of living conditions around the site

Important negative and long term effects are:

1. Change in the natural morphology and initial landscape
2. Contamination of the superficial aquifer of the flood plain, around the site
3. Contamination of the Colentina aquifer
4. Degradation of sanitary conditions, contamination of the drinking water resources of Balaceanca, and impact on health

4.3.4 Main Negative Impacts of the Glina Project

Important negative and short term effects are:

1. Degradation of living conditions around the site due to increased proximity of operation of the site
2. Loss of the activity and income of the population of scavengers
3. Air pollution and air related nuisances
4. Degradation of the landscape during operation

Important negative and long term effects are:

1. Contamination of the superficial aquifer of the flood plain, around the site
2. Contamination of the Colentina aquifer around the site
3. Degradation of sanitary conditions, contamination of the drinking water resources of surrounding villages, and impact on health

4.3.5 Summary of Major Impacts

The major impacts identified for the project sites are summarized in Table 4.3-1, according to their levels of significance:

1. Local level of the area or the village (economy, society, health)
2. Larger level than local only (natural and cultural patrimony).

Table 4.3-1 Summary of Major Potential Impacts

	Cretuleasca	Balaceanca	Glina
Natural patrimony	- Contamination of groundwater and surface water; - Loss of the aquatic habitat and wildlife; - Loss of the resources potential of the Pasarea river (irrigation, fishing, tourism);	- Contamination of groundwater and surface water;	- Contamination of groundwater and surface water; - Contamination and loss of the drinking water resource;
Cultural patrimony	- Loss of the sound and visual landscape during operation of the site;	- Degradation of the archeological sites, and of the cultural landscape;	- Increased degradation of the visual landscape;
Economical aspects	- Loss of crops yield; - New employment opportunity;	- Loss of crops yield; - New employment opportunity;	- Loss of the income source of the scavengers population; - New employment opportunity;
Social aspects	- Loss / transfer of land property and land use rights, with possible conflicts; - Pressure on the living environment; - Increased intensity of traffic on the NB part of Ring Road;	- Increased intensity of traffic on the Glina - Balaceanca axis; - Pressure on the living environment; conditions; - Change of the cattle feeding behavior for users of the site;	- Improvement of traffic conditions and related noise levels;
Health aspects	- Increased pressure of the air related nuisances and degradation of sanitary conditions; - Health risks for workers on the site;	- Increased pressure of the air related nuisances and degradation of sanitary conditions; - Health risks for workers on the site; - Health risks for residents around the site;	- Increased pressure of the air related nuisances and degradation of sanitary conditions;

4.4 Mitigation Measures

4.4.1 Summary of Priority Measures

Priority measures are summarized below in Table 4.4-1.

Table 4.4-1 Summary of Main Mitigation Measures

	Cretuleasca	Balaceanca	Glina
Natural patrimony	- Landfill design plan - Landfill post closure monitoring plan	- Landfill design plan - Landfill post closure monitoring plan	- Landfill design plan - Landfill post closure monitoring plan
Cultural patrimony	-	- Protection of the historical patrimony of Glina	-
Economical aspects	- Recommendation for the revival of the irrigation network (Cretuleasca plot)	-	-
Social aspects, traffic, health	- Recommendation for the management of traffic conditions - Recommendation for the conservation of the living environment and the improvement of sanitary conditions - Landfill design & operation plan	- Recommendation for the improvement of accesses and road infrastructure - Recommendation for the conservation of the living environment and the improvement of sanitary conditions - Landfill design & operation plan	- Recommendation for the revival of the water supply network - Recommendation for the conservation of the living environment and the improvement of sanitary conditions - Landfill design & operation plan

4.4.2 Environmental Measures Within the Landfill Design Plan

These measures are described in Chapter 5 and cover the following issues:

1. Protection of the water environment (leachate collection pipes, storage pond, and out-site treatment, rain water drainage on the site)
2. Environmental measures (embankment, fence, application of soil cover)
3. Post closure site use plan and environmental monitoring plan
4. Sanitary facilities for site workers
5. Harmony with the surrounding landscape
6. Control if hazardous waste

These points especially should be considered when planning.

The deep-underground water at the Cretuleasca is assumed to be free from contamination since the site is located on a clay layer. Preventive measures to eliminate the risks of contamination should be implemented. Also preferably collected leachete is

treated sufficiently or is piped out to the sewage of Bucharest to prevent the contamination of the Pasarea river water.

In Balaceanca, following the governmental guideline, the site should be constructed at 300m away from the Dimbouita river. The underground water in 15m beneath the lowland is already contaminated. A preventive lining should be installed against any further contamination, and collected leachete should be treated at the Glina sewage treatment plant. Since the areas surrounding the Balaceanca site provide magnificent landscape, consideration should be given to harmonize the site with surrounding areas.

At Glina the lining is impossible to provide, so the water level should not hit high to prevent the contamination of the drinking spring-water at the plateau. To reduce risks, a water supply system of the local area should be constructed. The design of the facilities should be protective for the living environment of local people.

4.4.3 Recommended Measures for the Best Integration of the Project Within the Natural and Social Environment

The following measures should be considered by the Bucharest municipality and discussed with the village councils for appropriate planning. The first measure below is however the jurisdiction of the Ministry of Culture. These measures are recommendations. They are as follows:

1. Protection of the historical patrimony of Glina, at Balaceanca project site.

2. Revival of the drinking water supply network of Glina, in order to make positive the impact of the project on drinking water resources.

3. Revival of the irrigation network at Cretuleasca village, in order to get acceptability of the project. Without local advantage of the project in terms of employment activity or increased income, and provided that standards of living are very low, social acceptability of the project would be difficult and would appear as a source of conflicts.

4. Improvement of accesses and road infrastructure for the people of Balaceanca, who are ready to accept the project if accesses and communications are improved.

5. Improvement of accesses and road infrastructure for the traffic of waste trucks between the Cretuleasca site and Bucharest, specially at crossing sections with the railway and the Ring Road.

6. Conservation of the living environment and improvement of sanitary conditions in each site, in order to integrate the sanitary landfill site in a clean environment. This measure is useful for the living conditions and health of the local people. It is also useful for the future acceptability of such projects in Romania. The purpose of this measure could be summarized as "a clean disposal of waste in a clean environment". Main actions are:

    a. Collection of solid waste from the local residents
    b. Cleaning and elimination of dumping sites
    c. Prohibition of illegal dumping

7. Information campaign concerning the environmental issues, in order to get full agreement of the people about the project, and to involve them in finding the most appropriate integration of the project within the site.

4.5 Conclusion

4.5.1 Acceptability of the Impacts at Site Level

The acceptability of the impacts means that the change of the initial natural or social conditions due to the implementation of the project appears to be acceptable as regards to the following:

1. Opinion and living of the local people around the project sites
2. National standards of living and sanitation
3. Standards of environmental quality
4. Environmental policy and environmental international conventions
5. Value that the Romanian people give to the culture and nature.

Given the application of recommended measures, the impacts of the project seem quite acceptable.

The comparison of impacts between measures / no measures alternatives has been made in Table 4.5-1, Table 4.5-2, and Table 4.5-3. In the case of Glina, no measures means continuation of the present open dumping practice, which also means no implementation of the improvement project. In the case of Cretuleasca and Balaceanca, no measure means non sanitary landfill conditions, which are those applied in the present landfill site of Glina.

CRETULEASCA SITE

The impact on sound landscape is negative during the operation of the landfill site only. The impact on land property and land use rights is limited to the starting stage of the project. If measures are taken, the project will have positive effects on the social environment, and should not raise major problems on the quality of the environment .

BALACEANCA SITE

As shown in the table, there will be no negative impact on the environment if recommended measures are taken. If measures are taken, the project will have positive effects on the social and cultural environment.

GLINA SITE

The impact on groundwater quality cannot be avoided because lining method is not possible. However, the measures which have been proposed will limit the contamination of groundwater, particularly compared with the actual open dump

practice. Impact on the scavengers community is negative, unless an alternative solution is found by the municipality in order to ensure their basic income. If measures are taken, the project will be almost positive for the surrounding natural and social environment.

4.5.2 Acceptability of the Impacts at Bucharest Level

The projects have very few negative impacts on the environment, once measures have been taken. The effect is obviously positive and extremely important for the sanitation, cleanliness, and amenity of Bucharest.

THEN, ACCEPTABILITY OF THE PROJECT AT LOCAL LEVEL IS THE MAJOR ISSUE. IT SHOULD NOT BE A PROBLEM IF THE MEASURES AS THOSE RECOMMENDED ABOVE ARE TAKEN.

Table 4.5-1 Comparison of Impacts of the Project at Cretoleasca Site Between Measures / No Measures Alternatives

		Impacts with no measures	Impacts with measures
NATURAL PATRIMONY	Impact on groundwater quality	B	A
	Impact on surface water quality	B	A
	Impacts on natural habitats and wildlife;	B	A
	Impact on resources potential (river)	B	A
	Impact on drinking water resource	B	A
CULTURAL PATRIMONY	Impact on sound landscape	B	B
	Impact on visual landscape	A	A
	Impact on resources potential (tourism)	B	A
ECONOMICAL ASPECT	Impact on income level	B	G
SOCIAL HEALTH ASPECT	Impact on transfer of land property and land use rights	B	B
	Impact on the living environment;	A	A
	Impact on traffic	B	A
	Impact on health	B	A
	Impact on air related nuisances	B	A
	Impact on sanitary conditions	B	G

Note: Ranking is G for good, B for bad, and A for acceptable;

Table 4.5-2 Comparison of Impacts of the Project at Balaceanca Site Between Measures / No Measures Alternatives

		Impacts with no measures	Impacts with measures
NATURAL PATRIMONY	Impact on groundwater quality	B	A
	Impact on surface water quality	B	A
	Impact on drinking water resource	B	A
CULTURAL PATRIMONY	Impact on sound landscape	A	A
	Impact on visual landscape	B	A
	Impact on cultural landscape	B	A
	Impact on resources potential (tourism)	B	G
ECONOMICAL ASPECT	Impact on income level	A	A
SOCIAL HEALTH ASPECT	Impact on transfer of land property and land use rights	A	A
	Impact on the living environment;	B	A
	Impact on traffic	B	G
	Impact on health	B	A
	Impact on air related nuisances	B	A
	Impact on sanitary conditions	B	G

Note: Ranking is G for good, B for bad, and A for acceptable;

Table 4.5-3 Comparison of Impacts of the Project at Glina Site Between Measures / No Measures Alternatives

		Impacts with no measures	Impacts with measures
NATURAL PATRIMONY	Impact on groundwater quality	B	B
	Impact on surface water quality	B	G
	Impact on drinking water resource	B	G
CULTURAL PATRIMONY	Impact on sound landscape	A	A
	Impact on visual landscape	B	A
ECONOMICAL ASPECT	Impact on income level	G	B
SOCIAL HEALTH ASPECT	Impact on the living environment;	B	G
	Impact on traffic	B	G
	Impact on health	B	G
	Impact on air related nuisances	B	G
	Impact on sanitary conditions	B	G

Note: Ranking is G for good, B for bad, and A for acceptable;

Chapter 5

Facilities Plan and Design

CHAPTER 5 FACILITIES PLAN AND DESIGN

5.1 Planning and Design Policy

1. Site Selection from Economic and Environmental View Points

11 candidate landfill sites were identified through the master plan study from both environmental and economic view points. Of those 11 sites, Balaceanca site listed as number 1 and Cretuleasca site have been chosen for the feasibility study because the Bucharest Municipality obtained consent from the local village councils (Cernica and Stefanesti de Jos), which have these 2 sites in their respective jurisdiction, for the execution of a feasibility study.

The Cretuleasca site itself is not very economical because excavation of a large quantity of soil is needed for site construction. Excavated soil can be used at Balaceanca and Glina sites for construction of embankment. If such excavated soil is not available from Cretuleasca, the Bucharest Municipality will have to buy soil. Selection of Cretuleasca site can be justified from this reason.

2. Non-Acceptance of Hazardous Waste

Planned sites will not accept any hazardous waste. Hazardous waste can be accepted at the sites only if it is treated and made harmless by waste generators through appropriate treatment.

3. Control of Incoming Waste Quantity

Incoming waste quantity is controlled through measuring the quantity with truckscale. This quantity control is required to ensure that the sites are filled according to the site use plan and that certain standards of landfill operation are met.

The landfill sites have been designed based on the following design policy:

4. Introduction of Sanitary Landfill and Pollution Control

In Balaceanca and Cretuleasca sites, sanitary landfill will be introduced. For the environmental protection and reduction of public health risks, the following facilities will be provided: artificial liner, embankment, on-site and access roads, drainage ditch

around the site, leachate transmission pipes leading to Glina sewage treatment plant, net fence, truck scale, and control office. Daily cover soil will be applied.

