3.3 Analysis of Waste Collection Survey Results

Two surveys to assist in evaluating operation were conducted by the Study; a time and motion survey, and solid waste survey at the two disposal sites for one week.

1) Time and Motion Survey

This survey was conducted during the second half of June, 1993 and covered the 24 BKC. A follow-up survey was held in January 1994. From each BKC 2 vehicles were surveyed, except for Sredets (3 veh.). The vehicles represented types in use in SGM. The survey called for the surveyor to ride beside the driver and maintain a record of the vehicle trip. A summation of the results is shown in Table 3-3 (following page).

Ten of 24 districts had average trip distances ranging between 39 and 48 km. Distance covered in one trip in Pancharevo district was the highest at 93 km. Mladost and Novi Iskar also had lengthy trip distances. In terms of trip time, averages of 11 districts were 3 to 4 hours/trip. Distance covered on collection routes averaged 3-4 km, however Pancharevo, a large district had an average of 11 km.

Speeds to and from dump sites were similar for first and second trips (for vehicles making more than one trip) which indicates that traffic congestions during the hours of 11 AM and 2 PM do not effect waste transport vehicles very much. It was noted that vehicles in most cases avoided main roads and no severe delays due to traffic congestions were reported.

Results of this survey were also used to calculate average time required to handle one ton of waste (total waste collected at collection route divided by time spent on the route). Container type has a big effect on time per ton. Time required to handle Meva is almost double that for the larger Ra. There was no significant difference in time when comparing vehicle types. The results are shown in Table 3-4.

Table 3-4 Waste Handling Time

(min/ton)

	Meva	Ra	Meva & Ra	Kison
Bobar/Europa	50.2	26.3	--	--
Norba	49.4	30.9	57.9	--
GAZ 53 KM	--	--	--	51.8

Table 3-3 Summation of Time and Motion Survey

Dist-rict	Veh.	No. Trip	Ave. /Trip (ton)	Ave. Dist. by Veh. (km)	Ave. Dist. by Dist. (km)	Ave. Time by Veh. (hr)	Ave. Time by Dist. (hr)	Ave. Speed by Dist. (kph)	Ave. to Dump Site (km)	Ave. in Zone (km)	Ave. in Zone (hr)
1.SRED	(1)Bobar(m)	1	2.5	42	44	5.8	5.0	8.8	18	5	3.3
	(2)Norba(m)	2	2.8	44		4.3					
	(3)Bobar(m)	1	3.5	46		4.9					
2.KSEL	(1)Bobar(b)	2	5.5	42	41	3.6	3.9	10.5	18	3	2.3
	(2)Bobar(b)	2	5.3	41		4.3					
3.VAZR	(1)Bobar(b)	2	5.8	24	23	3.2	3.6	6.2	9	4	2.4
(Suh)	(2)Europa(m)	2	5.0	22		4.1					
4.OBOR	(1)Bobar(m)	1	2.1	38	42	3.1	4.8	8.6	13	8	3.9
(D/B)	(2)Norba(mb)	1	1.8	45		6.6					
5.SERD	(1)Bobar(b)	2	5.1	33	30	3.8	5.4	5.5	14	6	2.6
(Suh)	(2)Norba(m)	1	2.2	27		7.0					
6.PODU	(1)Bobar(b)	2	3.3	42	40	3.4	3.5	11.4	17	5	1.7
(D/B)	(2)Norba(b)	2	2.1	39		3.7					
7.SLAT	(1)Bobar(b)	2	4.8	36	35	3.6	3.8	9.2	15	4	2.3
(D/B)	(2)Norba(b)	2	2.6	34		4.0					
8.IZGR	(1)GAZ53km	3	1.0	26	34	2.7	3.3	10.4	14	2	1.4
(D/B)	(2)Bobar(b)	2	4.0	42		3.9					
9.LOZN	(1)GAZ53km	3	1.5	47	47	3.1	3.2	14.7	21	0	0.5
(D/B)	(2)GAZ53km	3	1.5	47		3.3					
10.TRID	(1)Bobar(m)	2	3.4	48	48	4.3	4.3	11.0	20	4	2.4
(D/B)	(2)Bobar(m)	2	3.3	48		4.4					
11.KPOL	(1)Bobar(m)	1	4.3	30	33	6.0	4.4	7.5	14	4	2.2
(Suh)	(2)Bobar(m)	2	2.9	36		2.7					
12.ILIN	(1)Norba(mb)	2	4.7	41	40	3.9	3.8	10.5	17	5	2.4
(Suh)	(2)Europa(b)	2	5.0	39		3.6					
13.NADZ	(1)Norba(b)	2	4.5	51	48	3.8	3.9	12.3	23	2	1.5
(Suh)	(2)GAZ53km	2	1.0	45		4.0					
14.ISKR	(1)Norba(b)	2	5.8	39	38	2.3	2.4	15.6	20	4	1.3
(D/B)	(2)Bobar(b)	2	3.2	38		2.6					
15.MLAD	(1)Europa(b)	1	4.0	72	63	4.8	3.9	16.3	25	6	1.5
(D/B)	(2)Norba(b)	2	3.8	54		3.0					
16.STUD	(1)GAZ53km	1	0.3	50	45	2.0	2.6	17.2	22	3	1.3
(D/B)	(2)Bobar(b)	2	4.9	40		3.2					
17.VITS	(1)Bobar(m)	2	3.3	40	37	4.0	4.0	9.4	18	4	2.4
(Suh)	(2)Bobar(b)	2	3.5	35		4.0					
18.OKUP	(1)Bobar(b)	2	5.0	36	31	3.9	3.3	9.5	13	2	1.7
(Suh)	(2)GAZ53km	3	1.5	26		2.6					
19.LYUL	(1)Bobar(b)	3	3.8	24	29	2.3	2.8	10.6	11	5	1.7
(Suh)	(2)Norba(b)	2	4.5	34		3.3					
20.VRAB	(1)Bobar(m)	2	3.1	38	39	3.1	3.2	12.3	17	4	1.8
(Suh)	(2)Bobar(m)	2	3.6	40		3.3					
21.NISK	(1)GAZ53km	2	0.8	66	55	4.4	4.1	13.3	23	2	1.7
(D/B)	(2)Bobar(m)	2	2.8	44		3.8					
22.KREM	(1)GAZ53km	3	0.6	32	31	1.5	1.5	20.4	15	0	0.4
(D/B)	(1)GAZ53km	4	0.5	31		1.6					
23.PANC	(1)Bobar(m)	1	2.3	96	93	6.0	5.3	17.6	22	11	2.2
(D/B)	(2)Norba(m)	1	6.3	89		4.5					
24.BANK	(1)Bobar(m)	2	2.5	39	39	3.8	2.9	13.5	15	7	1.7
(Suh)	(2)Bobar(b)	2	3.8	39		2.0					

A total of nine GAZ 53KM vehicles were covered in this survey. These vehicles operate on the basis of stationary container system and haul $4m^3$ capacity containers (Kison). The vehicles leave the garage in the morning with an empty container, go to the collection point, replace the empty container with the full one and then to the disposal site for emptying the container. The vehicle then returns to the garage or proceeds to the next collection point. These vehicles averaged three trips per shift but the time required to handle one ton was long at 52 minutes, however idle time recorded by this vehicle type was the longest with recordings of two hours during the one trip. The vehicle crew is composed of only the driver.

Figure 3-1 show samples of waste collection vehicles routes within collection zones as recorded in the survey. The areas of the zones ranged between 40 and 60 Ha. The central district of Oboriste had small collection zones of 50 Ha. Serdika also had small collection zones. On the other hand Iskar collection zones had larger than average areas of 80 and 85 Ha.

2) Solid Waste Survey at Disposal Sites

During one week in the first half of June all waste collection vehicles entering the two disposal sites of Suhudol and Dolny Bogrov were surveyed. Survey items included the following;

- Vehicle registration and type
- Time of arrival
- Weight of hauled waste
- Area where waste was collected from
- Type of waste

The results of the summer survey were augmented by the winter survey. From these surveys it was possible to gauge the cleansing activity by district and vehicle type for one week. The results of the analysis by district are shown in Table 3-5.

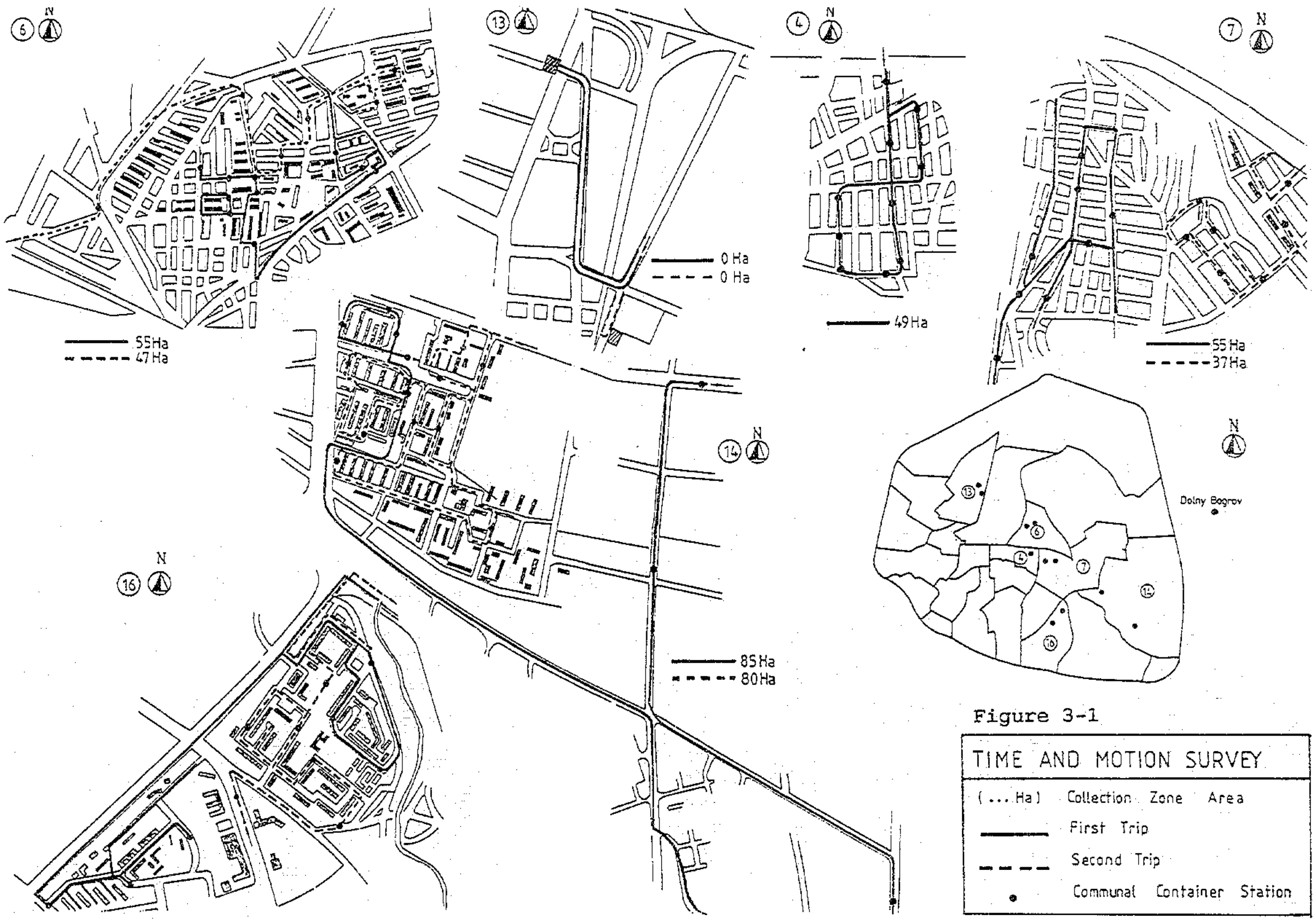


Figure 3-1

TIME AND MOTION SURVEY

Table 3-5 Operation Indices by District

District	Vehicle number used	Trip No.	Ave. Trip/ Veh. (Ton)	Total Waste Hauled (%) (*1)	Trip Haul Eff. (%) (*2)	Veh use Eff. (Lv/ Ton)	Cost
1.SRED	55	79	1.4	144.2	55%	31%	528
2.KSEL	65	91	1.4	310.3	80%	52%	379
3.VAZR	57	66	1.2	222.6	72%	41%	414
4.OBOR	70	114	1.6	236.4	65%	39%	435
5.SERD	75	101	1.3	357.4	87%	53%	317
6.PODU	72	146	2.0	323.6	67%	50%	398
7.SLAT	60	106	1.8	254.2	66%	49%	405
8.IZGR	39	63	1.6	134.4	68%	43%	441
9.LOZN	39	63	1.6	177.2	78%	51%	347
10.TRID	119	203	1.7	301.0	55%	31%	548
11.KPOL	68	133	2.0	390.7	71%	65%	324
12.ILIN	52	83	1.6	242.2	86%	56%	329
13.NADZ	64	106	1.7	390.5	88%	69%	313
14.ISKR	51	85	1.7	263.3	73%	55%	357
15.MLAD	91	163	1.8	415.1	71%	52%	414
16.STUD	32	58	1.8	149.5	69%	52%	399
17.VITS	87	131	1.5	364.7	71%	64%	381
18.OKUP	54	79	1.5	214.8	69%	63%	370
19.LYUL	60	106	1.8	402.2	89%	92%	294
20.VRAB	47	76	1.6	253.0	78%	62%	322
21.NISK	48	77	1.6	204.2	66%	82%	420
22.KREM	46	102	2.2	173.0	55%	84%	470
23.PANC	50	78	1.6	115.1	55%	58%	748
24.BANK	23	36	1.6	108.1	70%	94%	350
Tot.SGM	1424	2345	1.6	6147.5	72%	54%	388

Notes: *1: Trip Haul Efficiency = Actual Waste Hauled / Trip no. x Max. Haul by Veh

*2: Veh. Use Efficiency = Actual Waste Hauled / Vehicle Usage Potential

Veh. use potential = Vehicles used x pot. trip no. x max. haul by veh.

Average number of trips per vehicle (all types) during the 7 days was low at 1.6, which indicates that during most days vehicles make only 1 trip. Vehicle utilization efficiency was also low, at an average of 54%. Vehicle capacity utilization degree is represented graphically in Figure 3-2 by district.

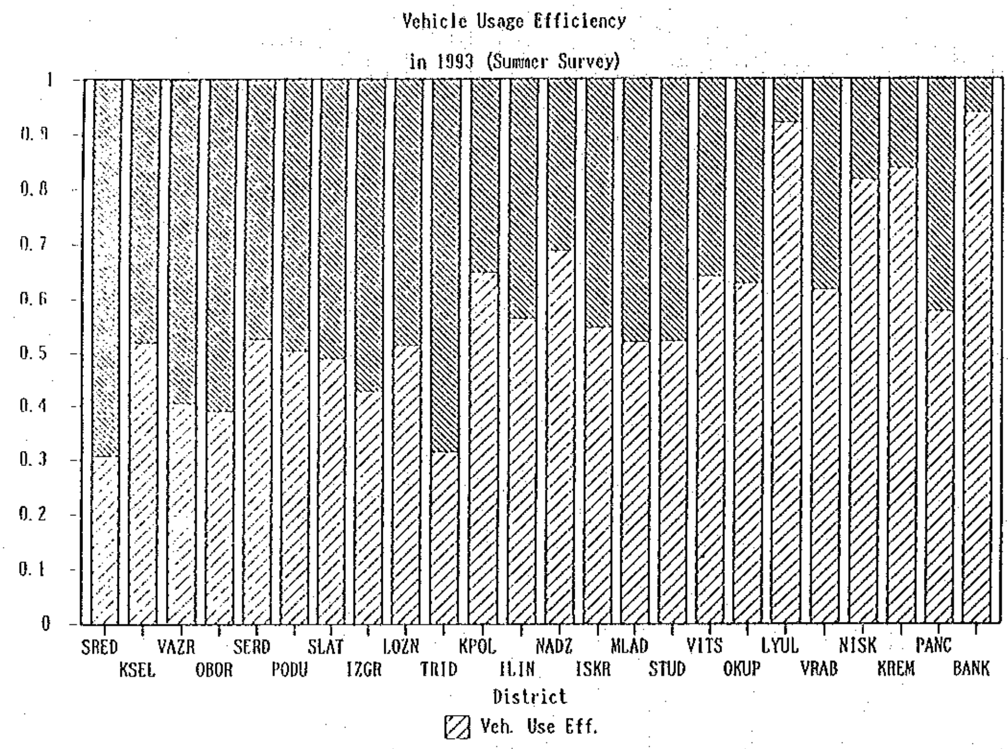


Figure 3-2 Vehicle Utilization Efficiency by District

The table shows that trip haulage efficiency is high for SGM at 72%. This means that the actual trips made by the vehicles are properly loaded.

However vehicle use efficiency is low at 54%. Although trip loadings are efficient, trip numbers a vehicle can make is not maintained. Therefore more vehicles and crews than required are operated and working hours/shift are less than a full shift or the time spent on collection route is too long.

Lyulin district, by far appeared to be making the best use of vehicles, making a high number of trips per vehicle and at the same time maintaining carrying nearly full loads per trip. The suburban districts of Bankia, Kremikovtsi and Novi Iskar also made good use of their vehicle haulage potentital. However it must be noted that as these districts are distant from the dump sites and cover large areas, the potential number of trips a vehicle can make per day is lower than that of the other districts. On the lower side Tridiste and Sredetz make poor use of their vehicle haul potential. The use of Meva containers in both districts increases the time a collection vehicle spends on the collection route and thereby limits most vehicles to one trip per shift. Both districts also showed poor loading efficincies per trip.

The cost per one ton of transported waste was calculated as follows (see Table 3-5):

- Vehicle operating cost (VOC) was calculated for each vehicle type, applying standards published by SMG and adopted by BKC. Mid-June prices were used for oil and fuel costing. VOC was calculated for each district applying average trip lengths derived from the time and motion survey. Cost per trip was thereby obtained.
- For each vehicle type used by a district, the number of trips by that type was multiplied by the cost per trip and the results of the different vehicle types were totaled to produce the total VOC of that district.
- Cost per ton was then obtained by dividing by actual amount of waste hauled.

Costs by district are influenced by trip lengths (distances to disposal sites), type of vehicle utilized, number of trips per vehicle shift, and loading per vehicle. As the table shows average cost during the survey week was 390 leva/ton. Pancharevo, Triadiste, and Sredetz districts showed comparitively high costs above 500 Leva/ton.

Table 3-6 shows costs and load/trip by vehicle type. Poor vehicle use efficiency of Sredetz contributed to the high cost. Throughout the week only one Bobar vehicle was utilized by that district, and had a load of only 0.3 ton. Norba vehicles utilized by that district also had low loading efficiencies. Unit cost for Norba at 93 Lev/m^3 was higher than that for other districts having similar trip lengths but better loading/trip. Also 7.2 tons were transported by GAZ 53M type vehicle, which has a comparatively high VOC. Usage of that vehicle type, and inefficient utilization of Bobar vehicles haulage capacity also contributed to increased cost in Lozenets and Tridiste districts as well. On the other hand, the main cause for high cost at Pancharevo district is traced to lengthy trips there.

High vehicle capacity utilization rates in Lyulin district were the main reason for the low cost per m^3. RTK vehicle type when used inefficiently can result in high costs but in Lyulin utilization efficiency was extremely high at 98% and therefore no cost burden was created. At both Krassno Selo and Ovcha Kupel districts both good utilization rates and not using either GAZ 53M or RTK contributed to the low cost.

