C.5 Water Quality Survey

C.5.1 Objectives

The objectives of the survey are the following.

- to investigate the present situation of environmental impacts, which are caused by leachate generated from Cerro Patacon Final Disposal Site,
- to analyze causes of problems if those are found, and
- to consider counter measures against the problems in the M/P.

C.5.2 Survey Schedule

a. Number of Samples and Sampling Points

Number of samples was 9 in total. The number of samples and sampling points shows below.

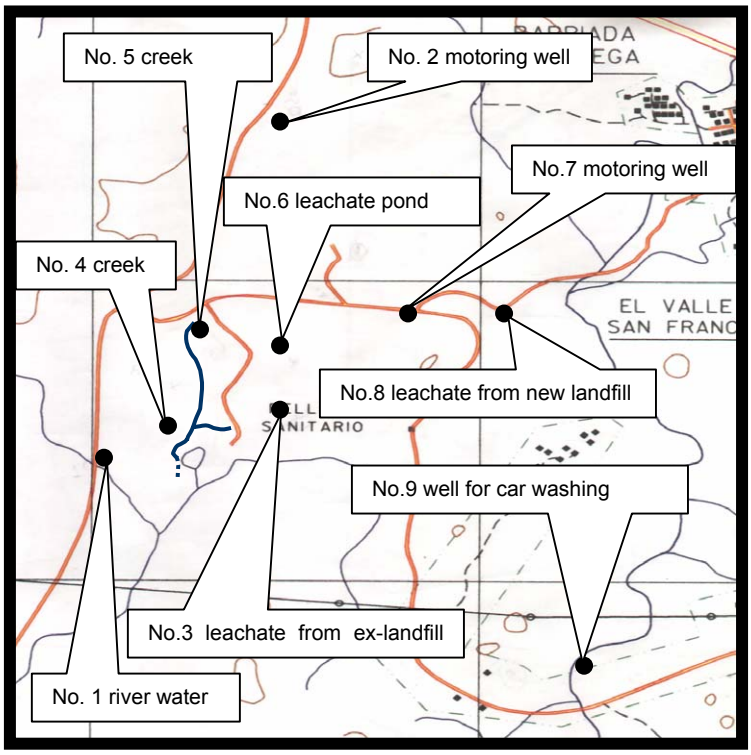

Figure C-7: Location of Sampling Point

Table C-64: Outline of the Sampling Point

Place of Sampling		Sampling Point	Coordinate
Leachate	Leacheate from the old dumping site	No.3	09º 03.06 North / 0.79º 33.99 West
	Leacheate discharge (actual)	No.8	09º 023.29 North / 0.79º 33.87 West
	Discharge from the oxidation pond	No.6	09º 03.19 North / 0.79º 34.02 West
River in which treated leachate is discharged	River in which the Leacheate is discharged (upper stream of the discharge point)	No.5	09º 03.17 North / 0.79º 34.04 West
	River in which the Leacheate is discharged (down stream of the discharge point)	No.4	09º 03.07 North / 0.79º 34.04 West
Natural River	Natural River close to Cerro Patacon's landfill site that flows from the Metropolitan Natural Park	No.1	09º 02.99 North / 0.79º 34.29 West
Groundwater	Car washing well	No.9	09º 02.74 North / 0.79º 33.81 West
	Monitoring Well, upper stream of the landfill	No.2	09º 03.53 North / 0.79º 34.02 West
	Monitoring Well, down stream of the landfill	No.7	09º 03.53 North / 0.79º 34.02 West

b. Construction of Monitoring Well

Before sampling, two monitoring well were constructed at upstream and downstream of the current landfill respectively on January 24 and 25, 2002.

Diameter of the wells are 6 inches, depths are around 10 m respectively.

c. Sampling

Sampling was carried out between January 28 and 30 at the designated points by the Study Team.

d. Analysis Items

Items analyzed were the followings.