The sanitary standards of the existing Glina site will be improved by providing all the above-mentioned facilities except for artificial lining and leachate treatment. Artificial lining cannot be installed at the existing Glina site. The Glina site is worth investing for improvement because it has a large remaining capacity to receive waste - possibly 10 years if the landfill sites in Balaceanca and Glina are developed and used as planned.

Typical pollutants generated from landfill and the planned control measures are summarized in the following table:

Table 5.1-1 Planned Environmental Pollution Control Measures for the 3 Sites in Balaceanca, Cretuleasca and Glina

Pollutants Generated from Landfill Sites	Possible Pollution if no measures are taken	Facilities Provided for Pollution Control
a. Dumped waste	Dumped waste may fly out of sites, and cause public nuisance.	1. Embankment 2. Fence 3. Cover soil
b. Leachate (waste water generated from waste deposit)	Leachate may contaminate surface and ground water.	1. Artificial lining (2 mm rubber sheet) on the bottom of the sites) 2. Leachate collection pipes 3. Leachate storage pond 4. Leachate transmission pipes 5. Leachate treatment at Glina sewage treatment facility 6. Rain water drainage around the sites 7. Monitoring facilities
c. Gas (Methane gas & CO^2 gas)	Methane gas may cause explosion.	1. Gas exhaust pipes 2. Monitoring facilities
d. Smoke, bad odor & rats and crow	These pollutants may reduce quality of life of local residents, and cause health risks to site workers.	1. Cover soil 2. Non-acceptance of municipal waste at part of the Glina site that is near to the Popesti-Leordeni village residents.
e. Waste, odor & noise from waste trucks	These pollutants may reduce quality of life of local residents.	1. Access road

Note: Artificial lining will be provided for the new sites (Balaceanca and Cretuleasca), but not for the existing Glina site as the provision of the lining is not possible for .

5. Satisfaction of EU Disposal Standards

Sanitary landfill sites in Balaceanca and Cretuleasca will satisfy EU Disposal Standards as these sites will be equipped with artificial lining and leachate will be treated (by transmitting leachate through pipes to Glina sewage treatment plant.)

6. Sanitary and Good Working Conditions for Site Workers

Sanitary and good working conditions, which are necessary for a modern landfill site, have been taken into consideration in designing site facilities. All the sites will provided with toilets, showers, lockers, rest rooms, kitchen and electricity. Planned application of cover soil will be helpful to keep the sites sanitary. For efficient office conditions, and office rooms, meeting room, air conditioning, telephone and computerized truckscale will be provided. Cars will be provided for site inspection.

7. Environmental Monitoring

Monitoring parameters include: leachate, ground water, gas, odor and settlement. Monitoring of ground water is useful to evaluate possible pollution risks. Monitoring of gas is necessary to know the gas density and explosion risks. No-smoking warning will be given if the gas density on site is higher than certain level. Monitoring of settlement will be useful to know the level of stability of waste, which will be considered in planning post-closure land use. (See Section 1.5.3 for details.)

8. Application of a Fill-up and Cell Method for Landfill Operation

A fill-up and cell method will be applied for landfill operation. (See Section 1.5.2 for details.) For smooth and sanitary landfill operation, quantity and quality of waste will be monitored and controlled through truckscale measurement and regular inspection.

9. Use of Local Materials and Economical Construction

Facilities design is based on use of local materials to keep construction costs low.

10. Landfill Operation is Locally Manageable

All planned facilities can be managed by Romanian people. Use of local people living in villages adjacent to the sites is advisable as it will give an income earning opportunity to them, and make landfill construction more acceptable to the village people.

11. No-Methane Gas Recovery

Recovery of methane gas from landfill sites is not considered because it is not feasible for the planned sites. Certain conditions must be satisfied for the gas recovery to be feasible.

a. Waste deposit must be higher than 15 m. However, the planned sites have height of about 10 m.
b. There must be demand for methane gas at places reasonably near to the sites. Demand for methane gas depends much on oil price. In 1970's and early 1980's when price of oil substantially increased and fluctuated, use of recovered methane gas was considered feasible. At present, however, there is very few cases where methane gas recovery is feasible.
c. Demand for and price of recovered methane gas also depends on the quantity and quality of recovered methane gas. However, they could substantially change over time partly due to changes in waste composition. It is difficult to estimate the quantity and quality of gas recovered in future. Under such uncertain conditions, gas recovery is risky to possible investors, and buyers will find it risky to depend on recovered methane gas as energy source.

12. Post-Site Closure Land Use

The landfill sites are designed in such a manner as to be used for some other purposes such as green park or golf course to increase values of the sites after closure.

5.2 Applicable Environmental Standards

There are some laws concerning location of landfill sites. For example, Law 8/1974 on Water stipulates that landfill sites should not be constructed near river beds, and measures should be taken to prevent ground water pollution. This law does not show standards on leachate discharged into rivers.

There are no design and environmental standards specifically applied to waste disposal (landfill) sites. Ministry of Public Works and Regional Planning (MLPAT) has organized a committee responsible for formulation of a national standard for landfill. At present, the committee is working on the standards.

The design of new landfill sites in Balaceanca and Cretuleasca follows EU Council Directives of Disposal Sites, which was issued in 1993. For the design caluculations and specification.

5.3 Major Specifications of Facilities

1) Type of Facilities

The landfill facilities consist of the following 4 components:

1. Main facilities
2. Management facilities
3. Other facilities
4. Landfill operation method

Contents of each component are shown below:

1. Main facilities

- Access road from main road,
- Embankment to store the waste,
- Liner,
- Rainwater drainage system,
- Leachate collection and treatment.

2. Management facilities

- Truck scale,
- Control office,
- Management road,
- Environmental monitoring facilities.

3. Other facilities

- Net fence,
- Sign Board.

4. Landfill operation

- on-site roads,
- landfill method and covering

2) Major Specifications of Facilities

Major specifications of each facility are described below.

1. Main Facilities

- Access Road

Width of access roads is 8m. They should be paved at the same standard as applied to the county roads. Standard cross section of access road is given in Fig.5.3-1.

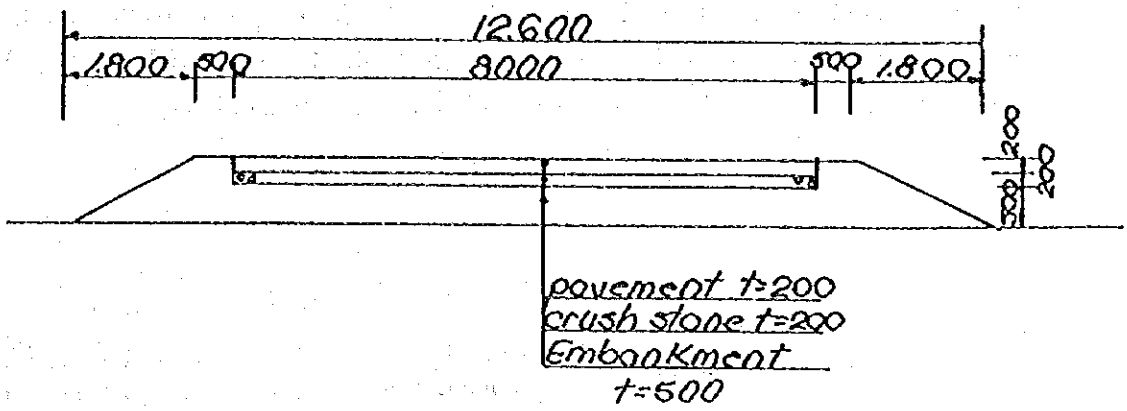


Fig. 5.3-1 Standrd Cross Section of Access Road

- Embankment

Standard cross section of embankment is given in Fig.5.3-2. Embankment slope is 1:2, and banquette should be constructed at least each 4.0m height. The embankment should have a safety coefficient of more than 1.2.

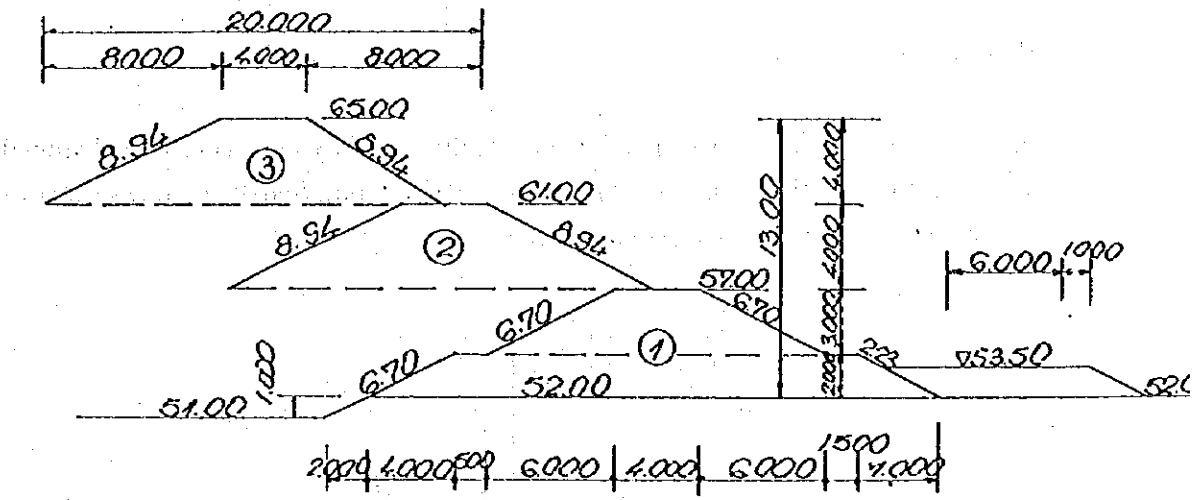


Fig. 5.3-2 Standard Cross Section of Embankment

- Liner

New sites should be installed with artificial liner to prevent ground water pollution, liner consists of 2mm rubber sheet with 20mm geotextile. These materials are available in Romania. Fig.5.3.-3 below shows the standard cross section of liner.

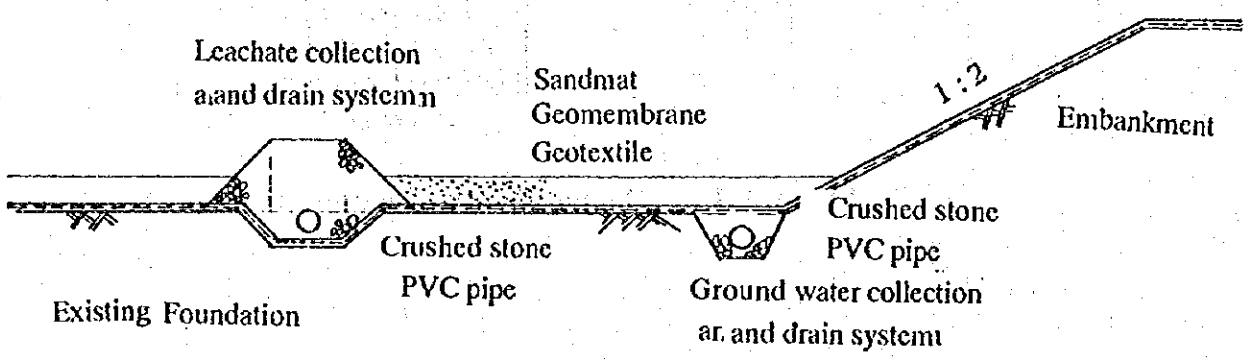


Fig. 5.3-3 Standard Cross Section of Liner

- Rainwater drainage system

Rainwater coming from the surrounding areas is drainaged by ditch constructed around the site. Design coefficient of rainfall intensity is 10mm/hour. Standard cross section of rainwater drainage system is given in Fig. 5.3-4.

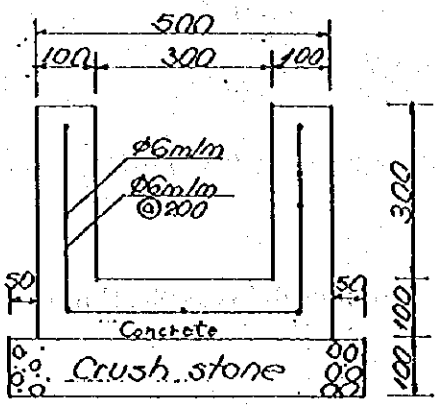


Fig. 5.3-4 Rainwater Drainage System

- Leachate collection and treatment

All leachate will be collected by collection system and stored in a storage pond. Later collected leachate will go through a sand basin and quantity regulation tank for sedimentation. And the leachate is sent to the sewage water treatment plant in Glina. Fig. 5.3-5 below shows standard cross section of leachate collection pipe. And Fig. 5.3-6 below shows the plan & cross section of leachate pump station.

