As mentioned in Chapter 3, characteristics of solid waste in Sofia are summarized as follows.

a. High content of non-combustibles
b. High ash content
c. Low lower calorific value

2) Change of Solid Waste Composition

Solid waste characteristics will change according to changes in life style. Experience in many countries show that the tendency in change for each component is as follows:

- Paper, plastic and metal will increase
- Putrecsible, cinder, stone will decrease
- Moisture content will decrease
- Organic (Volatile) will increase and lower calorific value will increase
- Density of solid waste will decrease

Based on the above tendencies, increase and decrease of each component in wet base composition has been set as follows.

a. Components to increase	
Paper	2% per year
Plastic	3% per year
Metal	3% per year
b. Components to decrease	
Putrecsible	1% per year
Glasswork	2% per year
Stone, cinder	2% per year
c. Other changes	
Moisture content in paper	decrease by 1% per year
Density of waste	decrease by 0.5% per year

As percentage of glasswork is presently very high compared with other countries, it is assumed that percentage of glasswork will decrease in the future. Moisture content of paper is also assumed to decrease because it is very high at present (50%).

3) Future Solid Waste Composition and Characteristics

Future solid waste composition is predicted based on the aforementioned changes as shown in Table 4-5-2 (and Figure 4-5-1). The table also shows the characteristic of solid waste considering recycling of used paper and glass as follows.

Table 4-5-2 Forecast Solid Waste Composition

Dry base composition	Original solid waste 1993	1995	2000	2005	2010	Remarks	After separation of reusable material 1993	1995	2000	2005	2010
Combustible (%)											
Paper	17.97	19.03	21.89	25.00	28.37		17.97	19.03	20.99	22.51	23.73
Textile	5.88	5.62	5.04	4.50	4.01		5.88	5.62	5.36	5.06	4.79
Plastic	6.61	6.99	8.03	9.20	10.52		6.61	6.99	8.55	10.35	12.57
Rubber & Leather	1.25	1.25	1.24	1.22	1.21		1.25	1.25	1.32	1.38	1.44
Wood	1.97	1.97	1.95	1.93	1.90		1.97	1.97	2.07	2.17	2.27
Putrecsible matter	18.70	18.26	17.21	16.17	15.16		18.70	18.26	18.33	18.20	18.12
Animal Residues	1.15	1.15	1.14	1.12	1.11		1.15	1.15	1.21	1.26	1.32
Sub total	53.54	54.27	56.49	59.15	62.27		53.54	54.27	57.83	60.93	64.24
Non-Combustible (%)											
Metal	4.97	5.25	6.03	6.91	7.90		4.97	5.25	6.42	7.78	9.44
Glasswork	22.85	21.86	19.58	17.49	15.59		22.85	21.86	16.68	12.79	9.31
Stone	3.33	3.19	2.85	2.55	2.27		3.33	3.19	3.04	2.87	2.71
Cinder(over 5 mm)	6.27	6.00	5.37	4.80	4.28		6.27	6.00	5.72	5.40	5.11
Concrete & block	2.68	2.56	2.30	2.05	1.83		2.68	2.56	2.44	2.31	2.18
Other (Over 5mm)	3.69	3.70	3.98	3.80	3.16		3.69	3.70	4.24	4.28	3.78
Other (Under 5mm)	2.68	3.16	3.40	3.24	2.70		2.68	3.16	3.62	3.65	3.23
Sub total	46.46	45.73	43.51	40.85	37.73		46.46	45.73	42.17	39.07	35.76
Total (%)	100.00	100.00	100.00	100.00	100.00		100.00	100.00	100.00	100.00	100.00
Three component (%)											
Moisture	42.12	41.91	41.37	40.68	39.83		42.12	41.91	42.11	41.86	41.41
Organic	27.37	28.01	29.73	31.59	33.64		27.37	28.01	30.04	31.90	33.79
Ash	30.51	30.08	28.91	27.73	26.52		30.51	30.08	27.85	26.24	24.80
Lower Calorific Value (Kcal/kg)											
Q = 45 V - 6 W	979	1,009	1,090	1,178	1,275		979	1,009	1,099	1,184	1,272
Karigo formula	1,109	1,147	1,250	1,363	1,490		1,109	1,147	1,268	1,389	1,522
Calculation	1,224	1,264	1,373	1,496	1,633		1,224	1,264	1,398	1,536	1,691

Note: Moisture content of paper is assumed to be decrease 1 % per year (52 % in 1993 and 44 % in 2010)

	2000	2005	2010
Paper recycle	10%	20%	30%
Glass recycle	20%	35%	50%

Dry base composition, moisture content, ash content and lower calorific value may be forecast based on the expected changes in wet base composition.

Moisture content and ash content will decrease and lower calorific value will increase to 1,600 kcal/kg in the year 2010.

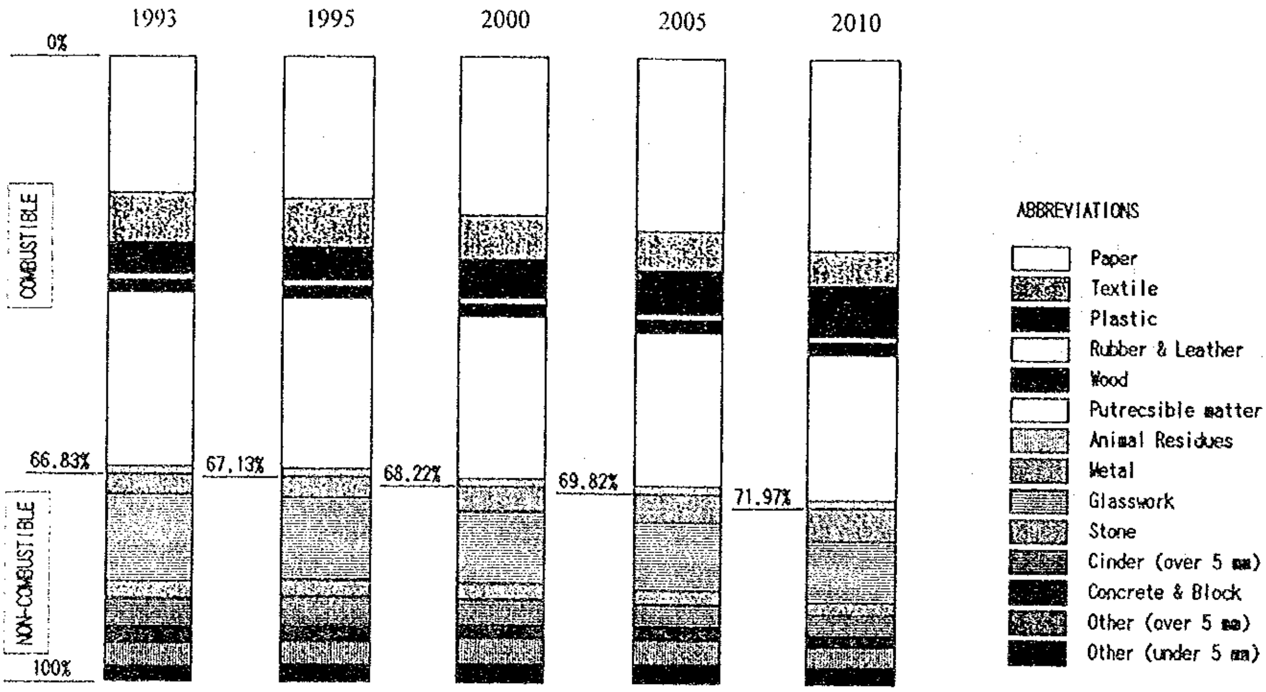


Figure 4-5-1 Forecast Waste Composition

4.6 Master Plan Targets and Goals

Sofia, a beautiful and ancient city in Europe is bound to be effected by the economic transformation taking place in Bulgaria. As Bulgaria sets its course on joining the European Community, the capital Sofia will surely take the lead. With its position as the nation's capital and the newly acquired freedom of Bulgarians to settle and work anywhere in the country, the city may suffer an increased demand on its existing infrastructure and public services.

The master plan sets its major goal to assist SGM in maintaining a beautiful and healthy city and assuming a leading position amongst the European Union cities. To realize this goal the master plan has been prepared with specific targets, which are shown in Figure 4-6-1.

TARGETS OF SWM MASTER PLAN

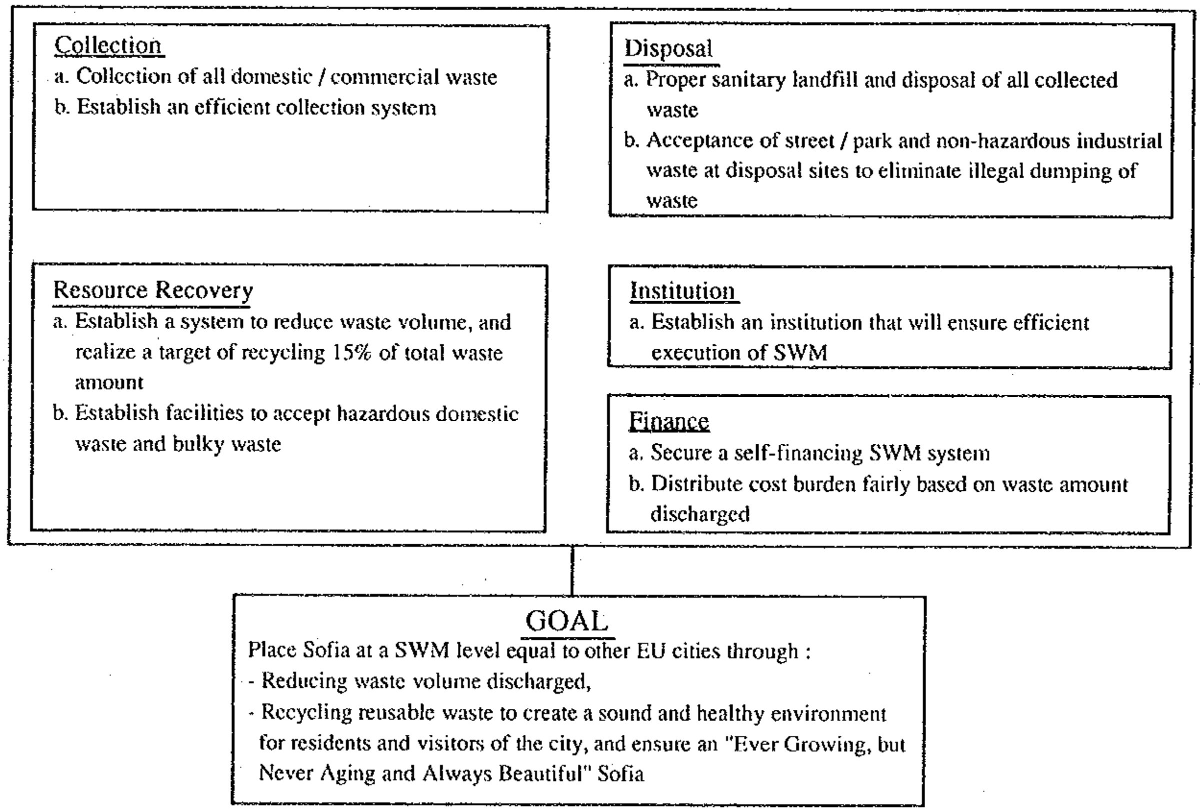


Figure 4-6-1 Goal and Targets of the SWM Master Plan

CHAPTER 5

SWM FACILITIES SITE SELECTION

CHAPTER 5 SWM FACILITIES SITE SELECTION

5.1 Landfill Site Selection Criteria

5.1.1 General

As a general rule, all solid wastes generated within Sofia will end up as landfill in one form or another, as a treated residue, as recycled or yet again-reused material or as a simple landfill material for storage and/or decomposition in a dump or in a controlled landfill site.

Existing and controllable landfill space is rapidly running out in Sofia and there is an urgent need to identify further landfill sites.

Under the Terms of Reference a 'Priority Project' should be identified during the study and this may probably include landfill facilities. It is to this end that the search was undertaken and a site identified as a Priority Project Landfill 'candidate' site. It was undertaken with a counterpart team from the Municipality.

Associated with this work were the tasks of Geographic, Geological, Hydrogeological, Geotechnical and other Environmental reviews required in conjunction with the search for prospective 'Candidate Site(s)'.

This Section 5.1 therefore describes the appreciation of the task, the Study team's approach to the work and, in conjunction with the SGM counterpart team, the respective site selection criteria agreed. Section 5.2 describes the sites considered and Section 5.3 the Selection; (Katina).

Section 5.4 deals with the sites proposed for the other intermediate treatment facilities, such as incineration plant and transfer stations.

5.1.2. Original Proposed Sites

As previously referred to, the Municipality initially proposed two possible landfill sites to JICA in Nov/Dec 1992: These are considered here with other possibilities since identified.

The two sites proposed to JICA are:

Koriata
Katina

5.1.3 Decision to Retain The Katina Site 'On-The-List'

As the search progressed, it became clear that the number of possible sites inside the Municipal Boundaries was restricted and one in Particular, at Katina had been a source of social controversy for many years.

More particularly, during May 1993, it was reported that the question of the site's former allocation for waste landfill had been the subject of public political debate and declarations.

Accordingly, a request for guidance was tabled to the Mayor's Office as to whether or not the 'Katina Site' should be retained as a 'Candidate'.

The reply, relayed through the counterpart staff was that the site should be technically considered as a 'candidate' with the others.

5.1.4 Site Search Methodology & Criteria Formulation

The work of identifying Possible Candidate Sites was carried out in close cooperation with the Counterpart staff who joined in the work and, when required, guided the study team.

The work commenced with a broad overview, identification of site type, local constraints, tentative criteria definitions, general regional desk studies and overviews. Eventually a model of general land suitability emerged and the general regional locational criteria presented here and plotted on the Map of Figure 5-1-1

Following detailed discussions with the counterpart team, a set of general landfill site criteria were drawn up and were the basis of the final site search and selection.

The Municipality were kind enough to arrange for an exhaustive and Helicopter Search of the area and aerial inspection of particular sites identified.