Flow volume, groundwater level, temperature, pH, electric conductivity, turbidity, color, alkalescency, oil content, number of colon bacillus, BOD_5, COD, SS, ammoniac nitrogen, total nitrogen, major ions, total phosphorus, heavy metals (cadmium, cyanogen, lead, total chromium, hexavalent chromium, arsenic, total mercury, copper, zinc, iron, manganese), PCB

C.5.3 Survey Record

Results of the water quality analysis shows below table.

Table C-65: Results of Waste Quality Analysis(1)

Item	Unit	Leachate			River water			Groundwater		
		Ex-landfill	Present landfill	Pond	Discharge point		Natural	Car wash	Upper	Down
					Upper	Down				
		No.3	No.8	No.6	No.5	No.4	No.1	No.9	No.2	No.7
Flow Volume	L/seg	0.00003	0.32	-	0.4	0.4	0.8	-	<0.1	0.95
Groundwater level	m	-	-	-	-	-	-	-	0.52	3.0
pH		6.9	6.9	9.6	6.8	6.7	7.0	7.7	7.1	6.9
Temperature	ºC	27.5	34.4	28.9	25.3	28.3	25.0	28.3	28.9	29.9
Conductivity	µS/cm	4130	9120	1255	1172	2140	287	696	1070	4590
Suspended Solids	mg/L	227.2	42	84.4	3.6	38.8	0.8	5.2	30.8	31.6
Turbidity	NTU	321	89.2	164	4.06	46.9	1.1	6.0	20.4	13.5
Color	PtCo	1638	1858	108	35	76	6	0	1	98
Alkalinity	mg/L	453	3192	199	434	440	140	313	302	735
Oil Content	mg/L	1181.0	28.0	434.0	36.0	13.0	14.0	17.0	2.0	35.0
Fecal Coliforms	cfu/100ml	12500	4750	6	20500	2400	520	0	95	30500
Total Coliforms	cfu/100ml	19500	51000	22	54000	5650	755	0	285	250000
BOD_5	mg/L	32.0	762.1	15.7	6.1	36.3	20.5	0	6.8	22.9
COD	mg/L	35.4	1009	20.9	4	54	25	0	0	37.5
Ammonia Nitrogen	mg/L	33.0	491.4	<5.0	8.1	7.8	<5.0	<5.0	<5.0	7.1
Total Nitrogen	mg/L	35.4	495.0	<5.0	9.0	8.2	<5.0	<5.0	<5.0	8.5
Na^+	mg/L	445.0	490	191.2	82.5	99.0	16.4	111.9	68.0	109.4
Ca^{2+}	mg/L	78.9	245.0	10.8	49.4	69.5	13.7	20.7	69	362.5
HCO_3^-	mg/L	553.8	3895.3	181.8	529.7	536.6	170.8	330.9	346.5	896.9
SiO_2	mg/L	31.8	40.9	17.7	29.5	55.7	50.5	50.6	31.3	83.6
Cl^-	mg/L	691.3	1181.7	254.1	141.8	336.8	53.2	59.1	100.4	756.3
P	mg/L	620.0	5616.0	365.0	35.0	194.0	79.0	25.0	37.0	92.0
Cd^{2+}	mg/L	0.018	0.035	0.008	0.010	0.017	0.005	0.012	0.008	0.035
CN^-	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pb	mg/L	0.35	0.30	0.26	0.24	0.35	0.21	0.22	0.33	0.23
Cr	mg/L	0.0021	0.0054	0.0030	0.0036	0.0018	0.0027	0.0024	0.0021	0.0017
Cr^{6+}	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
As	mg/L	0.0046	0.0021	0.0022	0.0033	0.0026	0.0024	0.0030	0.0048	0.0177
Hg	mg/L	0.0010	0.0011	0.0005	<0.0002	<0.0002	<0.0002	0.0010	<0.0002	0.0010
Cu	mg/L	0.262	0.038	0.013	0.015	0.025	0.022	0.025	0.020	0.047
Zn	mg/L	0.117	0.587	0.030	0.042	0.040	0.032	0.443	0.033	0.065
Fe	mg/L	15.720	8.195	0.113	0.420	7.890	0.115	0.063	0.552	0.595
Mn	mg/L	6.272	4.830	0.220	2.987	1.643	0.062	1.272	0.405	3.930
PCB's Aroclor 1016	µg/L	19.9	21.6	ND	ND	ND	ND	ND	ND	ND
PCB's Aroclor 1260	µg/L	41.5	24.8	ND	ND	ND	ND	ND	ND	ND