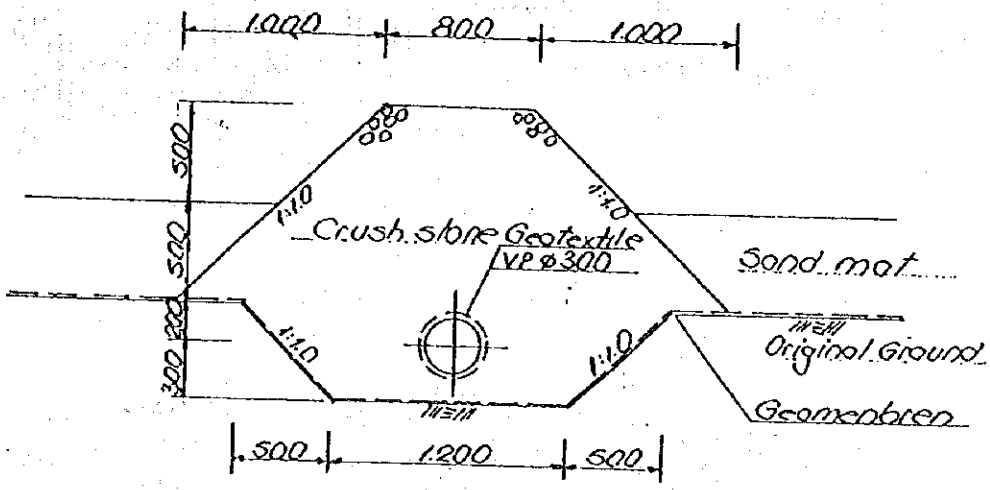


Fig.5.3-5 Cross Section of Leachte Collection Pipe

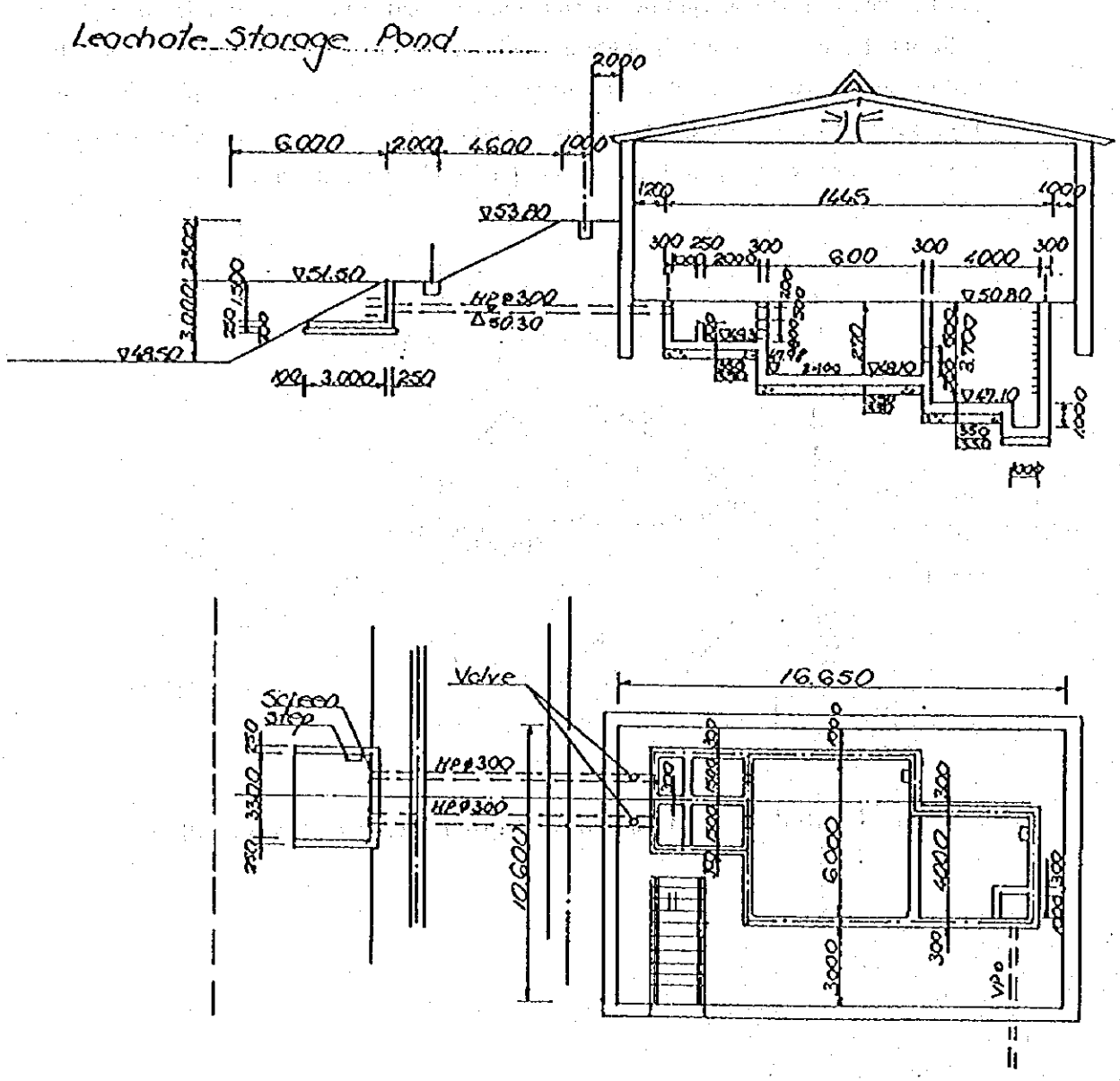


Fig.5.3-6 Plan & Cross Section of Leachate Pump Station

- Gas exhaust equipment

Standard cross section of gas exhaust equipment is given in Fig. 5.3-7. The equipment is connected with leachate collection system. The system not only exhaust gas but also supply air in waste layer.

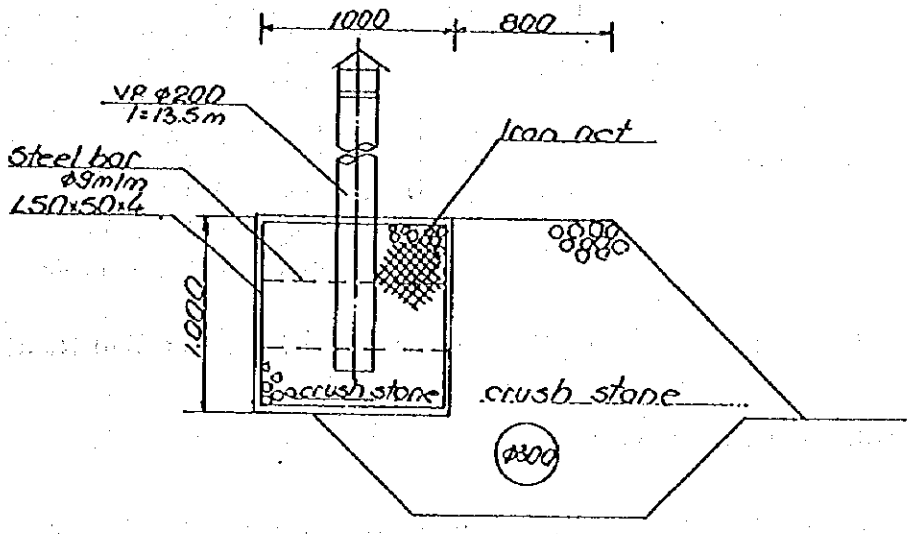


Fig. 5.3-7 Standard Cross Section of Gas Exhaust Equipment

2. Management Facilities

- Truck scale

Truck scale will have a 30t measurement capacity. It has such facilities as indicator, computer system with calculation software and card reader system. Control office will be equipped with an air conditioning.

- Control office

Control office will have several rooms, i.e., management room, discussion room, guest room, rest room, rocker room, store room, kitchen, bed room, toilet and shower room. Control office should also be equipped with such utilities as permanent electricity, lights, telephone, facsimile, water supply, gas, heating system and inspection car.

- Management road

Width of management road is 6m and pavement is of the local standard road class. Standard cross section of management road is given in Fig. 5.3-8.

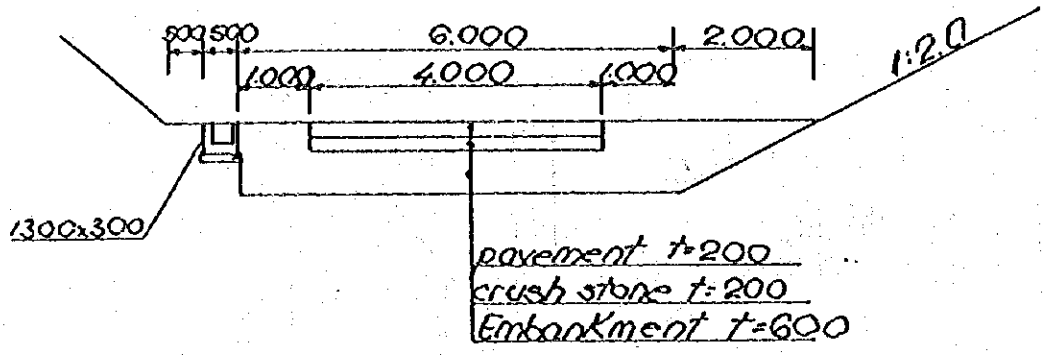


Fig. 5.3-8 Standard Cross Section of Management Road

- Environmental monitoring facilities

Monitoring facilities consist of ground water wells, gas out-let equipment and leachate storage pond.

3. Other Facilities

- Net fence & gate

Height of fence & gate is 1.8m. It is provided around the site to prevent free access to the site. Fig. 5.3-9 and 5-3.10 below show the standard drawings.

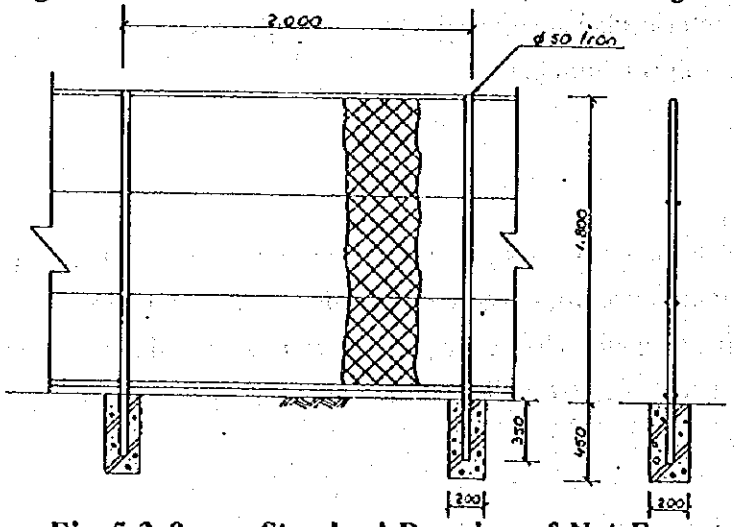


Fig.5.3-9 Standard Drawing of Net Fence

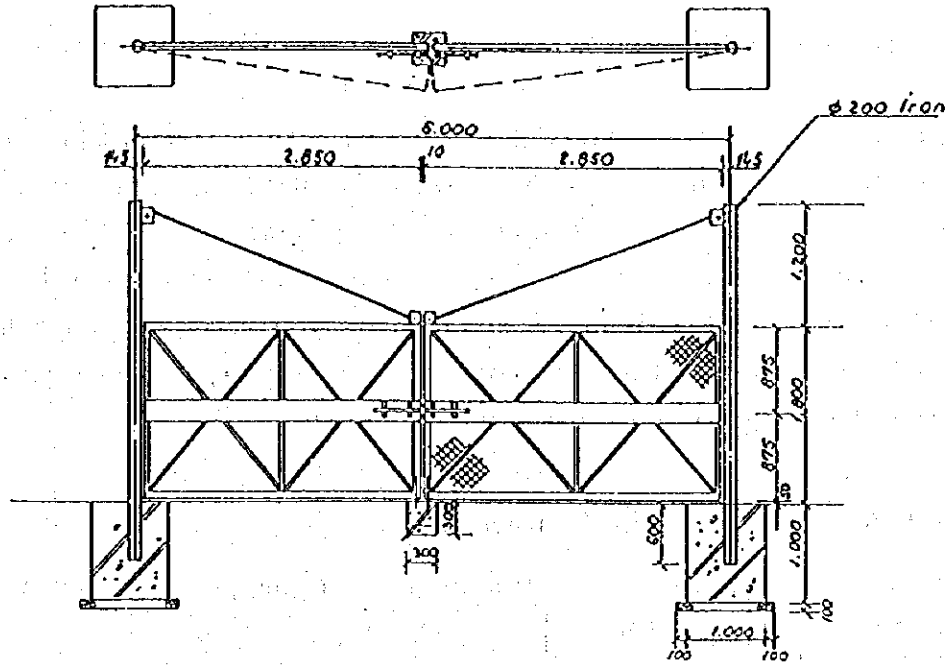


Fig. 5.3-10 Standard Drawing of Gate

- Sign (board)

Sign (board) should indicate site name, capacity, landfill period, kind of waste, responsible body and contact address.