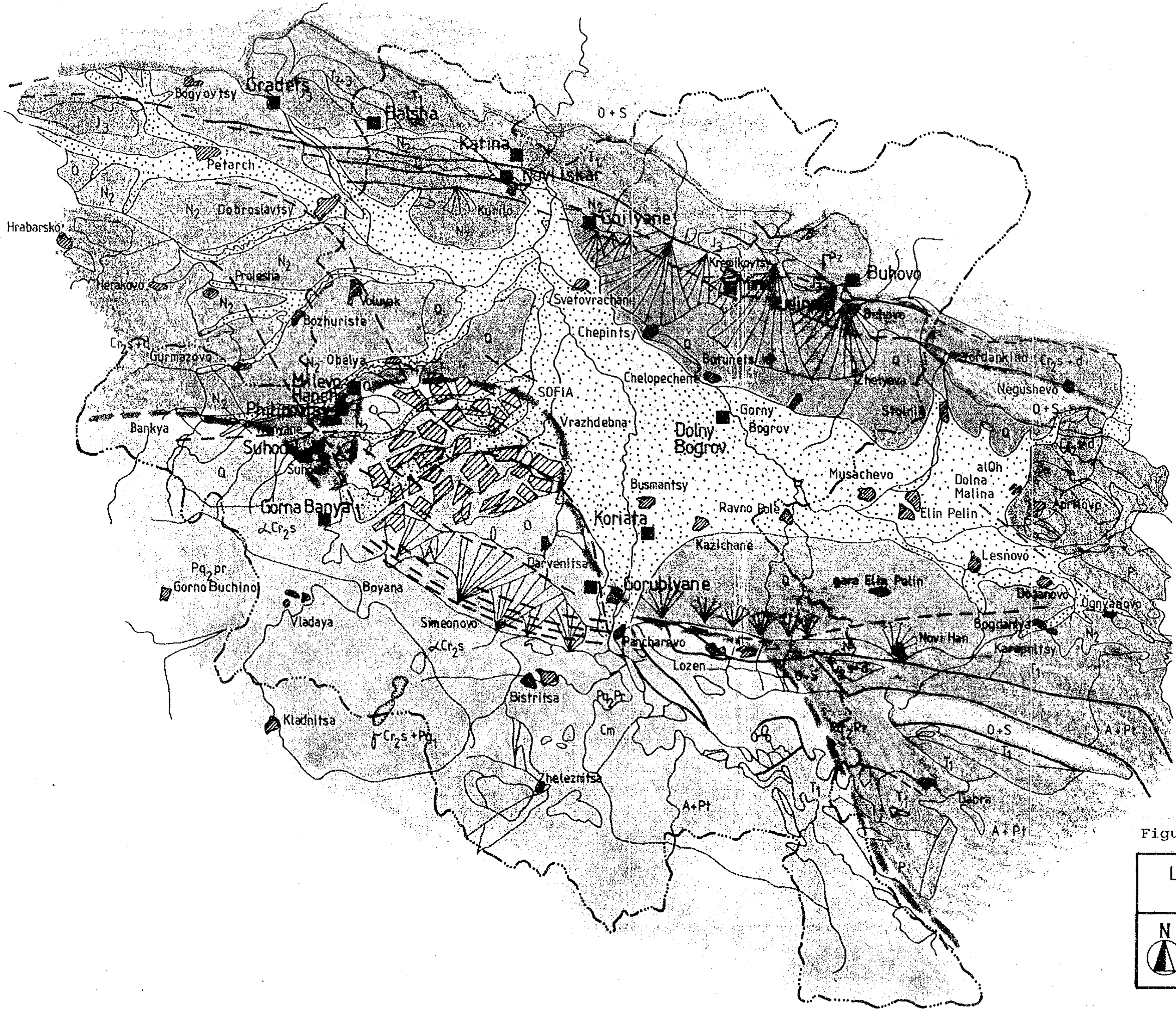


Figure 5-1-1

LOCATIONAL CRITERIA - SHEET 1

N

Scale

0 5 10km

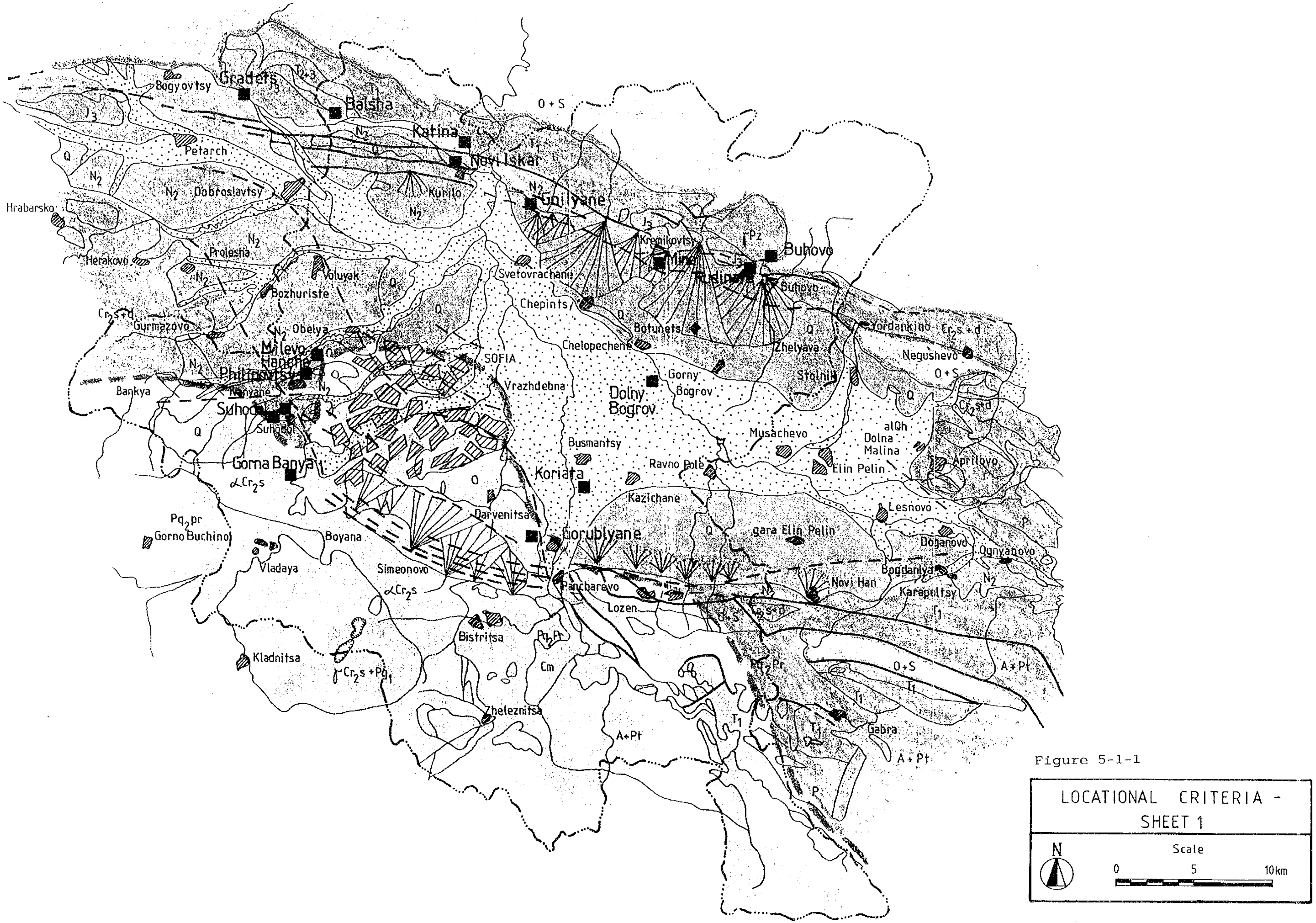


Figure 5-1-1

LOCATIONAL CRITERIA - SHEET 1

Region	Position	Relief	Geological Age	Lithological Structure	Under-ground waters	Depth from terrain surface	Water perme-ability of rock	Hazard	Recom-mendation
1	Central parts of the plain	Plain terrain, having almost no negative forms	Quaternary - alluvial	Gravel, Sandstone	In strata, no head	1 - 3 m	Highly transmissible	Unavoidable pollution of underground waters	Construction of dumping sites not recommended
2	Plain surrounding regions	Light sloping to hilly terrain	Quaternary prolluvial, diluvial, Pliocene	Clays, Sandstones, Gravel	In strata, no head - head	3 - 15 m	Little or average transmissivity	Considerable underground water pollution hazard	Construction of dumping sites possible after additional geological investigation
3	Surrounding slopes	Mountainous with natural negative forms	Middle and upper Triassic, upper Jurassic	Karstic Limestones	Karstic, zone feeding water bearing horizon	> 10 m	High water transmissivity	Hazardous for long term pollution of deep karstic waters expected	Construction of dumping sites prohibited
4	Surrounding slopes	Mountainous with natural negative forms	Cambrian, Ordovician, Silurian	Phyllites Diabase, Argyllites, Quartzites	Non water bearing	> 10 m	Water tight	No hazard for underground waters	Construction of dumping sites is possible, including sites for toxic waste
5	Surrounding slopes	Mountainous with natural negative forms	Palaeozoic, Permian, lower Triassic, middle and upper Jurassic, upper Cretaceous, Palaeogene	Metamorphite, sandstone, conglomerates, marls, andesite tuffs, tuffites, diorites, Syenite, Grano-diorites	Fissural waters	> 10 m	Low water transmissivity	No hazard for underground waters (with the exception of some tectonic zones where fissures in rock exist)	Construction of dumping sites is possible (the tectonic zones are excluded)
6	Sofia city, National park Vitosha, Liulin, Lozen mt.							Hygienic and sanitary hazard, degradation of ecological conditions	Construction of dumping sites is not recommended

Figure
LOCATIONAL CRITERIA-SHEET 2

5.1.5 Selection Criteria

Standard Criteria for landfill sites are well established and most of the usual technical and ecological checkpoints commonly applied in this work are appropriate, in principal to Bulgaria. Some of these are set out in Table 5-1-1.

SITE IDENTIFICATION CRITERIA:

The principle agreed criteria used for the initial site identification were:

- The proposed site must lie within the Boundary of SGM in order that the City retain jurisdiction over it.
- The lands should either be the property of SGM or the owner should be legally identifiable and the site should be 'acquirable'.
- The cultural patrimony of the lands should not be disturbed by the proposals to landfill: (Ie; natural 'unspoiled' lands should be avoided)
- The capacity available should be sufficient to justify economic development.
- The general locational criteria of Figure 5-1-1

SITE APPRAISAL CRITERIA:

The principal criteria used for the particular site appraisal are those above plus those of the Bulgarian Waste and Environmental Laws, ETC8 & Etc (as Table 5-1-1).

These criteria are discussed:

(i) Jurisdiction

Under existing and proposed future legislation, local authorities exercise a substantial degree of control over solid waste handling and disposal sites within their areas. In order that SGM retains full control over their own waste disposal it was determined that the site should not be outside it's boundary unless an exhaustive search showed that the available sites within the boundary were ultimately found to be unsuitable.

(ii) Land Availability

One of the most critical criteria set out was that of land availability.

Table 5-1-1 Table of a "Check List" of Standard Waste Disposal Site Selection Criteria

This Annex sets out general criteria which are commonly used as a 'check-list' against which the general suitability of a disposal site can be measured.

The main text sets out the Bulgarian laws, particular locations and the main environmental criteria (ETC 8) which are adopted for application to the Master Plan site seletion.

The standard procedure adopted typically reviews these criteria and includes such as the following :

Social Conditions

-The site should not be immediately adjacent to residential areas.
-The site should not be related to the future development planning of the city.
-The sites should not detract from amenity or be such as arable land or pasture.
-The flexibility of ultimate land use should be high.
-The site should not be selected rom privately owned areas.

Environmental Conditions

-The site should not be related to the source of drinking water.
-In the direction of down-stream the main wind, there should not be any residential areas.
-The landscape should not be changed on a large scale.
-Area for the environmental protection measurements such as leachate treatment equipment and central environmental control instrumentation should be enough.
-The site should not be ecologially undesirable.

Disaster Prevention Conditions

-The site catchment area should be small.
-The stability of the valley slope should be high.
-Disaster preventing works on site should be easily achievable in terms of topography.

Economical Conditions

-The location should be as close as possible to the built-up city area in order to reduce transport costs.
-The site should be close to a road which is capable of handling the traffic generated by the landfill site.
-Large sites are preferable to attract economies of scale and thence enable capital expenditure to be spread over a greater tonnage of wastes, thereby reducing unit cost.

Engineers must be prepared for the possibility of negative local public response to a sanitary landfill. A program designed to increase public acceptance for the landfill should be included in the early planning stages. An unnecessarliy defective attitude should be avoided, however.

Opposition to locating and operating a landfill can come from any of the population groups listed below.

-Property owners who believe a nearby landfill will lower their land values and social status.
-Citizens opposed to the expense.
-Citizens who resist change.
-Citizens concerned about conserving (not wasting) resources and natural areas.
-Neighbours concerned about traffic, safety and health, blowing paper, insects, rodents, noise, unaesthetic landfilling and other environmental efforts.
-Politically opposed voters.
-Citizens who believe previous poor operational practices may be continued.

Land ownership and land acquisition of sites within the Sofia area is currently in a state of turmoil following a parliamentary decision to return appropriated land to its original owners. The courts, districts, map offices, land agents, etc are in consequence swamped with land ownership problems and assisting with establishing data relating to the true and/or inherited ownership of many lands and sites throughout the country. Land acquisition is in consequence considered almost impossible at this time. Compulsory purchase problems would be compounded if an 'owner' cannot be clearly established.

It was however clear that the solution of the many current problems associated with acquisition of the lands was uppermost in the counterpart staff's considerations.

Priority was therefore to be given to lands at present owned by SGM, or which the counterpart staff were confident could be readily acquired.

Ultimately this 'ownership' criteria was confirmed as applying to lands 'occupied' by other state enterprises such as working Rock Quarries. Eg, Suggestions were made that a operational Quarry or its operator/owner could be 'Bought' if the price was right. They were rejected as 'impossible' under the present political climate: Not until such companies are scheduled for privatization.

(iii) Natural 'Patrimony' of the lands

As the next 'priority', was the general and the most subjective criteria of "Suitability": In principle it was determined that waste should not be landfilled onto natural 'unspoiled' countryside or at locations where it would be offensively 'obtrusive' to the discerning citizen.

Derelict land readily accessible and remote from population centers was therefore sought and attempts were made to avoid 'sensitive' sites and those which would clearly be rejectable on ecological or environmental grounds . (The ideal characteristics were all not found!)

(iv) Site 'Volume'

Ideally, landfill sites should be so sized as to provide 'least' cost storage and maximize the capital costs of the investment in the transportation requirements, site facilities, drainage and other establishments associated with the fill site.

The 1989 Bulgarian Code of Practice recommends that the capacity of the site should be sufficient for at least 15 years. Various other 'authorities' quote periods in the order of 5 to 10 years as being an optimum target capacity.

Applied to the Sofia region, it was determined that in view of the 'degree of technology' required to ensure a satisfactory safeguard against groundwater pollution that individual site storage capacity should be used to maximum effect and that new sites should be as voluminous as is reasonably achievable. If expensive gas and leachate containment works or lining systems must be adopted, sites with deeper filling possibilities should be the most economic.

The actual site capacitive sizing required for the city therefore depends on:

- Any pretreatment or volumetric pre-separation; eg. separation for composting or incineration;
- the number of sites proposed to be in operation at any one time;
- waste generation rate;
- permutations of these and other criteria.

On the basis of the above, and broadly estimating from present data analyzed, indications are that a Candidate site for landfill should preferably be at least 3 to 4 million cubic meters and, if one single site were sought, a sizing of some 5 to 10 million cubic meters would be ideal. This is on the basis of an annual output in the region of 350,000 to 550,000 tons of waste and possible compaction over the range of 0.6 to 0.95 tons of received waste stored per cubic metre of the landfill. (The latter could be possible with efficient compaction & controlled moisture content: Eg leachate recirculation or such as high density pre-compression).

(v) Locational Criteria

In addition to 'ETC 8' and the other criteria above, and for the purposes of this study a map of specific locational criteria was compiled. This work was completed using the data presented earlier pertaining to the Regional Geography, Hydrology and Hydrogeology. It is presented as Figure 5-1-1.