C.5.4 Findings

The survey was conducted only once in the dry season. The results obtained through this survey would be too limited to conclude the whole characteristics of water quality in this region. However, some environmental pollution was recognized at the river into which the groundwater and the leachate form Cello Patacon are flowing. This highly indicates the effect of the Cello Patacon Final Disposal Site.

a. Leachate

Sampling points for the leachate are No.3, 8 and 6. No.6 is the leachate pond. Since the leachate had not been supplied into the pond due to disorder of the pump, the leachate pond was left as a static pool during the survey. Therefore, No.6 did not really show the characteristics of leachate.

No.8 showed an appropriate water quality as leachate from the final disposal site. It is remarkable that some organic chlorine compound which seems to be PCB was detected at No.3 and 8. The origin is indistinct but is thought to attribute to buried materials. In this survey, PCB was detected only from leachate so that groundwater and surface water might be judged free from PCB. However, we cannot jump into a conclusion with this only one survey. Therefore, continuous observation will be needed in future.

b. River Water

Measurement of river water was attempted at three points. One is where there seems to be no effect of the Final Disposal Site (No.1). The other two points were at upper and down streams of the leachate pond outlet. The results at the down stream showed increases of;

- BOD and COD, indicators of organic pollution
- Chlorine ion concentration that seems to attribute to the leachate

These results, although the leachate pond is not currently functioning, are probably caused by sedimentation of pollutants at the riverbed after long-time discharge of leachate into the river. Additionally, a spring of water which presumably originates in Phase I discharges into the creek which might also contribute to water quality deterioration.

c. Groundwater

Groundwater samples were obtained from a well for car washing (No.9) and from two observation wells sunk at the upper and down streams of a reclaimed land which is currently under construction (No.2 and 7 respectively).

Well No.9 showed clean and normal water quality of the survey area. At well No.2 showed almost normal quality with some colon bacillus. On the other hand, well No.7 showed a high concentration of chlorine ion and many colon bacillus. Especially, chlorine ion is one of indicators of water pollution by leachate, so that well No.7 indicates a possibility of leachate contamination.

C.6 Traffic Volume Survey

C.6.1 Objectives

Traffic congestion is one of major problems, which Panama Municipality faces at present. It is said that the congestion decreases waste collection and transport work efficiency. Therefore, this traffic survey aims at investigating how the traffic congestion would affect the present transport work with quantified data. Results and findings will be good references for planning the transport system.

C.6.2 Survey Schedule

The survey was carried out at the intersection of Via Ricardo J. Alfaro and Ave. La Paz, Via Transistmica in Victoriano Lorenzo and Via Jose A. Arango in Santa Marta as follows.

- Intersection of Via Ricardo J. Alfaro and Ave. La Paz:

  25 Friday, 26 Saturday and 27 Sunday, January 2002 for 24 hours respectively

- Via Transistmica in Victoriano Lorenzo:

  1 Friday, 2 Saturday and 3 Sunday, February 2002 for 24 hours respectively

- Via Jose A. Arango in Santa Marta:

  2 Saturday, 3 Sunday and 4 Monday, February 2002 for 24 hours respectively

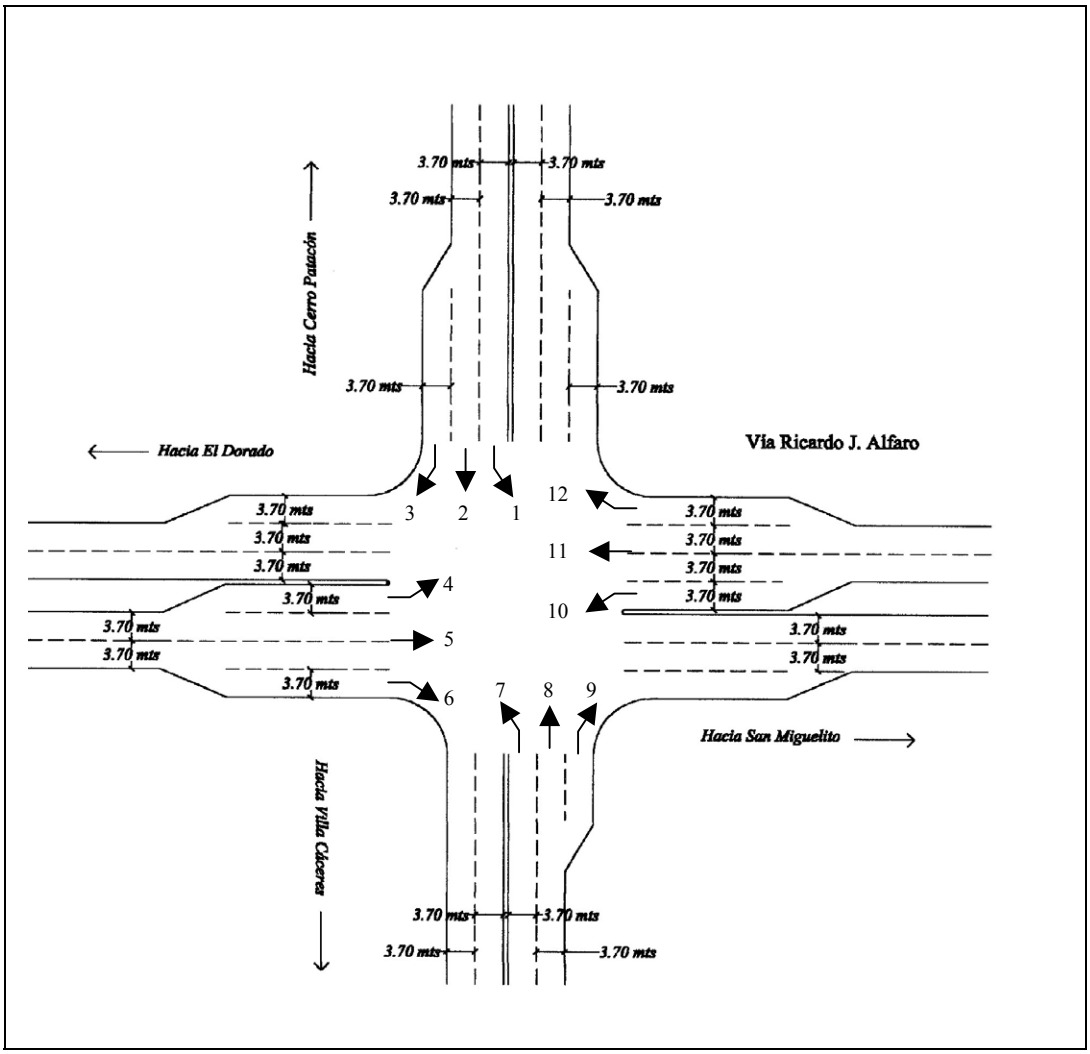

Figure C-8: Intersection of Via Ricardo J. Alfaro and Ave. La Paz

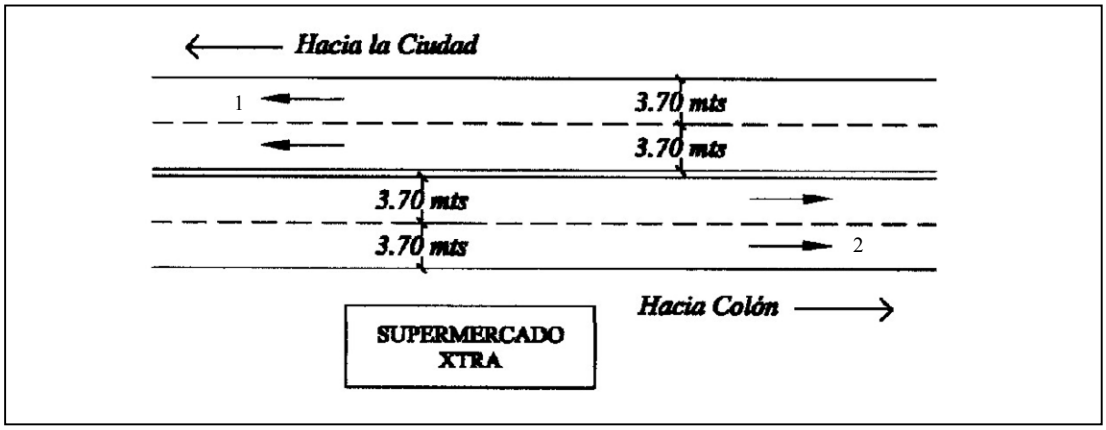

Figure C-9: Via Transistmica

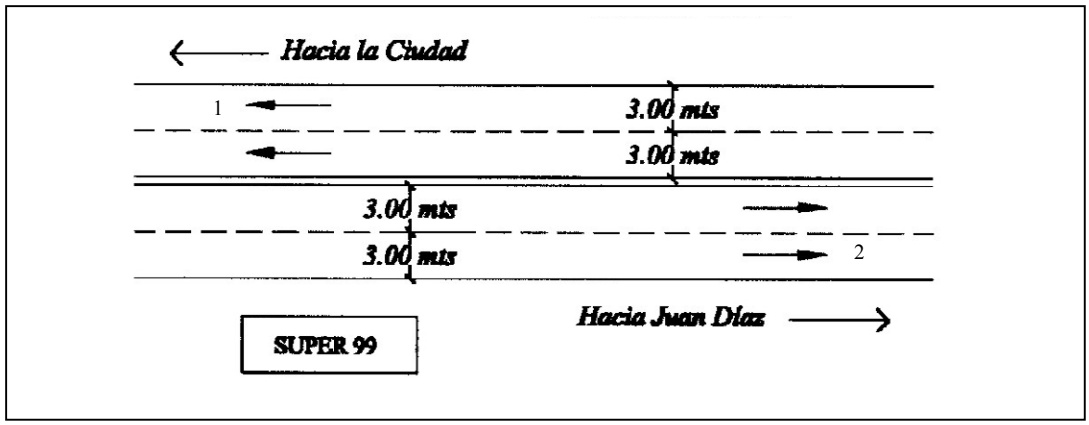

Figure C-10: Via Jose A. Arango

C.6.3 Survey Record

The survey record is presented in Annex.

C.6.4 Findings

a. Traffic Volume

a.1 Intersection of Via Ricardo J. Alfaro and La Ave. La Paz