4. Landfill Operation

- On-site roads

Width of on-site road is 6m. In the case of one way use the width is 4m. The pavement is made from crash stone only because the road is of temporary use.

- Landfill method

Landfill method is fill-up and cell method. Daily created cell should be covered with soil.

5.4 Design Outline

Each site is design in accordance with the design policy and the specifications shown in Sections 5.1, 5.2 and 5.3 respectively. The major site characteristics are shown in Table 5.4-1, and major construction work quantity is shown in Table 5.4-2. Table 5.4-2 can explain the difference of construction costs by site. Design plan drawing of each site is given in Fig.5.4-1, 5.4-2 and 5.4-3 respectively. A set of basic design drawings is in a separate report (Report 6). Appendices report (Report 5) contains design calculations and quantity calculations.

Table 5.4-1 Major Site Characteristics

Item	Glina	Balaccanca	Cletuleasca	(Total)
Distance from center of the city (km)	9 km	12 km	12 km	-
Site Area (ha)	104.1	39.9	28.0	172.0
Landfill Area (ha)	99.2	35.4	22.5	157.1
Site Capacity (Million m3)	6.53	4.15	1.44	12.12
Waste (Million m3)	5.10	3.46	1.20	9.76
Cover Soil (Million m3)	1.43	0.69	0.24	2.34
Leachate Storage Pond Capacity (m3)	60,000	20,250	15,500	-
Major Environmental Protection Measures and Facilities	See Table5.1-1			-

Table 5.4-2 Major Construction Work Quantity

Item	Unit	Glina	Balaccanca	Cleluleasca
Embankment	Total (m)	2,900	1,625	1,980
	Total (m3)	308,700	123,500	59,400
Road	Access Road (m)	0	5,060	620
	Management Road (m)	1,080	2,710	2,410
	On-site Road (m)	3,600	2,410	1,205
Leachate Collection System	Main Pipe (m)	650	667	858
	Branch Pipe (m)	2,760	2,848	1,725
Rainwater Drainage System	(m)	3,600	2,920	2,410
Net Fence	(m)	5,170	3,055	2,800
Gas Exhaust Equipment	(places)	17	24	23
Liner	(m2)	0	360,000	231,000
Pipeline	(m)	1,510	3,670	4,560

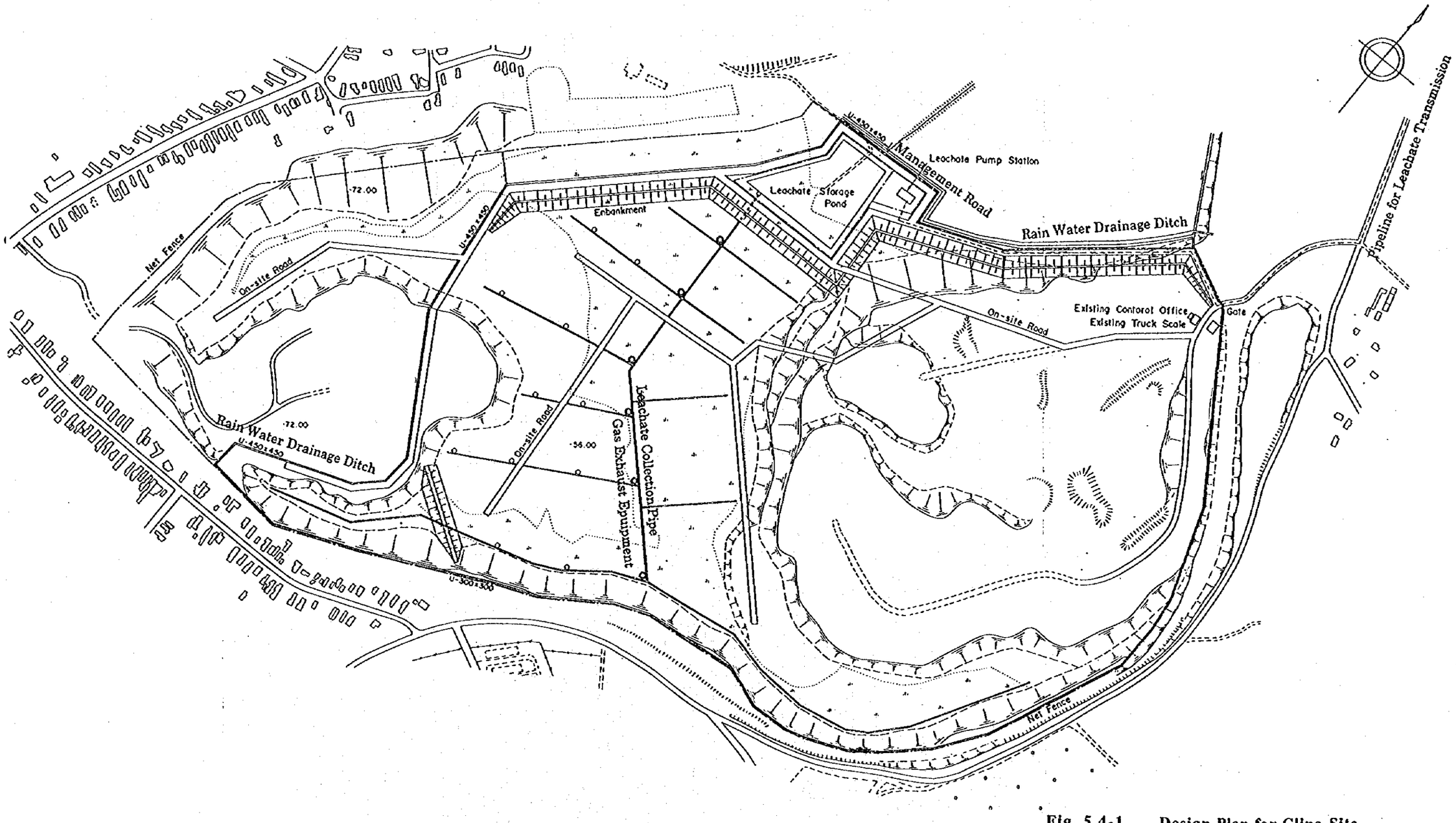


Fig. 5.4-1 Design Plan for Glina Site

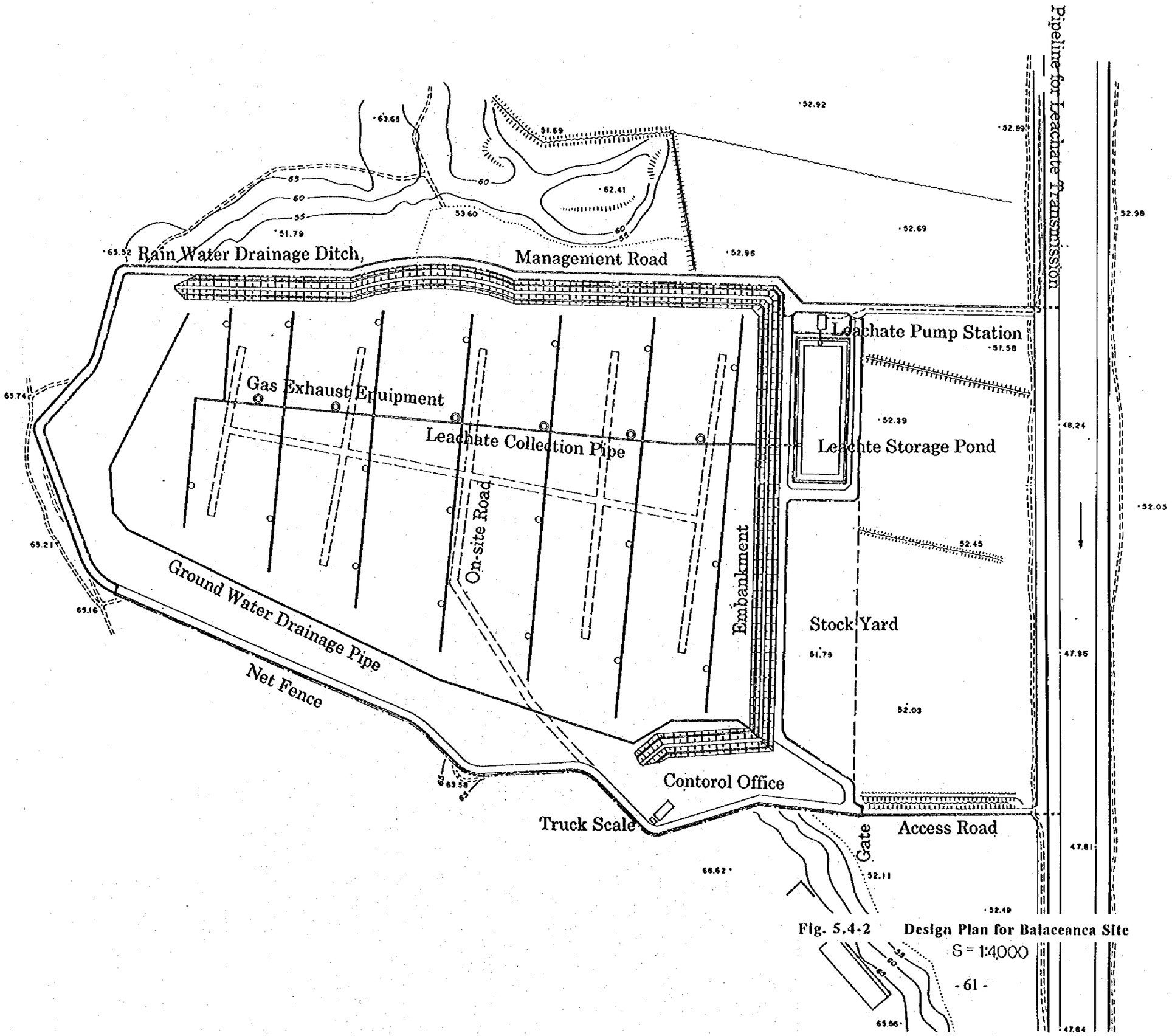


Fig. 5.4-2 Design Plan for Balaceanca Site

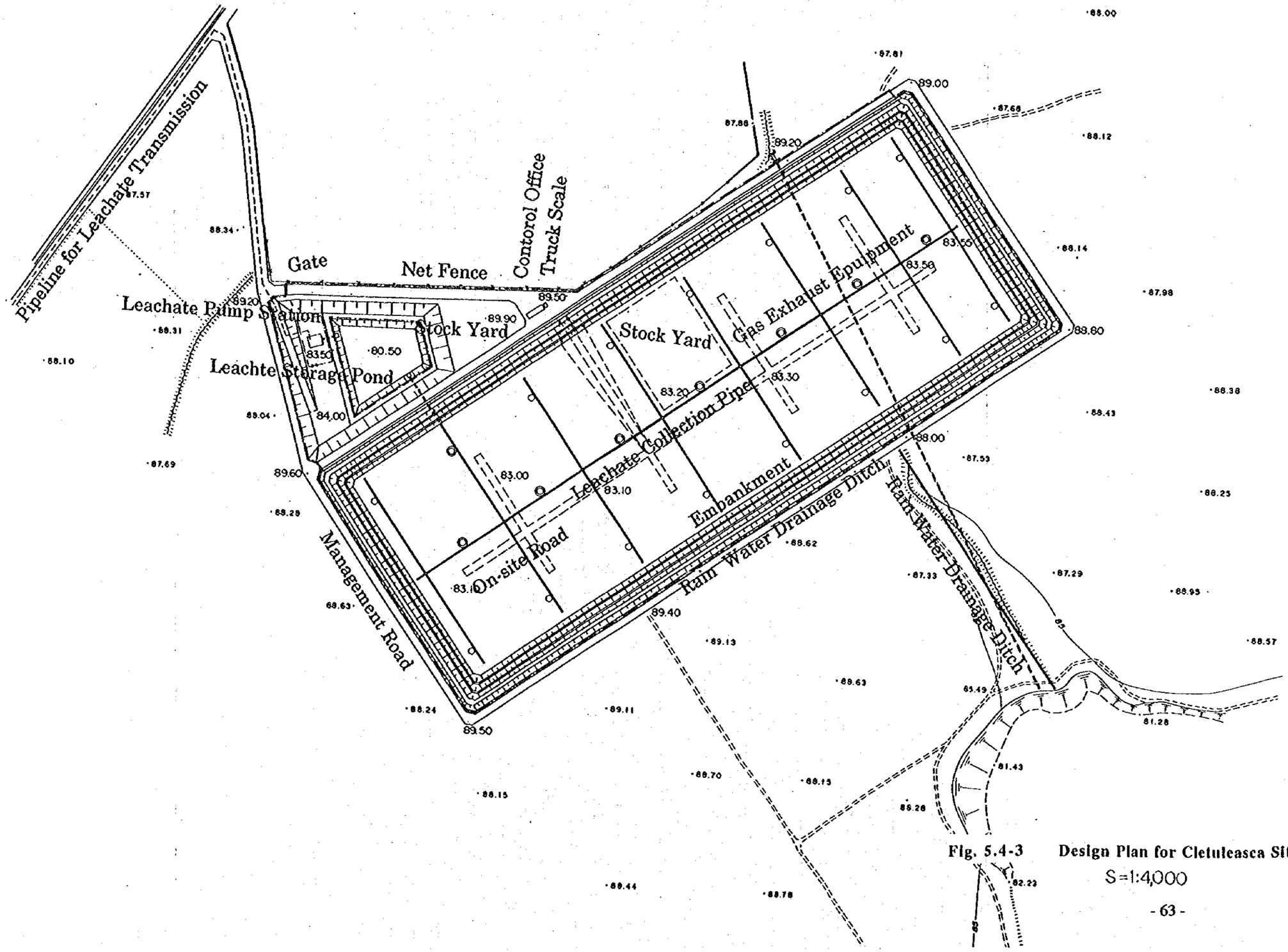


Fig. 5.4-3 Design Plan for Cletuleasca Site

S=1:4,000

5.5 Liner System

1) Purpose

Purpose of installation of lining system at the landfill site is to prevent surface and ground waters from contamination caused by leachate.