Table 3-7/A shows operation indices by vehicle type for the survey's one week. Overall, with 715 recorded trips, 48% of total waste collected and hauled to the two disposal sites

Table 3-6 Actual VOC by District and Vehicle Type

District		1)RTK	2)Eur-opa	3)Norba	4)GAZ 53M	5)GAZ 53KM	6)GAZ KO	7)GAZ Trk.	8)ZIL
1. SRED	Trip number	15	1	8	8	28	0	0	19
	Ld/trip(ton)	3773	300	2538	900	1046	0	0	1605
	VOC(Lev/m3)	45	1162	93	344	130	0	0	169
2. KSEL	Trip number	0	37	30	0	17	0	4	3
	Ld/trip(ton)	0	4824	3583	0	1006	0	800	1333
	VOC(Lev/m3)	0	46	24	0	142	0	340	256
3. VAZR	Trip number	0	44	13	0	2	0	5	2
	Ld/trip(ton)	0	4405	1262	0	2750	0	800	1450
	VOC(Lev/m3)	0	67	139	0	47	0	399	221
4. OBOR	Trip number	15	14	15	1	52	4	0	13
	Ld/trip(ton)	3220	3829	4360	3600	786	623	0	1698
	VOC(Lev/m3)	63	62	64	96	138	176	0	188
5. SERD	Trip number	0	55	8	2	19	0	6	11
	Ld/trip(ton)	0	4415	4950	1250	1395	0	1550	3336
	VOC(Lev/m3)	0	48	41	263	90	0	211	83
6. PODU	Trip number	4	48	8	0	67	0	1	18
	Ld/trip(ton)	2475	4018	4175	0	714	0	1400	2122
	VOC(Lev/m3)	78	52	20	0	137	0	245	117
7. SLAT	Trip number	17	33	12	0	40	0	4	0
	Ld/trip(ton)	2806	3906	2933	0	952	0	1075	0
	VOC(Lev/m3)	75	54	50	0	103	0	310	0
8. IZGR	Trip number	0	25	0	3	34	0	0	1
	Ld/trip(ton)	0	4252	0	600	702	0	0	2400
	VOC(Lev/m3)	0	49	0	554	154	0	0	140
9. LOZN	Trip number	10	4	19	2	24	0	0	4
	Ld/trip(ton)	4740	3525	4832	750	696	0	0	1425
	VOC(Lev/m3)	48	58	55	465	174	0	0	244
10. TRID	Trip number	23	9	18	1	126	0	8	18
	Ld/trip(ton)	3222	2367	3572	1100	691	0	925	2539
	VOC(Lev/m3)	67	131	69	320	167	0	376	125
11. KPOL	Trip number	1	56	28	17	21	0	10	0
	Ld/trip(ton)	3600	3886	3771	2012	781	0	1330	0
	VOC(Lev/m3)	91	45	35	116	118	0	166	0
12. ILIN	Trip number	2	27	13	0	34	5	0	2
	Ld/trip(ton)	3650	4978	4531	0	850	800	0	4350
	VOC(Lev/m3)	90	49	18	0	172	163	0	78
13. NADZ	Trip number	0	49	29	0	19	4	3	2
	Ld/trip(ton)	0	4398	4548	0	1068	550	5767	1650
	VOC(Lev/m3)	0	50	15	0	189	211	61	212
14. ISKR	Trip number	6	31	21	0	15	0	2	10
	Ld/trip(ton)	2183	4119	3462	0	693	0	1050	3730
	VOC(Lev/m3)	108	48	15	0	169	0	322	76
15. MLAD	Trip number	8	36	47	0	69	0	2	1
	Ld/trip(ton)	3500	4097	3685	0	920	0	1100	700
	VOC(Lev/m3)	81	56	18	0	145	0	334	528
16. STUD	Trip number	2	34	0	0	22	0	0	0
	Ld/trip(ton)	2300	3844	0	0	645	0	0	0
	VOC(Lev/m3)	146	59	0	0	224	0	0	0
17. VITS	Trip number	2	46	28	0	13	8	25	9
	Ld/trip(ton)	2950	3628	3589	0	1338	2000	1416	2511
	VOC(Lev/m3)	111	59	65	0	97	71	159	109
18. OKUP	Trip number	0	30	15	0	14	13	2	5
	Ld/trip(ton)	0	4253	2353	0	1171	1900	650	1900
	VOC(Lev/m3)	0	46	84	0	111	52	508	173
19. LYUL	Trip number	17	40	24	0	16	0	8	1
	Ld/trip(ton)	4424	4455	4238	0	1675	0	1575	7700
	VOC(Lev/m3)	42	46	11	0	84	0	120	43
20. VRAB	Trip number	0	47	10	0	8	3	6	2
	Ld/trip(ton)	0	3823	4970	0	850	1467	1367	2100
	VOC(Lev/m3)	0	55	35	0	147	100	181	162
21. NISK	Trip number	25	18	1	5	13	0	0	15
	Ld/trip(ton)	3280	4078	600	880	1315	0	0	1780
	VOC(Lev/m3)	61	56	723	220	110	0	0	180
22. KREM	Trip number	18	3	18	0	57	0	0	6
	Ld/trip(ton)	3522	3733	1667	0	871	0	0	3117
	VOC(Lev/m3)	52	88	105	0	114	0	0	76
23. PANC	Trip number	19	0	4	1	46	0	7	1
	Ld/trip(ton)	2653	0	5100	900	786	0	786	1700
	VOC(Lev/m3)	106	0	92	450	197	0	411	238
24. BANK	Trip number	0	28	0	0	8	0	0	0
	Ld/trip(ton)	0	3557	0	0	1063	0	0	0
	VOC(Lev/m3)	0	63	0	0	121	0	0	0

was by Bobar/Europa vehicles. Norba vehicles transported 22% of the total. The two vehicle types of GAZ 53KM and RTK were each responsible for transporting 11% and 10% respectively. These results correspond with the vehicle fleet breakdown by type as follows;

- Bobar/Europa 35%,
- Norba 15%,
- GAZ 53M 7%,
- RTK 5%,
- GAZ 53KM 21%
- ZIL 555/506 8%
- GAZ Truck 6%
- GAZ KO 4%

Table 3-7/A Operation Indices by Vehicle Type

Vehicle Type	Trip No.	Ave. Trip/ Veh.	Tot. Hauled Waste (Ton)	Ave. Load/ Trip (Ton)	Haul Eff. (%)	Veh. share of Total
RTK	184	1.8	617.5	3.36	69%	10%
Bobar	715	1.7	2,942.4	4.12	77%	48%
Norba	369	1.6	1,354.4	3.67	68%	22%
GAZ 53M	40	1.3	57.2	1.43	37%	1%
Gaz 53KM	764	1.8	665.4	0.87	62%	11%
Gaz KO	37	1.4	0.03	0.001	72%	0%
Gaz Trk	93	1.3	127.5	1.37	59%	2%
Zil	143	1.2	329.3	2.30	60%	5%

Haulage efficiency of Norba vehicle will decrease significantly if compared to its design haulage capacity of 9-10 tons. It is necessary to plan properly for collection zones to be served by that type of vehicle. Haulage efficiency is presented graphically in Figure 3-3.

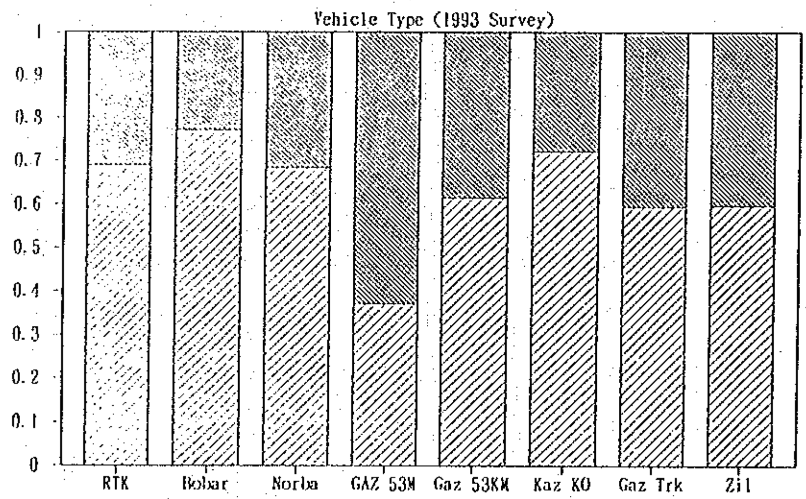


Figure 3-3 Haulage Efficiency by Vehicle Type

3.4 Hearing Survey Results of Street Cleaning

A questionnaire was prepared and dispatched to each of the 24 districts and Chistota General Co. enquiring about actual sweeping and washing operations in each district. Specifically areas of streets subject to washing and sweeping and frequencies of these activities. Unfortunately however there was been no response to any of the questionnaires. A second approach involved obtaining information from a selected number of BKC about their street cleaning operations. Over 16 BKC were interviewed and important points are described.

However overall it is safe to say that while the waste collection and transport activity is being done in a consistent, if sometimes inefficient manner, street cleaning is subject to financial conditions and is suspended when funds are lacking or when it is necessary to appropriate the available small funds to the waste collection activity. It is conceivable that a more efficient waste collection operation may result in savings which can in turn be used for street cleaning activities.

In general main roads are well cleaned and cleaning vehicles are very active there in day time and also with night shifts. However side roads and roads in residential areas are obviously not properly cleaned.

It is worthwhile to note that in the CAW survey, only 28% of those surveyed were satisfied with the street cleanliness conditions in general, and again a minority of 31% replied positively that streets near their dwellings were regularly cleaned. Perhaps a gradual shift of the burden of street sweeping to the citizens may be required. In the CAW survey 55% replied that they sweep the streets near their houses, although their sweeping frequency was low, the majority of 40% said that they do this 2 or 3 times a year.

Following are some of the more significant topics understood during the interview survey, by district. Each district is dealing with the problem of funds shortage differently, some by suspending work, and others by putting workers on leave and moth balling vehicles.

<u>Chistota General Co.</u>
Chistota General Co. is responsible for street cleaning and washing of approximately 150 Ha, mainly comprising major roads and squares. Figure 3-4 shows the roads which the Chistota Co. is responsible for cleaning.

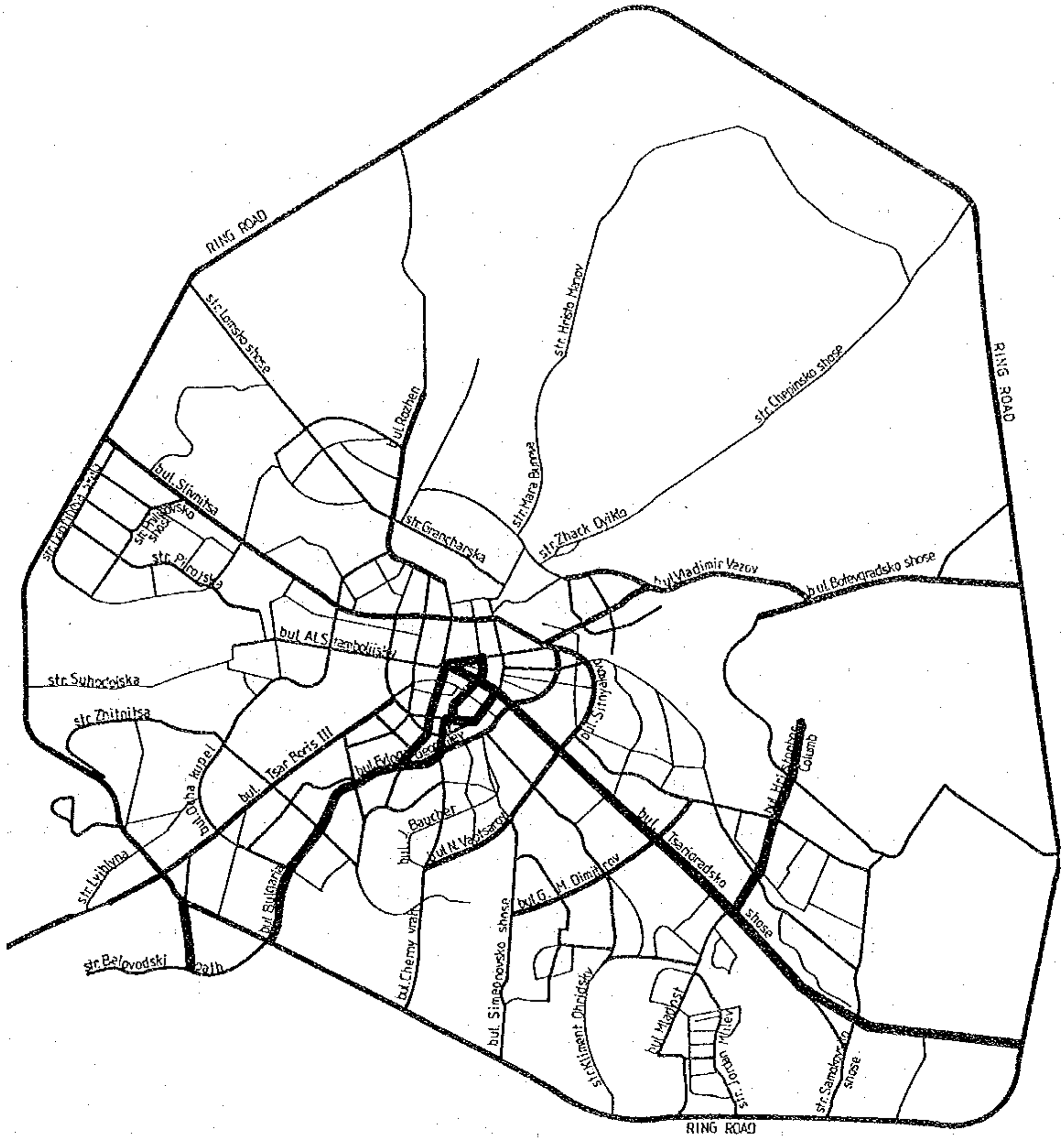


Figure 3-4

STREETS CLEANED BY CHISTOTA GENERAL Co.

N

Scheme

Vazrazhdane District

Manual sweeping is done at the city center and in the market area (the Women's Market). This is the largest market in the city. The district has one mechanical vehicle for sweeping. The main problem in street sweeping is the parked cars blocking the road. This makes it necessary to often work at night. In case of night work drivers and workers salaries are increased by 30%.

The BKC has an agreement with a number of shops to wash the streets in front of them. These shops cannot do this activity by themselves because they are prohibited from using tap water for street cleaning.

Triaditze District

Three years ago when there was no money problem and the district was divided into sub-districts classified by daily sweeping, once every two days and once every three days. There were enough funds for road construction and maintenance thereby making the cleaning task easier. At present funds are insufficient and scarce money is diverted into road maintenance.

Main routes are swept daily, and some twice in the morning and at night. Inner streets in the central area city are cleaned on weekends. There are 18-20 workers doing manual sweeping at underpasses and in the market area.

Of the three market areas in the district, one is swept by sweepers hired by the market administration. The BKC only transports that market waste.

Podayne District

One IFA vehicle is used for street waste collection and transport. Street baskets of diameter 0.6m and height 0.6m (made of RC with a basket within) are found at bus stops and markets.

The Chistota department staff includes 6 workers for manual sweeping.

Two shifts are used in the washing activity, with a total of about 8 trips daily. For washing water, the BKC has its own well and also draws water from a well belonging to the Chistota company (charge is 1 Lv./m^3).

There is heavy vehicle traffic along the main roads crossing the district, and in particular construction materials vehicles. These vehicles dirty the roads.

At present three vehicles are out of operation due to lack of funds for repairs (an Ifa, container carrier, and Skoda C8).

Lozenetz District
BKC has an agreement with the District this year to wash the streets 4 times a month. This is the lowest category, and is due to the financial constraints.

Manual sweeping is done at bus stops, market areas, underpasses, and where there is a large concentration of people.

Street sweeping is done by GAZ dump truck and 2 workers. During June, 4 workers were involved in manual street sweeping.

In many cases the BKC has to clean open spaces which have become "small disposal sites". The BKC claims that it receives no payment for such activity.

Mladost District
The district is not divided into sections as in waste transport activity. Some streets are washed daily while others once or twice weekly. In some cases a street is cleaned once a day in two shifts. In the first shift the street is hosed by the vehicle (and street waste collected by the workers in the crew) and in the second shift a driver using a nozzle cleans the street (no crew is required).

The activity of the cleaning workers is monitored by checkers from the BKC which are different from those of the waste collection workers.

The most difficult time for street sweeping is in the spring time when the curbs near the streets are very dirty from the long winter.

Oborishte District
For street washing 4 Skoda (Check) and 9 Zil (Russian) vehicles are used. In the case of sweeping, 3 IFA vehicles (East German) and 1 Faun (German) for pedestrian sweeping are available (that vehicle is not suitable for the district). Zil dump truck is also employed for collection of waste from the street sweeping activity.

Street sweeping and washing is done in winter also, provided that the temperatures are above zero.

Manual sweeping is done at bus stops, pedestrian pathways and markets. Two IFA sweepers are used for sweeping. Night shifts are maintained in some areas, where lighting conditions permit.

BKC's plan is to sweep every street at least 5 times a month. Sweeping is done daily, in two shifts all the month (even on Saturdays and Sundays). However since last week BKC had to suspend usage of 10 vehicles (7 water transports, 2 Ifa and 1 Zil) and 40 workers (given unpaid leave). Under these conditions the BKC can only clean each street twice a month.

<u>Slatina District</u>
Usually washing vehicles employed by the district make 4-5 trips daily.

BKC pays the Sofia Greater Municipality's Water and Drainage Company monthly 5000 Lv. for cleaning water they discharge in the drainage system during the cleaning of streets. This is calculated as follows:

10 veh. x 4 trips x 6 m^3/veh. x 24 days = 5700 m^3/month

<u>Nadezhda District</u>
In May there was no money from the district for street cleaning and that activity was suspended during the period of May 6th to the 20th.

<u>Iskar District</u>
Manual street sweeping is done in spring time only (raking of leaves). At present cleaning and sweeping vehicles are operated on a one shift basis. Street cleaning/sweeping were operated in two shifts last year however, due to budget constraints shifts were reduced to only one this year.

<u>Lyulin District</u>
The district road space is divided into 286 sections and streets are categorized. District streets fall into categories 1 and 3. In case of lack of funds roads categorization is not strictly observed.

3.5 Results of Solid Waste Composition Test

In order to estimate the solid waste composition in SGM field surveys were conducted both in Summer 1993, and Winter '93-'94. Samples were collected from 15 areas of the city as listed below:

1. Boyana in Vitosha District: Detached housing area outside the ring road
2. Hemus in Slatina District: Low-medium rise apartment block in the central area
3. Pirotska Street in Vazrazhdane District: Low-medium rise apartment block in the central area with shops and restaurants
4. Belite Brezi in Krasno Selo District: High-rise apartment block
5. Ovcha Kupel: Medium-rise apartment block
6. Lyulin: Medium-high rise apartment block
7. Mladost: Medium-high rise apartment block
8. Dolni Bogrov: Detached houses in a village area
9. Fuklteta in Krasna Polyana district: Gypsy area, old detached houses
10. Vitosha and Denkoglo street in Sredets district: Busy commercial area with housing
11. Sopping center "RUM" of Ovcha Kupel: Shopping center with supermarket and restaurant
12. Genski Pazar in Vazrazhdane district: Busy open market area
13. Ministry of Construction building in Oborishte district: Typical public office building
14. Slavianska and Aksakov street in Sredets district: Medium-rise buildings with residential apartments houses, offices, shops and restaurants
15. Novotel Hotel Europa, Serdika district: First class 4 star hotel

Both Summer and Winter surveys were conducted by the National Center of Hygiene, under the supervision of the Study Team.