Figure C-11 shows traffic volume passing through the intersection on weekday. Vehicles going through Via Ricardo J. Alfaro occupied the majority of the traffic volume. Number of vehicles running from direction of San Miguelito to El Dorado exceeded the opposite direction in the morning and vice versa in the afternoon.

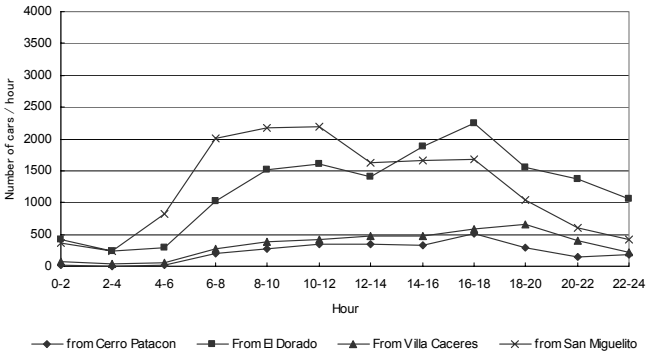

Figure C-11: Traffic Volume at the Intersection of Via Ricardo J. Alfaro and Ave. La Paz (Weekday)

Meanwhile, major variation was not found in number of vehicles passing through Ave. La Paz the whole day, although the traffic volume had a peak early in the evening.