2) Liner System

Liner system consists of not only liner but also many sub-systems as shown in Fig. 5.5-1. Especially, leachate collection system influence the total liner system, for example if leachate can be drained quickly , leachate will not infiltrate to the underground. In most of the developing countries budget is not enough to install the artificial liner. Accordingly, practical design is applied to have steeper slope and/or filter layer constructed by crushed stone to drain leachate quickly. Typical structure of the liner system is shown on Fig. 5.5-2.

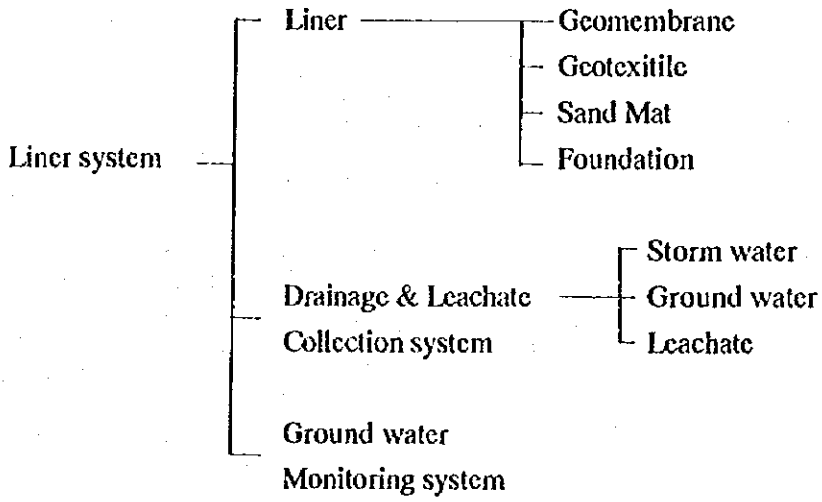


Fig. 5.5-1 Components of Liner System

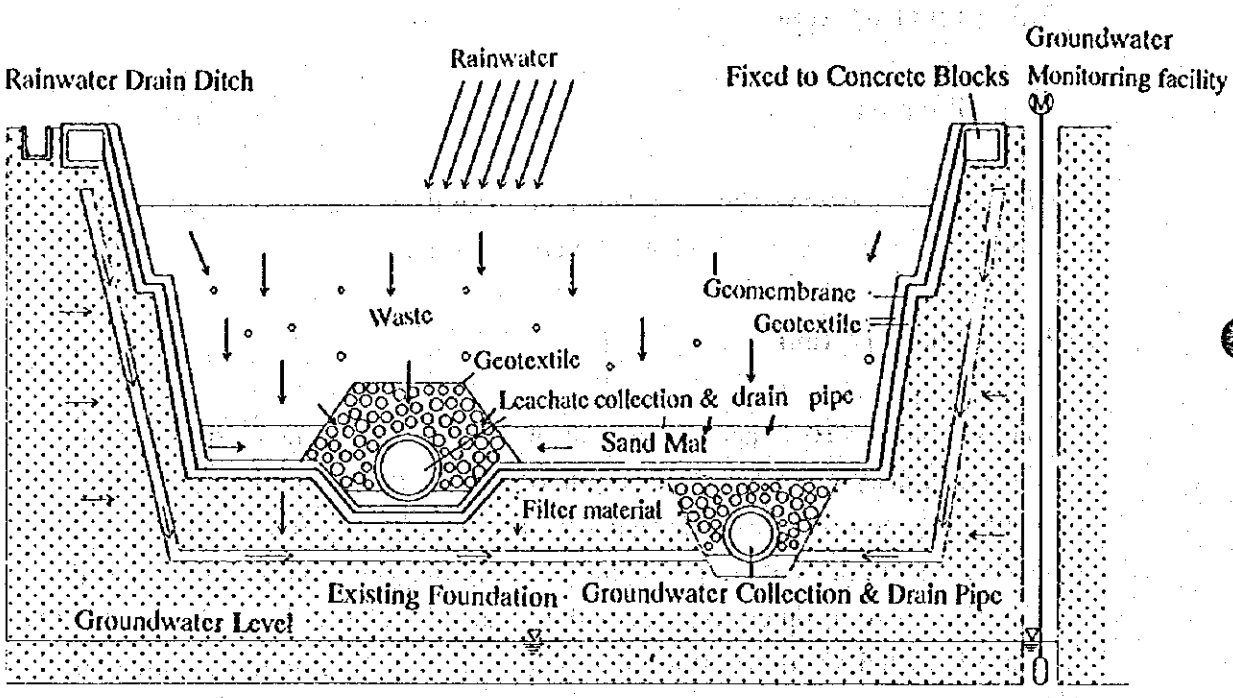


Fig. 5.5-2 Typical Structure of Liner System

3) Factors Related with Liner System

There are many factors related with liner system in designing a sanitary landfill site. Those factors are shown as follows.

a. Quality of waste ,
b. Surface and ground water conditions ,
c. Site location ,
d. Hydrogeological conditions and
e. Project cost.

4) Relation between Quality of Waste and Liner System

Quality of leachate depend on the type of waste to be disposed. Therefore, the liner system should be installed in considering of the leachate quality so as to have the appropriate level of the system to minimize environmental risk. Generally, the type of waste for landfill are classified as shown in Fig. 5.5-3.

Waste for Landfill
- Combustible Waste
- Incineration Residue
  . Incineration residue generated without hazardous gas removal equipment
  . Mixed fly ash generated with hazardous gas removal equipment
  . Separated fly ash generated with hazardous gas removal equipment
- Incombustible Waste & Bulky Waste
- Shredded Incombustible Waste
- Others

Fig. 5.5-3 Classification of Waste for Landfill Disposal

Type of landfill waste are classified as shown in Table 5.5- 1. Leachate quality of each type is shown in Table 5.5-2. Degree of level of lining system of each type is shown in Table 5.5-3.

Table 5.5-1 Classification of Landfill Waste

Type	Kind of waste	Remark
1	Combustible Waste	
2	Incombustible Waste	
3	Incineration Residue + Incombustible Waste	Include Non-treated Fly Ash
4	Incineration Residue	Include Non-treated Fly Ash
5	Incineration Residue + Treated Fly Ash + Incombustible Waste	
6	Incineration Residue + Treated Fly Ash	
7	Treated Fly Ash	

Table 5.5-2 Relation between Landfill Waste and Leachate Quality

Type	BOD	COD	SS	T-N	Cl-	Heavy Metal	Ca+
1	A	A	B	A	C	C	C
2	B	B	B	B	C	C	C
3	B	B	B	B	A	A	A
4	C	B	B	B	A	A	A
5	B	B	B	B	B	C	C
6	C	B	B	B	B	C	C
7	D	D	C	D	B	D	D

Note A: High Concentration
B: Medium Concentration
C: Low Concentration
D: Non-detection

Table 5.5-3 Relation between Type of Landfill Waste and Required Liner System

Type of Waste	Objective Parameters	Level of Required Lining System	Type of Liner System
1,2	BOD, COD, SS, T-N	Low	I
3,4	BOD, COD, SS, T-N, Cl-, Ca+, Heavy Metal	High	II
5,6	BOD, COD, SS, T-N, Cl-	Medium	III
7	-	Low	IV

5) Liner Structure

Artificial liner is classified by tree types, single liner , double liner and muluti liner types. The structure of each type is shown from Fig. 5.5-4 to 5.5-6. The muluti liner type has many variations according to the combination of geomembrane, geotextile, artificial clay layer, filter layer, etc.

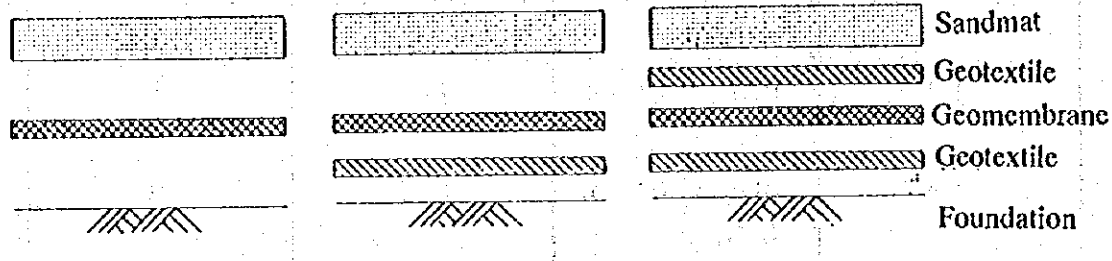


Fig. 5.5-4 Conceptual Structure of Single Liner

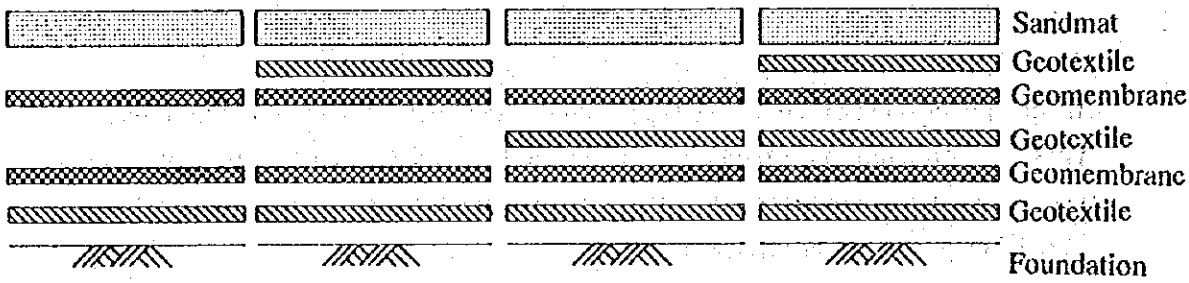


Fig. 5.5-5 Conceptual Structure of Double Liner

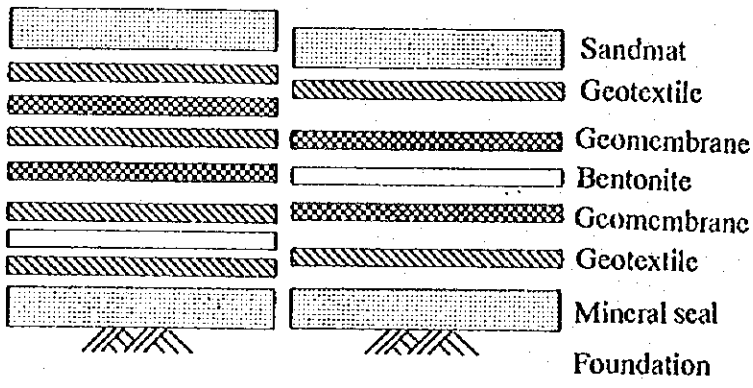


Fig. 5.5-6 Conceptual Structure of Multi Liner

6) Selection of Liner System

It is important to consider the balance among the leachate such as environmental risk, reliability of liner and economical system in designing the basic structure of the landfill site. The following facts are learned by our many experiences.

a. Environmental risk will increase to the landfill waste include hazardous components.
b. Higher level of multi liner has higher reliability to environmental risk.
c. Higher level lining system require higher cost.
d. Lining system shall be designed on the balance between the risk and the reliability .

Based on the above mentioned facts, Table 5.5-4 is proposed for the liner system for each type of landfill waste to meet with the appropriate level to the environmental risk.