Solid waste samples were taken from the 15 specified areas. Physical composition, ash content, calorific value and elements were analyzed for each component of the samples. The test results are shown in Table 3-7/B, sheets (1) to (8), and described hereafter.

Table 3-7/B Sampling and Separation Record (1)

Sampling	No.1	No.2	No. 3	No. 4	No. 5	No.6	No.7	No. 8	No. 9	No. 10	No.11	No. 12	No. 13	No. 14	No. 15	Average	Deviat.		
Sampling & recorded																			
Sampling Area																			
Date	6	6	6	6	6	7	7	7	8	8	8	8	8	8	9				
Whether	Cloudy	Cloudy	Cloudy	Cloudy	Cloudy	Cl-Rain	Cloudy	Cl-snow	Cl-rain	Cl-snow	Cl-snow	Cl-snow	Cl-snow	Cl-snow	Cl-snow				
Total Weight	1100	1200	1500	700	1300	700	600	200	400	400	800	200	470	780	300	710	394		
Weight of sample	13.6	9.2	7.77	7.3	15.6	10.3	8.8	8.6	13.6	14	10.8	8	5.5	4.25	5.5	9.52	3.31		
Volume of sample																			
Balk density	0.374	0.250	0.208	0.183	0.432	0.280	0.244	0.238	0.377	0.388	0.294	0.222	0.152	0.118	0.152	0.261	0.093	0.276	0.079
Wet Base composition	**No.1**	**No.2**	**No. 3**	**No. 4**	**No. 5**	**No.6**	**No.7**	**No. 8**	**No. 9**	**No. 10**	**No.11**	**No. 12**	**No. 13**	**No. 14**	**No. 15**	**Acerage**	**Deviat.**	**Acerage**	**Deviat.**
Conbustibel																			
Papaer	15.22	25.44	22.15	29.37	10.71	15.98	34.13	20.29	3.55	7.76	11.66	15.97	24.91	34.43	20.56	19.48	8.88	21.66	7.29
Textile	4.45	0.65	11.07	2.62	1.41	3.71	0.91	0.35	0.36	0.22	3.57	2.89	8.06	2.36	0.88	2.90	2.97	3.15	3.30
Plastic	3.45	5.13	6.57	5.10	2.82	5.47	5.46	4.06	1.63	6.75	10.26	2.77	13.19	8.02	3.35	5.60	2.96	4.76	1.15
Rubber & Leather			1.03												0.18	0.08	0.43	0.13	
Wood	0.92	0.44	0.32	0.45	0.71	0.58	0.22	0.58	0.30	0.65	0.19	1.87			0.13	0.49	0.44	0.53	0.21
Putrecsible matter	57.39	29.47	23.57	51.15	12.63	44.44	21.05	37.33	3.92	30.24	52.78	5.68	24.17	10.85	33.27	29.20	16.48	34.63	14.63
Animal Residues				0.14												0.01		0.02	
Sub total	81.43	61.13	64.71	88.83	28.28	70.18	61.77	62.61	9.76	45.62	78.46	29.18	70.33	55.66	58.37	57.75	20.83	64.87	16.75
Non-Conbustible																			
Metal	5.63	3.71	2.19	2.76	1.28	1.95	14.22	1.33	0.36	1.01	4.14	3.27	3.30	1.41	1.06	3.17	3.26	4.13	4.04
Glasswork	6.40	21.40	18.93	3.45	4.11	23.10	17.06	29.45	5.62	7.76	10.26	19.25	26.37	41.04	11.92	16.41	10.42	15.49	9.08
Stone	4.04		2.06	3.58	6.15	0.58		1.16	0.30	1.29					1.41	1.37	1.81	2.20	1.89
Cinder(over 5 mm)		6.66	0.32	0.41	55.82		0.58	0.23	39.32	38.43	2.63	35.60			0.44	12.03	20.22	8.00	20.32
Concrete & block		0.87	0.26			2.53				1.22	0.94	3.02			13.95	1.52	4.46	0.46	0.96
Other (Over 5mm)	1.76	4.91	6.25	0.69		0.78	6.37	3.71		4.67	3.57	9.68			4.82	3.15	2.53	3.06	2.27
Other (Under 5mm)	0.74	1.32	5.28	0.28	4.36	0.88		1.51	44.64					1.89	8.03	4.60	12.80	1.80	1.81
Sub total	18.57	38.87	35.29	11.17	71.72	29.82	38.23	37.39	90.24	54.38	21.54	70.82	29.67	44.34	41.63	42.25	20.83	35.13	16.75
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	100.00	0.00

Table 3-7/B Sampling and Separation Record (2)

Dry base composition	No.1	No.2	No. 3	No. 4	No. 5	No.6	No.7	No. 8	No. 9	No. 10	No.11	No. 12	No. 13	No. 14	No. 15	Acerage	Deviat.	Acerage	Deviat.
Conbustibel																			
Papaer	11.36	14.54	21.02	29.49	7.83	14.03	28.66	17.13	1.42	6.79	6.97	14.02	25.19	36.76	16.10	16.75	9.50	18.01	7.34
Textile	3.76	0.39	9.32	3.72	1.19	2.80	0.33	0.34	0.19	0.11	2.97	2.50	5.66	2.18	0.68	2.41	2.45	2.73	2.85
Plastic	3.58	8.25	8.23	7.73	2.58	6.60	5.37	4.92	1.71	7.70	11.56	1.84	16.45	6.23	3.79	6.44	3.77	5.91	2.01
Rubber & Leather			1.30												0.20	0.10	0.55	0.16	0.00
Wood	1.24	0.39	0.32	0.66	0.40	0.99	0.17	0.68	0.29	0.57	0.22	1.67			0.07	0.51	0.45	0.61	0.34
Putrecsible matter	52.28	14.93	12.46	37.22	10.61	27.56	15.96	26.97	1.42	21.73	49.22	3.01	16.20	1.87	27.33	21.25	15.27	24 75	13.47
Animal Residues				0.14												0.01		0.02	
Sub total	72.22	38.50	52.65	78.96	22.61	51.98	50.49	50.04	5.03	36.90	70.94	23.04	63.50	47.04	48.17	47.47	19.47	52.18	16.54
Non-Conbustible																			
Metal	9 20	5.70	3.25	5.73	1.78	3.30	19.87	1.61	0.28	1.13	6 08	3 01	2.06	0.93	1.35	4 35	4 78	6.31	5.63
Glasswork	10 49	37 52	31.42	7.16	6.05	37.79	23.94	41.90	7.03	11 77	15.42	24.87	34.44	51 09	17.59	23.90	13 98	24 53	13.85
Stone	6.05		3.36	6.00	8.13	0.99		1.53	0.38	0.96					1.15	1 90	2.69	3.26	2.59
Cinder(over 5 mm)		7.46	0.43	0.86	57.56		0.65	0.17	45.87	46.29	2.96	37.06			0.41	13.31	22.10	8.39	20.89
Concrete & block		1.18	0.32			3.96				1.25	1.19	3.01			19.49	2.03	6.29	0.68	1.55
Other (Over 5mm)	1.42	8.46	3.36	0.86		0.99	5.05	3.22		1.70	3.41	9.01			4.67	2.81	2.67	2.92	2.52
Other (Under 5mm)	0.62	1 18	5.21	0 43	3.87	0.99		1.53	41.41					0.94	7.17	4.22	11 89	1.73	1.69
Sub total	27.78	61.50	47.35	21.04	77.39	48.02	49.51	49.96	94.97	63.10	29.06	76.96	36.50	52.96	51.83	52.53	19.47	47.82	16.54
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	0.00	100.00	0.00

Tree component	No.1	No.2	No. 3	No. 4	No. 5	No.6	No.7	No. 8	No. 9	No. 10	No.11	No. 12	No. 13	No. 14	No. 15	Acerage	Deviat.	Acerage	Deviat.
Moisture	40.44	44.43	40.57	51.84	35.33	40.94	30.15	31.65	22.17	36.53	36.55	24.65	28.75	24.29	34.77	34.87	7.89	39.42	6.59
Organic	28.97	21.78	30.95	32.61	12.59	24.49	30.97	25.36	3.52	16.85	35.31	17.71	40.73	32.75	27.64	25.48	9.34	25.96	6.14
Ash	30.59	33.79	28.48	15.55	52.08	34.57	38.88	42.99	74.31	46.62	28.14	57.64	30.52	42.96	37.59	39.65	13.71	34.62	10.07
Volatile of plastic	2.00	4.34	4.73	3.48	1.64	3.70	3.71	3.30	1.28	4.86	7.31	1.36	11.49	4.65	2.45	4.02	2.53	3.36	0.99
Lower Calolific Value																			
Q = 45 V x 6 W	1061.1	713.6	1149.2	1156.4	354.7	856.4	1212.7	951.1	25.3	539.0	1369.7	648.9	1660.4	1328.0	1035.1	937.4	410.3	931.9	269.2
Karigo fomula	1131.1	865.6	1314.9	1278.3	412.1	986.0	1342.7	1066.5	70.2	709.0	1625.6	696.3	2062.5	1490.6	1120.8	1078.1	476.4	1049.6	287.2
Measurent result	938	967	1408	1329	462	1057	1395	1096	95	846	1879	783	2541	1622	1240	1177.2	562.8	1,081.4	292.5
Dulong formula	784.2	913.0	1314.5	1217.4	413.4	990.1	1293.0	1026.5	90.5	829.7	1782.9	735.5	2518.1	1516.2	1166.7	1106.1	553.8	994.0	280.8

Table 3-7/B Sampling and Separation Record (3)

Ash content Analysys	No.1	No.2	No. 3	No. 4	No. 5	No.6	No.7	No. 8	No. 9	No. 10	No.11	No. 12	No. 13	No. 14	No. 15	Acerage	Deviat.	Acerage	Deviat.
Ach content																			
Papaer	11.00	10.80	12.00	11.30	8.10	16.20	9.20	8.80	8.40	11.20	10.00	9.10	8.50	8.50	9.00	10.14	2.02	10.93	2.36
Textile	8.20	7.60	1.20	8.80	3.90	8.70	4.10	3.90	14.20	2.10	2.70	3.60	2.40	2.50	2.80	5.11	3.47	5.80	2.69
Plastic	6.10	5.30	3.20	6.50	1.70	5.00	1.00	2.00	3.60	0.60	0.30	2.20	2.00	1.50	0.90	2.79	1.98	3.85	2.00
Rubber & Leather			1.00												1.50	1.25	0.25	1.00	0.00
Wood	0.40	0.20	0.40	0.50	0.50	0.30	0.20	0.30	0.30	0.60	0.40	0.40			0.50	0.38	0.12	0.35	0.11
Putrecsible matter	43.10	29.30	18.40	20.00	28.50	31.20	32.50	48.00	21.20	46.20	33.00	39.90	23.00	41.20	30.30	32.39	9.23	31.38	9.52
Animal Residues																			
Other (Over 5mm)	59.20	21.00	40.10	55.30	73.10	36.40	65.60	63.20		70.80	48.20	65.90			60.10	54.91	14.97	51.74	16.45
Other (Under 5mm)	74.80	63.80	49.80	72.50	84.20	69.10		71.30						72.50	70.40	69.82	8.73	69.36	9.83
Organic Content																			
Papaer	89.00	89.20	88.00	88.70	91.90	83.80	90.80	91.20	91.60	88.80	90.00	90.90	91.50	91.50	91.00	89.86	2.02	89.08	2.36
Textile	91.80	92.40	98.80	91.20	96.10	91.30	95.90	96.10	85.80	97.90	97.30	96.40	97.60	97.50	97.20	94.89	3.47	94.20	2.69
Plastic	93.90	94.70	96.80	93.50	98.30	95.00	99.00	98.00	96.40	99.40	99.70	97.80	98.00	98.50	99.10	97.21	1.98	96.15	2.00
Rubber & Leather			99.00												98.50	98.75	0.25	99.00	0.00
Wood	99.60	99.80	99.60	99.50	99.50	99.70	99.80	99.70	99.70	99.40	99.60	99.60			99.50	99.62	0.12	99.65	0.11
Putrecsible matter	56.90	70.70	81.60	80.00	71.50	68.80	67.50	52.00	78.80	53.80	67.00	60.10	77.00	58.80	69.70	67.61	9.23	68.63	9.52
Animal Residues																			
Other (Over 5mm)	40.80	79.00	59.90	44.70	26.90	63.60	34.40	36.80		29.20	51.80	34.10			39.90	45.09	14.97	48.26	16.45
Other (Under 5mm)	25.20	36.20	50.20	27.50	15.80	30.90		28.70						27.50	29.60	30.18	8.73	30.64	9.83
Calolific value	**No.1**	**No.2**	**No. 3**	**No. 4**	**No. 5**	**No.6**	**No.7**	**No. 8**	**No. 9**	**No. 10**	**No.11**	**No. 12**	**No. 13**	**No. 14**	**No. 15**	**Acerage**	**Deviat.**	**Acerage**	**Deviat.**
Papaer	3980	3890	3640	3880	4220	3360	4160	4060	4130	3870	4160	4300	4210	4220	3900	3,998.7	244.3	3,898.8	265.0
Textile	4850	4800	5360	4830	5280	4740	4980	4920	4320	5380	4880	5300	5290	5320	5070	5,021.3	290.9	4,970.0	214.1
Plastic	9240	9300	9630	9210	9700	9360	9730	9490	9300	9630	9820	9720	9620	9590	9590	9,528.7	191.0	9,457.5	195.8
Rubber & Leather			4010												3930	3,970.0	40.0	4,010.0	0.0
Wood	3980	4070	4120	3880	4080	4070	4170	3780	3850	4090	4090	4080			4040	4,023.1	111.8	4,018.8	122.4
Putrecsible matter	1770	3500	3630	3550	3390	3290	2630	2200	3940	2840	3360	3430	5350	3000	3700	3,305.3	788.0	2,995.0	659.1
Animal Residues																			
Other (Over 5mm)	2550	3680	2750	1890	1140	2250	1940	1970		1620	2190	1660			1580	2,101.7	636.0	2,271.3	699.8
Other (Under 5mm)	1060	1600	2130	1270	570	1520		1280						1550	1380	1,373.3	399.9	1,347.1	447.8
Lower Calorific value	938	967	1408	1329	462	1057	1395	1096	95	846	1879	783	2541	1622	1240	1,177.2	562.8	1,081.4	292.5

Table 3-7/B Sampling and Separation Record (4)

Elementary analysis	No.1	No.2	No. 3	No. 4	No. 5	No.6	No.7	No. 8	No. 9	No. 10	No.11	No. 12	No. 13	No. 14	No. 15	Acerage	Deviat.	Acerage	Deviat.
Carbon	47.09	58.56	55.31	53.19	52.63	52.60	54.75	54.16	63.08	61.05	54.77	56.37	63.79	57.49	54.32	55.94	4.20	53.53	3.03
Hydrogen	5.75	7.16	7.27	7.03	8.00	8.37	6.64	7.01	8.39	8.70	9.30	6.54	8.87	6.65	7.28	7.53	0.98	7.15	0.75
Nitrogen	0.78	0.74	0.59	0.60	1.16	0.67	0.87	0.49	0.54	0.91	1.58	0.71	0.87	0.46	0.66	0.77	0.28	0.74	0.20
Chlorine	0.19	0.08	0.06	0.07	0.15	0.08	0.09	0.11	0.04	0.13	0.15	0.07	0.03	0.02	0.18	0.10	0.05	0.10	0.04
Salfur	0.77	0.61	0.50	0.38	0.37	0.13	0.32	0.41	0.31	0.32	0.24	1.39	0.18	0.23	1.27	0.49	0.36	0.43	0.18
Oxgen	45.43	32.86	36.28	38.73	37.69	38.15	37.33	37.84	27.64	28.90	33.96	34.92	26.26	35.16	36.29	35.16	4.69	38.04	3.27
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100.00	0.00	100.00	0.00

Lower Calorific valu	No.1	No.2	No. 3	No. 4	No. 5	No.6	No.7	No. 8	No. 9	No. 10	No.11	No. 12	No 13	No. 14	No. 15	Acerage	Deviat.		
45 V - 6 W	1061.1	713.6	1149.2	1156.4	354.7	856.4	1212.7	951.1	25.3	539.0	1369.7	648.9	1660.4	1328.0	1035.1	937.44	410.36	931.90	269.28
Karigo fomula	1131.1	865.6	1314.9	1278.3	412.1	986.0	1342.7	1066.5	70.2	709.0	1625.6	696.3	2062.5	1490.6	1120.8	1078.14	476.44	1049.64	287.20
Caliculation by																			
component	938	967	1408	1329	462	1057	1395	1096	95	846	1879	783	2541	1622	1240	1,177.2	562.8	1,081.4	292.5
Dulong	784.2	913.0	1,314.5	1,217.4	413.4	990.1	1,293.0	1,026.5	90.5	829.7	1,782.9	735.5	2,518.1	1,516.2	1,166.7	1,106.1	553.8	994.0	280.8
Steuer	950.2	1,004.9	1,458.1	1,378.2	474.2	1,109.7	1,440.0	1,148.7	103.2	893.1	1,938.2	814.8	2,658.4	1,662.9	1,295.4	1,222.0	584.7	1,120.5	304.8
Scheurer-Kestner	1,110.8	1,090.6	1,593.1	1,530.8	531.2	1,221.9	1,579.9	1,264.6	114.7	950.5	2,080.5	888.9	2,783.5	1,801.9	1,415.5	1,330.6	613.9	1,240.4	329.2
H - O /8	0.1	3.1	2.7	2.2	3.3	3.6	2.0	2.3	4.9	5.1	5.1	2.2	5.6	2.3	2.7	3.1	1.4	2.4	1.0

Table 3-7/B Sampling and Separation Record (5)