This map presents the Master Plan Locational Overview and general summary findings in respect of the general geographic suitability of the regional lands for construction of Waste Landfill. It is intended to be used as an initial guide as to the possible general suitability a particular site.

The map refers to several regional 'categories' which are discussed hereafter as "Regions " of suitability. These are:

REGION 1

This includes the central parts of Sofia basin. The terrain is flat with a well developed river network. There are no natural negative relief forms. Geologically the region is made up of alluvial gravel, sands and clay. A 50 m deep water bearing layer has been formed in it. Groundwater level is 1 to 3 meters beneath the ground. Due to the high water transmissivity of the sand and gravel layers risk of pollution of the adjacent groundwater is high. That is why construction of new landfill sites in this region is not recommended.

REGION 2

Includes the fringes of the river basin and transition areas between the plain and surrounding slopes. The terrain is slightly sloping and hilly. At certain places there are negative relief forms: small valleys, dry valleys and ravines. Geologically the region is built up of Quaternary proluvial and diluvial materials and Pliocene sediments; gravels, sands and clays.

The groundwater are generally not under pressure but the occasional confined aquifers have developed and these tend to restrict underground aquifer interconnection and hence limit the water flow rates in the water bearing strata. The level of the groundwater is between 3 and 15 meters below ground level. Here there is a risk that potential pollution of the surface aquifers from leachate contamination could penetrate into the lower quaternary water bearing strata. Accordingly any landfill site in this area should be considered only following detailed hydrological studies. The scope and details of the investigations should reflect the pollution potential of the site and the recommendations of ETC 8 in particular should be adhered to.

REGION 3

This region includes several areas with karstic Jurassic and middle Triassic limestone in the southern slopes of Stara Planina, the regions above Peturch village and above Kremikovtsi. These are zones which supply two great water bearing aquifers within the middle triassic and jurassic strata which feed deep below the upper plain pliocene levels. These aquifers feed the well known and protected deep karstic springs.

Construction of Solid Waste Landfill Sites in this region is accordingly prohibited.

REGION 4

This region includes large regions on the southern slopes of and dales of Stara Planina mountain, as well as several smaller spots in Sredna Gora (the Lozen and Ihtiman regions). The terrain is mountainous, there are varieties of negative relief forms - ravines and valleys. Geologically, the region comprises Cambrian, Ordovician and Silurian phillytes, diabases, argillytes and quartzites which eologically, the region comprises Cambrian, Ordovician and Silurian phillytes, diabases, argillytes and quartzites which are considered virtually water tight.

The risk of groundwater pollution is accordingly low and the area is considered generally suitable for construction of dumping sites including sites for permanent disposal of some 'special' wastes.

REGION 5

This region includes the foot hills and lower slopes of the region. The relief is mountainous, there are a variety of negative relief forms present - ravines and valleys. Geologically, the region includes rocks from different eras - metamorphytes from the lower series of the metamorphic complex, Permian sandstones and conglomerates, lower Triassic sands, Senonian marls, sands, andesite tuffs and tuffites, upper Cretaceous and Paleogenic diorites, sienites and granodiorites, Priabonic conglomerates, sands and marls.

These rocks have the following in common: They are water bearing only along fissures where fissure waters circulate. Groundwater level is over 10 m from the surface. The rocks are almost water impermeable and there is little risk of polluting the groundwater. An exception may be some of the tectonic zones, where rocks are extremely fissured, broken down and display a greater water transmissibility. This region is generally suitable for the construction of appropriately designed landfill sites (tectonic zones excepted).

REGION 6

This region is mapped to include, regardless of the geological structure and the hydrogeological conditions, The territory of Sofia city, The National Park at Vitosha, the Liulin and Lozen mountain (both are tourist sites and recreation areas).

The unsuitability of this region for landfill site construction is obvious.

(vi) European Technical Appraisal Criteria

The Technical Environmental Engineering criteria applied and upon which our individual site appraisal was made are those of the European Technical Committee which was formed to work on the Geotechnics of Landfills and Contaminated Land (ETC 8).

These criteria were originally those of the Greater London Council but were revised and re-published in 1991 after extensive deliberations and up-dating to account for current waste management practice and European requirement. They are set out for European designers dealing with new landfills & contaminated lands following resolutions and undertakings given by the European Countries at the 1989 Rio de Janerio International Conference. They are applicable in Bulgaria and in the EC. They are known as 'ETC 8'.

5.2 Disposal Sites Considered

5.2.1 The Sites

The sites selected according to the previous procedures are all located in Figure 5-1-1. They were:

Balsha
Buhovo
Dolny Bogrov (extension)
Graditz
Gnilyane
Katina
Koriata
Novi Iskar
Rudinata
Suhudol (Monofill)
Suhudol Stage II
Suhudol (Further Expansion)

and:

The Kremikovtsi Mine ... a longer term possible site!

Katina was considered following consultation with the counterpart team: As reported in Section 5.1 above.

5.2.2 Balsha

This Site comprises the lower end of a small natural farmland valley within the crook of the east-west highway near the Village of Balsa. Although the lands are at present owned (or claimed) by a Balsa Co-operative farming group, it was understood that it was nevertheless possibly 'acquirable'.

An inspection of the Site shows that it has already been partly used as a dumping ground next to a roadside car park but the main valley floor is still 'virgin farm pasture'. The study's review of this site has identified some development drawbacks.

They include:-

- The immediate adjacency of the East-West highway (ie site location is contrary to the proximity guideline);
- the requirement for catchment flood diversion;
- the relative small storage capacity of the valley.

- inspection of the valley floor showed typical characteristics of a dry bedded limestone valley floor.
- the general location was within the 'Region 3' area of the locational Criteria. Ie landfilling prohibited.

Having regard to the immediate proximity of the roadway and obviously high unit site development costs, this site was not considered as a realistically viable site for the substantial filling of landfill required of the priority project Site.

5.2.3 Buhovo

This site was identified both from the air and from existing maps as a potential Solids Waste disposal location. It is within the edge of Region 5 and is shown located on the plan of Figure 5-1-1. It comprises a natural valley immediately adjacent to large sedimentation ponds used for settling out aluminium processing waste waters and formerly, as understood by the team, for Uranium process water recovery and uranium extraction sludge ponds.

The study, local enquiries, site visit and subsequent follow up discussions with SGM lead the study team to believe that the site should not be used for any waste deposit.

The existing ponds are reputed to be most seriously contaminated with chemical and radioactive residues from their previous use. The team's observations showed the pond embankments to be constructed with soft materials and escaping liquids were noted to be discharging into the surface water system.

The Study Team is of the opinion that the site reputation is such that to further develop and operate new disposal facilities in this location itself is undesirable, could be impossible to effect and could hamper the implementation of proposals for a general area clean up.

This site is accordingly not considered further.

5.2.4 Dolny Bogrov (Extension)

Although SGM resolved some 5 years ago that this site should be closed down, its storage remaining potential does nevertheless exist and it was considered whether or not this site could be 'retained' for some use under certain circumstances:

Say for further operations providing such use were technologically possible, legally permissible and environmentally acceptable.

Possible options so far identifiable are:

a) To fill the remaining capacity with inert waste;
b) to extend the fill vertically above the existing levels;
c) to line further capacity and properly exploit the potential;
d) to accept that the contamination potential of the site has already reached unacceptable proportions and the site must now be filled no more than is absolutely necessary.

None satisfy the agreed Municipal waste general and technical criteria set. Under the proposed new waste act, it will be illegal to continue to deposit household waste within the Dolny Bogrov quarry pit in the same manner as at present due to:

a) its inevitable immersion within the Sofia Plain Aquifer.
b) the higher groundwater level which will occur when the irrigation pumps close down.
c) the risk of further increasing contamination.

In extreme circumstances (Eg: Absolute necessity due, say to a postponement of the development of the Priority Project) it may be possible to temporarily countenance further use of the site by lining a suitable area at ground level and extending the fill vertically above the Natural Ground level.)

This option essentially 'compounds' an existing unsatisfactory site problem and would require relaxation of the agreed Master Plan site selection and appraisal criteria.

In accordance with the undertaking given in Section 9.5 - (10.) of Progress Report I, this Report discusses this possibility as an alternative to the Priority Project. It is not recommended as a satisfactory long term 'Master Plan Strategy'. The quarry remains a possible Inert Waste Dump site (Glass, Street Waste, Selected Builder's Waste etc.

5.2.5 Graditz

This potential Landfill Site was first introduced to the JICA team (along with the Koriata and Katina potential Sites) at the Project inception stage in 1992.

The site is shown located to the North West of Sofia on Figure 5-1-1. Its use is questionable as it appears to lie on the boundary of the limestone area: Region 3: see the Figure.

Being outside the present boundaries of SGM however, the site is out of the Control and Jurisdiction of the Municipality.

The counterpart staff advise that even if the administrative 'locational' problems could be overcome the respective neighboring Authorities would strongly oppose any suggestion that Sofia deposits waste on their territory.

This site is therefore not considered further.

5.2.6 Gnilyane

This site is a natural and steep sided valley, and is shown located in Figure 5-1-1. It is within Region 2. It was first identified by desk study.

The subsequent aerial inspection confirmed the location to be a viable location: It is remote from population centers, and in some respects similar in topographical features to the existing Suhudol disposal site.

Site visits with the counterpart staff and the initial area surveys however showed this valley was an unspoilt area of notable natural beauty. It had been partially forested by the Municipality. It was clear that any proposal to fill the valley with waste would be unsupportable on environmental grounds and could generate justifiable opposition.

This site is therefore not considered further.

5.2.7 Katina

The Katina site comprises a former open cast lignite coal mining area of 160 Ha. It is was the property of the Ministry of Energy but it is now allocated by Parliament to SGM for solid waste landfill disposal should the City wish to take up the option. It is understood that the entire 160 Ha is available without land cost to the municipality.

The Site rests at the edge of the locational criteria of Region 5 and Region 2 (but mainly the former). It is shown located in Figure 5-1-1 and comprises two distinct areas:

- The first is an open park area with a large pond contained at lowish level in the old excavations.

- The second is a more-or-less hidden quarry cut into the crest of an adjacent hill and hidden from the roadway and main residential areas. This section also contains ponded former deep workings, possibly fed by or standing on the hydraulic head of a coal seam aquifer

Previous proposals in 1974 to develop the first of these areas were not realized and neither were later 1984 proposals by Vodokanal accepted. The Study team understands that there was, and there still is, considerable opposition to the construction of a landfill at this location.

As mentioned in Section 5.1.3, following consultations with the counterpart team, the site is nevertheless still considered as it is so far the only substantial landfill storage facility which satisfies the two prime criteria above: Land availability and a degree of technical suitability.

Having visited the site, it is appreciated that any proposal to adopt 'Dolny-Bogrov-Type' operations at this location would again generate extreme resistance from the residents: particularly if the first of the above areas were developed.

The hidden area however was reported to have a potential for accommodation of some 6.4 million m^3 of landfill and the possibilities at this location was therefore more fully explored (capacity turned out to be 8,200,000 m^3.)

This site was therefore actively considered and preliminary site studies and geotechnical investigations were implemented in accordance with the appraisal procedures of ETC 8.

Amongst other options for use of this site, particular merit in considering an option accommodating "pretreated" precompressed dressed blocks of solids waste within the inner hidden Quarry.

Site use option are the proposals of:
- SGM claiming the whole of the site and thus gaining a valuable property;
- using the 'hidden quarry' to receive partially treated landfill in the form of properly compacted /and or compressed bales of wire bound solid waste.
- mitigating local impact of the shock of the landfilling by enhancing the amenity value and usefulness of the un-

touched land. Eg Leasing the land to a property developer for commercial and communal development or say an employment creating activity;

- to avoid a 'Dolny Bogrov type of situation, contracting out the operation of the landfill site to open tender with a improved terms and with financial payments linked almost totally to performance criteria such as bonded contributions to the site aftercare fund, site maintenance, covering material efficiency, turnround time, leachate quality, locally monitored groundwater quality, methane production, nuisance, laboratory services, engineering records production, staff skills, landfill weight entering the site, volume occupied, and the like. It is envisaged that Municipal officers would man the weigh bridge
- advancing construction of the proposed Novi Iskar by-pass roadway (shown in Figure 5-2-1) which skirts both the Novi Iskar clay quarry and the Katina landfill site;
  or;
  reconnecting the original rail link which connected this site to the nearby Bulgarian railway system.

Technologically, the site is not as ideal as could be hoped for. Open cast coal mines have notorious features requiring special consideration. This particular site exhibits several of these and other notable features:

They are summarized and include:

- Self igniting coal seams - approximately 20 to 25 smoke plumes evident on one occasion;
- a reported possible presence of coal gas;
- exposed seams and strata which should be appraised for gas permeability;
- high standing water level, (but can be lowered by gravity discharge to the nearby Katinska stream);
- a military airfield nearby;
- adjacent holiday homes constructed around the rim of the quarry;
- absence of any existing central sewage treatment works capable of handling partially treated leachate;
- unstable vertical clay quarry faces, (landslides are common).

In view of the site's advantages and development potential (later shown to be as low as some US$2 per m^3), none of these above constituted reason for abandoning this site, and appraisal work proceeded.

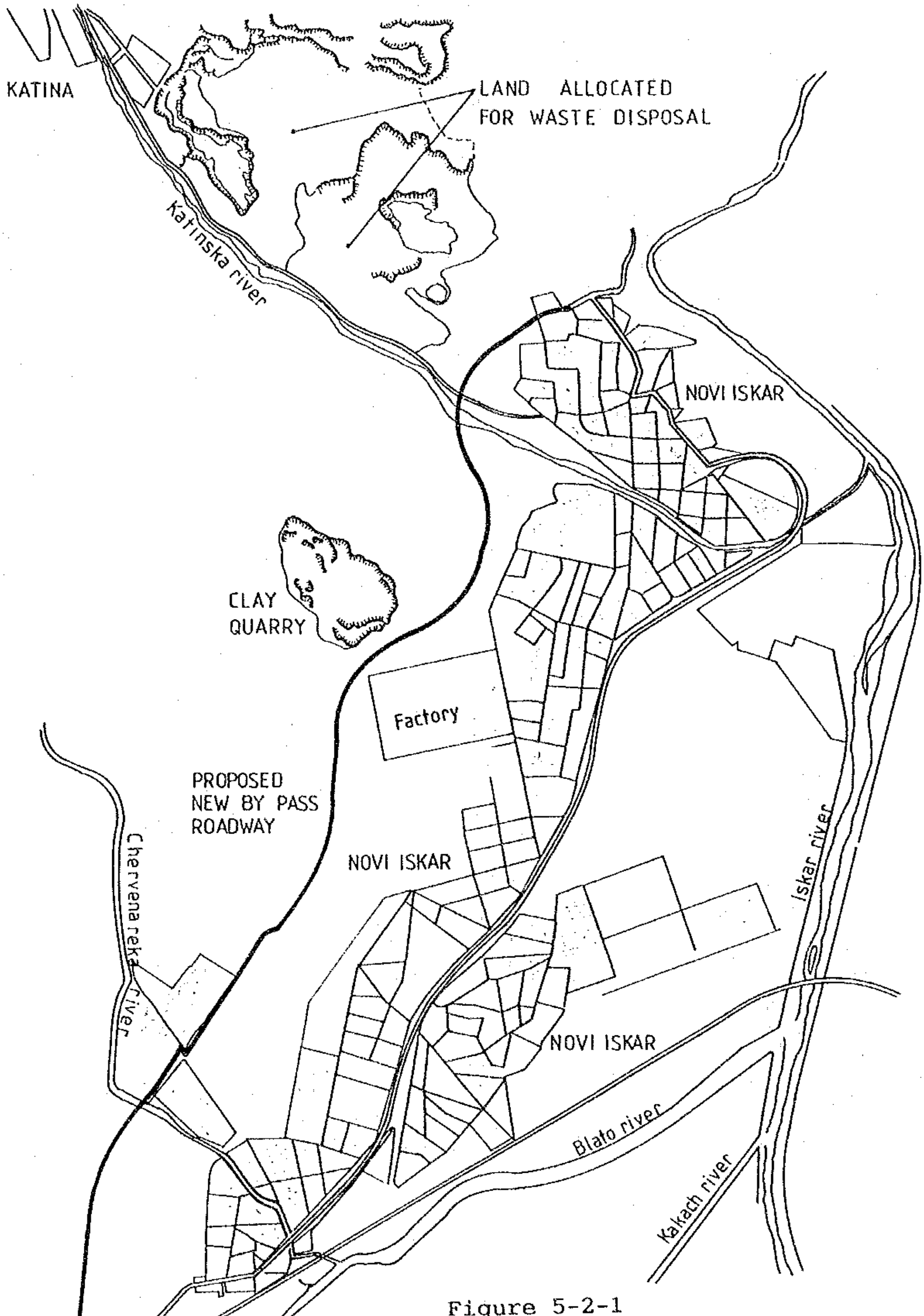


Figure 5-2-1

NOVI ISKAR - PROPOSED BY - PASS

Due to the particular complexities of the site, care was taken to ensuring project appraisal covered all aspects identified in order that appropriate engineering proposal could be costed. It was envisaged that expensive imported liners could be avoided and to this end a particular study of the use of local internal quarry clays was thought necessary. The site has potential for economic landfill: using locally available clay seals.