Table 5.5-4 Proposed Lining System by The Type of Waste

Type of Waste	Municipal Waste (Non-treated)	Incineration Residue (Treated Fly Ash)	Incineration Residue (Non-Treated Fly Ash)	Hazardous Waste
Environmental Risk	Low	Medium	High	High
Liner System	Single liner	Double Liner	Multi Liner	Multi Liner

7) Recommendation

Liner system for the project is recommended in accordance with the results of Table 5.5-4 and other factors mentioned earlier as shown on Fig. 5.5-7. With the recommended liner system, environmental risk of the landfill site in Bucharest will be minimized.

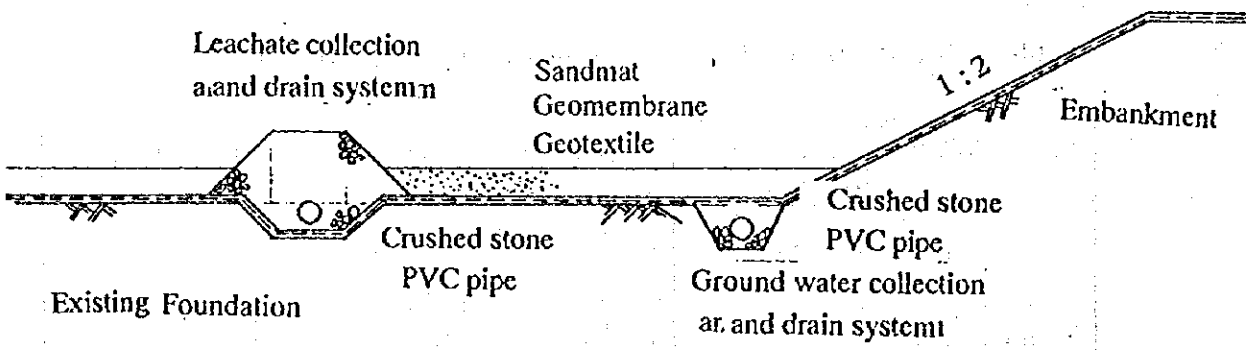


Fig. 5.5-7 Typical Cross Section of Liner System in This Study

Chapter 6

Plan for Site Operation and Environmental Monitoring

CHAPTER 6 PLAN FOR SITE OPERATION AND ENVIRONMENTAL MONITORING

6.1 Site Management Activities

Conditions of the planned sanitary landfill sites equipped with necessary environmental protection facilities can become as bad as that of an open dumping site if there are no proper site management activities. Necessary site management include the following:

1) Staff the Site with a Site Manager and Qualified Engineers

Management and operation of a sanitary landfill site require qualified persons. Recommendable organization and manpower required for a site are shown in Chapter 9.

2) Control of Hazardous Waste and Quantity Checking

The planned sites will not accept any hazardous waste unless they are treated. Site inspectors should check waste types when waste weight is measured by truck scale. Occasionally, inspectors should physically inspect type of dumped waste on dumping area. Hazardous waste affects not only leachate quality but also health of site workers.

Waste quantity (weight) will be measured by the truck scale. A site engineer must be able to analyze the quantity data obtained.

3) Make Weekly and Monthly Plan for Use of Landfill Area

An engineer should prepare the above-mentioned plan to specify dumping areas. Landfill operation should be carried out in accordance with such plan.

4) Inspection of Site and Off-Site Areas

Inspectors should regularly inspect the site and also off-site areas to see if there are any illegal dumping.

5) Monitor Labor and Health Conditions of Site Workers

There must be a person on site who is responsible for monitoring labor and health conditions of site workers, and making sure that such facilities as showers and toilets are properly functioning.

6) Inform the Citizens of who is Responsible for Site Management

The Bucharest Municipality is the body responsible for the site management. This has to be informed to the citizens. On a sigh (board) placed at the entrance of each site, the name of responsible body and contact persons should be clearly indicated.

6.2 Landfill Operation Method

The solid waste must be sufficiently compacted so as to stabilize the landfill foundation and prolong use period of landfill. A layer of cover soil must be systematically placed after landfilling each layer of solid waste.

The waste are unloaded at the toe of the earth dike and spread and compacted on the slope of the dike in a series of layers that vary in depth from 30 to 60 cm. The recommended slope of these layers is 1 to 3.

At the end of each day's operation, a 15 cm to 30 cm layer of cover soil is placed over that day's completed fill. This one day's completed fill including the cover soil is called a cell. The quantity of daily cover soil is required about 10 ~ 20 % of daily waste quantity. Therefore, the daily cover soil should be prepared and stoked by sellection of suitable construction waste.

The cell method is recommended for sanitary landfill in view of large area of landfill, and up-fill method is recommended for bedding and compassion. Daily covering by soil should be done. The method is shown in Fig. 6.2-1 ~ 6.2-5.

Some heavy equipments are required for bedding and compaction of waste and cover material. It is estimated that bulldozer and excavator with wide caterpillars, dump truck to move for cover material from stock yard to landfill site will be required for the planned sanitary landfill operation judging from amount of waste and cover material to be handled. Detail information is described as Section 4.3 in Appendices of F/S report, total number of heavy equipments is shown in Table 6.2-1.

Table 6.2-1 Total Number of Heavy Equipments

Equipment	Glina	Balacheanca	Cleturcasca	Remark	Total
Bulldozer	6	10	5	1 unit/site standby	21
Excavator	1	1	1	-	3
Dump Truck	2	3	1	-	6
Jeep	1	1	1	for inspection	3

Municipal Waste Disposal Adoministration should be organized appropriate site office member to manage the landfill site. Table 6.2-1 below shows in our proposed site office member.

Table 6.2-2 Site Office Member

Site	Manager	Secretary	Cheif Engneer	Truck Scale Engineer	Cheif Operator	Operator	Total
Glina	1	1	1	2	1	9	15
Cretuleasca	1	1	1	2	1	7	13
Balaccanca	1	1	1	2	1	14	20
Total	3	3	3	6	3	30	48

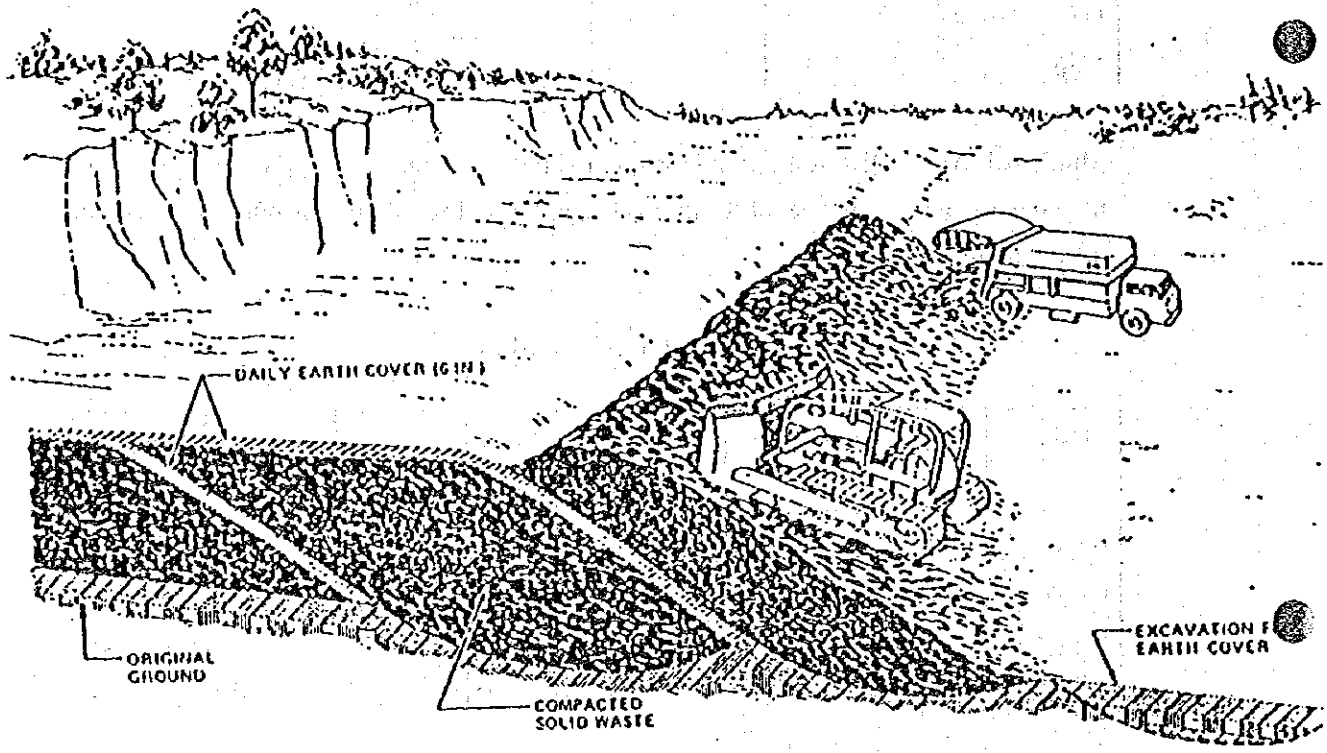


Fig.6.2-1 Landfill Methods

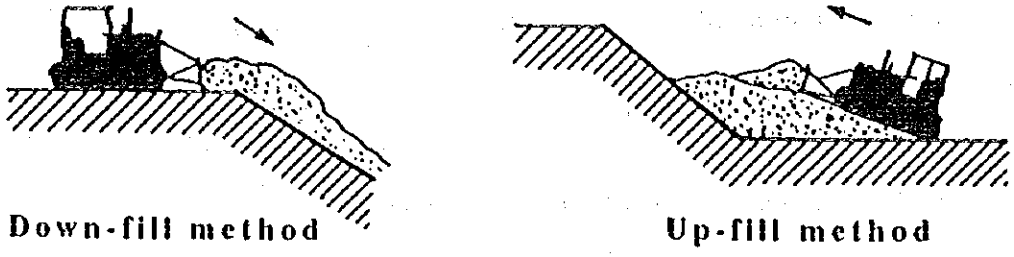


Fig.6.2-2 Method of Bedding and Compaction

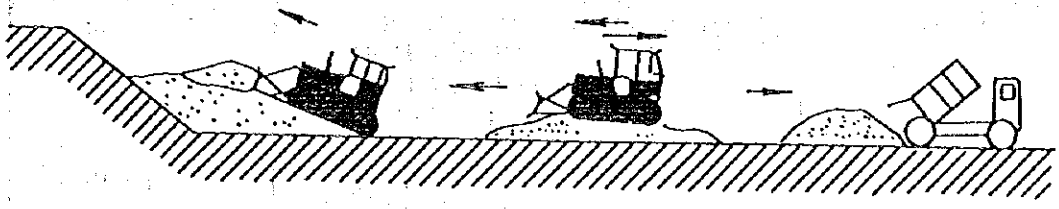


Fig.6.2-3 Preparation of A Unit of Cell with the Up-fill Method

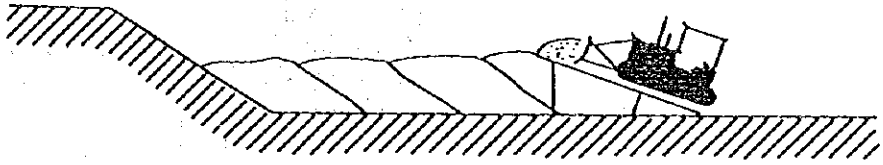


Fig.6.2-4 Preparation of Cells with the Up-fill Method

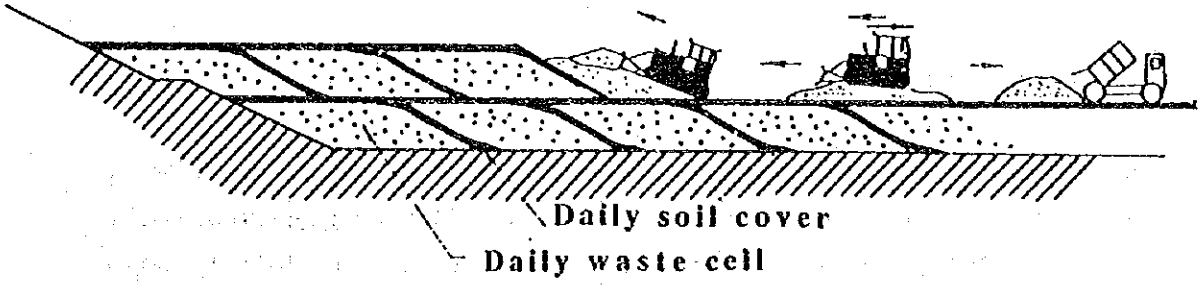


Fig.6.2-5 Typical Landfill by Cell Method

6.3 Environmental Monitoring

1) Monitoring Scheme

Table 6.3-1 shows a proposed monitoring scheme.