Moisture content	No.1	No.2	No. 3	No. 4	No. 5	No.6	No.7	No. 8	No. 9	No. 10	No.11	No. 12	No. 13	No. 14	No. 15	Acerage	Deviat.	Acerage	Deviat.
Conbustibel																			
Papaer	55.55	68.24	43.60	51.64	52.69	48.17	41.33	42.28	68.75	44.44	62.10	33.86	27.94	19.17	48.93	47.25	13.33	50.44	8.30
Textile	45.59	66.67	50.00	31.58	45.45	55.26	75.00	33.33	60.00	66.67	47.37	13.49	50.00	30.00	50.00	48.03	15.59	50.36	14.08
Plastic	38.30	10.63	25.49	27.02	40.90	28.57	31.25	17.14	33.33	27.66	28.44	50.00	11.11	41.17	26.32	29.16	10.53	27.41	9.40
Rubber & Leather			25.00												25.00	25.00	0.00	25.00	0.00
Wood	20.00	50.00	40.00	30.30	63.63	0.00	50.00	20.00	0.00	44.44	25.00	33.33			66.67	34.11	20.38	34.24	19.32
Putrecsible matter	45.74	71.85	68.58	64.96	45.68	63.38	35.14	50.62	71.70	54.39	40.82	56.25	52.27	86.95	46.42	56.98	13.54	55.74	12.35
Animal Residues				50.00												50.00		50.00	0.00
Sub total	47.18	65.00	51.64	57.19	48.29	56.25	42.90	45.37	59.85	48.66	42.63	40.52	35.68	36.02	48.18	48.36	8.20	51.73	6.87
Non-Conbustible																			
Metal	2.61	14 70	11.76	0.00	10.00	0.00	2.40	17.39	40.00	28.57	6.82	30.77	55.55	50.00	16.67	19.15	17.40	7.36	6.48
Glasswork	2.30	2.55	1.36	0.00	4.69	3.38	2.00	2.76	2.63	3.70	3.67	2.61	6.94	5.75	3.70	3.20	1.65	2.38	1.29
Stone	10.90		3.13	19.23	14.58	0.00		10.00	0.00	52.78					46.88	17.50	18.37	9.64	6.50
Cinder(over 5 mm)		37.70	25.00	0.00	33.31		20.00	50.00	9.21	23.55	28.57	21.55			40.00	26.26	13.45	27.67	15.61
Concrete & block		25.00	25.00			7.69				35.29	20.00	25.00			8.86	20.98	9.08	19.23	8.16
Other (Over 5mm)	52.08	4.44	68.00	40.00		25.00	44.64	40.63		76.92	39.47	29.87			36.69	41.61	18.80	39.26	18.66
Other (Under 5mm)	50.00	50.00	41.46	25.00	42.64	33.33		30.77	27.81					62.50	41.76	40.53	11.04	39.03	8.92
Sub total	10.89	12.08	20.26	9.25	30.22	4.90	9.52	8.68	18.10	26.35	14.41	18.12	12.34	9.57	18.77	14.90	6.78	13.23	7.62
Total	40.44	44.43	40.57	51.84	35.33	40.94	30.15	31.65	22.17	36.53	36.55	24.65	28.75	24.29	34.77	34.87	7.89	39.42	6.59
Calolific value check																			
Papaer	4,472	4,361	4,136	4,374	4,592	4,010	4,581	4,452	4,509	4,358	4,622	4,730	4,601	4,612	4,286	4,446.4	189.7	4,372.3	192.2
Textile	5,283	5,195	5,425	5,296	5,494	5,192	5,193	5,120	5,035	5,495	5,015	5,498	5,420	5,456	5,216	5,288.9	161.9	5,274.7	120.1
Plastic	9,840	9,820	9,948	9,850	9,868	9,853	9,828	9,684	9,647	9,688	9,850	9,939	9,816	9,736	9,677	9,803.0	91.3	9,836.5	68.6
Rubber & Leather			4,051												3,990	4,020.2	30.3	4,050.5	
Wood	3,996	4,078	4,137	3,899	4,101	4,082	4,178	3,791	3,862	4,115	4,106	4,096			4,060	4,038.6	112.4	4,032.8	121.7
Putrecsible matter	3,111	4,950	4,449	4,438	4,741	4,782	3,896	4,231	5,000	5,279	5,015	5,707	6,948	5,102	5,308	4,863.8	829.3	4,324.7	555.5
Animal Residues																			
Other (Over 5mm)	6,250	4,658	4,591	4,228	4,238	3,538	5,640	5,353		5,548	4,228	4,868			3,960	4,758.3	763.2	4,812.0	822.5
Other (Under 5mm)	4,206	4,420	4,243	4,618	3,608	4,919		4,460						5,636	4,662	4,530.3	522.3	4,353.4	377.2

Table 3-7/B Sampling and Separation Record (6)

Elementary analysis	No.1	No.2	No. 3	No. 4	No. 5	No.6	No.7	No. 8	No. 9	No. 10	No.11	No. 12	No. 13	No. 14	No. 15	Acerage	Deviat.	Acerage Deviat.
Paper																		
Carbon	44.20	44.30	41.10	44.00	44.80	39.60	47.40	47.00	46.10	44.20	40.90	47.90	47.50	47.90	44.50	44.76	2.55	
Hydrogen	5.30	5.30	5.50	5.40	5.40	4.80	5.30	5.50	5.80	5.30	4.70	5.60	5.50	5.40	5.50	5.35	0.27	
Nitrogen	0.10	0.10	0.10	0.10	0.50	0.10	0.40	0.10	0.20	0.20	0.40	0.60	0.60	0.40	0.10	0.27	0.19	
Chlorine	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.01	0.03	
Salfur	0.52	0.47	0.61	0.51	0.23	0.07	0.32	0.54	0.24	0.44	0.45	0.42	0.18	0.21	0.55	0.38	0.16	
Oxgen	38.77	39.03	40.69	38.69	40.97	39.23	37.38	38.06	39.26	38.66	43.52	36.38	37.72	37.59	40.35	39.09	1.70	
Textile																		
Carbon	50.70	50.10	55.30	50.50	54.70	49.80	52.30	53.40	45.90	55.40	49.70	54.90	55.00	55.00	53.00	52.38	2.73	
Hydrogen	6.50	6.60	7.30	6.50	7.00	6.50	6.80	6.20	5.90	7.30	7.60	7.10	7.10	7.20	7.00	6.84	0.45	
Nitrogen	0.90	0.80	0.60	0.90	0.30	0.80	0.70	0.60	0.50	0.60	0.60	0.20	0.40	0.60	0.70	0.61	0.20	
Chlorine	0.13	0.08	0.00	0.08	0.03	0.00	0.02	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04	
Salfur	0.60	0.59	0.15	0.63	0.17	0.31	0.35	0.48	1.28	0.15	0.21	0.15	0.16	0.21	0.30	0.38	0.29	
Oxgen	32.97	34.23	35.45	32.59	33.90	33.89	35.73	35.40	32.18	34.45	39.19	34.05	34.94	34.49	36.20	34.64	1.64	
Plastic																		
Carbon	83.37	84.10	85.10	83.00	86.10	84.56	86.20	85.00	84.50	85.30	86.00	86.00	85.40	86.00	85.90	85.10	0.98	
Hydrogen	10.10	10.00	11.20	10.10	11.10	10.20	11.30	10.80	10.10	11.30	11.70	11.20	11.10	10.00	10.90	10.74	0.57	
Nitrogen	0.20	0.40	0.30	0.00	0.30	0.20	0.30	0.20	0.40	0.30	0.60	0.40	0.30	0.40	0.30	0.31	0.13	
Chlorine	0.00	0.00	0.05	0.03	0.10	0.00	0.08	0.04	0.04	0.00	0.08	0.00	0.00	0.06	0.00	0.03	0.03	
Salfur	0.23	0.18	0.10	0.24	0.10	0.04	0.13	0.13	0.17	0.10	0.10	0.11	0.20	0.11	0.11	0.14	0.05	
Oxgen	0.00	0.02	0.05	0.13	0.60	-0.00	0.99	1.83	1.19	2.40	1.22	0.09	1.00	1.93	1.89	0.89	0.81	
Rubber & Leather																		
Carbon			47.50												47.00	47.25	0.25	
Hydrogen			5.40												5.30	5.35	0.05	
Nitrogen			0.60												0.60	0.60	0.00	
Chlorine			0.11												0.00	0.06	0.06	
Salfur			0.59												0.63	0.61	0.02	
Oxgen	0.00	0.00	44.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.97	5.98	15.26	

Table 3-7/B Sampling and Separation Record (7)

Elementary analysis	No.1	No.2	No. 3	No. 4	No. 5	No.6	No.7	No. 8	No. 9	No. 10	No.11	No. 12	No. 13	No. 14	No. 15	Acerage	Deviat.	Acerage	Deviat.
Wood																			
Carbon	47.90	48.30	48.50	47.60	48.20	48.00	49.00	46.50	47.00	48.40	48.20	48.30			47.90	47.98	0.63		
Hydrogen	5.20	5.40	5.50	5.00	5.50	5.60	5.60	5.10	5.20	5.50	5.60	5.50			5.50	5.40	0.20		
Nitrogen	0.40	0.30	0.20	0.30	0.20	0.20	0.20	0.50	0.30	0.20	0.20	0.30			0.20	0.27	0.09		
Chlorine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00	0.00		
Salfur	0.38	0.34	0.30	0.41	0.31	0.05	0.02	0.06	0.10	0.25	0.34	0.27			0.26	0.24	0.13		
Oxgen	45.72	45.46	45.10	46.19	45.29	45.85	44.98	47.54	47.10	45.05	45.26	45.23	0.00	0.00	45.64	39.63	15.56		
Purtrescible																			
Carbon	22.90	36.40	40.60	38.10	31.10	30.50	29.90	23.90	37.20	27.50	31.00	32.10	45.30	29.40	36.60	32.83	5.94		
Hydrogen	2.80	5.10	5.00	5.60	6.90	6.60	4.20	3.60	6.90	4.70	6.40	5.60	9.00	5.00	5.70	5.54	1.46		
Nitrogen	0.60	1.30	1.50	0.90	1.50	0.80	1.30	0.50	0.90	0.90	1.50	1.00	1.70	0.50	0.80	1.05	0.38		
Chlorine	0.14	0.11	0.08	0.11	0.21	0.11	0.15	0.12	0.06	0.14	0.14	0.08	0.10	0.16	0.19	0.13	0.04		
Salfur	0.53	0.53	0.30	0.16	0.40	0.11	0.25	0.17	0.36	0.12	0.13	0.35	0.10	0.36	0.90	0.32	0.21		
Oxgen	29.93	27.26	34.12	35.13	31.39	30.68	31.70	23.71	33.38	20.44	27.83	20.97	20.80	23.38	25.51	27.75	4.88		
Animal residue																			
Carbon																			
Hydrogen																			
Nitrogen																			
Chlorine																			
Salfur																			
Oxgen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Other(over 5mm)																			
Carbon	24.50	41.80	27.63	21.60	14.70	24.70	20.40	20.90		19.10	24.90	20.00			20.00	23.35	6.44		
Hydrogen	3.60	4.50	4.70	2.70	0.80	4.60	2.30	2.50		1.10	3.10	1.20			1.60	2.73	1.34		
Nitrogen	0.40	0.50	0.20	0.20	1.10	0.30	0.90	0.30		0.40	0.70	0.40			0.30	0.48	0.27		
Chlorine	0.07	0.15	0.17	0.16	0.18	0.12	0.22	0.11		0.18	0.07	0.16			0.19	0.15	0.04		
Salfur	0.13	0.61	0.60	0.05	0.86	0.15	0.08	0.09		1.12	0.62	2.74			1.20	0.69	0.73		
Oxgen	12.10	31.44	26.60	19.99	9.26	33.73	10.50	12.90	0.00	7.30	22.41	9.60	0.00	0.00	16.61	14.16	10.51		

Table 3-7/B Sampling and Separation Record (8)

Elementary analysis	No.1	No.2	No. 3	No. 4	No. 5	No.6	No.7	No. 8	No. 9	No. 10	No.11	No. 12	No. 13	No. 14	No. 15	Acerage	Deviat.	Acerage	Deviat.
Other(under 5mm)																			
Carbon	12.60	18.60	23.90	14.80	9.70	15.50		15.80						16.20	16.30	15.93	3.69		
Hydrogen	1.30	1.80	3.00	1.40	0.30	2.40		1.20						1.90	1.30	1.62	0.73		
Nitrogen	0.10	0.20	0.10	0.80	0.40	0.20		0.20						0.30	0.20	0.28	0.20		
Chlorine	0.08	0.17	0.18	0.19	0.11	0.14		0.09						0.14	0.23	0.15	0.05		
Salfur	0.05	1.68	0.80	0.03	0.14	0.05		0.10						0.36	1.93	0.57	0.70		
Oxgen	11.07	13.75	22.22	10.28	5.15	12.61	0.00	11.31	0.00	0.00	0.00	0.00	0.00	8.60	9.64	6.98	6.64		
Total																			
Carbon	22.90	22.95	28.80	36.01	10.25	21.81	24.27	20.09	2.85	16.21	30.48	13.25	36.47	24.87	23.01	22.28	8.78	23.39	6.86
Hydrogen	2.80	2.81	3.78	4.76	1.56	3.47	2.94	2.60	0.38	2.31	5.17	1.54	5.07	2.88	3.09	3.01	1.29	3.09	0.88
Nitrogen	0.38	0.29	0.31	0.41	0.23	0.28	0.39	0.18	0.02	0.24	0.88	0.17	0.50	0.20	0.28	0.32	0.19	0.31	0.07
Chlorine	0.09	0.03	0.03	0.05	0.03	0.03	0.04	0.04	0.00	0.03	0.08	0.02	0.02	0.01	0.08	0.04	0.03	0.04	0.02
Salfur	0.37	0.24	0.26	0.26	0.07	0.05	0.14	0.15	0.01	0.08	0.14	0.33	0.10	0.10	0.54	0.19	0.14	0.19	0.10
Oxgen	22.10	12.88	18.89	26.23	7.34	15.82	16.55	14.04	1.25	7.67	18.90	8.20	15.01	15.21	15.37	14.36	6.09	16.73	5.42
Total	48.64	39.20	52.07	67.71	19.47	41.47	44.34	37.10	4.52	26.54	55.65	23.50	57.17	43.26	42.37	40.20	15.72	43.75	12.88

3.6 Existing Disposal Sites Conditions

3.6.1 Suhudol Site Geology and Locational Hydrogeology

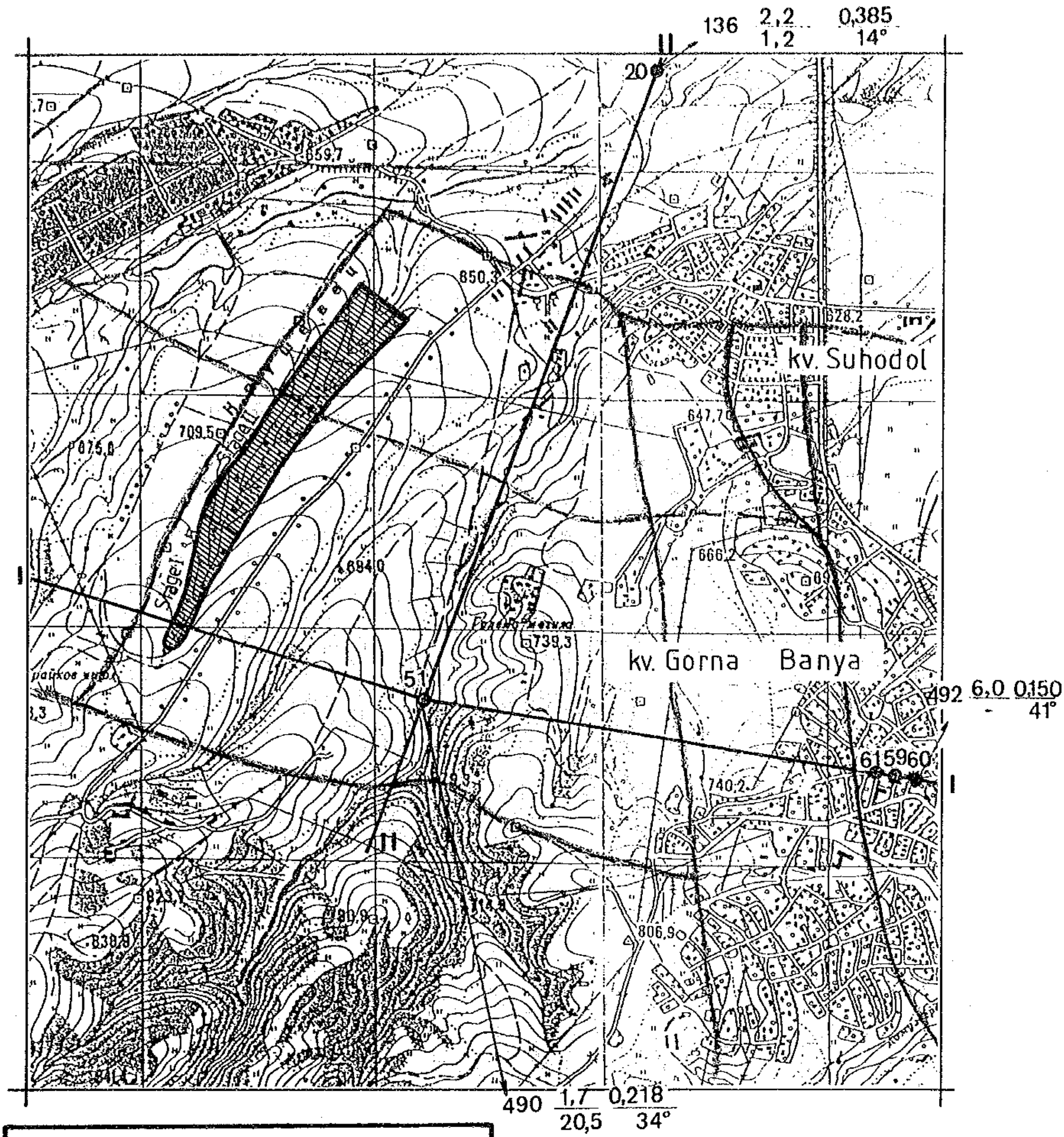
Studies of the General area and particular locational geological and hydrogeological regimes are based on existing data and local expert opinion. (Figures 3-5 and 3-6 refer).

The geological structure of the area is that of diluvial clay, which lies on andesit tuffs and tuffobreccia of senonian age. The deluvial layer is some 6 to 8 m thick and comprises clay-ash or ash-sand which in some places is mixed with gravel. In some places no clay-andesit tuffs appear, and in some places the thickness is over 15 m. It is typical of this area that the depth of the layers on the slopes is greater than the thickness in the centre of the valleys.

Senonian andesit tuffs and tuffobreccias thickness is over 500 m. The upper most layers (on the surface or immediately under the deluvial clay) are considerably creviced and weathered. The tectonic structure of the region is rather complex. Having several faults the andesit tuffs are divided into some blocks with differing declinations and elevations. The blocks in the Sofia plain are covered with pliocene sediments. In some of these faults and accompanying deep tectonic fissures; thermo-mineral water circulates. Gorna Banya, Knyazhevo and Bankya thermal springs are connected with these fissures.

Water connected to senonian andesit tuffs and tuffets is interesting from hydro-geological viewpoint. Surface water infiltration is fed to the lower strata via fault planes either directly or from perched water held over the upper diluvial clays. Part of these waters travel in shallow weathered fissures and on the slopes or within the valleys and discharge as springs with small and rather changeable flow rate of 0.1 to 0.5 l/sec. The balance of these waters in this area infiltrates slowly down to the deeper strata and eventually is thought to be an ultimate supplier of the lower level water bearing structures which feed the Sofia thermomineral springs.