Particular advantages of this site include:

- The 'negative' land cost situation;
- the secluded nature of the inner quarry;
- the capacity;
- the immediate-on site availability of semi permeable cover material;
- a conveniently low lying adjacent watercourse which should be able to receive gravity discharges from the site.

Geotechnical Investigation and Available Data

Over the years at least some 50 boreholes have been sunk in and around the site. Although these give a very comprehensive picture of the respective geological structures and intrusions within the area, unfortunately was very little data relating to the requirement to understand the nature of the aquifer, the permeability of the upper strata to gas migration, or the stability characteristics of the quarry floor & clay walls (floor subject to subsidence).

The extent of the existing geological data availability is illustrated on the Figure 5-2-2, and the Sectional elevation of Figure 5-2-3.

5.2.8 Koriata

The Koriata site was one of the original sites identified at the time of the JICA Pre-Investment visits in 1992. It is shown in Figure 5-1-1 and is within the Locational Criterion Zone 1 (Site not recommended). It is near to the Koriata City Heating station and from time to time has been considered as a potential site for a waste incineration plant and solid waste disposal. At first sight it appears to be a semi-derelict excavation in the Sofia plain and in need of reclamation by filling.

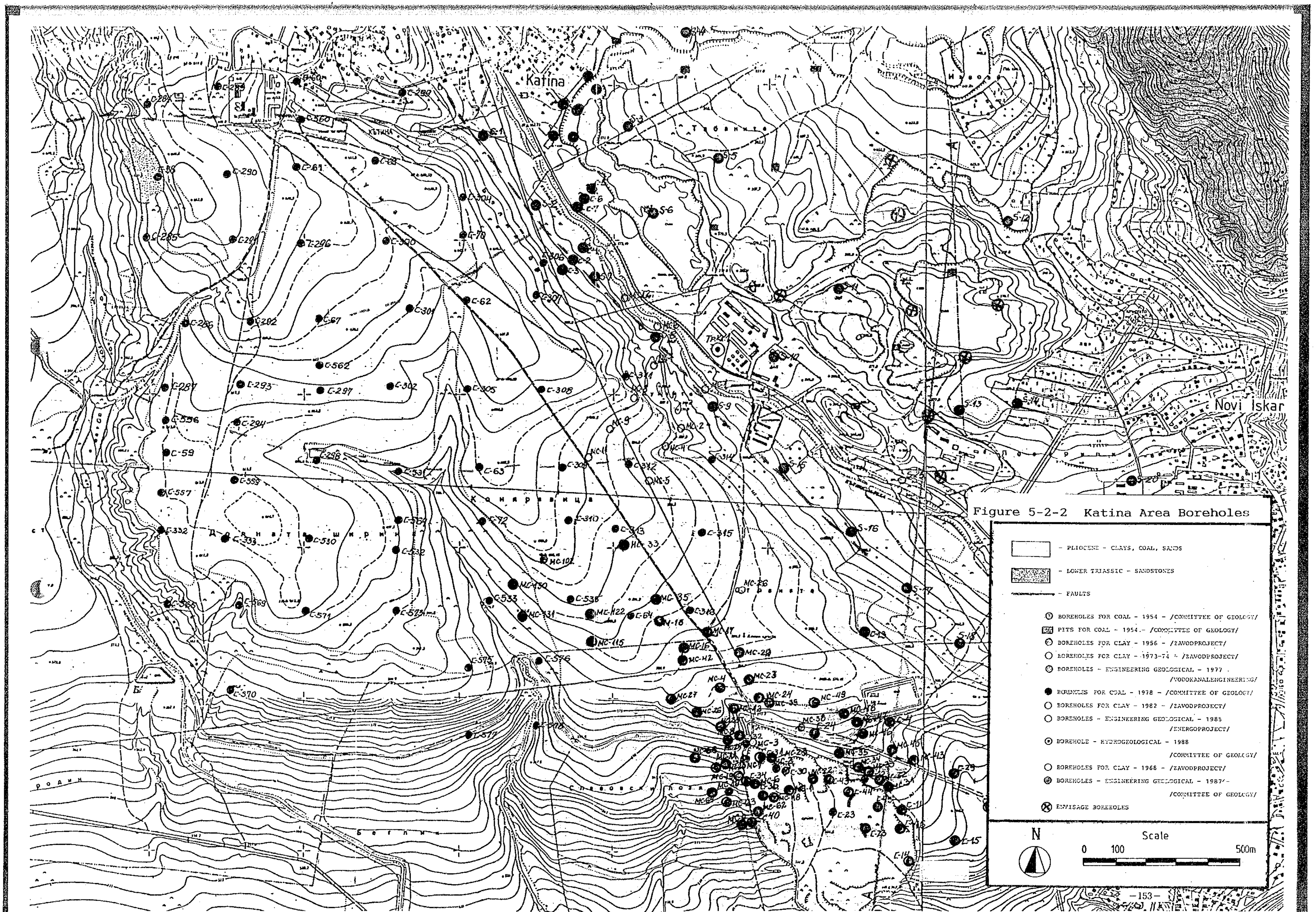
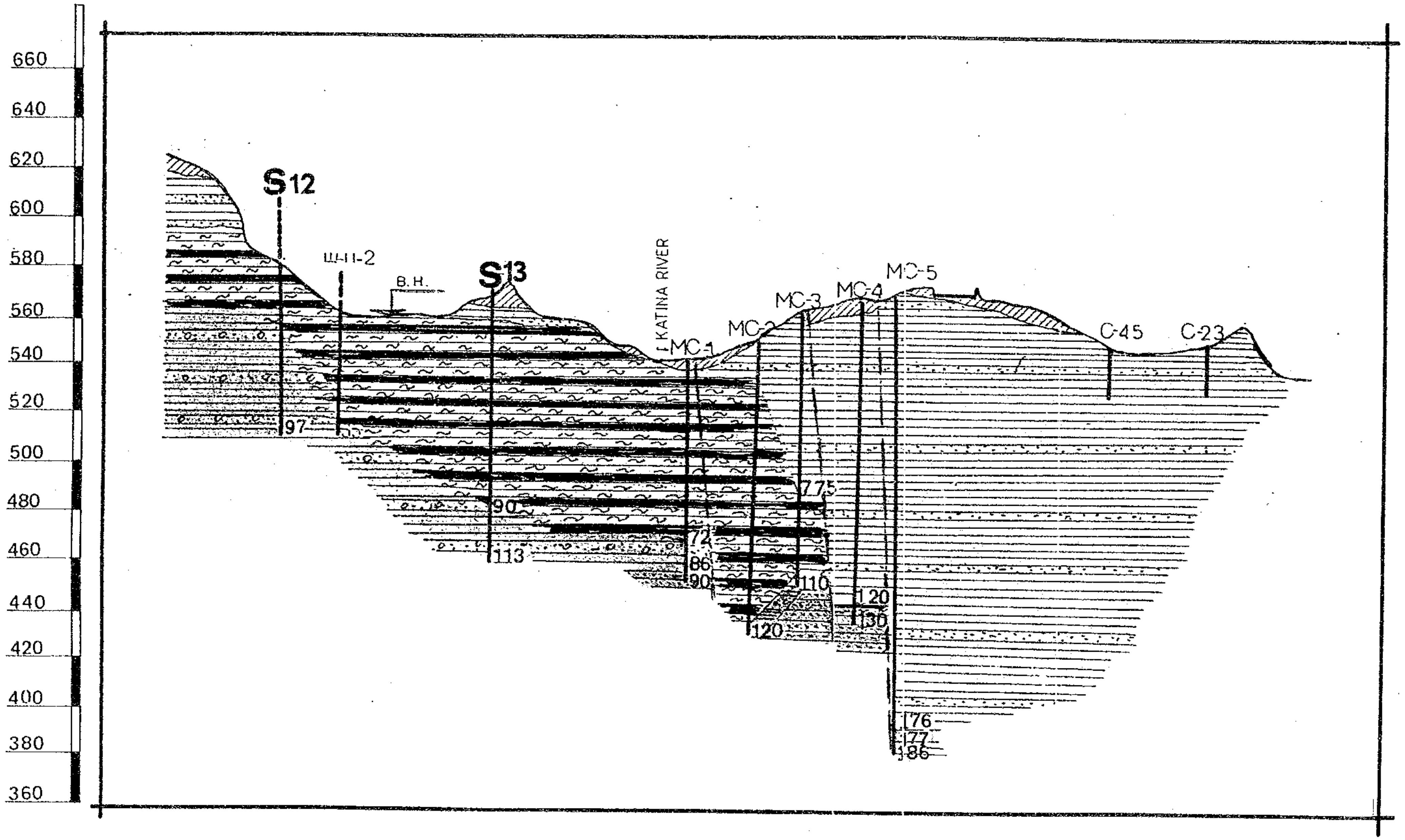
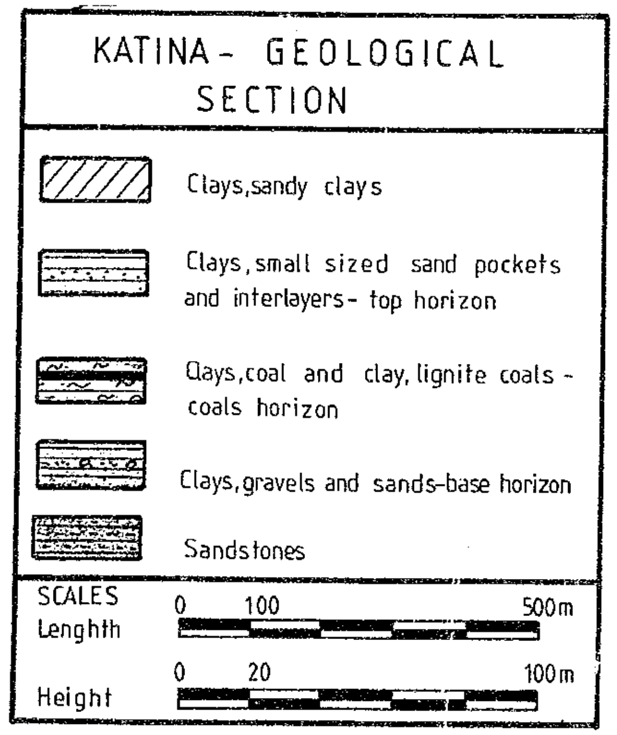


Figure 5-2-2 Katina Area Boreholes



SECTION ON A - A

Figure 5-2-3



The site area and location have been carefully studied. Mapping has been obtained (available at scales of up to 1:1,000). Older aerial photographs of the site and its surrounds are held by SGM at a scale of 1:10,000.

The site is reviewed here on the basis of general geographic, geological, hydro-geological and hydro-chemical & ecological investigations, the historical data and site data collected.

Brief description of the area.

The proposed area for landfill site is South East of Gara Iskar housing development at the Southern end of Sofia plain.

The area is immediately adjacent to the River Iskar on the right bank side of the Iskar river bed. Natural terrain is flat and rests some 550-560 m above the sea level with a slight Northerly inclination (following the river flow).

The proposal is reminiscent of that which must have been taken for the Dolny Bogrov and the Goroblyane Waste Sites namely: To reinstate/recover former lands which have suffered quarrying below natural water level and appear suitable for filling with non-inert domestic solid waste. Such sites can prove difficult to engineer and can be exceptionally expensive to isolate when pollution from them is to be combatted.

This particular site was the former southerly excavations of "Koriyata" sand and gravel quarry. The quarry depth of the excavations is up to 10 to 12 m below the surrounding ground level. There are exposed water ponds and channels at the bottom of the quarry.

At the current time in the western most part of a former pit a pumping station operates, supplying sand wash water at a rate of 80 - 120 l/sec. The total area of the excavations that can be used for solid waste is not less than 500,000 m^2.

Hydro-geological conditions

From geological point of view the region is built entirely of quaternary materials: alluvial and proluvial gravels, sands and clays of a thickness 35 to 40 m. They lie on pliocene deposits, mainly clays and sands. From hydrological point of view waters (aquifers) accumulated in alluvial and proluvial deposits are of interest: they mix with and blend in places with water from the upper pliocene levels. A geological plan is shown in Figure 5-2-4 and section in Figure 5-2-5.