Table 6.3-1 Proposed Monitoring Scheme

MONITORING ITEMS	MONITORING FACILITY	MONITORING PARAMETERS	MINIMUM FREQUENCY
Ground water	Monitoring well	pH, CN, Pb, T-Hg, Cd, BOD, COD,NH3-H, SS, MPN, Color, Temperature	1 / month
Gas	Gas exhaust pipe	Temperature and humidity of original air, Temperature and volume of gas, component analysis (CH4, CO2, O2)	1 / month
Settlement	Settlement board	Settlement of ground level	1 / month
Odor	-	Monitoring parameters should be selected according to odor conditions	2 / year
Leachate	Leachate reservoir pond	pH, CN, Pb, T-Hg, Cd, BOD, COD, NH3-H,SS, MPN, Color, Temperature	1 / month

2) Monitoring Purposes

a. Ground water

Ground water quality analysis is useful to know whether or not contamination by leachate has occurred and degree of contamination. This Monitoring should be carried out at least 1 time per month by using monitoring wells those are located at the upper and lower ground water stream of the site, the result should be publicly available. If monitoring results show the contamination has occurred by leachate, the municipality should carry out appropriate surveys and take countermeasures. If local people use the same aquifer as shallow well, the municipality should consider construction of a water supply system.

b. Gas

Gas exhaust pipes are used for gas monitooring. Temperature, volume and component analysis show organic material condition of waste and ground air condition. If density of CH4 is high, the site manager should instruct " No smoking on the site". After closure of the site, gas volume will decrease and component will become increasingly similar to the original air. When methane gas density become less than 1.5 %, the site can be used carefully for other purpose.

c. Settlement

When final soil covering for the site is completed, settlement boards should be installed at appropriate places and periodical measurements are necessary to know the waste organic material conditions and to estimate the future settlement. The settlement will decrease year by year. It will take over 20 years before the settlement stops completely. The municipality should consider the land use according to the stability of the ground.

d. Odor

Odor generated from waste organic material is a serious problem to local people. Daily soil covering can prevent the generation of odor. Imperfect covering sometimes causes odor problems. Therefore, the municipality should carry out odor analysis periodically.

e. Leachate

Leachate analysis is also one of the most important source of information to understand organic material condition in waste. BOD & COD should be monitored. Level of BOD and COD will decrease year by year. When density level become as low as natural surface water, we can know the site has become stable and stop the leachate treatment.

Chapter 7

Schedule for Site Development and Use

CHAPTER 7 SCHEDULE FOR SITE DEVELOPMENT AND USE

7.1 Schedule for Site Development and Use

Table 7.1-1 shows schedule for the development and use of the 3 sites. It is planned that the design and engineering services will start in early 1997, the construction will start in early 1998. The operation of the Glina site (newly constructed part) will start in early 1999, while Balaceanca and Cleturcasca sites will be open in the middle of 1999. It is planned that all 3 sites will be closed in 2006.

According to the Master Plan, 3 more new landfill should be developed; Berceni, Afumati and Jilava so that they should be available after closing 3 sites. See Fig.7.1-1 for locations of the new 3 sites, total area of these 3 sites will be 99 ha and have capacity of deposing 6.8 million m3 of waste and cover soil. Total capacity of the 5 new sites (Balaceanca, Cleturcasca, Berucени, Afumati and Jilava) will 12.39 million m3 and will be sufficient to meet the demand arising from 1996 to 2010.

A planned project implementation schedule and necessary activities for the implementation are shown in chapter 13.

Note 1: Land Required for landfill until 2010

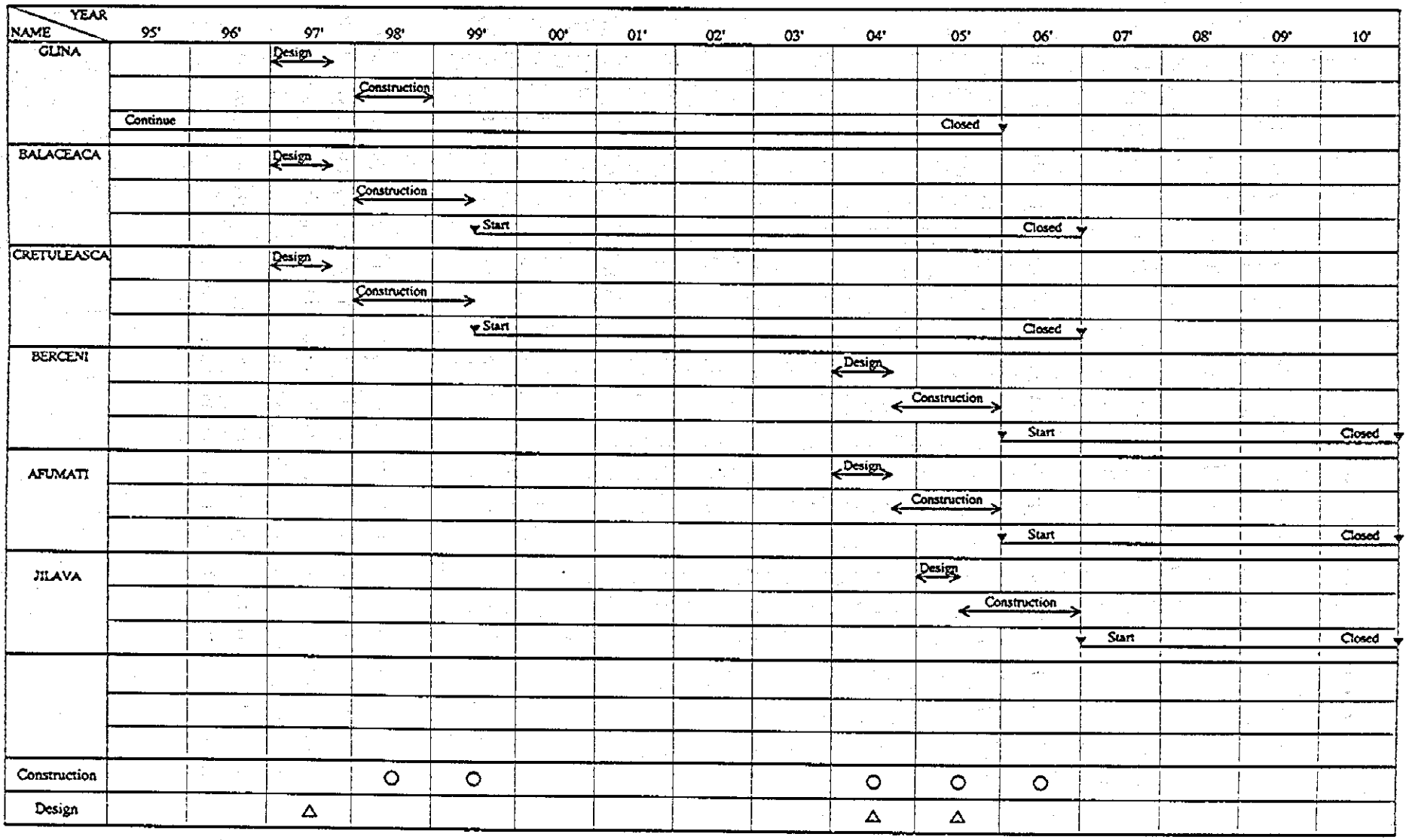
According to the Master Plan, total land area required for landfill until 2010 is 157 ha excluding the remaining area of the Glina site. A total site area of Balaceanca and Cretuaresca is 57.9 ha. Estimated total area of Afumati , Berceni and Jilava is 99 ha.

Note 2 : Selection of a Capable Construction

A qualified contractor must be selected to ensure that all the construction will be completed period. Required qualification of contractor will be shown by consultants selected for engineering services.

Fig.7.1-1 Planned Landfill Site Locations

Table 7.1-1 Final Disposal Sites Development Schedule



7.2 Incoming Waste Allocation Plan

It is planned that the two new sites (Balaceanca and Cretuleasca) will open in the mid 1999. At that time, there will be three final disposal sites in Bucharest, and all these sites will be used simultaneously. Disposal waste quantity for each of the 3 sites are planned as shown in Table 7.2-1 and Fig.7.2-1 considering that Balaceanca and Cretuleasca sites will be used for 7 years respectively starting from the second half of 1999.

Table 7.2-1 Annual Disposal Volume and Waste Allocation by Site

Year	Disposal Quantity		Site Name			
	Weight (t/year)	Volume (m^3/year)	Glina	Balaceanca	Cretuleasca	Afumati, Berceni & Jilava
1995	486,545	695,064	695,064	0	0	
1996	503,144	718,777	718,777	0	0	
1997	521,723	745,319	745,319	0	0	
1998	549,610	785,157	785,157	0	0	
1999	582,278	831,826	499,090	247,023	85,763	
2000	618,337	883,339	217,863	494,047	171,429	
2001	635,651	908,073	242,597	494,047	171,429	
2002	953,449	933,499	268,023	494,047	171,429	
2003	671,746	959,637	294,161	494,047	171,429	
2004	690,554	986,506	321,030	494,047	171,429	
2005	709,890	1,014,129	312,919	529,781	171,429	
2006	729,767	1,042,524	0	211,289	81,753	74,5,522
2007	750,200	1,071,714	0	0	0	1,071,714
2008	771,206	1,101,723	0	0	0	1,101,723
2009	792,800	1,132,571	0	0	0	1,132,571
2010	814,998	1,164,283	0	0	0	1,164,283
Total	10,481,898	14,974,141	5,100,000	3,458,328	1,200,000	5,215,813

Note) Volume x 0.7 = Weight

Disposal volume shown in Table 7.2-1 has been estimated based on the assumptions shown in the Master Plan, which poses that desirable recycling target in the year 2000 and thereafter being 10 - 15 % of household waste, while the minimum target is 8 %. To be on the safe safe side in the disposal planning, future waste disposal quantity is calculated based on the assumption that the recycling rate is 6 % at present, would increase to 8 % by 2000 and stay in the same percentage thereafter.