It is for this reason that these ground waters are considered particularly 'sensitive' and why no infiltration of waste waters from Solids Waste Dumps or other gross polluters into or over the andesit tuffs and tuffo-breccias is considered admissible.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20
kv. Suhodol
kv. Gorna Banya
51
492 6,0 / - 0,150 / 41°
615960
490 1,7 / 20,5 0,218 / 34°

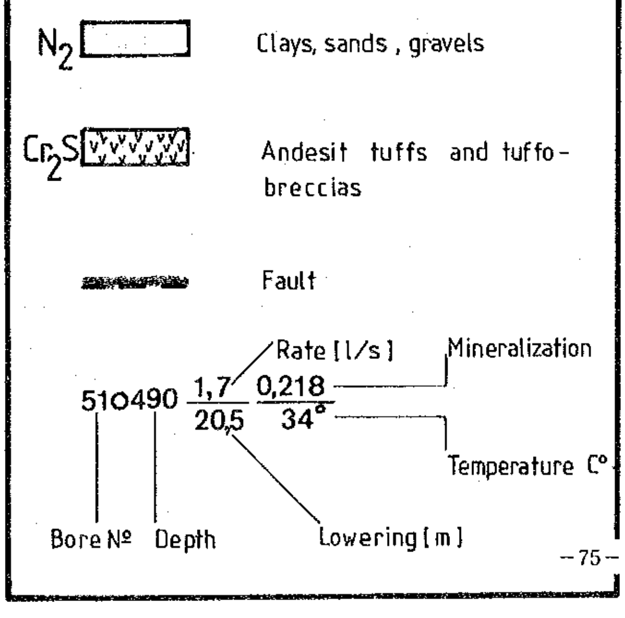
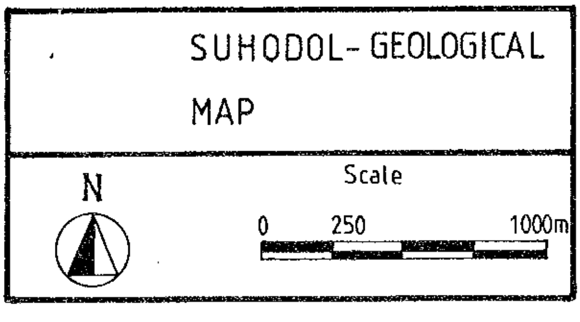
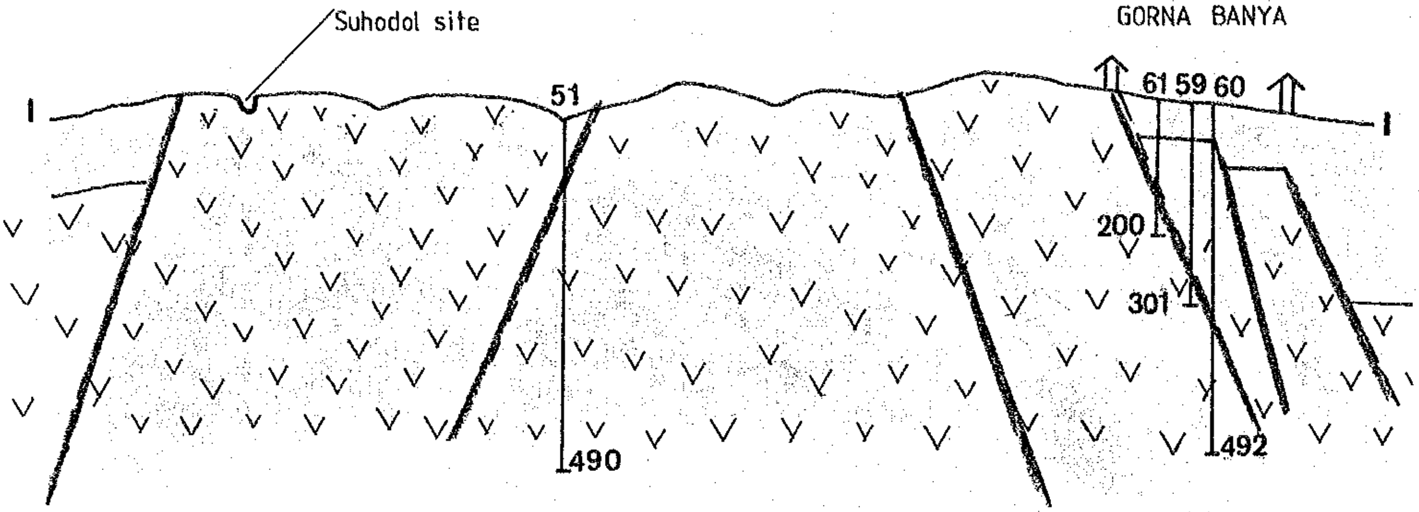

N2
Clays, sands , gravels
Cr2S
Andesit tuffs and tuffo-breccias
Fault
Rate [l/s]
Mineralization
510490 1,7 / 20,5 0,218 / 34°
Temperature C°
Bore №
Depth
Lowering [m]

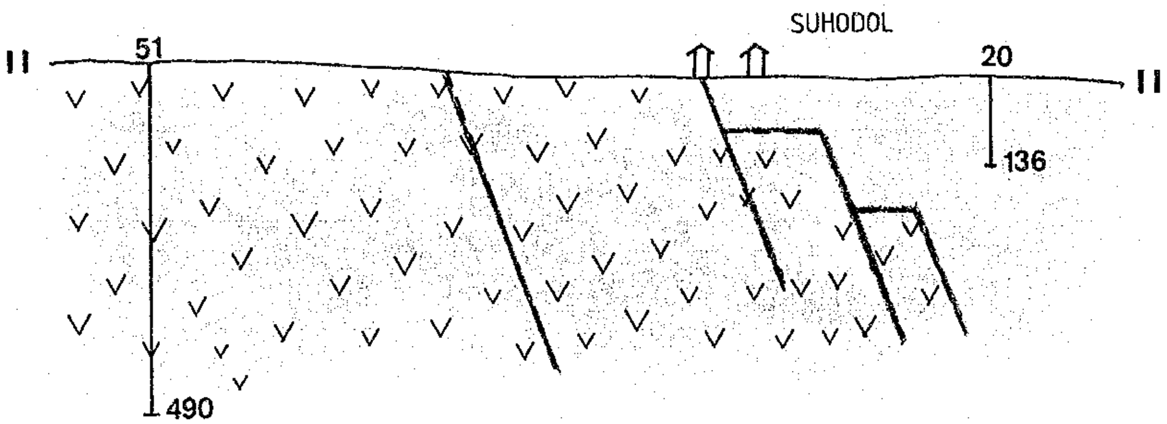
Figure 3-5


SUHODOL-GEOLOGICAL MAP
N
Scale
0 250 1000m

GEOLOGICAL SECTION I-I



GEOLOGICAL SECTION II - II



Clays, sands, gravels	
Andesit tuffs and tuffo - breccias	
Fault	

Figure 3-6

SUHODOL- GEOLOGICAL SECTIONS

SCALES

Length 0 250 1000m

Height 0 10 50m

1) Physical composition (Wet base and dry base)

Winter survey result shows a high content of non-combustible components, specially glasswork and cinder. Differences between both surveys are as follows:

a. Percentages of paper and textile in winter are lower and putrecsible matter is higher.
b. Percentage of combustibles is summer is higher.
c. Percentages of cinder and non-combustibles in winter are higher.

2) Moisture, Organic and Ash content

Moisture content result of the winter survey is only 35% in average, although the same survey's average of residential area is 40%, which is less than the summer survey' corresponding figure. Ash content result in winter is very high and more than that of the summer survey.

3) Elemental Content

According to average elemental analysis results, organic matter of solid waste in Sofia consists of:

Carbon	55.9%,	Hydrogen	7.5%,	Nitrogen	0.8%
Chlorine	0.1%,	Sulfur	0.5%,	Oxygen	35.2%

4) Lower Calorific Value

Lower calorific value was measured by each component and was also estimated by several methods. Lower calorific value of solid waste in Sofia is 1,200 Kcal/kg in average.

Because of the lack of special investigations for water permeability and filtration properties of the andesit tuffs and tuffo-breccias in the area of the Suhudol Waste Disposal Site the Study referred to historical data recorded in relation to deep bores in the area sunk for other purposes.

These bores are shown located in Plan in Figure 3-5 and the geological structure broadly illustrated in Figure 3-6.

Reference is made to past borehole results; No 51 shown located in Figure 3-5 is entirely in the andesit tuffs. The depth is 490 m. A pump discharge test produced a flow rate of 1.7 l/sec with a drawdown of some 20.55 m indicating a specific flow rate of 0.08 l/sec/m. The depth of borehole No 45 is 675 m. In the first 210 metres no pliocene deposits were encountered but the depth of the andesit tuffs and tuffo-breccias was passed. The results from the pumping tests were: flow rate 1.6 l/sec. with a drawdown of 67.1 m and an indicated specific flow rate of 0.02 l/sec/m. Water permeability was determined to be approximately 2 to 8 sq.m/24 hours and the co-efficient of infiltration is 0.004 to 0.017 m/24 hours. Bearing in mind that both boreholes were sunk for mineral water borehole exploration purposes and were located specifically in the region of tectonic zones and faults, the findings indicate that water permeability of the andesit tuffs and tuffo-breccias is low and direct pollution of groundwater is unlikely. (Indirect pollution risks are referred to above).

Regarding the upper perched surface flows in the deluvial clays: the quantities are low and usually seasonal. Observed surface wet spots are generally connected with fissure water in the andesites, covered with clays with low permeability properties (a filtration coefficient of lower than 0.1 m / 24 24 hours).

A site-specific investigation for the 2nd stage works was undertaken by Vodokanal for the purposes of prov hours).

A site-specific investigation for the 2nd stage works was undertaken by Vodokanal for the purposes of providing detail for detailed design. This report has been studied and referred to. It was based on previous work and supplementary bores were sunk in order to complete a pattern of some 30 boreholes in the valley.

The findings confirm the general nature of the foregoing area appraisal. Clay of permeability in the range 1 x 10E-8 to 10E-9 m/s was located on the valley sides with a depth of up to some 12m deep. Along the valley floor however the clay thickness thinned out to nil and was notably only 700 mm deep at the lower end or the 1st stage site.

Groundwater was reported as being between 0 and 1 m below the valley floor surface at the foot of the slopes and some 10 to 12 m below the surface at the higher levels.

From the study site observations, the groundwaters seem to be at surface level, with flows of water into and out of the valley leachate pipe 'enroute' (corrodible pipe with bad joints), possible flow into and out of the pipe trench and mixed spring waters, surface collections and leachate.

This discharge is therefore over the lower exposed over the Andesit Tuffs which, for the reasons outlined, should otherwise be carefully protected lest the contaminants work their way into the thermal spring aquifers. The Leachate quality is burdened with pollutants and must be isolated from all access to these strata.

3.6.2 Design Review of Suhudol 2nd Stage Extension

A preliminary study of the 2nd stage development was prepared in 1990, and as far as can be determined no alternative location was studied at that time.

For various reasons, (principally the high water table, thin clay layer and unstable slopes) the site is far from ideal but it is assumed that no available acceptable alternative had been identified at that time.

The study was based on accommodating 2,200,000m^3 of fill within the lower confines of the site in a single 'unicellular' development with a common leachate collection pipe from both the 1st and 2nd stages running down the centre of the original valley at the foot of the fill.

Two 'variations' were proposed for this extension. These are briefly reviewed:

Option A:
A single filling of municipal solid waste on top of a leachate drainage layer laid on top of the original clay deposit. Top soil was to be stripped off and where necessary the clay layer as to be reinforced to ensure a minimum clay thickness of 500 mm was achieved throughout the full length of the valley. No facilities were provided for final waterproof sealing of the surface, cellular monitoring or gas control.

Option B:
A similar mono-celled filling within a plastic lining laid on the valley sides and floor, internal drainage and gas collection and a sealed covering.

This design was based on single cell filling adopting full leachate isolation, layer filling and gas collection all which would accord with the intent of the current proposed regulations and modern Bulgarian design practice.

No provisions were made in either option to ensure:
- groundwater was lowered to acceptable levels
- groundwater quality monitoring was possible
- leachate from respective cellular portions could be separately monitored
- predesignated space allowance was made for site storage of adequate stocks of cover and drainage materials
- full provision for intensive peak traffic flow. Routine internal roads adjustment would be essential to ensure filling was confined to minimum face area(s) necessitated by controlled operations: The site roadworks should theoretically be capable of handling vehicles from the whole of the city. Some 500 vehicles offloading per day with intensities of a peak of over 100 vehicles arriving per hour.

At the request of the Steering Committee the original 1991 2nd stage design was reviewed. The design was based on the least cost option presented: Option A above.

The review was completed in June 1993 and attempted to reflect the current siuation as seen at that time. It was drawn up to reflect the latest requirements of the proposed October 1993 waste disposal regulations. At SGM's suggestion, the review took the form of a semi-formal presentation and discussion with the investor, the designers and the contractor. Some 'notes' of some comments and observations were presented. Table 3-8 sets out these notes. They were intended to

Table 3-8 Points Noted in Review of Suhodol Extension
Observations and Notes Arising

1 Environmental

The previous Preliminary Study Report did not include a detailed environmental impact appraisal with an ecological survey.

However, the team's own (unfinished) Suhodol survey work to date has possibly determined red data listed organisms (plants and animals) at the foot of the valley.

It is therefore recommended that the design, construction specification and operating instructions be tempered to account for any risks to the ecology of the area until further or final results of the different surveys are available.

2 Roads and Service Area

Permanent vehicle wheel washing facilities were not included in the original scheme. Consideration should be given to the inclusion of such a facility (see EC guidelines, Annex 1, Para 2).

The existing site internal road system is inadequate during wet weather when the operators have to abandon layering and can only tip down the steeper faces. During this period particular attention should be given to ensuring cellular covered working is achieved.

Consideration should be given to separating `in-out' routes : Suggest portable road matting / reusable precast concrete road panels.

3 Protection of Soil and Groundwater

Considerations of soil and groundwater protection were not expressed in the definitive engineering terms of the total permeability. The minimum currently required in Western Europe is 3 m of substratum of permeability $K = 1 \times 10^{-9}$ m/s.

4 Gas Control

Current regulations require this feature which is absent from the present proposals.

Vertical gas relief wells should be considered for installation in the first stage, particularly at the deeper end.

5 Seismic Conclusions

As the site is within a scale 9 seismic area the final arrangement and construction specification should be tempered to permit flexibility for movement. Instances of features which could be considered for incorporation include:

- Use of flexibly jointed pipes
- Replacement of unreinforced concrete pipes

- Use of compressible fill around pipe lengths entering structures : including short differential settlement pipe lengths

- Special measures at existing land slip areas

- Double layering of the valley floor isolation. I.e. 2 mm plastic sheeting (HDPE) and an engineered clay layer laid at optimum moisture content, site worked and supervised by a full time geotechnical engineer.

6 Existing Groundwater

Groundwater appears to be high at times and may have the potential for positive flow from the surrounding strata in to valley at floor level or through the valley sides.

In the absence of historic groundwater monitoring well levels, the designers may care to consider installing a groundwater drainage pressure relieve system throughout the length of the valley. This to ensure the water table cannot apply negative pressures to the valley sides or the floor.

At least 3 (and possibly 5) new groundwater monitoring wells or piezometer tip monitors should be constructed to facilitate monitoring of the water table levels/soil pore pressures.

7 Leachate Quantity and Temperature Monitoring

As it is generally desirable in the longer term to monitor the `water balance', leachate quantity and quality and the general activity in each cell of a land fill site, the team recommend :

- The establishment of a raingauge on site

- Monitoring the rate of leachate abstraction per `cell' of the site development

- Arranging the leachate collection pipework to enable flow measurements to be made

- Locating sample points immediately adjacent to each cell in order to monitor leachate temperature, gas content etc.

8 Gas Control

Gas control and ventilation facilities should be designed to accord with the current proposed legislation and international practice. Perforated HDPE pipe systems are commended.

9 Site Regulations

The construction contract (or other arrangements) should provide `as built' drawings so arranged as to enable site facilities to be established in order to locate and plan the day-by-day filling and pipe arrangements in a controlled engineered fasion.

Weekly updated engineering records should be maintained of the filling with references to pipes laid by the operators together with the exact location and elevation of all non-inert, industrial, medical and veterinary wastes received.

10 Cellular Development

The existing single monolithic extension is unusually large and will be difficult to maintain / monitor in its present size.

It is suggested that the future extension be split into 3 cells each with separate and independent under drains and leachate collection pipes.

11 Miscellaneous Technical Plants

- Bench works and levelling stations should be set up to facilitate longterm fill settlement monitoring.

- The Operators should be required to meet pre specified requirements (to ISO) regarding the installation of drainage and ventilation blankets, geotextiles, etc. This will require experienced site supervision, expert assistance to the contractor's staff, and tight standards of technical control.

- The construction contractor should be supervised on a full-time day-to-day basis by the representatives of the designers.

- The standards of all site materials should be pre-specified and test certificates issued by independent laboratories before acceptance on site.

- Liner sample welds should be inspected and all site welds tested by non-destructive testing by an independent authority (or the designers).
- All drainage material in the respective layers should be checked (sampled), sieve analyses regularly carried out on site and compliance with the specification certified as routine.

- Vent pipes to be HDPE, slotted.

- Drainage pipes to be class D (or 8 to 12 bar) uPVC, socket and spigot type and drilled.

12 Design and Arrangements

Design and Site Arrangements should be such that :

- The Operator maintains the site for 10 years after closure.

- The monitoring facilities are designed for 50 years' monitoring.

13 Design and Operational Standards

That a longterm view of the site technological requirements is taken and the EC standards adopted as an interim measure (until all full Bulgarian Requirements are developed).

A copy of an extract from the proposed EC guidelines are attached for reference.

14 Leachate Treatment

That the long term requirement be investigated now and the practicalities and economics of the following be considered :

- Tankering to sewer or for treatment;

- The treatment costs should be calculated in relation to the quantity of leachate collected and whether or not the fill is to be covered with a rain-excluding membrane. ('Dilute and disperse' or 'isolate and treat'.);

- Piping to the sewer.

15 Weighbridge

Weighbridges are usually installed to :

- Enable a charge to be made to private companies delivering waste for disposal;

- Assist the site manager in calculating his compaction factors, controlling the filling, monitoring total tonnages, etc.

At present the weighbridges are not being used for this purpose and the present records are of no obvious use to either the Municipality or the operator (the cleaning company).

Revised regulations are required on site.

16 Cover Material

No record of filling levels or cover material usage is kept and it appears that the site is hardly ever covered as per the current regulations.

New site storage aprons and facilities are required to ensure proper site stocks of cover material can be held at planned locations.

The municipality currently delivers huge quantities of suitable material to the area (across the access roadway). This should be properly used at the Municipal Site and facilities must be provided for its storage.

17 First Stage Leachate Containment.

Past water quality records indicate occasional gross pollution of the small stream in the valley. This appears to have arisen because of deficiencies in the First Stage leachate collection system.

In order to reduce the risk of first stage leachate build up and infiltration (to either the ground or surface water) we recommend that the first stage leachate collection system be redesigned and a replacement system installed in flexible non-corrodible pipework before the second stage site filling commences.

The following is commended for consideration :

(i) The design and installation of a new intercepting network of drains and UPVC pipes at the foot of the present solid waste, below any further first stage deposit and up to the edge of the second stage.

(ii) The removal of the first stage steel pipework (lest it bypasses the new work).

(iii) The construction of a new monitoring chamber for the first stage connected to new non-corrodible (not concrete) drains to the common leachate discharge point.

18 Operational Matters

In line with the advanced degree of operational technology required to operate (and supervise the operational contractor) the team recommend that the Municipality reinforce its technical staff with engineering supervisors to guide their operational subcontractor and ensure the technological requirements are met by providing skilled support to achieve.

- Maximum utilisation of Landfill volume

- Compliance with the regulations

- Supervision of the ongoing pipework and plastic membrane work

- Monitoring of cellular levels and drainage layer materials, covering materials

- Receipt of detailed weekly and monthly landfill reports

- Periodic recallibration of weighbridges, etc.

- Coordinating of Sampling and Monitoring of these and the older waste sites.

draw attention to specific points which could be considered by the design and construction teams. The original notes were in Bulgarian and were accompanied by a translation or relevant portions of the EC draft guidelines on landfill of waste and a copy of an English version of ETC 8 (Geotechnics of landfills and contaminated land).

3.6.3 Dolny Bogrov Site Geology

The general geological structure of the site is illustrated in Figure 3-7 and is shown in detail in Figure 3-8.

The underlying alluvial strata includes water bearing sand beds of high permeability. The Natural Water Table in the area is estimated to be some 1 to 3m below ground level and gravitating down to the water levels of the river Levsnovska passing alongside the site. At present the Irrigation station pumping maintains a substantially lower water table and appears to have done so since 1970.

In addition to this review of the general geological structure of the area, the Study undertook a limited exploratory Geotechnical Borehole, at a point shown located in Figure 3-8-3, Volume I of the Main Report.

The geological formations of the area are those of the alluvial deposit of the Lesnovska river: gravels, sands and clays with a total thickness of 30 to 40 m. which lie over thick pliocene deposits of mainly clays and sands.

The groundwater related to the operation of the Dolny Bogrov site are those accumulated in the alluvial deposits of the Lesnovska river and upper pliocene bedding.