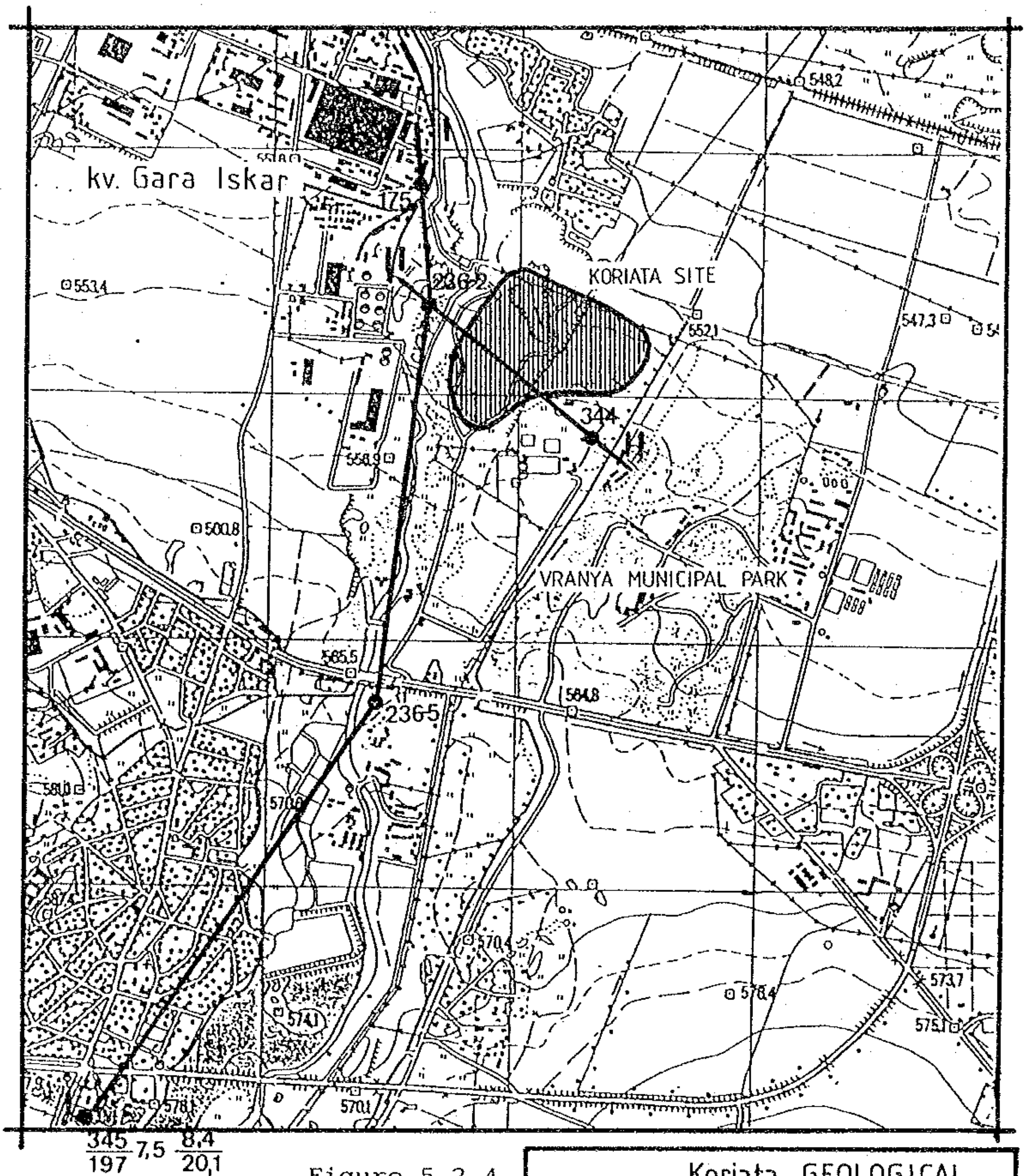


Figure 5-2-4

Koriata - GEOLOGICAL MAP

Q — Quarternery-alluvial and proluvial-gravels, sands, clays

I ——— I Geological section I-I

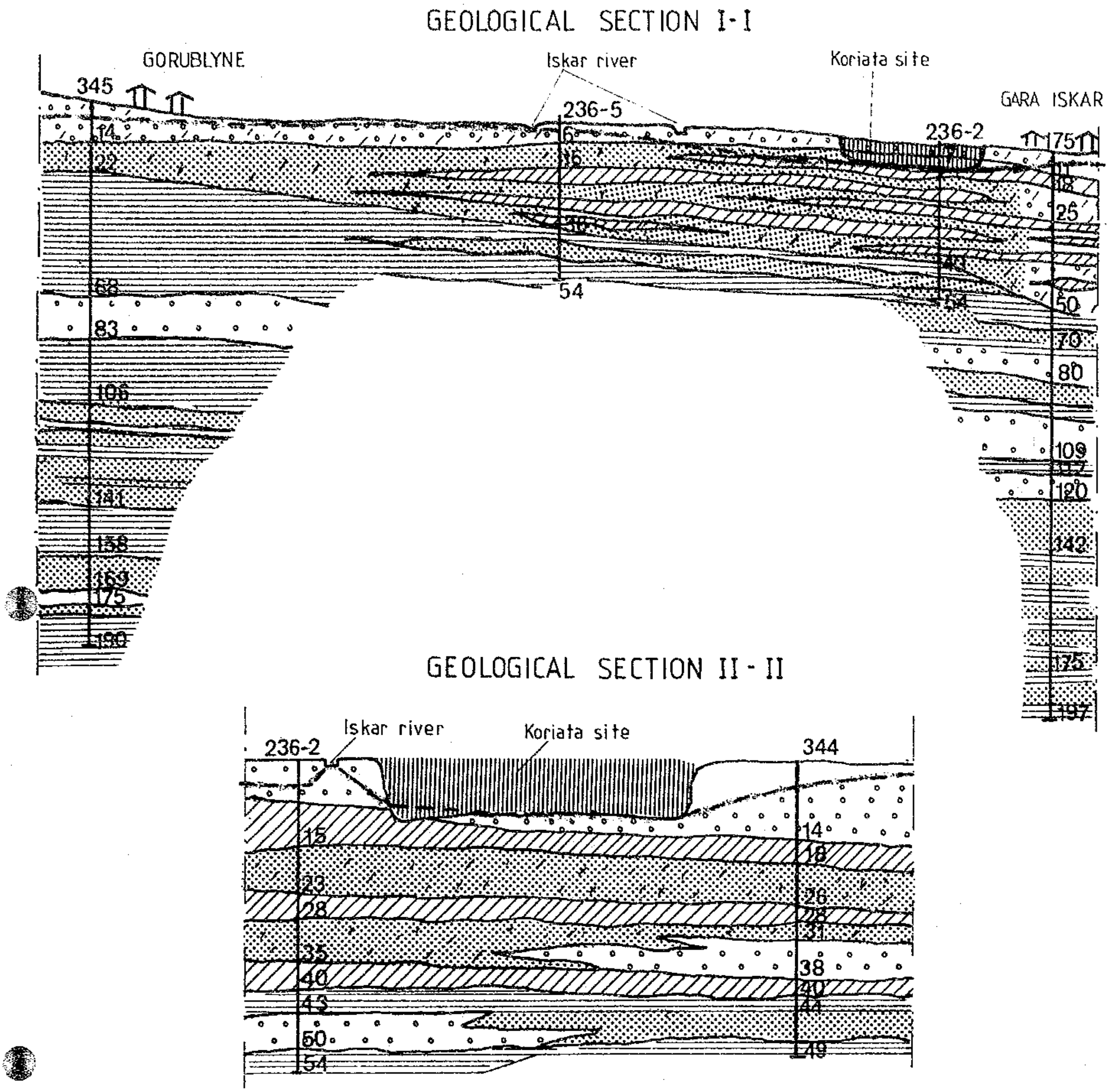
● $\frac{345}{197}$ 7,5 $\frac{8,4}{20,1}$ — Bore N° (345); Depth (m) (197); Average water level (7,5); Rate (l/s) (8,4); Lowering (m) (20,1)

N

Scale 0 250 1000m

BORE WELLPOINT DATA

Bore Nº	Depth m	Geol. age	Average water level m	Water flowrate l/s	Lowering m	Permeability m^2/d	Level transmission coefficient m^2/d
175	197	Q-N_2	5,30	20,0	11,0	148	$4,8\times10^3$
236.2	54	Q-N_2	+0,43	10,5	16,6	59	$5,1\times10^4$
236 5	54	Q-N_2	+0,50	1,9	22,0	10	$3,1\times10^6$
344	49	Q	3,20	3,0	3,2	104	$4,2\times10^2$
345	197	Q-N_2	7,50	8,4	20,1	42	$3,6\times10^4$



Legend

- Gravels coarse clayish at different extend
- Stones coarse clayish at places
- Clay - brown and sandy
- Sands, clayish at places
- Gravel coarse
- Gray clay
- Level of ground water

Figure 5-2-5

Koriata - GEOLOGICAL SECTIONS

SCALES

Section I-I
Lenghth 0 250 1000m
Height 0 20 100m

Section II-II
Lenghth 0 100 500m
Height 0 10 50m

These alluvial and proluvial deposits (35 to 40 m thick) are represented by gravels of different sizes (mainly coarse), different sands and clays with seemingly irregular distribution of different layers and sublayers. Due to hydraulic inter connection of the differently leveled permeable strata, aquifers abound and essentially form one common water bearing plane with common feeding and draining zones, common levels, hydraulic inclination and regime.

The aquifer flows through the upper strata under gravity. In some sections this is within clay strata confines and artesian discharge is possible. Direction of groundwater flow is generally northwards and follows the fall of river Iskar. The natural (undisturbed) hydraulic inclination in this area is notable: about 0.005.

Groundwater recharge is by infiltration of rainfall, by the infiltration of the Iskar river and principally by groundwater collected in the proluvial cones at the foot of the slopes to the Sofia plain.

Drainage is carried out under the ground to the North - to the central parts of the plain - as well as by operating of a number of water supply wells north of the area. The biggest depression of underground water is in the region of Gara Iskar where there are more than 50 wells and take not less than 200 - 250 l/sec for industrial water supply. Typical drawdowns are around 8 to 10 m below the ground level.

Natural groundwater level in the area is 3 to 5 m below ground level (sections with disturbed aquifers excluded). Water bearing deposits in that part of the Sofia plain are not well fed and hence groundwater abstraction yields in the region of 2 to 5 l/sec are obtained from 40 to 50 m wellpoints. Deeper wells penetrating into pliocene are necessary to source higher flow rates of the 8 to 12 l/sec and possibly peak at 20 l/sec. Permeability of the strata is low: some 10 to 150 sq.m/day and for level transmission - within the range 4.2 * 10 to 3.1 * 10 sq.m/day.

Co-efficient for infiltration of the upper most layers of the terrain (up to 1 m) is in the limits 0.3 - 3.0 m/day.

Chemical composition of groundwater is hydro-carbonate and calcium with low mineralization (dry remainder 0.2 - 0.3 g/l) and low hardness - 8-12 deg. The waters are unaggressive to cement and concrete construction and are suitable for industrial water supply and irrigation.

Local flooding and the Pit Water level

The Koriata quarry was excavated out of the River Iskar's Eastern bank some 10 to 30 m distant from the edge of the watercourse.

The quarry floor is some 8 to 10 m below the river levels.

At the time of the team's visits the pumping installations were holding the water level down to an 'average' of some 3 m or so below River level and the ponds in the quarry floor were estimated to be around 5 m deep. The local water table is thus artificially depressed by the pumping which feeds a northerly quarry extension and overflows back to the river.

Figure 5-2-6 illustrates the arrangement. Figure 5-2-5 demonstrates the notable difference in levels between the river and the quarry pit floor.

Despite the immediate open exposure of the Quarry to the river, the site has proved to be remarkably well isolated from flooding so far. Although Iskar has a large catchment, it is substantially controlled. Iskar dam has acted as an effective lag on the recent hydrographic flood run off patterns. In recent memory, flood patterns in the river have only caused the riverwaters a rise over 1 meter on two occasions since 1965. The peak recalled was represented by a 1.7 m rise at a downstream Gauging Station whereas the available freeboard at the quarry is some 2.5 m. before the workings would be overwhelmed.

Should the site be used for any waste storage (eg inert waste) a more thorough investigations would have to be commissioned and the appropriate precautions taken against the flooding risks.

Vranya Municipal Park

The Koriata site is immediately next to the Northern end of the Vranya Palace park which is a designated protected area and is of significant historical interest.

The park was first laid out during the 19th Century in the typical style of some of the large European Manor house gardens of the time. Gardeners were employed to assemble a wide variety of internationally collected trees and shrubs and to lay the house grounds and the park out in the tradi-

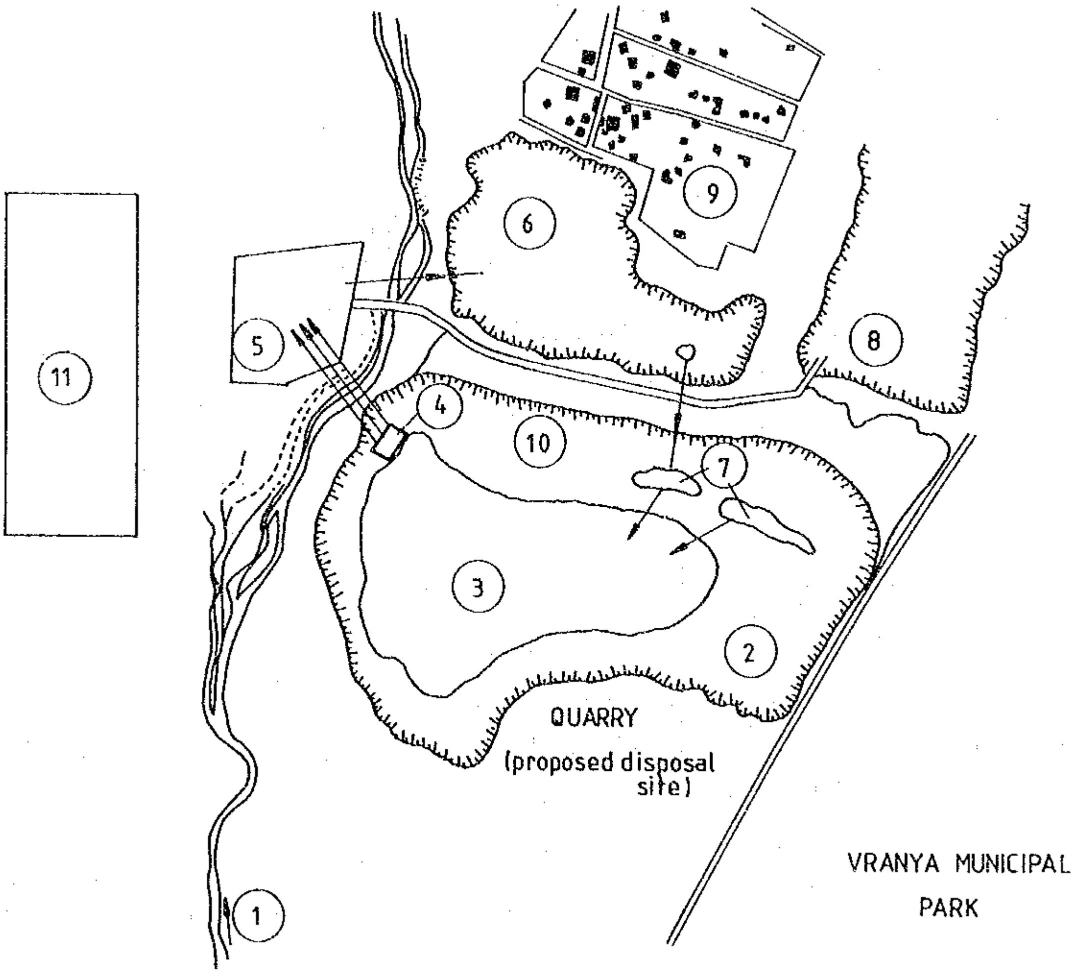


Figure 5-2-6

KORIATA SAND QUARRY

1. Iskar river	7. Extra sedimentation of the waste water
2. Old quarry site	8. Operated quarry
3. Water body	9. Residential areas
4. Pumping station for pure water	10. Road
5. Washing installation	11. Heating power station „Traycho Kostov"
6. Settler	

N

Scale

0 100 500m

tion of the time. The present park and palace are now of considerable historic, botanic and cultural interest. The Palace was the one time residence of the Sofia Turkish Governor, it is a former residence of the Bulgarian Royal Family and more recently was the scene of many historic meetings and conferences. It is currently under SGM's care who are restoring the grounds and the Palace buildings and intend to open the park for tourists.