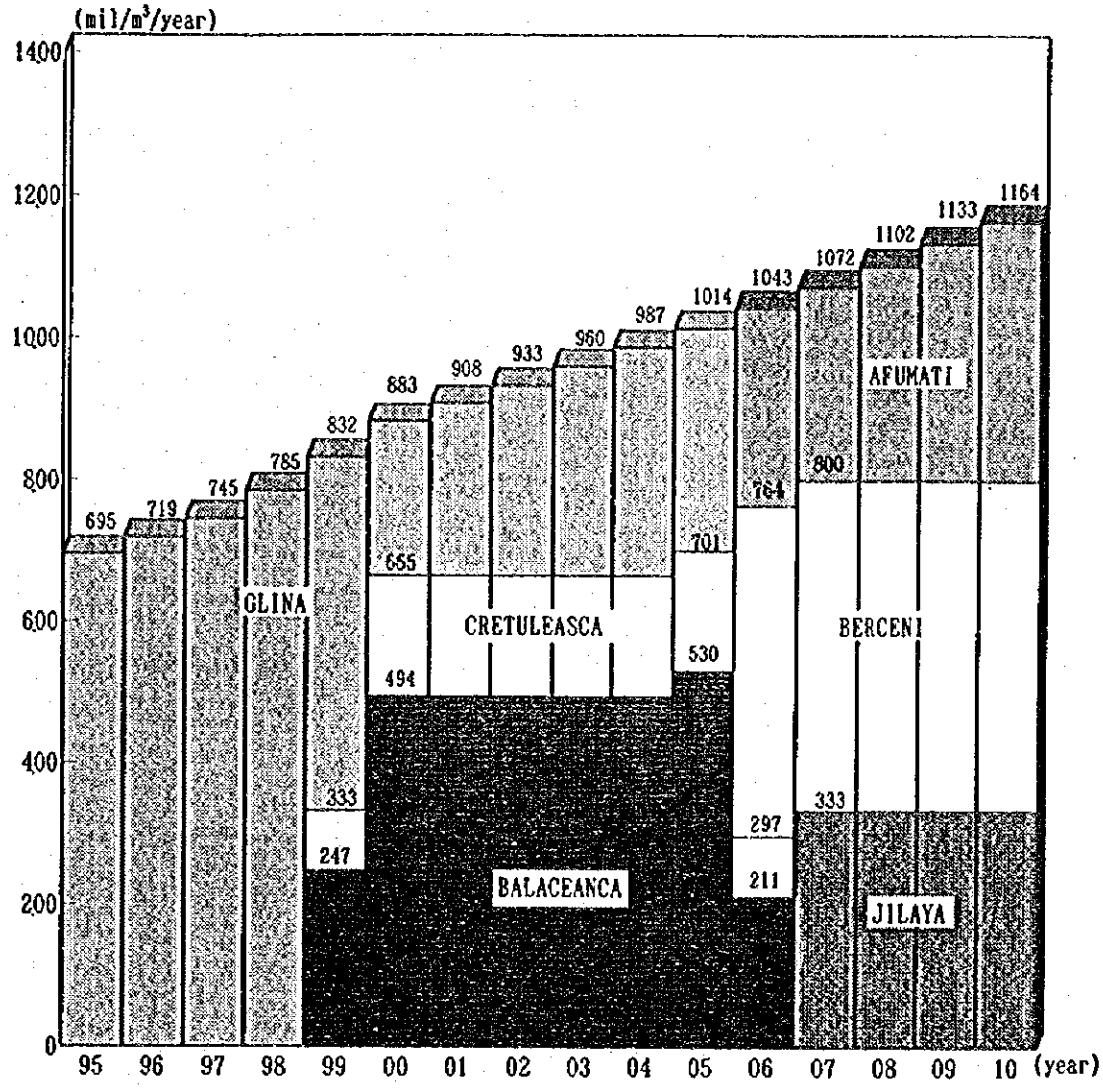


Fig 7.2-1 Annual Disposal Volume and Allocation Plan

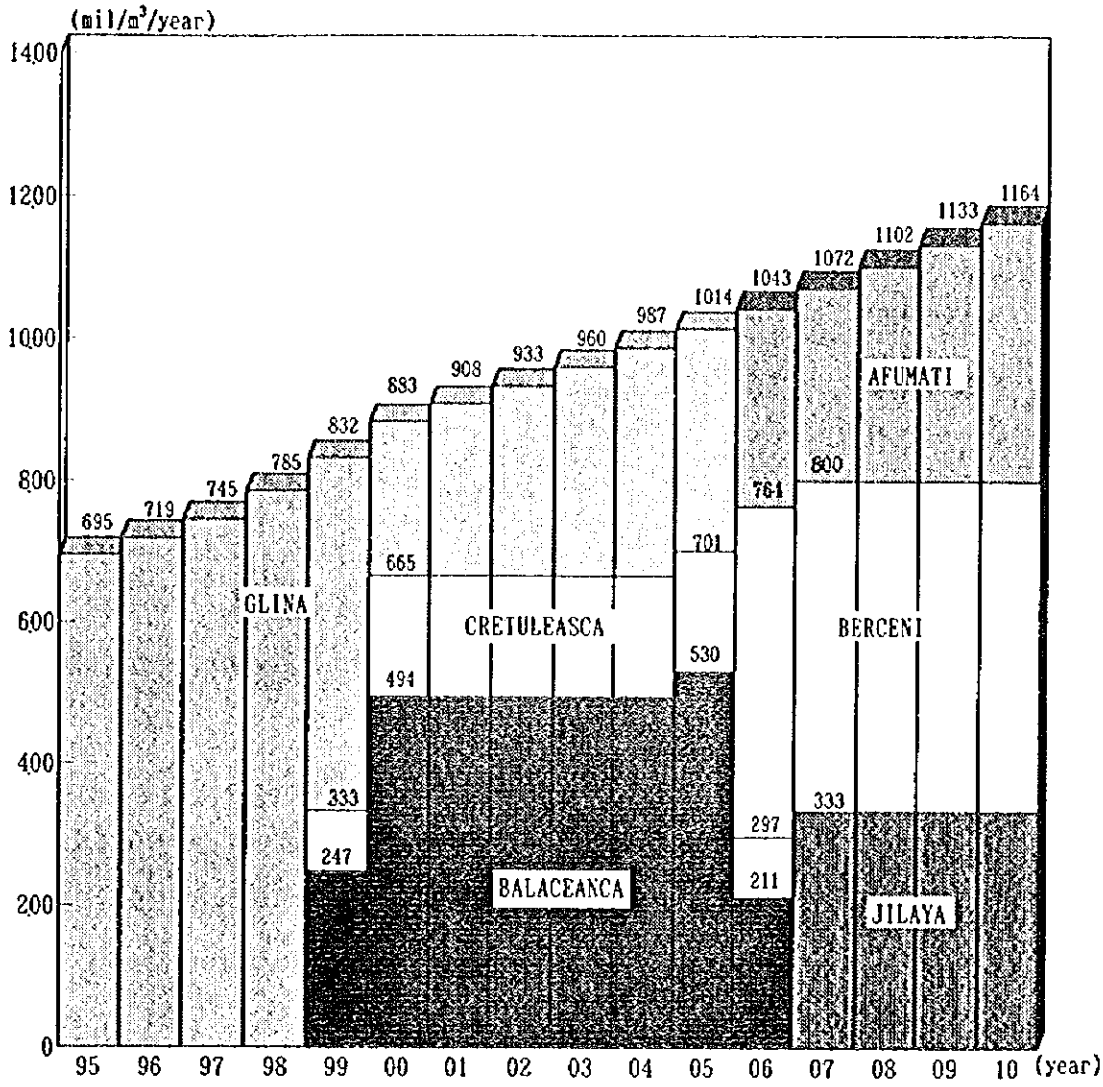


Fig 7.2-1 Annual Disposal Volume and Allocation Plan

Chapter 8

Project Costs

CHAPTER 8 PROJECT COSTS

8.1 Project Cost Components

The project costs consist of the following components:

1. Investments
   - 1.1 Engineering services
   - 1.2 Technical assistance
   - 1.3 Construction works
   - 1.4 Equipment procurement

2. Operation and maintenance of the landfill sites

The above cost Items 1.3 (construction) and 1.4 (equipment procurement) as well as Item 2 (operation & maintenance) have been estimated based on the Romanian prices using an exchange rate of 2,000 lei/dollar which is the prevailing rate in 1995.

The Item 1.3 includes 1) overhead which is assumed to be 20 % of the direct construction cost, 2) 18 % value added tax, and 3) both physical and price contingency that is assumed to be 15 % altogether.

The Item 1.4 includes 1) 18 % value added tax and 2) 10 % price contingency.

8.2 Estimated Project Costs

Total project cost is estimated to be about $ 38 million. The estimated project costs are shown in Table 8.2-1. Details of the construction costs and the equipment procurement costs are shown in Tables 8.2-2 and 8.2-3 respectively. Annual disposal expenditures for the period 1996 - 2010 are shown in Table 8.2-4.

Table 8.2-1 Project Costs

Unit: US dollar in 1995 price

	Balaceanca (a)	Cretuleasca (b)	Glina (c)	Sub Total a + b + c = (d)	Value Added Tax (18% of d) (e)	Total d + e = (f)
1. Investments						
1.1 Engineering Services for Items 1.3 & 1.4	735,000	389,000	407,500	1,531,500	275,670	1,807,170
1.2 Technical Assistance	35,000	18,500	19,500	73,000	13,140	86,140
1.3ConstructionWork including 15 % physical & price contingency	8,096,000	4,289,000	4,496,000	16,881,000	3,038,580	19,919,580
1.4 Equipment Procurement including 10 % price contingency	489,000	264,000	324,000	1,077,000	193,860	1,270,860
1.5 Total (1.1+1.2+1.3+1.4)	9,355,000	4,960,500	5,247,000	119,562,500	3,521,250	23,083,750
2. Operation & maintenance of Landfill Sites	1,351,951	683,760	967,844	3,003,555	0	3,003,555
3. Total (1+2)	10,706,951	5,644,260	6,214,844	22,566,055	3,521,250	26,087,305

Note:

1) Physical contingency and price contingency of the Construction work (Item 1.3) are assumed to be 5 % and 10 % of the original construction cost respectively. 10 % price contingency is assumed for the procurement of equipment. No contingency is assumed for other work items.

2) Tables 8.2-2, 8.2-3, and 8.2-4 show details of the project costs.

Table 8.2-2 Details of Site Construction Cost (Table 8.2-1 Item 1.3)

Unit: US dollar in 1995 price

	Balaceanca (a)	Cretuleasca (b)	Glina (c)	Sub Total a + b + c = (d)	Value Added Tax (18% of d) (e)	Total d + e = (f)
1. Embankment	583,913	460,719	1,446,035	2,490,660	448,320	2,938,987
2. Lining	2,436,725	1,217,818	0	3,654,543	657,818	4,312,361
3. Roads	2,101,640	664,495	731,880	3,498,095	629,643	4,127,658
4. Others	748,047	768,697	1,085,035	2,601,779	468,320	3,070,099
5. Sub-Total	5,870,325	3,111,729	3,262,950	12,245,004	2,204,101	14,449,105
6. Overhead 20%	1,169,675	618,271	647,050	2,434,996	438,299	2,873,295
7. 15 % Contingency	1,056,000	559,000	586,000	2,201,000	396,180	2,597,180
8. Total (5 + 6 +7)	8,096,000	4,289,000	4,496,000	16,881,000	3,038,580	19,919,580

Table 8.2-3 Details of Equipment Cost (Table 8.2-1 Cost Item 1.4)

Unit: US dollar in 1995 price

	Unit cost	Balaceanca (a)	Cretuleasca (b)	Glina (c)	Total a + b + c = (d)	Value Added Tax (18% of d) (e)	Total d + e = (f)
1 Bulldozers (S1500)	31,700	317,000 (10)	158,500 (5)	190,200 (6)	665,700 (21)	119,826	785,526
2 Excavators (S1203)	52,300	52,300 (1)	52,300 (1)	52,300 (1)	156,900 (3)	28,242	185,142
3 Trucks (R 10215)	23,000	69,000 (3)	23,000 (1)	46,000 (2)	138,000 (6)	24,840	162,840
4 Jeep (ARO 244)	6,750	6,750 (1)	6,750 (1)	6,750 (1)	20,250 (3)	3,645	23,895
5. Sub-total	-	445,050	240,550	295,250	980,850	176,553	1,157,403
6 10 % price contingency	-	43,950	23,450	28,750	96,150	17,307	113,457
7. Total (5+6)	-	489,000	264,000	324,000	1,077,000	193,860	1,270,860

Note: Figures in parenthesis show number of units to be procured.

Table 8.2-4-a Annual Project Costs
(Investments include contingency & value added tax)

Unit: US dollar in 1995 price

Year	Investment (including construction, engineering services & technical assistance) (a)	Operation & Maintenance (b)	Total (a + b + c) = (d)
1996	7,080	0	7,080
1997	741,630	0	741,630
1998	16,343,635	0	16,343,635
1999	5,991,405	325,721	6,317,126
2000	0	409,260	409,260
2001	0	414,700	414,700
2002	0	420,295	420,295
2003	0	426,044	426,044
2004	0	431,956	431,956
2005	0	438,033	438,033
2006	0	137,546	137,546
2007	0	0	0
Total	23,083,750	3,003,555	26,087,305

Table 8.2-4-b Annual Project Investment Cost Details by Components
(Including Contingency & Value Added Tax)

Unit: US dollar in 1995 price

Year	Construction of Disposal Sites (a)	Equipment Procurement (b)	Engineering Services for Disposal Sites (c)	Technical Assistance (d)	Total (a + b + c + d + e + f =) (g)
1996	0	0	0	7,080	7,080
1997	0	0	686,170	55,460	741,630
1998	15,096,861	382,320	850,294	14,160	16,343,635
1999	4,822,719	888,540	270,706	9,440	5,991,405
Total	19,919,580	1,270,860	1,807,170	86,140	23,083,750

Note:
Costs of the construction and equipment procurement by site are shown in Table 8.2-4-c. Details of the engineering services and the technical assistance are shown in Chapter 10.

Table 8.2-4-c Annual Project Investment Costs Details by Sites (Construction & Equipment only) (Including Contingency and Value Added Tax)

Unit: 1,000 US dollar in 1995 price

Year	Glina (a)			Balaceanca (b)			Cretuleasca (c)			Construction of Water Supply & Sewage (d)	Total (a + b + c + d)		
	Construction (1)	Equipment (2)	Total (1+2) (3)	Construction (1)	Equipment (2)	Total (1+2) (3)	Construction (1)	Equipment (2)	Total (1+2) (3)		Construction (1)	Equipment (2)	Total (1+2) (3)
1996	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	5305	382	5687	6401	0	6401	3391	0	3391	5664	20761	382	21143
1999	0	0	0	3152	577	3729	1670	312	1982	5664	10486	889	11375
Total	5305	382	5687	9553	577	10130	5061	312	5373	11328	31247	1271	32518

Table 8.2-4-d Annual Operation & Maintenance Costs of Disposal Sites

Unit: US dollar in 1995 price

Year	Glina (a)	Balaceanca (b)	Cretuleasca (c)	Total (a + b + c) = (d)
1996	0	0	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	180,313	96,568	48,840	325,721
2000	118,444	193,136	97,680	409,260
2001	123,884	193,136	97,680	414,700
2002	129,479	193,136	97,680	420,295
2003	135,228	193,136	97,680	426,044
2004	141,140	193,136	97,680	431,956
2005	139,556	200,997	97,680	438,033
2006	0	88,706	48,840	137,546
2007	0	0	0	0
Total	967,844	1,351,951	683,760	3,003,555