Alluvial deposits are presented by graded gravels, different types of sands and clays total thickness of which is up to 30-40 m. Gravels and sands generally prevail when profiles are constructed. Clays are presented by different slices and interlayers but with a limited horizontal distribution permitting a general hydraulic interconnection of all the respective upper layers of sands and gravels.

The situation is similar for the higher layers of the upper pliocene beds and because of this the boundary with the overlying alluvial beds is not always distinguishable. That is why water bearing gravel-sand sublayers in the alluvial and in upper most parts of the upper layer of pliocene (50-60

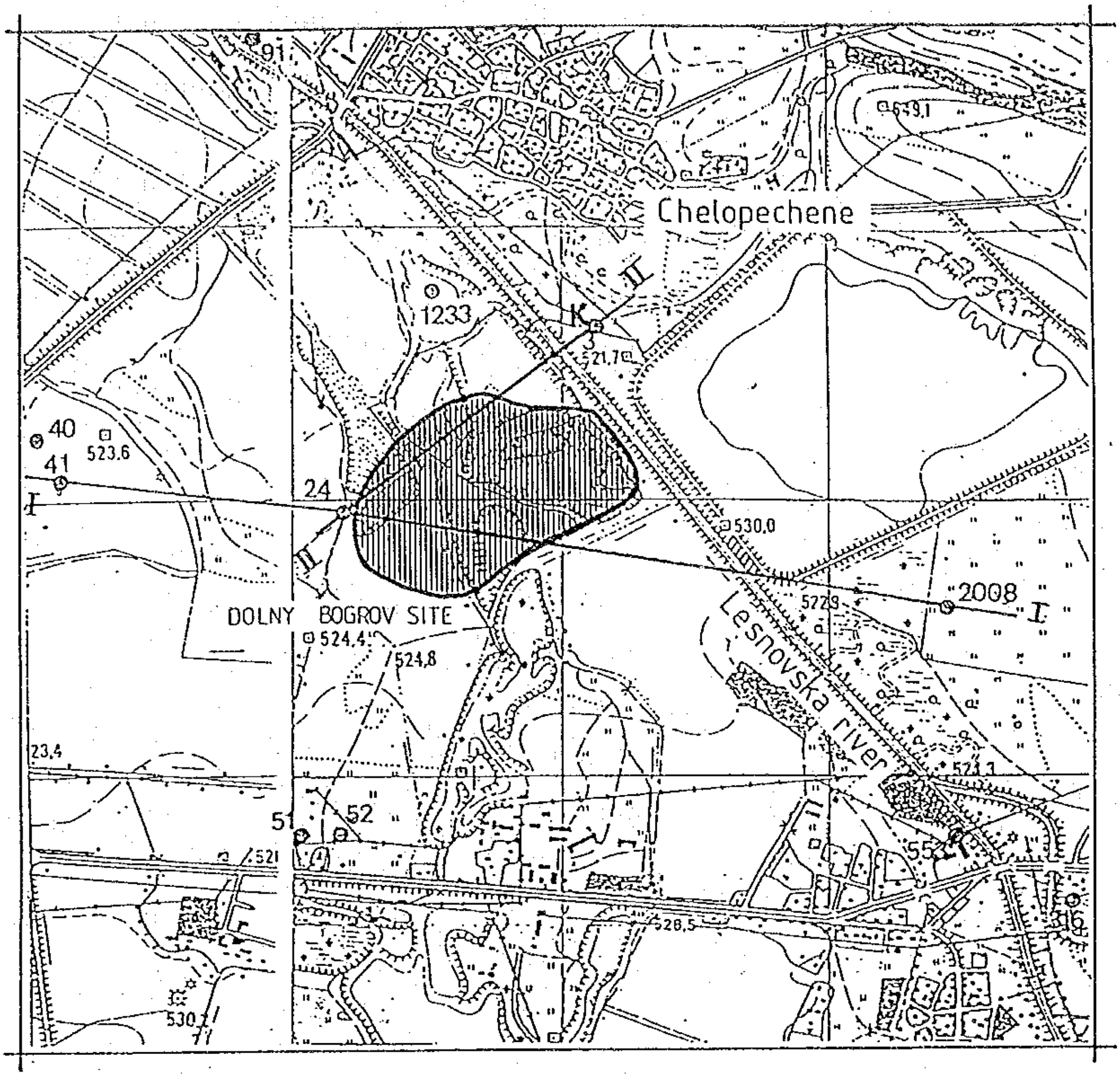


Figure 3-7

BORE WELLPOINT DATA								
Bore Nº	Depth m	Geol. age	Average water level m	Water flowrate l/s	Decrease m	Permea-bility m^2/d	Level transmi-ssion coefficient m^2/d	Remark
K-3	20	Q	0,50					
24	20	Q	3,35					
40	48	Q+N2	4,25	15,3	2,3	1070	$4,7\times10^4$	
41	46	$Q+N_2$	5,25	13,3	2,6	760	$5,0\times10^4$	
51	49	$Q+N_2$	1,46	27,8	2,9	289	$5,4\times10^4$	
52	48	$Q+N_2$	1,74	28,0	3,2	1456	$1,0\times10^4$	
91	44	$Q+N_2$	0,50	18,5	5,0	972	$8,7\times10^5$	
316	20	Q	1,38	13,3	2,0	825		
553	804	N_2	+ 10,1	4,5	9,2			mineral water t=46,5C
2008	20	Q	0,50				—	

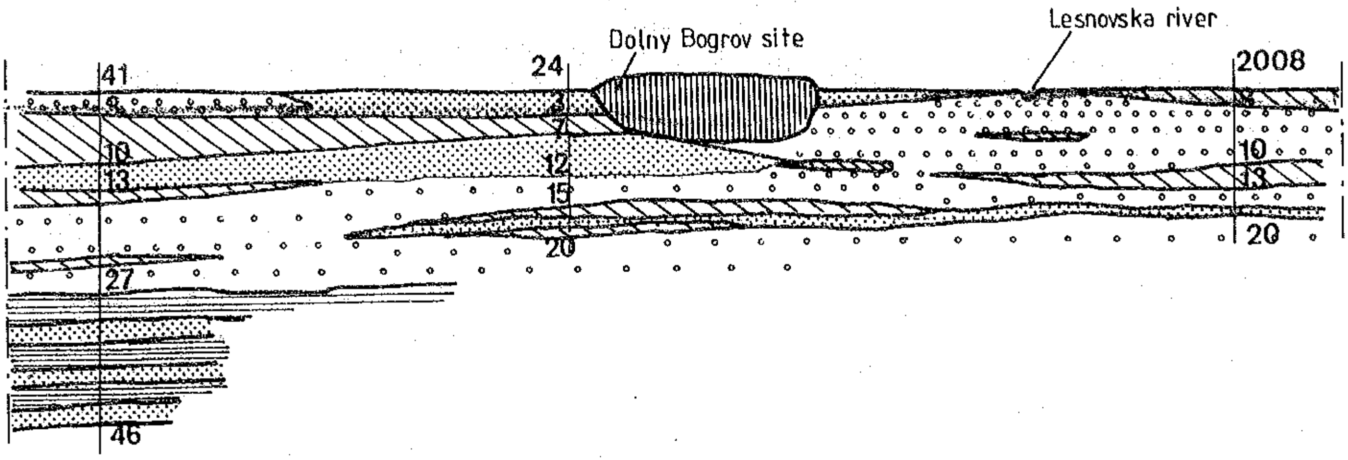
Dolny Bogrov - GEOLOGICAL MAP

Qal	Quaternary-Alluvial-Gravels, sands and clays
⊙	Bore Nº 51
I ——— I	Geological section I-I

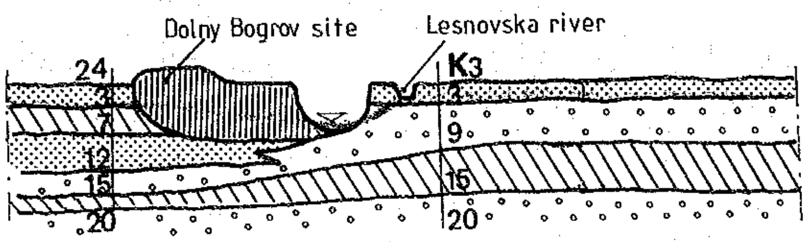
N

Scale 0 250 1000m

GEOLOGICAL SECTION I-I



GEOLOGICAL SECTION II-II



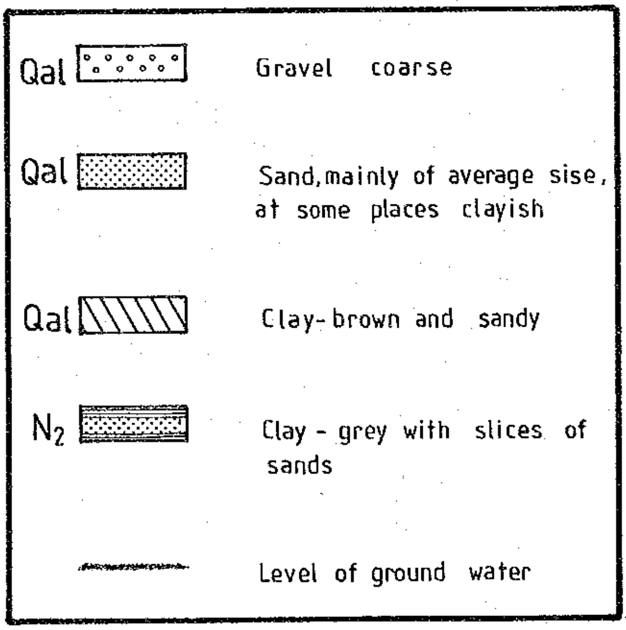
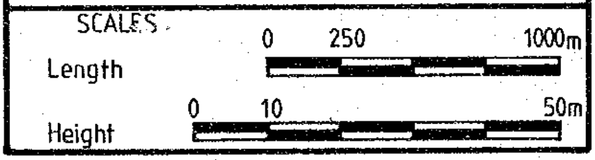


Figure 3-8

Dolny Bogrov-
GEOLOGICAL SECTIONS



m below the level of the terrain) form one general (common) water baring configuration with common zone of feeding and drainage, common levels for hydraulic inclination and regime. Water bearing horizon is without pressure. Direction of groundwater follows (generally) the inclination of the field - North-westwards. The natural (undisturbed) hydraulic gradient is about 0.0008.

Aquifer supply is from surface water infiltration, by the infiltration of the Lesnovska river (at high waters) and by the infiltration of the water of the irrigation channels.

Aquifer discharge and general groundwater drainage is to the Lesnovska river (at low waters), to the area's regional quarries and to wells under operation. Eg The Quarry 300 l/sec irrigation system supply. These draw-downs on the aquifer create the unfavourable conditions of a strong depression of the water table with the Waste Disposal Site sitting within the zone of accelerated water flow rate which exacerbates the distribution of the landfill leachate and the spread throughout the area of the contaminants.

Natural groundwater level in the Dolny Bogrov region are in the region of 1 to 2 m under the natural terrain (North-West sections are excluded).

Water bearing deposits in this region are some of the richest ones in the Sofia plain. 40 to 50 m deep boreholes readily provide a yields in the 30 to 50 l/sec range. The aquifer transmissivity is high at 760 to 1456 sq.m/day and the co-efficient of level transmission is within the range: 1.0 x 10 to 8.7 x 10 sq.m/day.

The hydrogeological conditions are most unsuitable for the accommodation of unmonitored, uncontrolled, unconfined uncontained landfill: The risks of the serious pollution spread are obvious and clear.

Infiltration co-efficient of the uppermost layers of the terrain (up to 1 m.) is around 0.5 to 5.0 m/day.

The natural chemical composition of groundwater is principally calcium carbonate based with a dry residue not exceeding 500-600 g/l & hardness in the range 12-14 deg. It is not corrosive to cement and concrete structures and is generally good for industrial water supply and irrigation.

In recent years however local hydro-geologists and monitoring laboratories report that their investigations indicate a declining tendency in the quality of groundwaters in the area with dry residues, manganese & oxidability and nitrates all at increasing levels. Poor water quality samples obtained at the "Tchelopechene" end of the quarry at monitoring station no. 1233 in 1985 are reported to be the first real 'evidence' quoted as illustrating the early effect of the groundwater contamination and its spread to the irrigation system.

The historical records of quality at this station and that of No. 316 are included in Tables 3-9 and 3-10.

Aquifer water quality monitored from a study sunk is briefly reviewed below and our ecological surface water study findings are separately reported.

Groundwater quality was monitored by prologued pumped extraction from within the lower aquifer by partially withdrawing the wellcasing and by appropriately arranging an internal screen.

The results were:

pH	7.6
Dry residue	3239
Permanganate Value	77.60
Chlorides	1349.00
Sulphates	102.67
Nitrates	5.0
Nitrites	Not Detected
Ammonia	0.3
Iron (total)	0.1
Manganese (total)	Not Detected
Calcium Oxide	392
Calcium	281
Magnesium Oxide	292
Magnesium	177
Sodium & Potassium	718
Hydro Carbonates (HCO3)	1068
Combined CO3	525
Free CO2	220
Tot Hardness mgeq	28.5
Carb Hardness mgeq	17.5
Perm Hardness mgeq	11.0

(All concentrations are in mg/l unless otherwise stated)

Table 3-9 Chemical Composition of Boreholes

1	Borehole No.	1233	1233	1233	1233
2	Borehole depth				
3	Aquifer				
4	Date of the probe	06. 1984	09. 1984	12. 1984	06. 1985
5	T° of the water				
6	Ph	7.30	7.50	7.65	7.30
7	Oxidizability	4.40	2.56	3.40	19.84
8	NH_3 mg/l	0.20	0.0	0.30	1.40
9	NO_2 mg/l	0.08	0.0	0.0	0.14
10	NO_3 mg/l	2.0	0.0	8.0	0.0
11	Mn mg/l	0.55	0.0	0.0	1.65
12	Fe mg/l	0.32	0.12	0.06	0.51
13	CO_2 mg/l				
14	Dry resedue mg/l	480.0	480.0	510.0	570.0
15	Mineralization mg/l				
16	Total hardness	14.58	14.14	14.28	15.98
17	Na+K mg/l				
18	Ca mg/l	66.13	66.13	68.14	86.17
19	Mg mg/l	23.10	21.28	20.67	17.02
20	Cl mg/l	31.90	31.91	33.68	99.28
21	SO_4 mg/l	155.30	164.15	159.25	35.40
22	HCO_3 mg/l	244.07	250.13	268.48	430.17
23	BSS 2823/75	No	No	No	No
24	Note				

BSS - Bulgarian State Standard 2823/75

Table 3-10 Chemical Composition of the Water in the Boreholes - Dolny Bogrov, Chuchaya Section - the Bridge of the Botevgrad Road

1	Borehole No.	316	316	316	316	316	316
2	Borehole depth	20.0					
3	Aquifer	Qal+dl					
4	Date of the probe	7.10. 1983	01. 1984	20.04. 1984	10.09. 1984	5.12. 1984	20.06. 1985
5	T^0 of the water						
6	Ph	7.45	7.30	8.13	7.50	7.40	7.35
7	Oxidizability	2.56	2.00	1.28	0.64	1.76	1.124
8	NH_3 mg/l	0.00	0.0	0.0	0.0	traces	0.0
9	NO_2 mg/l	0.035	0.04	0.02	0.06	0.14	0.19
10	NO_3 mg/l	50.0	3.0	2.0	4.0	6.0	5.0
11	Mn mg/l	0.0	0.11	0.0	0.0	0.17	0.11
12	Fe mg/l	0.26	0.32	0.16	0.26	0.07	0.24
13	CO_2 mg/l						
14	Dry resedue mg/l	289.0	400.0	382.0	312.0	425.0	410.0
15	Mineralization mg/l						
16	Total hardness	9.25	16.26	13.74	11.90	17.95	16.24
17	Na+K mg/l						
18	Ca mg/l	42.08	74.15	62.12	53.11	80.16	72.14
19	Mg mg/l	14.59	25.54	21.89	19.46	29.18	26.75
20	Cl mg/l	8.86	42.55	19.50	17.77	47.87	31.91
21	SO_4 mg/l	22.60	94.22	65.00	62.14	84.40	94.90
22	HCO_3 mg/l	216.62	253.23	362.40	237.97	280.68	262.38
23	BSS 2823/75	No	No	No	No	No	No
24	Note						

BSS - Bulgarian State Standard

The existence of this landfill is causing gross and direct contamination to an otherwise good quality and valuable faster flowing aquifer.

The choice of this particular location (within a reasonably fast flowing aquifer and in such permeable strata as found by the team) is most unfortunate.

3.7 Industrial Hazardous Waste

3.7.1 Hazardous Waste Quantities and Their Origin

1) General

The composition of a large range of hazardous waste that has been recorded during the first survey is now available.

Quantities of hazardous waste generated by petroleum companies and petroleum related services is not included in the related data in the Supporting Report.

Waste containing hydrocarbon residues generated by petroleum companies and petroleum related services, are given in Table 3-11 (e.g. petrol products and sludges from 1991 as well as some data on 1987 quantities). The 1991 data are more complete; a certain increase in the quantities can be observed.

Table 3-11 Quantity of Hazardous Waste Containing Hydrocarbon Components Generated by Petroleum Companies and Petroleum Related Services (m^3)

No.	Type of hazardous waste generated	1991	1987
1	From machine parks		
	- petroleum products	1,115	
	- sediments	1,956	
2	From local industrial treatment plants		
	- petroleum products	3,269	4,385
	- sediments	5,644	
3	From petroleum storages old petroleum products and sediments;	1,800	700
	annual production	240	180
4	From Municipal Waste Water Treatment Plant old petroleum products and sediments;	2,500	
	annual production	690	
5	Drilling oil emulsion	671	871
6	Used compressor oils	28	2,050
	TOTAL	17,913	8,186

The total of old petroleum products and sediments that are stored is about 4,300 m^3. The generation of petroleum products and petroleum sediments from petroleum companies and petroleum related services is 13,613 m^3 for 1991.

Quantities of petroleum products and sediments caught have been defined assuming that all machine parks and industries have their own local treatment plants and collect the petroleum products and sediments. In reality the annual quantities represent about 50% of the ones presented above due to the fact that many industries do not have treatment facilities. The petroleum products and sediments removed are usually deposited in the municipal waste disposal site or in other sites - ravines and the municipal sewerage system. Old petroleum products and sediments can be found only in the petroleum storage and the Municipal Waste Water Treatment Plant.

The drilling oil emulsion and the used compressor oils are not stored but deposited on various sites.

Since many economic and other changes are currently taking place in the car parks and the factories the annually produced quantities of petroleum products and petroleum containing sediments have to be updated.

If it is assumed that the quantity of hazardous waste containing hydrocarbon components generated by petroleum companies and petroleum related services in 1990 would be similar to that in 1991, the total quantity of hazardous waste generated in 1990 within SGM can be calculated. It would amount to about 52,712 ton, which does not include the total quantity of hazardous waste that is temporarily stored in different factories. This quantity is about 8,307 ton.

2) Waste Quantities in Some Plants and Factories Visited in May 1993

In May 1993 some plants on the territory of Sofia were visited for the survey of both periodically produced and stored industrial hazardous and non-hazardous wastes. Quantities of hazardous waste generated by these companies are given in Tables 3-12 to 3-15 below for 1992 and previous years, and some are compared with the quantities defined in 1990.

a. Petrol Joint Stock Company

Quantity of oil (plastic) bins sold by the State company Petrol keeps decreasing since several private gas stations have begun importing oil from abroad. Their exact quantity however is unknown. On average the forecast quantity is 75-80 t/yr of one liter and three liter plastic bins. Quantity of the discarded bins for the whole country is 350 - 400 t/year.