Effect to the Park of the proximity of the Waste

On the basis of existing data, it is not possible to accurately predict how far the local upper alluvium would conduct Methane gas. Should this site be used for solid waste deposit, special investigations would have to be instigated to ascertain what costs, if any, should be incurred to protect the tree and plant roots from risk of methane damage.

Prevailing westerly directions of the wind (see Section 3.1) place the northern end of the park down wind of the Site.

Results of the ecological survey

Particular effort was made to undertake a special ecological review of this site. This is reported:

As the site represents a low level excavation area the main biological features are aquatic and semi-aquatic elements of flora and fauna. The permanent pools and trenches of the site show different levels of water quality and as well as different diversity of species especially for phytoplankton and phytobenthos. As the excavation ground lacks a sufficient humus horizon the floral communities of the site show a rather low diversity. The faunal elements of the excavation area are mainly dominated by fish and bird species.

The encompassing scarps are of importance for the site, too. They are one of the main breeding area for the resident bird species for which the richness of the different permanent water bodies with their high level of primary and secondary production are the basic feeding grounds.

There is only one evidence of directly degraded habitats. Waters which are used for the processing of the excavated sediments are re-discharged into the northern excavation area. They contain a high percentage of silty materials which cause a negative influence on the primary production processes of the receiving pools. Another negative influence arises from the activities of fisherman which visit the entire area. Apart from the exploitation of the fish populations these activities mainly disturb the bird fauna.

Due to the fact that Koriata is an area where many protected species have been recorded, ecological importance of this site is very high. All-the-more as the entire site is composed of habitats which are in a recolonisational stage of secondary succession. If this area remains undisturbed or even its actual impacts are decreased the ecological importance of the entire area will still rise. The site is a very promising place for development of controlled sport fishing and spots for bird watching.

Conclusions and recommendations

From hydrological, hydro-geological and ecological viewpoints it is not possible to recommend construction of a Waste landfill at this Site, or any other in "Koriata" area because of real danger of polluting groundwater and difficulty and probable high costs in engineering a landfill project and the proximity of the Palace Grounds.

Although permeability of the water bearing materials is low (10 to 150 m^2/day) the natural hydraulic inclination of 0.005 provides a constant movement of the groundwater northwards to the center of the plain and would carry any contamination.

Designs can be developed to isolate the site and literally construct a protective tank around the fill but costs of resisting flotation forces, seismic protection and other such works would be prohibitive if they were to provide reliability.

Following the study's investigations, the team is of the opinion that the site is quite unsuitable and landfilling should be avoided if at all possible. Accordingly this site cannot be recommended for solid waste disposal, and it is not considered further.

5.2.9 Novi Iskar

Very much related to the Katina Site is the apparently closed and adjacent Clay Pit at Nova Iskar. Figure 5-1-1 illustrates the General location and Figure 5-2-1 its common access potential alongside that of Katina. It rests within Region 2 of the general locational criteria.

The site is considered as a potential clay source and may be a smaller landfilling possibility as a complimentary installation to Katina - depending on groundwater and clay permeability. Eg. for local area operation and receipt of loose wastes.

In parallel with the more active Geotechnical Site investigations at Katina, a passive desk study of this site's potential was undertaken.

Preliminary enquiries as to it's availability produced a degree of resistance from the State Operating Co but the economic valuation of the abandoned site was not discussable: The owners claim previously rejected clay levels can still be economically worked.

This site lies in the direct flight path of a Military Airfield. Its capacity is relatively 'insubstantial' in relation to the waste generation rate.

It is not considered further.

5.2.10 Suhudol Monofill

This site was proposed as a potential 'candidate' site for land filling municipal domestic waste. It is within Region 5.

The site is currently one of the Municipal Greenery Company's Monofill sites. It was thought that the site could possibly be converted for domestic waste. The remaining fill capacity was reported to be 325,000 m^3 in June 1993.

This site has been studied in some detail. The study's review and report is set out in Section 3.8.

The study team finds that it is not possible to recommend that the site be simply 'converted' for purely domestic use until the existing landfill is cleaned up and properly drained and until professional opinions are available as to the safety of the existing fill which has most unfortunately been built as a potential dam across the foot of one of the Suhudol valleys.

This site is therefore not considered further.

5.2.11 Suhudol Stage II

The Municipality's proposals to extend this site are described in Sections 3.8. Up until the time of writing, no funds have however been allocated to enable the designers to proceed with the site redesign work.

The Municipality have indicated a commitment to the extension at least to the presently intended capacitive limit (a further 2,200,000 m^3).

A contract for construction of the works has been awarded and it is probable that construction of the associated site works will be completed in the near future.

Apart from the managerial and operational requirements and the possibility of further enlargements of the filling, this 'Site' is not considered further.

5.2.12 Suhudol (Further Expansion)

The possibility of raising the landfill levels of the 1st and 2nd stages are discussed in Section 3.8. This would provide the following additional capacities:

Over Stage I . . . 150,000 m^3
Over Stage II. . . 190,000 m^3

These possibilities were considered but in view of the present proposal's intent to stack the waste some 12 m above the natural terrain art the lower end of this natural valley, the proposals exacerbate a 'breach' of the new site selection criteria. At existing design elevations the extension's waste will already be dominantly visible.

This proposal will not be considered further.

5.2.13 Rudinata Quarry

This potential landfill site is a Dolomite rock quarry owned and operated by the 'ZCK (Kremikovtsy)' Company. It is located in the north of the region, above the main Kremikovsty Complex as shown in Figure 5-1-1. The rock is crushed and conveyed to Kremikovtsy for stock piling for concrete and general civil granular material use.

The quarry is at least 2km distance from the nearest village.

Although the site appears on to rest at border between the Figure 5-1-1 Region 3 (to be avoided) and Region 5, indications are that it is geologically within or on the edge of a 'Region 5' location.

The quarry Company owns all land and mining rights to enable it to fully exploit some 26,300,000 m^3 of rock. To date only some 5,000,000 m^3 of this rock had been extracted and the company are still working the main extraction face.

As a potential landfill site, this quarry is one of the best so far examined from the geotechnical and engineering viewpoints. Development cost potential could well be lower than Katina (but no immediately available cover material located).

The quarry is still in operation and despite the depressed construction market, there appears to be no hope of its closure in the foreseeable future.

Although the counterpart staff advised that the acquisition of this quarry was not possible, nevertheless the quarry was not totally deleted from the 'future list': In view of the scarcity of landfill sites satisfying the criteria, this quarry remains a future option for economic re-appraisal should it ever become available (ie purchaseable or usable for waste future filling).

Possibilities for future consideration are:

- Possible outright purchase of the quarry;
- possible acquisition of the company by the Municipality;
- possible 'Contracting out' of the City's Waste Disposal operations to the present owners for profitable return from the disposal of a 'guaranteeable supply of' raw material.

Due to these uncertainties the site was not proposed as a possible candidate for the Priority considerations.

5.2.14 The Kremikovtsy Iron Ore Mine

This site was noted during the Helicopter survey and no overview of potential waste disposal sites would be complete without specific mention of the potential of this location.

The potential site is within Region 2. It comprises the extraordinarily large open cast iron ore mine at Kremikovtsy which seemingly spirals into the very depths of the Sofia mantle. The Iron and Steel complex is still in operation and regrettably therefore the site is not available. It nevertheless should be refilled sometime.

The capacity was not been appraised during the study, apart from an approximation that its capacity may be in the region of 50,000,000 to 100,000,000 m^3.

Unfortunately the site is still in operation but its potential for refilling with waste materials is massive. Municipal counterpart staff were not encouraging as to its use (in full or in part).

The study team was unable to forecast its availability.

5.3 Disposal Site Selection

Of all the 13 sites visited and considered in Section 5.2 against the criteria only one, that of Katina substantially satisfied the overall requirements. A comparative evaluation of the sites is shown in Table 5-3-1.

The detailed desk studies and Helicopter search showed no other apparent exploitable site or quarry or other location which could be used and even considered against the criteria: Quarries such as that at Rudinata (the Rock Quarry), were in use by the State construction organizations and their reuse was advised as impossibly at this time.

Table 5-3-1 Comparison of Candidate Disposal Sites

	Municipal Property	Capacity	Geology and Hydro-logy	Ecology and Enviro-nment	Flood liabi-lity	Loca-tion suit-ability	Located in SGM	Total Eval-uation
Balsha	X	X	X	X	0	X	0	X
Buhovo	X	0	0	X	0	X	0	X
Dolni Bogrov (extention)	0	0	X	X	X	X	0	X
Graditz	X	0	0	X	0	X	X	X
Gnilyane	X	0	0	X	X	0	0	X
Katina	0	0	0	0	0	X	0	0
Koriata	0	0	X	X	X	X	0	X
Novi Iskar	X	X	0	0	0	X	0	X
Rudinata	X	0	0	0	0	0	0	0
Suhodol(west)	0	X	X	0	X	0	0	X
Suhodol II	0	X	0	0	0	0	0	0
Kremikovtsi	X	0	0	0	0	0	0	0

5.4 Sites for Other SWM Facilities

The M/P not only considered disposal site location, but also suitable sites for locating intermediate transfer stations, to study their effect on decreasing transport cost to the Katina site. Sites for an incineration plant were also considered.

Based on discussions with the Bulgarian side, two locations were selected, one at Koriata (south-east) and the second south-west of the city.

CHAPTER 6

MASTER PLAN ALTERNATIVES

CHAPTER 6 MASTER PLAN ALTERNATIVES

6.1 Technical Aspects

6.1.1 Collection and Haulage

1) General

The Master Plan aims to introduce an efficient collection and haulage plan for SGM with the target year of 2010. However not only must the master plan address the anticipated future growth in solid waste, but it should also be developed on the basis of determining and solving problems associated with present collection and haulage practices.

In this section technical aspects associated with the collection of domestic and commercial waste and its haulage shall be considered to formulate technical alternatives.

The proposed collection system is basically the same for all alternatives in terms of service level and type of equipment, however there are some differences according to the location of haulage or intermediate facilities.

Haulage pertains to transporting the collected waste from collection points to their final destination. Therefore in alternatives having intermediate treatment facilities, haulage of the waste to the facilities as well as the waste generated from intermediate treatment of the waste as these facilities to the final disposal site shall be considered.

Analysis is made under the following preconditions:

- The existing administrative structure of 24 districts.
- Katina disposal site shall commence operation in 1997 and continue to receive waste for the master plan duration.

2) Discharge

a. Fixed Discharge Time

The master plan shall consider both daily discharge and discharge within specified days and hours. Daily discharge is suitable in case of adopting plastic bag (45 lit.) collection in commercial areas and city centers and elimination of communal containers. On the other hand this type of discharge may increase working time of the collection vehicles.

Discharge two or three times a week within fixed hours (morning or evening) will improve collection vehicle utilization efficiency and enhance cooperation, which is a perquisite for the system's success, between citizens and waste collection organizations. The need for citizens to store two or three days waste in their homes may also encourage them to reduce the amount of waste they generate.

The master plan shall introduce fixed day and time discharge.

Citizens shall be encouraged to recycle waste items such as glass and paper. In the year 2010 the amount to be collected from the city by the SWM authority shall be about 83% of the total domestic and commercial waste generated by the city. However the master plan shall not provide for collection or transport of the remaining 17% of waste, as these shall be delivered by the citizens themselves to recycling centers or private companies will be responsible for this activity.

b. Containers

The city can be broadly divided into three parts, as follows:

a) Central area comprising districts no.1, no.4 and parts of no.2, no.3, and no.10 (186 t/day to be collected in 2010),
b) Urban area, located within the city's outer ring road (1,063 t/day), and
c) Suburban area, outside the outer ring road (135 t/day).

Selection of small sized containers, such as Meva (0.11 m^3), for communal stations will result in an increase in travel time and number of trips that can be run by a vehicle in a shift will decrease. At present a Norba compactor vehicle needs on average 50 minutes to unload one ton of waste from Meva containers, as opposed to 30 minutes for Ra containers. This means that for collection of 6 tons by that vehicle, it would take 5 hours if Meva containers are used, while for Ra containers only 3 hours will be necessary. Where a second trip in one shift would be impossible in the former case, it is conceivable in the latter.

The master plan proposes the city's central area discharge its waste in plastic bags (@ 45 liters) and the elimination of Ra and Meva communal containers there. Kison containers will continue to be used for commercial waste. Communal points shall be established for discharging the waste.

Removal of big containers from the city center is expected to have a positive effect on the commercial, official and touristic atmosphere in that area. However waste collection must be efficiently conducted to ensure that waste is promptly removed. Waste collection service should start early in the morning before the influx of day population. It is necessary to fix discharge time in coordination with collection time.

Daily discharge (6 days/week) for the central area is adopted.

The urban area mainly comprises medium to high rise housing buildings and Ra (1.1 m^3) containers are considered suitable here. Discharge shall be restricted to three days a week with the exception of commercial areas where daily discharge is required.

Kison containers (4 m^3) will be basically used in the suburban area along with Ra containers and plastic bags. Discharge in these areas shall be restricted to once or twice a week.

Meva containers (0.11 m^3) will be gradually phased out of service by 2000. However Meva containers may be used in the suburban area beyond that year, but responsibility for their purchase and maintenance shall be solely that of the users.

Container requirements in the city, based upon the above assumptions, are estimated as shown in Table 6-1-1.

Table 6-1-1 Container Requirements in the Master Plan

Container Type	Year 1996	2000	2005	2010	Remarks
Plastic bags (1000)	5,000	6,000	6,400	6,900	3 bags/wk/hh
Ra (1100 lit)	11,140	12,000	12,900	13,800	3 days cap.
Kison (4000 lit)	1,150	1,300	1,300	1,350	5 days cap.
Meva (110 lit)	9,150	11,500	10,000	10,400	3 days cap.

c. Door to door service and communal station

Door-to-door service, and communal stations are considered. Door-to-door service shall be provided in commercial areas where a location for setting up a communal station or the presence of such a station interferes with the area's atmosphere. However door-to-door service in central and commercial area increases time spent by the collection vehicle on the collection route and may create traffic problems. Early morning collection should also be considered when necessary, providing there is no problem of over night parked cars hindering the collection service.

Communal stations should be considered for highly residential areas or remote areas not easily accessible. Suitable size containers, such as Ra (1.1 m^3) or Kison (4 m^3) should be placed at these stations to accommodate two or three days waste generated by surrounding residents.

For urban and suburban areas, communal stations for discharging waste are proposed. Door-to-door service will continue in the center area.

Number of stops to be made by the collection vehicle in case of door-to-door service will increase and therefore a longer time on the collection route is estimated. As it is necessary for collection vehicles to start collection early in the center area, discharge time should be accordingly fixed. The present discharge time of 8 PM to 8 AM in a small area of Oborishte district using plastic bags may be adopted.