The exhaust oils are collected and transported for treatment to the plant in the city of Russe and they are practically reused. The stored petroleum sludge is incinerated (about 1,800 m^3) and at present there are about 500 m^3 of petroleum sludge in the Petrol Tankfarm in Ilientsi.

Table 3-12 Quantity of Hazardous Waste Generated by Petrol Company

No	Types of waste generated by petrol	1989	1990	1991	1992	1993 (est)
1	Discharged oil 3 and 5 l. oil plastic bins incl. imported ones (t/year)	130.8	111	36.2	67.8	@70.0
2	Used oils t/yr, treated and reused	5000			@1000	@1000
3	Accumulated sludges in the petrol facilities		1400	1800 (incinerated once)		500

b. Sopharma State Owned Company

Sopharma production has decreased, so has the quantity of waste; however, the waste discharged periodically as well as resin contaminated waste have been transported and deposited at the Dolny Bogrov site.

Table 3-13 Quantities of Hazardous Waste Generated by Sopharma Company (m^3/year)

No	Types of hazardous wastes generated by Sopharma	1990 periodically discharged	1990 stored	1992 periodically discharged	1992 stored
1	Resins and lyes	350	1,050	137	n.a.
2	Contaminated vegetable waste	400	-	270	
3	Rubber hoses			20	
4	Alkali lye	7,300			
	TOTAL	8,050	1,050	427	

c. 6 Septemvri Company

This plant produces forklift trucks. It generates hazardous and industrial waste whose quantities are given in Table 3-14 below. This plant stores the greatest quantities of cyanide contaminated solid waste - the amount is 150 tons, with a sodium cyanide content between 0.3% and 5.3%

Table 3-14 shows reduced quantities of hazardous wastes, as there is a reduction in production of forklift trucks.

Table 3-14 Quantities of Hazardous Waste Generated by 6 Septemvri (m^3/year)

No	Types of hazardous wastes generated by 6 Septemvri	1990 periodically discharged	1990 stored	1992 periodically discharged	1992 stored
1	Cyanide containing sludge		150		150
2	Accumulator batteries	33			
3	Sludges from purification plants, paint and lacquer	407.2		149	
4	Compressor condensates	780		220	
5	Cooling emulsions	150		22	
6	Machine oil	3			
7	Polyethylene bags	1.4		2	
8	Metal cans containing alkide, paint and priming coat wastes	13.4			
9	Petroleum contaminated wood waste			10	
	TOTAL	1,388	150	403	150

Actual forklift truck production (1993) reaches about 2,600 units. It is assumed that after the economic situation in Bulgaria is stabilized production will reach its 1990 level of 30,000 forklift trucks and waste quantity will increase.

d. Sredets Company

Table 3-15 shows hazardous waste quantity generated.

Table 3-15 Quantities of Hazardous Waste Generated by Sredets Company (m^3/year)

No	Types of hazardous wastes generated by 6 Sredets	1990 periodic-ally discharged	1990 stored	1992 periodic-ally discharged	1992 stored
1	Compressor condensates	6		These data could not be found	
2	Cooling emulsions	20			
3	Cyanide containing salts	1.8	0.25		
4	Purification plant sludge containing:				
	- Cr 3+ 0.3 to 0.8%				
	- Fe 1.5 to 2.8%				
	- Zn 0.5 to 3.7%	366			
	TOTAL	393.8	0.25		

Forklift truck production has reduced and, consequently, have the generated quantities of industrial and hazardous waste.

The cyanide containing salts together with the pig iron pots are sent to the Pernik Metallurgical Plant where they are deactivated. The other waste is either deposited at the municipal dumping site or is discharged into the municipal sewage network.

e. Municipal Waste Water Treatment Plant

In addition to biological sludge, the Municipal Waste Water Treatment Plant in Sofia generates several types of waste. Retained floating substances - heavy oil fractions, petroleum products, oils and others - represent hazardous waste. Quantity of the stored petroleum products and sludges in the sand fields is about 2,500 ton (m^3), and the annually produced quantities amount to 690 ton (m^3), the tendency being towards reduction. These quantities do not include accidentally discharged heavy oil fractions and petroleum products.

In 1989 Eco Aqua Tech-Sofia issued a technological regulation on the expansion of the Municipal Waste Water Treatment Plant, which regulation also set the limit values on the quality of the incoming waste water.

In 1992 some tests were carried out on the old petroleum products and sediments from the Municipal Waste Water Treatment Plant with the following results :

- moisture	18.80%
- inorganic substances	4.04%
- organic substances	95.96%
- grain composition of minerals:	
- below 0.25 mm	3.20%
- 0.25 - 2.50 mm	19.80%
- above 2.50 mm	77.00%

In order to ensure degree of waste water treatment necessary to enable their discharge into Iskar river, of the treated waste waters to enable them to be reused as irrigation waters, the sediments as fertilizers, and not overload the treatment processes, the content of some heavy metals, extractable substances and petroleum products in the waters reaching the Sofia Municipal Waste Water Treatment Plant were set as follows :

Cu-	< 0.600 mg/l
Zn-	< 0.950 mg/l
Pb-	< 0.400 mg/l
Cd-	< 0.015 mg/l
Cr(6+)-	< 0.200 mg/l
Ni-	< 0.150 mg/l
Mn-	< 0.300 mg/l
Co-	< 0.095 mg/l

extractable substances - < 10 mg/l
petroleum - < 4 mg/l
products (included in extractable substances)

Polluted waters at the plant input plant were sampled on May 25 and 26, 1993, every 15 minutes for 24 hours continuously. Mean values of the indicators are given in Supporting Report. It should be noted that at the time of sampling there was some short but intensive rainfall in the Sofia area which may have influenced the quality of incoming unpurified waters.

Previous studies on waste water qualities in 1987 and 1988 show Pb and Zn concentrations exceeding the set limits. These concentrations were respectively 0.5 mg/l and 1.1 mg/l. Concentration of the other heavy metals was higher than those measured in the 25 - 26 May 1993 sampling, but still below the standard limit.

It can be seen from from data provided in the Supporting Report that heavy metal content in untreated waters is not high which can be accounted for in two different ways -

dilution with precipitation waters and a reduction in industrial waste waters, since many plants operate below normal capacity while others have been completely closed down.

3.7.2 Industrial Waste Treatment Methods

1) Non-hazardous Waste Treatment

Apart from disposal to landfill (as at present is contracted with Chistota Company) industrial waste recycling is generally the most effective means of treatment from the point of view of waste volumes reduction and more effective use of resources. The following describes some simple techniques of non-hazardous waste treatment and recycling.

(1) Sorting

Sorting techniques are generally applied in combination with crushing techniques for the following purposes:
- Extraction of valuable substances (reusable)
- Separation and collection of valuable substances and organic materials immediately prior to recycling
- Separation of combustible and non-combustible materials from mixed wastes as pretreatment in landfilling and incineration
- Separation and collection of valuable substances

(2) Compression and Cutting

Compression processes for various types of industrial waste ensure reduction in waste volumes, which is one of the objectives of immediate treatment.

(3) Destruction and Crushing

Destroying and crushing processes reduce industrial waste volumes and meet one of the requirements of immediate treatment. They also comprise an effective pretreatment method in the filling-up operation.

(4) Dehydration and Extraction

Dehydration is mainly applied to sludge.

In chemical engineering, the term "extraction" means a process of dissolving and separating soluble components contained in a solid or liquid raw material.

(5) Drying and Concentration

To dry wastes is to evaporate and separate water from wet wastes and reduce the residual water content. Drying reduces their volumes and stabilizes their states.

(6) Thermal Decomposition

Thermal decomposition is also called dry distillation and is applied to treatment of cellulose and plastic organic substances. It is a chemical reaction in which these substances are heated in anaerobic conditions, so that their molecules are decomposed into smaller ones.

(7) Incineration

Incineration is a process of converting organic waste into a large amount of stable oxidized gases and a smaller amount of stable inorganic substances, by oxidizing them at a high temperature in a gaseous atmosphere. It also affects their volume by reducing it. In addition, the high temperature exhaust gases obtained from combustion provide thermal energy that can be collected as steam, heating water and electrical power from thermal generation by means of heat exchange. The accompanying flue gases have to be cleaned in an appropriate facility before discharging into the atmosphere.

(8) Composting

Compost is a kind of fertilizer made from organic substances. Organic substances present in wastes and other raw materials are decomposed into carbon dioxide, water and heat as microbes activate metabolism (fermentation of organic materials) under presence of water and oxygen (aerobic conditions). The energy required for microbes to live is supplied through biological oxidation of carbon. Phosphoric acid, nitrogen, potassium in the form of K2O and other organic salts are produced at the same time out of dead animals and vegetables as final products of metabolism. These products represent the fertilizing components contained in compost.

2) Treatment Methods of Medical Specific Waste

Medical specific waste (to be distinguished from the household waste part of hospital residues), being hazardous to the environment and to people because of its composition, has to be treated before its disposal. The most important treatment methods of medical specific waste are:

- Steam treatment and landfill
- Micro wave treatment and Landfill
- Steam treatment and incineration as household waste
- Incineration as hazardous waste

3) Hazardous Waste Treatment methods

(1) Treatment Methods

In order to eliminate hazardous potential in hazardous waste and to meet the objective of directing waste substances towards the appropriate disposal method, all organic waste should undergo thermal treatment. Through such treatment the highest possible volume of organic constituents are converted into carbon dioxide and water.

A further aim of hazardous waste thermal treatment is to reduce the initial volume, which can be cut down to 15 - 20%.

(2) Chemical and/or Physical Treatment

These processes take place according to the following principle: the toxic compounds are decomposed using physical and/or chemical means (heat, catalysts, special reagents, etc.); the elements obtained, which are still toxic, are directed to other chemical agents with which they can combine to form in noxious and easily disposable products, or else the toxic elements are collected and treated in a thermal process.

The most important examples for such processes are:

- Chemical/thermal decomposition
- Perchlorination
- Dechlorination
- Oxidation process
- Photolysis and radiolysis
- Solvent extraction

(3) Biological Processes

In these, microorganisms such as bacteria or special fungal types are used in order to degrade organic poisons.

Biological treatment is limited to a few types of hazardous waste and is not essential for the disposal of hazardous wastes in general.

Some examples of this type of process are:

- Biological decomposition by fungal putrefication agents
- Physical microbiological regeneration of contaminated soils

4) Thermal Processes

Thermal processes operate on the principle that no organic compound can be preserved under the following three conditions: Temperatures over 1000°C, a certain Time Period during which an organic compound is subjected to such temperatures, and the Turbulence giving rise to an even temperature profile in the flue gas stream preventing the formation of colder flue gas streams and promoting the conversion of the freed carbon and hydrogen atoms into CO_2 and H_2O as completely as possible. The other elements obtained from the previously strongly toxic compounds but still toxic in their elementary form, such as Cl, F, Hg, Cd, etc., are transported with the flue gas stream and have to be eliminated in the flue gas cleaning systems downstream of the incinerator. In view of this it becomes clear why toxic waste disposal by thermal processes can only be successful if it is combined with an effective and efficient flue gas cleaning process.

The major currently available thermal processes can be divided into three categories:

- Process for the combined treatment of solid, pasty and liquid wastes, for example:
  * Rotary kiln technology
  * Circulation fluidized bed firing
  * Incineration in molten glass

- Process for treatment of contaminated soils, for example:
  * Infrared continuous furnace
  * Electric reactor
  * Photolysis
  * Circulating fluidized bed firing

- Processes for treatment of contaminated or toxic liquids, for example:
  * Plasma waste process
  * High-turbulence reactor
  * Chemical-thermal decomposition
  * Photolysis

3.7.3 Categories of Hazardous Industrial Waste

The following Tables 3-16 to 3-22 define the categories of hazardous industrial wastes, components of the waste which render the waste hazardous, properties of the waste which renders them hazardous, quantities of industrial waste not containing harmful pollutants in 1990 and 1991, hazardous waste quantities generated and stored in SGM in 1990, and recent analysis of waste water at SGM sewage treatment plant respectively.

Table 3-16 (1)

CATEGORIES OR GENERIC TYPES LISTED ACCORDING TO THEIR NATURE OR THE ACTIVITY WHICH GENERATE THEM (*) (WASTE MAY BE LIQUID SLUDGE OR SOLID IN FORM)

ANNEX 1.A.

Wastes displaying any of the properties listed in Annex III and which consist of:

1.	Anatomical substances, hospital and other clinical wastes
2.	Pharmaceuticals, medicines and veterinary compounds
3.	Wood preservatives
4.	Biocides and phyto - pharmaceutical substances
5.	Residue from substances employed as solvents
6.	Halogenated organic substances not employed as solvents, excluding inert polymerized materials
7.	Tempering salts containing cyanides
8.	Mineral oils and oil substances
9.	oil/water, hydrocarbon/water mixtures, emulsions
10.	Substances containing PCBs and/or PCTs (e.g. dielectrics)
11	Tarry materials arising from refining, distillation and any pyrolitic treatment (e.g. sall bottoms, etc.)
12.	Inks, dyes, pigments, paints, lacquers, varnishes
13.	Resins, latex, plasticizers, glues adhesives
14.	Chemical substances arising from research and development of teaching activities which are not identified and/or are new and whose effects on men and/or the environment are not known (e.g. laboratory residues, etc.)
15.	Pyrotechnics and other explosive materials
16.	Photographic chemicals and processing materials
17.	Any material contaminated with congener of polychlorinated dibenzo-furan
18.	Any material contaminated with congener of polychlorinated dibenzo-dioxin

Table 3-16 (2)

ANNEX I.B.

Wastes which contain any of the constants listed in Annex II and having any of the properties listed in Annex III and consisting of:

19.	Animal or vegetable soups, fats, waxes
20.	Non-halogenated organic substances not employed as solvents
21.	Inorganic substances without metals or metal compounds
22.	Ashes and/or cinders
23.	Soil, sand, clay including dredging spoils
24.	Non-cyanidic tempering salts
25.	Metallic dust, powder
26.	Spent catalyst materials
27.	Liquids of sludges containing metals or Metal compounds
28.	Residue from pollution control operation (e.g. baghouse disks) except (29), (30) and (33)
29.	Scrubber sludges
30.	Sludges from water purification plants
31.	Decarbonisation residue
32.	Iron exchange column residue
33.	Sewage sludges, untreated or unsuitable for use in agriculture
34.	Residue from cleaning of tanks and/or equipment
35.	Contaminated equipment
36.	Contaminated containers (e.g. packing, gas cylinders, etc.)
37.	Batteries and other electrical cells
38.	Vegetable oils
39.	Materials resulting from waste collections from households and which exhibit any of the characteristics listed in Annex III
40.	Any other waste which contain any of the constituents listed in Annex II and any of the properties listed in Annex III

Table 3-17 (1)

CONSTITUENTS OF THE WASTES IN ANNEX I. B. WHICH RENDER THEM HAZARDOUS WHEN THEY HAVE PROPERTIES DESCRIBED IN ANNEX III (*)

Wastes having as constituents

C1	Beryllium, beryllium compound
C2	Vanadium compound
C3	Chromium (VI) compound
C4	Cobalt compound
C5	Nickel compound
C6	Copper compound
C7	Zink compound
C8	Arsenic, arsenic compound
C9	Selenium, selenium compound
C10	Silver compound
C11	Cadmium, cadmium compounds
C12	Tin compounds
C13	Antimony, antimony compounds
C14	Tellurium, tellurium compounds
C15	Barium compounds, excluding barium sulfate
C16	Mercury, mercury compounds
C17	Trillium, trillium compounds
C18	Lead, lead compounds
C19	Inorganic sulphides
C20	Inorganic fluorine compound, excluding calcium fluoride
C21	Inorganic cyanides
C22	The following alkaline or alkaline earth metals: Lithium, sodium, potassium, calcium, magnesium, in incombined form
C23	Acid solutions or acids in solid form
C24	Basic solution or bases in solid form
C25	Asbestos (dust and fibres)
C26	Phosphorus, phosphorus compounds, excluding mineral phosphates
C27	Metal carbonyls
C28	Peroxides
C29	Chlorates

Table 3-17 (2)

C30	Perchlorates
C31	Azides
C32	PCBs and/or PCTs
C33	Pharmaceutical and veterinary compounds
C34	Biocides and phyto-pharmaceutical substances
C35	Infectious substances
C36	Creosotes
C37	Isocyanites, thiocyanites
C38	Organic cyanides (e.g. nitriles, etc.)
C39	Phenol, phenol compounds
C40	Halogenated solvents
C41	Organic solvents, excluding halogenated solvents
C42	Organihalogen compounds, inert polymerized materials and other substances referred to in this Annex
C43	Aromatic compounds, polycyclic and heterocyclic organic compounds
C44	Aliphatic amines
C45	Aromatic amines
C46	Others
C47	Substances of an explosive character, excluding those elsewhere listed in this Annex
C48	Sulphur organic compounds
C49	Any congener of polychlorinate dibenzo-furan
C50	Any congener of polychlorinate dibenzo-dioxin
C51	Hydrocarbons and their oxygen, nitrogen and/or sulphur compounds not otherwise taken into account in this Annex

(*) Certain duplication in generic types of hazardous wastes listed in Annex I are international

Table 3-18 (1)

PROPERTIES OF WASTES WHICH RENDER THEM HAZARDOUS

H1	Explosive substances and preparations which may explode under the effect of flame or which are more sensible to shocks or friction than dinitrobenzene
H2	Oxidizing substances and preparations which exhibit highly exothermic reaction when in contact with other substances, particularly flammable substances
H3A	Highly flammable: - liquid substances and preparations having a flash point below 21o C (including extremely flammable liquids), or - Substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any application of energy, or - Solid substances and preparations which may readily catch fire after a brief contact with a source of ignition and which continue to burn or to be consumed after removal of the source of ignition, or - Gaseous substances and preparations which are flammable in air at normal pressure - Substances and preparations winch, in contact with water or damp air, evolve highly flammable gases in dangerous quantities.
H3B	"Flammable" liquid substances and preparations having a flash point equal to or greater than 21o C and less than or equal to 55o C.
H4	"Irritant": non-corrosive substances and preparations which through immediately, prolonged or repeated contact with the skin or mucous membrane, can cause inflammation.
H5	"Harmful": substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may involve lirnited health risks.
H6	"Toxic": substances and preparations (including very toxic substances and preparations) which, if they are inhaled or ingested or if they penetrate the skin, may involve serious, acute or chronic health risks and even death.
H7	"Cancirogenic": substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce cancer or increase its incidence.

Table 3-18 (2)

H8	"Corrosive": substances and preparations which may destroy living tissue on contacts.
H9	"Infectious": substances containing viable micro-organisms or their toxins which are known or reliably believed to cause disease in main or other living organisms.
H10	"Teratogenic": substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce non-hereditary congenital malformations or increase its incidence.
H11	"Mutagenic": substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce hereditary generic defects or increase its incidence
H12	Substances and preparations which release toxic or very toxic gases in contact with water, air or an acid
H13	Substances and preparations capable by any means, after disposal, of yielding another substance, e.g. a leachate, which processes any of the characteristics listed above
H14	"Ecotoxic": substances and preparations which present or may present immediate or delayed risks for one or more sections of the environment.

Notes:

1. Attribution of hazardous properties "toxic" (and "very toxic"), "harmful", "corrosive" and "irritant" is made on the bases of the criteria , laid down by Annex VI, part I A and part II B, of Council Directive 76/548/EEC of 27 June 1967 of the approximation of laws, regulations and administrative provisions related to the classification, packaging and labelling of dangerous substances (1), in the version as amended by Council Directive 79/831/EEC (2).

2. With regard of attribution of the properties "cancirogenic", "mutagenic" and reflecting the most recent findings additional criteria are contained in the Guide for classification and labelling of dangerous substances and preparations of by Annex VI, (part II D) to directive 67/548/EEC in the version as amended by Council Directive 83/467/EEC (1).