Communal stations should be chosen in conjunction with collection routes and in such a manner as to decrease amount of time spent by collection crew and vehicle on the route. Implementation of two or three days discharge per week can help concentrate waste at stations and decrease number of stops of a collection vehicle. This is expected to have a positive effect on decreasing collection time. Therefore communal stations must be conveniently located in order to have enough space for a sufficient number of Ra containers.

One Ra can absorb some 80 households daily discharge (assuming 3.5 persons/household, daily generated waste 0.9 kg/cap). In case of every other day discharge, number of households shall be reduced to 40, ie a second container is required.

Kison shall be used in suburban areas where accessibility is poor or in mountainous areas. While required capacities shall be calculated to accommodate 5 days discharge amount, discharge time shall not be so rigid, as it is difficult to request citizens to keep putrescible waste in their houses for over three days. In addition to Kison in some areas residents shall also be encouraged to purchase their own Meva containers. However such areas shall be decided based on compactor vehicle performance suitability.

An important point in suburban areas is to maintain containers used (whether Kison or Meva) in good condition, as the collection frequency will be low, and discharge time unrestricted. Containers must have lids and be regularly washed and disinfected. Cooperation between dischargers and concerned authorities to achieve this is necessary.

In general, communal container stations should be chosen in coordination with users and responsibility for maintaining cleanliness of stations should be shared by both waste collection organization and users.

3) Collection Vehicle Type

Four different types of compactor vehicles, two types of hauled container vehicles, and a number of dump trucks are presently used. Average vehicle ages are 6-7 years.

The master plan proposes to unify vehicles into one type compactor vehicle type and another hauled container vehicle type. Dump trucks will be considered as standby vehicles and will not play a principle role in municipal waste collection.

Compactor vehicles presently employed range in capacity from 7 to 13.5 m^3. SGM plans to commence assembly and production of 16 m^3 capacity compactor vehicles at the start of 1994, with staged phasing out of the other compactor vehicle types.

The two types of hauled container vehicles in use are that which carries a Kison container, and another which transports up to 16 containers, each 0.75 m^3. However the latter is hardly in use. The master plan shall consider the former.

Of the present three types of waste collection; compactor vehicle, hauled container vehicle and dump trucks, the master plan shall consider the first two types. Dump trucks shall be available as standby and for haulage of bulky waste.

SGM is presently embarking on a plan to assemble compactor vehicles in Bulgaria in cooperation with a German enterprise. Production is scheduled to start this year, and by May 1994 the first 10 vehicles shall be produced. The vehicle specification are as follows:

- Container capacity 16 m^3
- Compaction 1 - 5 by compaction
- Diesel engine

This vehicle is slightly larger than the Norba Madara (13.5 m^3) at present in operation. The master plan shall adopt the new vehicle as the compactor vehicle.

A Russian made vehicle, GAZ 53KM is presently employed to haul 4 m^3 Kison containers. These vehicles are relatively new, average 3-4 years and 78 vehicles are presently operating. A valid argument can be made for using larger vehicles to carry 6 or 8 m^3 containers and therefore minimize number of runs. However the M/P shall maintain the existing vehicle type and container capacity for the following reasons:

- Availability of relatively new vehicles.
- Locating larger containers in residential areas may have an unpleasant effect on the area's environment and cause disturbance to pedestrian and traffic flows.
- Waste share to be transported by hauled container system is forecast to be very small and it is therefore not worthwhile to increase capital expenses to change the system.

It is however necessary to note that for commercial or business facilities where suitable locations are available within the premises for locating larger containers, special consideration should be made. Introduction of larger 6 m^3 containers for such places may not necessarily mean change in the vehicle type, although adjustments to the vehicle may be required. The present GAZ 53KM is understood to have the capacity to carry larger containers.

b. Container Type

The two types of stationary container system (SCS) and hauled container system (HCS) presently employed shall be continued. In the Study's 1993 survey compactor vehicles collected and transported 81% of the waste, while the hauled container vehicles were responsible for 12%.

In terms of vehicle operating costs, assuming that a compactor vehicle will make 1.7 trips/shift and the corresponding figure for a hauled container vehicle shall be 4.0 trips, than for trips of one way distances to destination greater than 10 kilometers it is more economical to use SCS. Considering direct haulage of waste, to the disposal site at Katina, of the 24 districts only (21) Novi Iskar is at a distance of less than 10 kilometers from Katina.

However hauled container system collection is more convenient in the collection of waste from suburban areas with difficult access and from commercial areas. Therefore the master plan considers that only 40% of the total collected commercial waste and most of the domestic waste in (17) Vitosha district's mountainous areas shall be collected by HCS. This represents just over 7% of the total waste collected in 2010, or 98 ton/day. Figure 6-1-1 shows the graphical presentation of the economical distance.

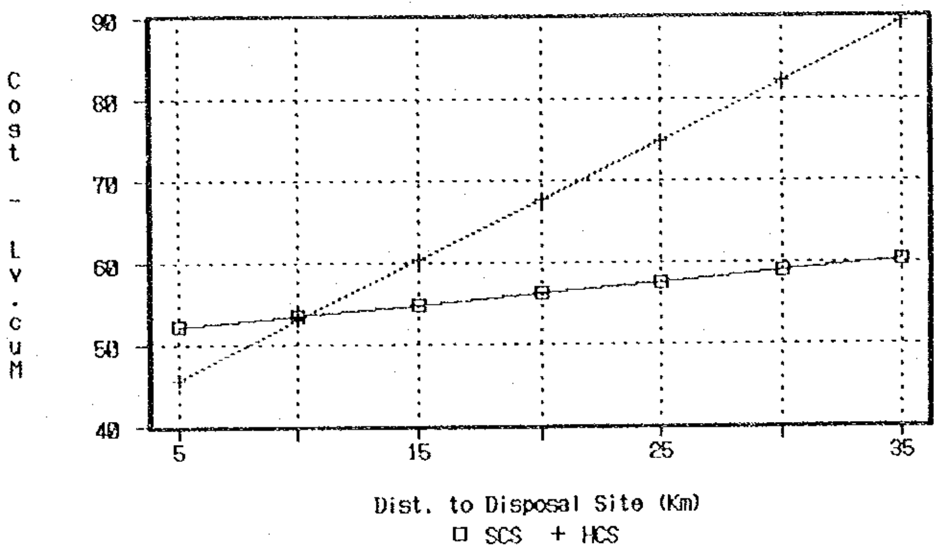


Figure 6-1-1 Cost Comparison of HCS and SCS

In 2010, an average additional cost of Lv. 20/m^3 will be incurred for waste transported by HCS, which translates into Lv 2,650,000 per year (US$ 98,150.00). However to transport the same amount by SCS compactor trucks, and assuming 1.7 trips/shift 11 vehicles shall be required, as opposed to 40 vehicles in the HCS system. Therefore in capital cost terms 40 vehicles at US$ 15,000 each (total US$ 600,000) is a sum smaller than 11 vehicles at US$ 95,000 per vehicle (total US$ 1,045,000).

c. Number of trips

The number of trips per shift is closely related to the following factors:

- Working hours per shift (taken as 8 hours).
- Time spent on the collection route.
- Distance from collection route to final disposal site or intermediate treatment facility.

The time spent on the collection route shall be discussed in this section while distances to the disposal site and proposed intermediate facilities shall be outlined in the following section.

- Time spent in Collection Route

The two types of hauled container vehicles in use are that which carries one Kison, and another which transports up to 16 containers, each 0.75 m^3. However the latter is hardly in use. The master plan shall consider the former type.

At present on average 2.5 hours are spent on collection routes. However although it is possible to achieve two shifts at that rate, the time spent does not allow for realizing sufficient loading of the vehicles. It is necessary to consider maintaining or slightly decreasing that time while increasing the loading efficiency of the vehicle.

Overall trip frequency is 1.6 per shift at present but the utilization of the vehicle capacity is only 54%. Utilization efficiency needs to be improved.

The study survey showed that 50 min/ton and 30 min/ton are required to empty waste stored in Meva and Ra containers respectively. In case there is no change in these figures time required on the collection route in case of Ra containers can be estimated as follows:

Number of Ra cont. = (16 m^3 x 2 (compaction factor))/1.1 m^3
= @ 30 containers

Time required = 30 x 1.1m^3 x .23 t/m^3 x 30 min/t
= 3.8 hours

However in order to increase trip number per shift from the current average of 1.4 (for compactor vehicles) to 1.7 while maintaining high loading efficiencies it is necessary to cut down collection time to around 3 hours. This can be accomplished by decreasing number of stops per vehicle by concentrating waste in a lesser number of stations. Two or 3 days discharge per week will assist in accomplishing this.

The following formula shall be applied to estimate time spent on the collection route:

Pscs = C x T1 + (S - 1) x T2

where: Pscs : Time spent on collection route (hours)
C : Number of containers (30)
T1 : Ave. Time unloading each container (1.5 minutes)
S : Number of stops (16)
T2 : Ave. Time traveling between stops (10 minutes)

Accordingly 3.2 hours are required to collect the waste amount, and this figure has been adopted in the master plan. In the center area where plastic bag discharge and daily collection are adopted a longer time of 3.5 hours has been estimated.

- Time spent to reach Disposal Site and other facilities.

Distance from collection area disposal site or other facilities will differ according to facilities introduced. Therefore, trip time and required number of collection vehicle are estimated for each alternative set in section 6.3. These estimations are inserted in the Supporting Report.

6.1.2 Haulage of Solid Waste

1) General

When disposal site is located at a remote distance from the collection area, transfer haulage will be more economical than direct haulage. Since Katina disposal site is the only future disposal site as mentioned in Chapter 5, transfer haulage will be one option of the technical alternatives.

As applied to Sofia all options should be under operational cover due to the severity of the winter weather and the high sensitivity to the local environs of any proposals to rehandle solids waste within the City boundary.

Transfer of solid waste from collection vehicles to larger more economic long haul vehicles is a transport option that invariably presents for evaluation and consideration - that of the transfer station. Possible advantages to Sofia SWM system are:

- Use larger transport vehicles to carry the waste to the disposal sites rather that use the purpose made collection trucks;
- improve the collection vehicle utilization due to shorter runs and also achieve a more effective use of the waste collection manpower;
- restrict traffic intensity at the disposal site;

- achieve long haul operating economies due to the increased vehicle payload;
- reduced traffic nuisance particularly where the final disposal site is located in a sensitive rural area.

Use of transfer stations are considered viable and alternative waste management schemes incorporating them are advanced for evaluation.

2) Type of transfer station

There are three different types of transfer station:
- Loose transfer type
- Compaction type
- Pre-compressed type

3) Loose transfer

Several standard variations of the general theme have been considered and that of the direct transfer of loose waste has been generally examined.

It is felt that having gone to the expense of land purchase, detailed design and applied the EIA procedures, that the alternative of applying a degree of compaction/pretreatment at the point of transfer is economically sensible: It achieves economy of haulage and vehicle investment. This option is not considered further.

4) Compaction Type

Mechanical vehicle packing or waste densification systems are therefore recommended within transfer stations in order to fully realize the economies achievable. These involve packing the waste into hopper or conveyor fed compaction chambers in which the waste is automatically divided into batches, hydraulically pressed and the air expelled.

With sufficient compression the waste can be ejected from the chamber in compact form for self supported transportation in thin walled standard trucks (ie untied large bales), or alternatively the waste can be packed into more costly purpose made and strengthened waste packing transport chambers - the transported density is lower and the volume larger.

The option of waste transfer to the land disposal site in the specialized transit containers (at a density of 550 kg/m^3) is considered viable and is advanced for evaluation.

5) Pre-Compressed Waste Blocks (Wire Tied)

This process (Pre-Compressed Waste Blocks - PWB) is a particular variation of the hydraulically packed 'transfer' option whereby waste is fastened with steel ties at the end of the compression process within the machine and being held together by steel wires, it is more easily handled, facilitates rapid turnaround. It does not require site bulldozed placement and site compaction in layers with multiple passes etc (as is otherwise necessary). Higher site waste compaction levers can be relied on. However special equipment to handle the blocks are required at disposal site.

Capital costs of the Pre-Compaction installations are marginally more expensive than for the untied transfer of hydraulically compressed waste. Operational costs are increased due to cost of wire. These costs achieve the main benefit of reduced environmental upset at the disposal site (due to absence of loose waste). Because PWB produces a reduced volume and hence an extended landfill live is achieved and hence some financial benefit can be relied upon in return.

This option is therefore advanced as a viable alternative for consideration and evaluation.

The process is therefore considered unproven as a suitable and applicable mass waste treatment process for Sofia. It is not considered further.

6.1.3 Intermediate Treatment

This Section of the report appraises the applicability of the various solid waste treatment options available to meet the criteria.

The main treatment options considered in this section are:
- incineration.
- waste conversion to compost;
- Shredding
- Waste conversion to fuel pellets or powder;
- waste conversion to building materials;

1) Incineration

Incineration as a process is widely used for the treatment of municipal solid waste and is considered a suitable and highly appropriate process for Sofia. Compared with landfill, it is however generally found to be costly particularly in view of the tighter environmental standards now required.

In consequence a lot of attention has been given to the design and operational features of incinerators and the current established solids waste incineration technology is considered a highly successful and 'clean' when compared to the previous generation of installations.

The design of modern incinerators to meet proper handling requirements and the new environmental regulations is illustrated is Figure 6-1-2.

Incineration in a 'modern and compliant installation' is therefore considered a viable alternative option for the reduction of the Sofia solid waste and this option is therefore developed further and evaluated.

2) Composting

Generally the organic constituents of Municipal Solid Waste, if separated and subjected to bacterial decomposition produce a compost which can be usefully reutilized for agricultural or horticulture as 'humus' (soil conditioning). Humus should not be confused with fertilizer which it is not.

To a Municipality short of landfill space, composting can offer an alternate means of disposal to that of landfill: Typically with composting up to 20% of the eventual bulk volume of a municipal landfill can be freed for extended service. To compost the waste, commercial processes have been developed and are well proven which will provide accelerated composting and production of a commercially re-utilizable material. This is especially of interest in central Europe where not only is landfill space at a premium but the approval procedures for new SWM facilities introduce a prolonged uncertainty and excascerbate the need to conserve existing established facilities.

Typically, commercial composting processes include separation of all glass, plastics, etc, (most efficiently by pure-separation and by hand picking of such as plastics and mechanized screening and separation), seeding, agitation in an air flow under carefully controlled conditions, stabilization, mechanized spreading, turning and maturation.