Test methods

The test methods serve to give specific name to the definitions given in Annex III.

The methods to be used are described in Annex V to Directive 83/467/EEC in the version as amended by Council Directive 84/449/EEC (2), or by subsequent: Commission directives adapting Directive 67/ 548/EEC to technical progress. These methods are themselves based on the work and recommendations of the competent international bodies, in particular the OECD.

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(1) OJ No 196, 16.8.1967, p.1. (2) OJ No 259, 15.10.1979, p.10.

Table 3-19

INDUSTRIAL WASTE NOT CONTAINING HARMFUL POLLUTANTS YEAR 1991 (tons)

	Waste art	Available at the beginning of the year	Received from other Co's	Produced generated	Inter-nal utilize	Delivered to other Co's	Ecolo-gical deac-tivated	Irrevo-cally lost	Available at the end of the year
1	Mining companies	199.069.685	0	1.514.195	0	138.380	0	0	200.445.000
2	Textile industry	1.880	1.202	366.326	0	359.602	0	5.222	4.584
3	Waste containing natural fibres	0	36	160	36	104	0	56	0
4	Waste containing synthetic fibres	0	0	0	0	0	0	0	0
5	Wood waste	210	0	695	6	595	0	298	6
6	Paper and carton waste	0	0	89	0	82	0	7	0
7	Textile industry	0	0	0	0	0	0	0	0
8	Chemical industry	5	0	133	30	41	0	63	4
9	Rubber industry	0	9	88	0	41	0	56	0
10	Glass industry	0	0	0	0	0	0	0	0
11	Ferrous metal working industry	0	0	110	0	107	0	0	3
12	Non-ferrous metal working industry	0	0	1	0	1	0	0	0
13	Building industry	108.681	0	31.540	3.750	5.120	0	25.660	105.691
14	Food industry	1	0	120959	0	12.564	0	383	13
15	Rest not containing harmful pollutants	988	144	2.752	395	1.244	45	1.126	1.074
	TOTAL	**199.181.450**	**1.391**	**1.929.048**	**4.217**	**517.881**	**45**	**32.871**	**200.556.876**

Table 3-20

INDUSTRIAL WASTE NOT CONTAINING HARMFUL POLLUTANTS YEAR 1992 (tons)

	Waste art	Received from other Co's	Produced generated	Inter-nal utilize	Delivered to other Co's	Ecolo-gical deac-tivated	Irrevo-cally lost	Available at the end of the year
1	Mining companies	0	1.514.195	0	138.380	0	0	201.670.354
2	Textile industry	0	304.469	280	194.263	0	10.455	107.065
3	Waste containing natural fibres	270	283	270	174	10	10	172
4	Waste containing synthetic fibres	0	67	0	0	0	38	26
5	Wood waste	211	160	230	28	0	110	3
6	Paper and carton waste	0	348	5	335	0	8	0
7	Textile industry	0	9	0	4	0	0	5
8	Chemical industry	44	86	61	1	0	62	10
9	Rubber industry	0	10	0	4	0	6	0
10	Glass industry	2.204	1	2.204	0	0	0	1
11	Ferrous metal working industry	0	743	68	649	0	0	26
12	Non-ferrous metal working industry	0	442	1	440	0	0	1
13	Building industry	0	28.405	500	3.485	0	20.782	109.374
14	Food industry	0	130315	3.473	9.499	0	195	161
15	Rest not containing harmful pollutants	0	962	29	330	0	35	1.642
	TOTAL	**2.729**	**1.668.105**	**14.121**	**296.121**	**10**	**31.701**	**201.888.840**

Table 3-21 (1)

Hazardous waste quantities generated, stored and reused on the Territory of Sofia Greater Municipality for the year 1990

No.	Index	Type of Wastes	Periodically discharged	Stored tons	reused tons
1	11108	Galvanic sludge containing copper and zinc	150	2,200	
2	11327	Salts containing cyanides	11.9	181	
3	12101	Battery acids	16.0		
4	12101	Inorganic acids - mixtures, acidic staining solutions	4,034	-	
5	12302	Alkaline mixtures from alkaline staining solutions	1,905		
6	12403	Cyanide containing concentrations	612		
7	12402	Chromium^{+6} containing concentrations	330		
8	12407	Sulphite lye		-	250
9	13101	Plant protection chemicals	-	76.3	
10	13306	Waste from the production of organic pharmaceutical preparations - alkaline lye	7,800	-	
11	13401	Waste from the production of alkaloids - resinified products	350	1,060	
12	14104	Used machine and turbine oils	245		
13	14103	Used motor oils	205	-	-
14	14102	Fuels (diesel) contaminated	22	-	22
15	14108	Used transformer oils	4.8	-	-

Table 3-21(2)

16	14304	Compressor condensates	1,365	-	-
17	15103	Halogenated solvents Tri-chlor-ethylene per-chlor-ethylene	 10 10		 10
18	15203	Acetone	12		12
19	15215	Mixed solvents, not containing halogenated organic solvents	5.2		
20	15403	Remains from paints and varnishes	99.2	21	
21	16102	Plastic containers with hazardous waste	15		
22	16203	Industrial waste from plastic production and processing	1.2		1.2
23	17101	Sediments from textile dyes, finishes and washing	30		
24	17203	filter membranes and sleeves containing organic contaminants	10	3	-
25	21202	Aluminum containing slags	40	60	
26	21207	Slag from other non-ferrous metal melts	20	-	20
27	21208	Dust from steel production	9,362		
28	21404	Foundry sand from cores	1,000	-	600
29	21405	Mineral remains from gas purification	6	400	-
30	22101	Hazardous waste in cans containing painting and lacquer wastes	15.5		
31	35104	Wooden waste and containers with hazardous, mainly inorganic impurities	91		

Table 3-21 (3)

32	36103 36104	Pulp and cardboard containers with hazardous organic and inorganic contaminants	135		
33	41101	Sludge from local industrial waste water treatment plants of which hydrooxidal	11,186 10,457		
34	Old hazar dous wastè	Old hazardous waste - mixed cyanides, arsenic, copper sulphate etc.		5.7	
		TOTAL	39,098.8	4,007	915

Table 3-22 (1)

Recent analyses of the waste waters at the inlet to sewage treatment plant in Sofia

No	INDICATORS	Measuring unit	Sample date 25.05.93	Sample date 28.05.93
1	Odour		decaying	decaying
2	Colour	mg Pt/l	40	30
3	pH		8.9	7.4
4	Alkalinity	mg eq./l	4.75	3.60
5	Acidity	mg eq./l	0	0
6	COD	mg/l	270	246
7	BOD 5	mg/l	153	100
8	Insoluble Subs. organic inorganic	mg/l	106 48 58	272 176 96
9	Dissoloved subs. organic inorganic	mg/l	428 144 284	352 194 158
10	Dry Residue organic inorganic	mg/l	534 192 342	624 370 254
11	Chlorides	mg/l	42.38	23.92
12	Detergents	mg/l	1.25	1.00
13	Nitrites (nitrite N)	mg/l	0.97/0.29	2.2/0.66
14	Nitrates (nitrate N)	mg/l	0.875/ 0.201	0.75/ 0.173
15	Total Fe	mg/l	0.51	0.35
16	Mn	mg/l	not det	ectable
17	Ca	mg/l	40.48	28.34
18	Mg	mg/l	12.28	11.52
19	Cd	mg/l	0.002	0.003
20	Pb	mg/l	0.010	0.020
21	Ni	mg/l	< 0.005	< 0.005
22	Zn	mg/l	0.160	0.150
23	Cu	mg/l	0.021	0.022

Table 3-22 (2)

24	Co	mg/l	< 0.005	< 0.005
25	As	mg/l	0.025	0.002
26	Cr(+6)	mg/l	< 0.01	<0.01
27	Extractable substances - fats and petroleum products	mg/l	26.02	27.30

CHAPTER 4

COLLECTION AND TRANSPORT MASTER PLAN ALTERNATIVES

4. COLLECTION AND TRANSPORT MASTER PLAN ALTERNATIVES

4.1 Time spent to reach treatment facility of disposal site

Alternatives 1a. and b., 3 and 4 offer intermediate treatment facilities or transfer stations which shorten vehicle traveling time to disposal site from some districts.

SGM is divided into 154 sub-districts and population data for each is known. This division was used and distances of each sub-district to candidate sites of facilities, ie Katina, Koriata and a location south-west of the city (hereafter S/W) were measured off the map. Arterial and major roads were considered suitable for collection vehicles and crossing the area located within the inner ring road was avoided, except for vehicles collecting waste there. The 154 sub-districts were then grouped into the 24 districts and average distances were computed. Speeds were estimated in the range of 45 kph.

Accordingly time spent to travel from the collection zone to destination (depending upon alternative) was calculated for each district. Assuming an 8 hour shift the possible number of shifts that can be achieved by a compactor vehicle and a hauled container vehicle were estimated by district. Table 4-1 shows the results for each alternative.

Table 4-1 Compactor Vehicle Trip Number/Shift in 2010

Dist.	Alt. 1	Alt. 2	Alt. 3	1993	Alt 2/ 1993	Dist.	Alt. 1	Alt. 2	Alt. 3	1993	Alt 2/ 1993
1.SRED	1.6	1.6	1.8	1.4	114%	15.MLDT	1.9	1.5	1.9	1.5	102%
2.KSEL	1.6	1.6	1.9	1.4	113%	16.STDN	1.6	1.5	1.8	1.7	90%
3.VAZR	1.6	1.6	1.6	1.2	135%	17.VITS	1.6	1.7	1.8	1.4	122%
4.OBOR	1.6	1.6	1.7	1.6	100%	18.OVKU	1.5	1.5	1.8	1.4	110%
5.SERD	1.6	1.6	1.6	1.3	126%	19.LYIN	1.6	1.6	1.6	1.7	96%
6.PODU	1.6	1.6	1.7	1.5	105%	20.VRAB	1.7	1.7	1.7	1.6	104%
7.SLAT	1.8	1.5	1.8	1.3	119%	21.NISK	1.6	1.6	1.6	1.5	109%
8.IZGV	1.8	1.6	1.8	1.6	99%	22.KREM	1.6	1.5	1.6	1.6	95%
9.LOZN	1.8	1.6	1.9	1.6	100%	23.PANC	1.6	1.3	1.6	1.5	87%
10.TRID	1.7	1.6	1.9	1.3	123%	24.BANK	1.4	1.4	1.4	1.5	92%
11.KPOL	1.6	1.6	1.8	1.8	90%						
12.ILIN	1.6	1.6	1.7	1.3	122%	Total	1.7	1.6	1.8	1.5	108%
13.NADZ	1.7	1.7	1.7	1.5	113%						
14.ISKR	1.9	1.5	1.9	1.6	96%	Ave Haul/trip(t)			5188	2622	198%

All alternatives offer an improvement in trip number/shift from present average of 1.5. It should be noted that present average is achieved under inefficient loading condition and relatively closer distances to the present Suhodol and Dolni Bogrov disposal sites. Alt. 3, where two transfer stations are provided shows the best trip number per shift.

4.2 Number of Collection Vehicles Required

Required vehicle number is calculated based upon amount of waste to be collected, number of possible trips that each vehicle can be operated in a shift and capacities of the utilized vehicles.

The procedure adopted to estimate the vehicle number in the years 2000, 2005 and 2010 can be described as follows:

- From total waste amount generated, waste to be collected per collection day (6 days/week) is calculated after removing waste to be separated at source.
- Waste amount is distributed over the 154 sub-districts.
- For each sub-district percentage of SCS collection and HCS collection is determined.
- Distances from each sub-district to proposed intermediate facilities and disposal site location are identified.
- Destination of each sub-district waste is determined (alternatives 1, 3 and 4), and trip lengths are estimated.
- Possible trip number per shift is calculated knowing time required on collection route and that to travel from collection route to destination and back, ie trip time.
- Required number of trips per shift for each sub-district is estimated knowing amount of waste to be collected at that sub-district and capacity of vehicle to be used.
- Number of vehicles are then calculated by sub-district.

From the above explanation it is apparent that locations of intermediate facilities (Alt. 1, 3 and 4) and which sub-districts are using them are two important factors in determining vehicle number required.

(1) Locations of Intermediate Facilities

Alternatives 1, 3 and 4 propose intermediate treatment facilities at the following locations:

- Alt. 1a: 1 Incineration plant at Koriata
  Alt. 1b: 1 Incineration plant at S/W
- Alt. 3 : 2 Transfer stations at Koriata and S/W
- Alt. 4 : 3 PCW plants at Katina, Koriata and S/W

Presently SGM uses two disposal sites located east and west at Suhudol and Dolni Bogrov. However under the master plan for disposal only one site, Katina has been selected as the new disposal site. This site is located north roughly 18 kilometers from the center. It was therefore decided to consider introduction of intermediate facilities and the effect that would have on collection and transport costs.

The use of Koriata for construction of intermediate treatment facilities has been approved in discussions with the Study Team and Counterparts. On the other hand, although it was decided to choose a second location south-west of the city, to be nominated by the counterpart team, no definite site was proposed. The Study Team then utilized available land use maps and determined a candidate site at a location near the Outer Ring Road in an area still to be developed.

(2) <u>Distribution of Districts by Facility</u>

The second step called for deciding which districts would be served by the intermediate facilities. Basically districts having distances to Katina longer than 20 km, and distance to Katina is more than 1.5 times the distance from the district to Koriata or S/W were considered for service by the intermediate facilities. Waste composition was also considered for Alt. 1a. and 1b.

Figure 4-1 shows the savings that may be achieved in transportation costs depending upon distances. The horizontal axis describes the difference in distance between the district and Katina and that district and the intermediate facility. For example in the case of (No.17) Vitosha, the distance to Katina is 26 km, while that to S/W is 5 km, ie a distance reduction of 21 km may be achieved. This in turn will reduce the vehicle operating costs (voc) by about 48%. For (No.6) Poduyane the respective distances are 19 and 11 km, ie a reduction of 8 km can be accomplished, and the cost will be reduced by about 20%. Twelve districts will be effected by the use of intermediate facilities, and overall the total voc may be reduced by about 14%.

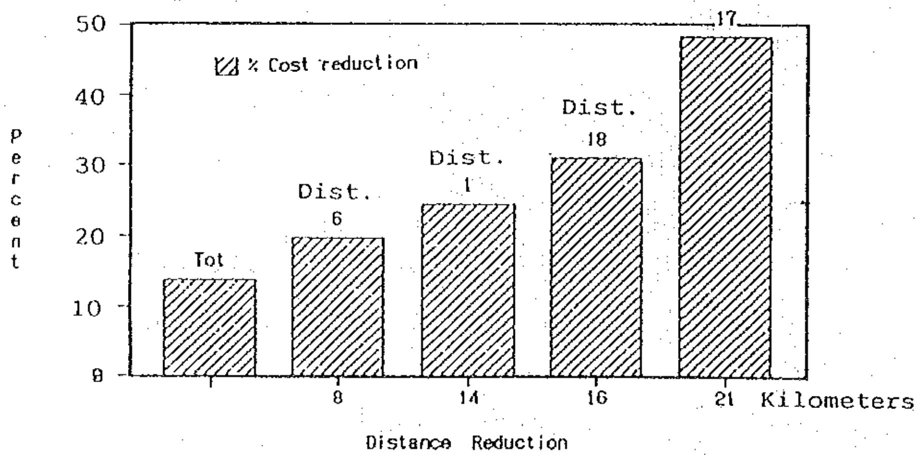

Figure 4-1 Cost Reduction in VOC

(3) Determination of Vehicle Number

In order to estimate required number of vehicles under each alternative for the years 2000, 2005 and 2010 it was assumed that waste collection organization would be trimmed down from the present 24 independent organizations (BKC) to a smaller number. The purpose is to ensure more efficient utilization of vehicles. For analysis purposes only the city was divided into 7 zones as shown in Figure 4-2. The division was made upon the following conditions:

- Existing district borders would be used to draw up borders of the zones with the exception of the central zone.
- Land use similarity in the zones.

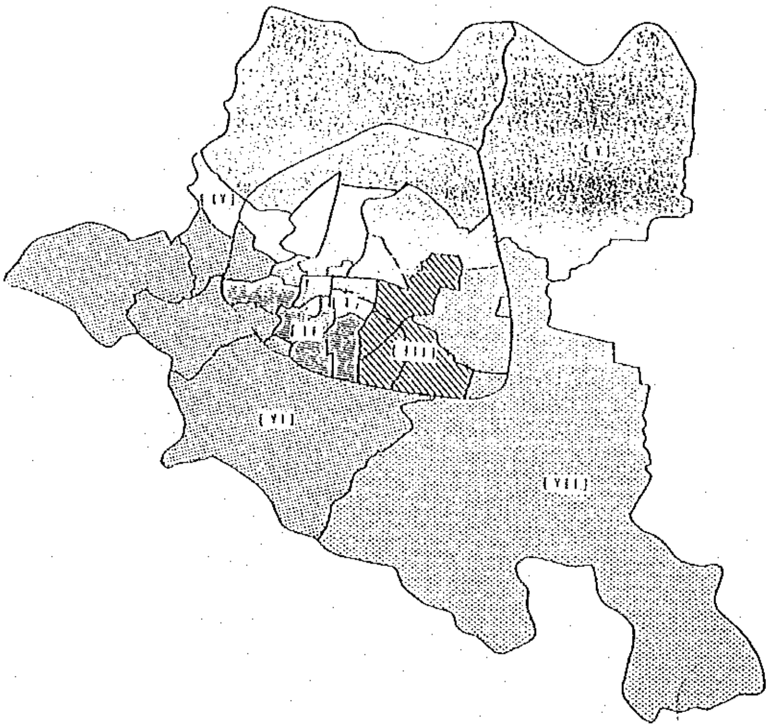

Figure 4-2 Division into 7 Collection Zones

Required vehicle numbers under the present 24 BKC companies were calculated and compared with vehicle requirements estimated for the seven zones. A reduction of 10 compactor vehicles and 8 haul container type vehicles was possible under the more centralized seven collection zones. This reduction in terms of cost savings is estimated to be US$ 1.46 million in 2010. Estimation is as follows:

(4) Cost Saving from Vehicle Number Reduction

a) Vehicle Number Reduced

-	Compactor	10 Vehicles
-	HC Type	8 Vehicles

b) Ave. Annual Operation & Maintenance Cost/Vehicle (Lv)

-	Compactor	
	Fuel/Oil	93,380 Lv
	Salary	292,455 Lv
	Deprecation	320,625 Lv
	Maint. & Repair	128,250 Lv
-	HC Type	
	Fuel/Oil	93,380 Lv
	Salary	93,305 Lv
	Deprecation	50,625 Lv
	Maint. & Repair	20,250 Lv

c) Savings in Operating Cost

-	Compactors	8,347,000 Lv	309,152 US$
-	HC Type	2,060,000 Lv	76,314 US$
-	Total	10,408,000 Lv	385,466 US$

d) Savings in Investment Costs

-	Compactors	25,650,000 Lv	950,000 US$
-	HC Type	3,240,000 Lv	120,000 US$
		28,890,000 Lv	1,070,000 US$

e) Total Savings in Costs (1000Lv)

-	Compactors	33,997,000 Lv	1,259,152 US$
-	HC Type	5,300,000 Lv	196,314 US$
		39,298,000 Lv	1,455,466 US$

Vehicles were estimated for each as outlined in the procedure described earlier and a contingency of about 5% was added to the vehicle number for each of the seven zones. Table 4-2 shows the required number of vehicles and trip/vehicle in the year 2010 by alternative.

As the table shows vehicles required under Alternative 3, at 130 compactors and 31 hauled container vehicles are the lowest.