Composting is widely adopted as a principal means of waste re-cycling and volumetric reduction. It is well proven, is

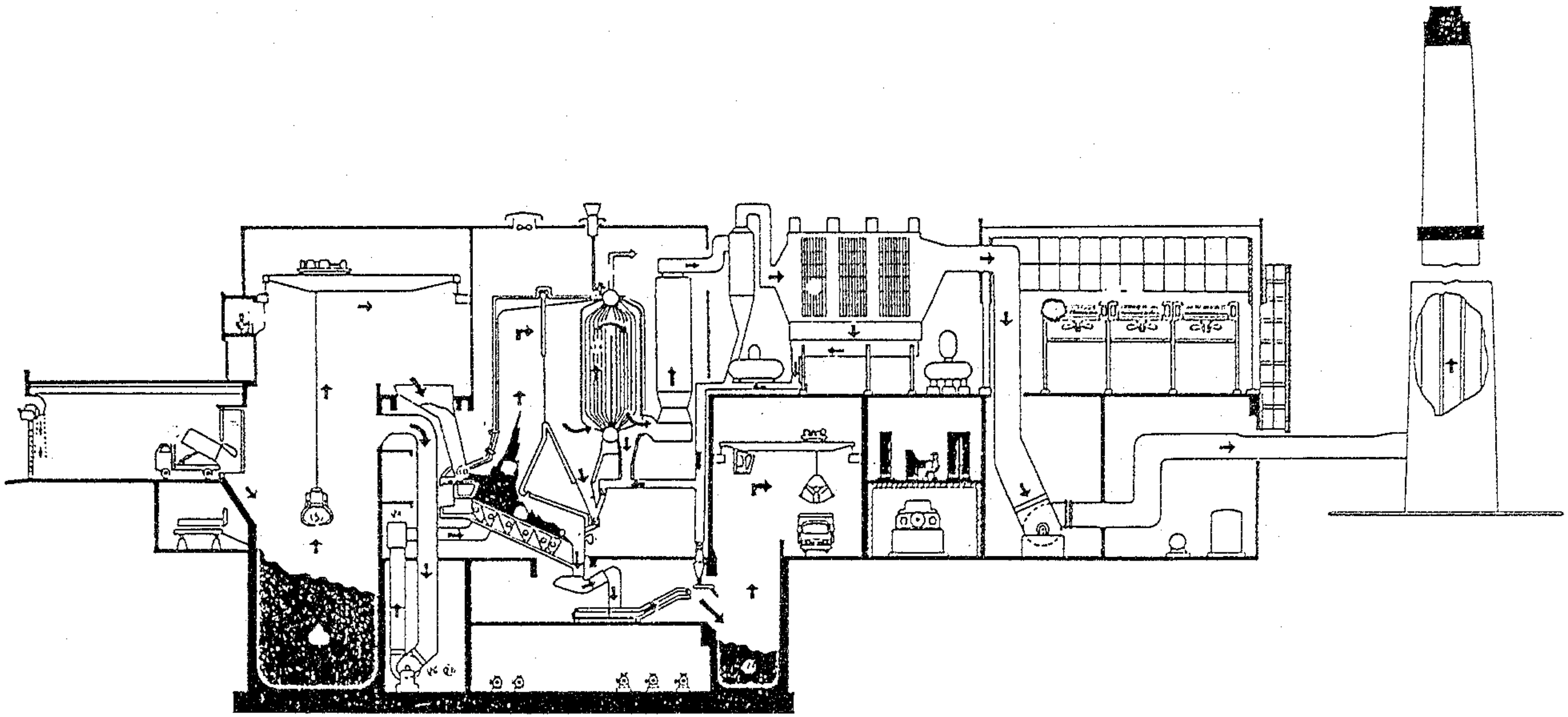


Figure 6-1-2 Outline of an Incineration Plant

used in Tokyo on a small scale and is extensively used in Austria, Germany, and in such as the Persian Gulf. It is considered a suitably viable alternative for Sofia.

Unfortunately efforts to identify a market for compost in Sofia have been unsuccessful. Approaches to specialists in the Sofia soils laboratory and to the Ministry of agriculture to fully explore the possibility were most helpful, but it appears that following de-socialization and resulting confusion concerning agriculture land ownership it is too early to be assured that supplies of bulk compost are in demand.

It is concluded therefore that although the process may be applicable, until such time as foreign dumping (surplus Austrian compost was recently offered to Bulgaria 'FOB' but offer was rejected due to lack of demand) of compost ceases and until an economic Bulgarian market can be proven, composting should not be employed.

It is therefore not considered further.

3) Shredding

Shredding is considered as an intermediate 'process' or additional variant to the foregoing processes. At one time it was seen as a solution to waste bulking, improving the compactibility and the aesthetic nature of solid wastes and generally producing a seemingly homogeneous and handleable product. Shredded waste is suitable for baled or loose transit. It was claimed by the manufacturers that landfill of shredded waste offers improved site hygiene and can be carried out without the use of daily cover. The practice of mass shredding of municipal waste has been tried in Europe but the general economics and operational problems are such that the sales of the necessary machinery for full scale shredding of municipal waste have almost ceased.

4) Refuse Derived Fuel (RDF)

Although RDF reduction processes are now well established as a reliable means of disposal/waste conversion, the capital and running costs of the installations required to processes the fuel are high. In addition to disposal of the fuel, it is necessary to secure long term commitments from consumers who will be prepared to convert their burning appliances for the fuel and are prepared to tolerate a degree of variability.

It is believed that until such time as Conventional SWM Disposal Options and Procedures are well established and alternative possibilities exhausted, this process should be considered as not being commercially viable (not profitable to develop and run), it should not be adopted in Bulgaria.

5) Building Material Manufacture

Various institutions and commercial companies have tried and promoted pilot processing plants for manufacture and distribution of such as compressed waste fiber boards and the like.

More recently, an Australian process has been developed to market building blocks from Municipal Waste and large scale conversion plant is currently under detailed design.

To date none of these processes have been proven to be commercially successful and the usual more competitive 'fall-back' options of landfill, incineration etc are still generally adopted as the ultimate disposal option.

These processes are not therefore considered viable for Sofia at the present time.

6.1.4 Disposal of Solid Waste

1) General

At present SGM runs 6 major landfill sites, only two of which are authorized to receive Municipal Household Waste: at Dolny Bogrov and at Suhudol. (The others are depositaries for construction waste and excess earth).

It was determined that the Existing Site at Dolny Bogrov was causing gross pollution of the main Sofia flood plain aquifer and that is should be closed as soon as possible. There is an extension plan for Suhudol but it will provide a capacity of only 3 years if all SGM waste is hauled to the site. Therefore a new disposal site shall be constructed as soon as possible even with the introduction of incineration.

One possible future landfill site is technically available at Katina with a potential life of some 10 to 17 years (depending on use). Development of this site has been postponed since the 1970's as there has been local resistance to its development.

Due to current land ownership reforms and uncertainties regarding ownership and transfer of lands and State Company assets, further potentially suitable sites cannot be definitely identified even though several possibilities exist.

Effort therefore has been made to enhance the general acceptability of the site: ie to identify a method of developing the Katina Site while minimizing nuisance, improving the operational procedures and adopting the New Bulgarian and EC design and operational features.

All alternative disposal options are therefore founded on development of this Site. All are planned as technically compliant with the engineering criteria.

2) Waste Type & Quantities

Based on existing data, Section 2 sets out details of the present waste type and the respective quantities estimated to be generated and handled within the Sofia region.

Based on these, and the analyses of the incoming deliveries to Suhudol and Dolny Bogrov, estimates and forecasts have been developed of the Municipal Household Waste, the Street waste and the Institutional/Commercial Waste collectible within the Region.

In addition, detailed waste analyses work has enabled a forecast of the recyclable elements of this waste to be made and waste reduction targets have been set.

Further forecasts of extra waste quantities originating from external commercial/businesses and small factories have been developed and included in the gross tonnages for disposal (to landfill or for incineration). As this waste is assumed to be purely commercial rejects no deductions have been made to them on account of recycling potential.

A combined forecast of the provisional waste quantities for disposal has been built up based on the Study surveys, summarized as annual Tonnages, and plotted (see Figure 6-1-3). The Diagram shows:

- The assumed build up of waste forecasts until and beyond 2010 (to show the longer term requirement for disposal);
- ratio of commercial to municipal waste - illustrates the scale of the waste for which costs can be recovered if proper charges are levied;

- the recycling targets (level beyond 2010);
- the waste for disposal - showing increasing quantities despite the recycling deductions.

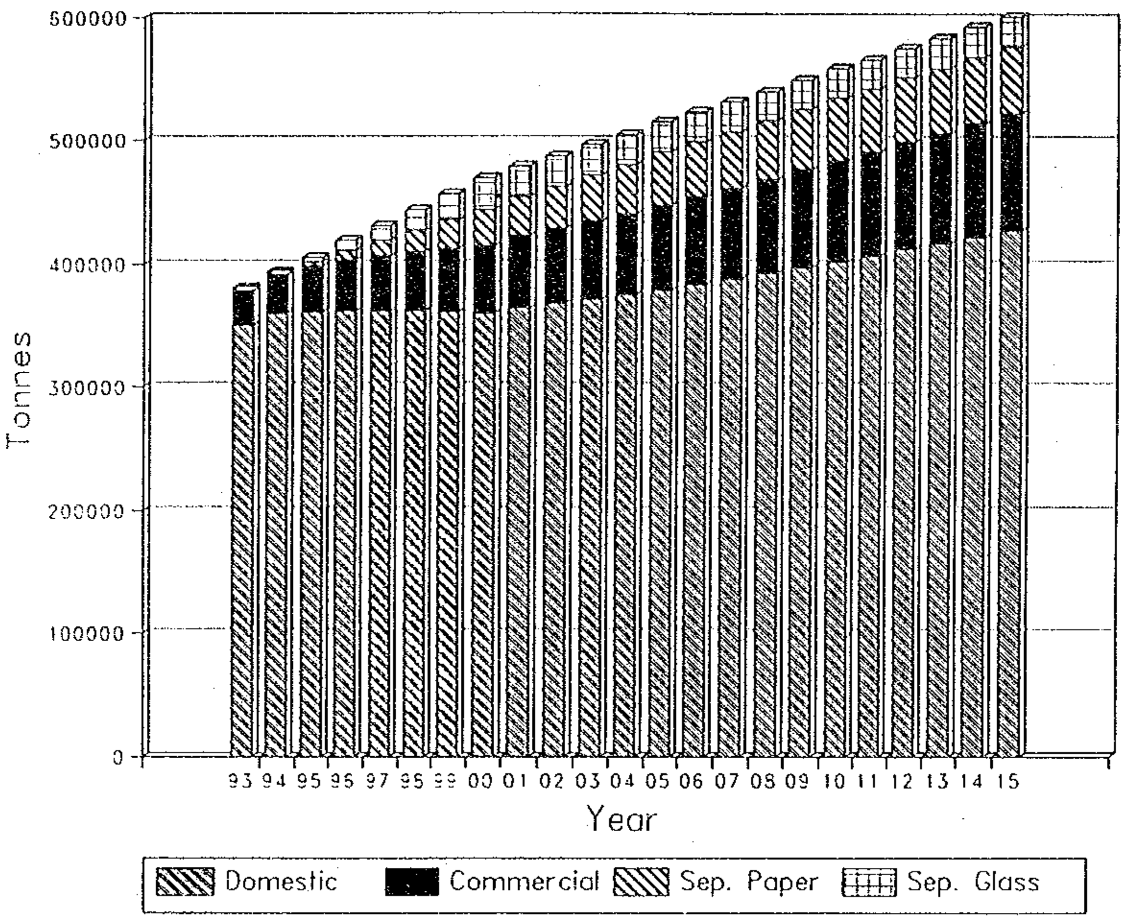


Figure 6-1-3 Annual Waste Production

3) Waste Volumes used to Appraise Landfill Life

For the purpose of appraising respective incineration residues and landfill capacities, and in order to calculate the waste estimations to be deposited (in Dolny Bogrov, Suhudol and Katina) these gross weights were adjusted to bulk volumes depending on specific option considered and the particular degree of compaction or process variant applicable. The specific densities are:

Waste packed at a transfer station	-	550 kg/m^3
Loose waste compacted at the landfill	-	700 kg/m^3
Waste precompressed in blocks	-	850 kg/m^3
Incinerated waste ash and flue dust	-	1,000 kg/m^3
Commercial and similar misc. waste	-	850 kg/m^3

4) Bases of Assumptions:

In developing the disposal options the following assumptions are made:

a. That Dolny Bogrov will be closed at the end of 1993.
b. That the maximum remaining capacity at Suhudol will be limited to an additional 2,200,000 cubic meters beyond the 1st Jan 1994, and that improved on-site compaction will be established on site.
c. That all commercial waste arrives at Katina.
d. That net storage capacity of Katina is 6,400,000 cubic meters; (the final priority project work reported in Volume II will confirm the exact figure).
e. That efficient landfill volume utilization (compaction management, exclusion of building rubble, etc) will improve with the advent of project implementation.
f. That the nominal capacity of the incinerator is 600 tons per day, with an 80% availability and a 15% ash and dust residue to be delivered to Katina.
g. That, in the case of PCW, Landfilling is constructed of PCW blocks (to take advantage of the improved site conditions & compaction achieved).
h. That the earliest date when filling operations can start at Katina is in January 1997.

6.1.5 Recycling of Solid Waste

1) General

The planning criteria of the master plan refers to a requirement that SGM take measures to target waste reduction and waste separation. Waste minimization and recovery is an underlying principal of new Bulgarian legislation; (the draft waste act). Accordingly these master plan proposals explore here achievable methods of introducing Municipal participation in 'Recycling', and 'Waste Reduction'.

Associated with and closely linked to the establishment of these services is the requirement to provide inhabitants with a minimum number of convenient Waste Depositaries and to actively promote their use and expansion. This is to provide a service, encourage the receipt of waste (especially pre-separated) and to provide local alternatives to illegal dumping.

Recycling for energy and resource recovery and waste reduction and the like is formally encouraged and actively promoted in most Western European countries.

Most German authorities have extensive recycling facilities and enjoy a substantial degree of cooperation and encouragement from the public. They willingly preseparate waste, recycle packing materials (in supermarkets), and effectively subsidize paper recycling by demanding and paying a premium for the product; even though it is technically inferior and more costly. By active promotion of resource preservation principals (and waste minimization) public awareness has created an atmosphere whereby a self-sustaining and accelerating pressure movement has entrenched itself, and a notable reduction in wastes has commenced.

In the UK where local authority budgets have been subject to central government cutbacks, some recycling activities by the respective authorities have been abandoned as privatization of the collection and transportation has been introduced. Edinburgh city for example, is located near Europe's largest paper mill and yet it has recently abandoned separate waste paper collection as the cost was more than the resale value of waste paper: Preseparated waste paper is now baled and used for landfill.

Despite economic constraints, UK legislation is currently being prepared which will require all Waste authorities to attempt to recycle 25% of domestic waste by year 2000. Local authority opinion is that whereas some 40% of UK waste is theoretically recyclable (with composting, separation, etc), some sort of subsidy will be required if these targets are to be achieved. In Scotland for example 1989/90 landfill costs were as low as PDS 5.39/ton (200 lv/ton); in England the equivalent cost approximated PDS 25/ton (1,000 lv/t). The UK DoE figures published tend to imply that as costs increase towards the end of the century it will still be cheaper to use landfill than to recycle suitable waste.

Current prices quoted as examples of the return achievable by municipalities (or their privatized operators) for recoverables from UK municipal pre sorted recyclable sources are:
- Aluminum cans (Baled) - PDS 300 /ton (12,000 lv/t);
- steel cans (for tin recovery) - PDS 20 /ton (800 lv/t).

Mechanized separation for recycling is possible with gross costs approximate 1,800 lv/ton. More economically, hand separation is occasionally still advocated for poorer commu-