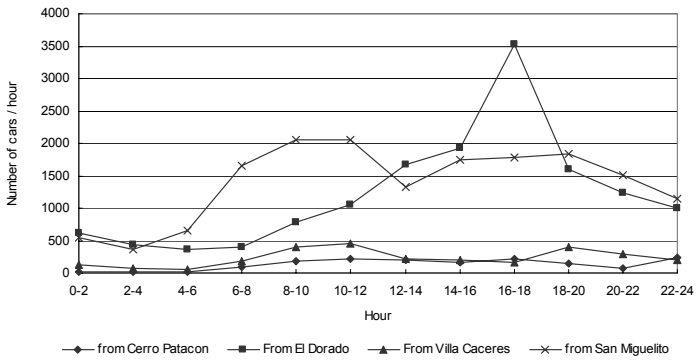

Figure C-12: Traffic Volume at the Intersection of Via Ricardo J. Alfaro and Ave. La Paz (Saturday)

Figure C-12 shows traffic volume in the intersection on Saturday. The traffic tendency was as almost same as one on the weekday.

However, as Figure C-13 shows, the traffic volume on Sunday was obviously fewer than that on weekday and Saturday. And there were no peaks of traffic in the morning and evening.

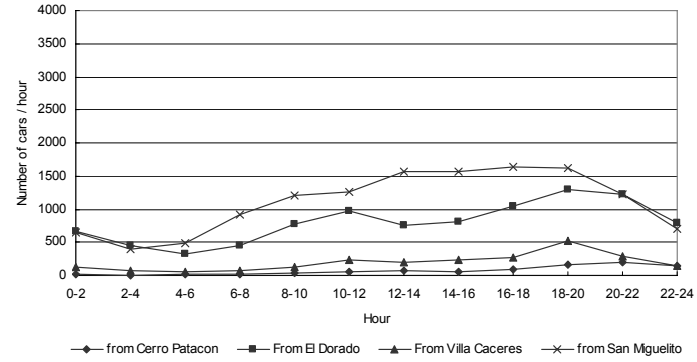

Figure C-13: Traffic Volume at the Intersection of Via Ricardo J. Alfaro and Ave. La Paz (Sunday)

a.2 Via Transistmica

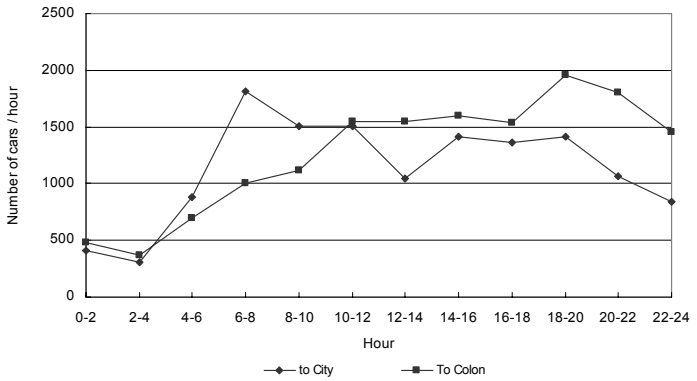

Figure C-14: Traffic Volume of Via Transistmica (Weekday)

As Figure C-14, Figure C-15 and Figure C-16 show, vehicles going to the city center through Via Transistmica exceeded ones to Colon in the morning in number and vice versa in the afternoon/evening through the week. This tendency was prominent on weekday

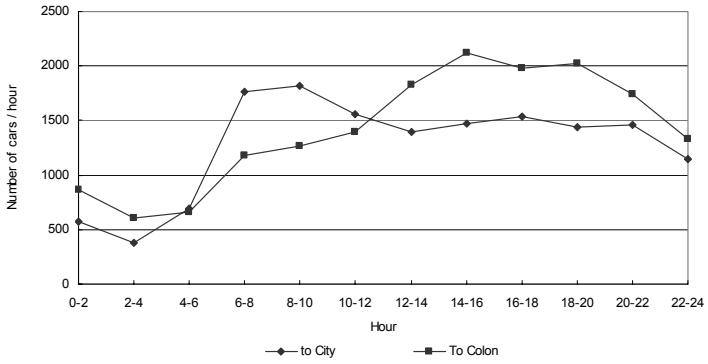

Figure C-15: Traffic Volume of Via Transistmica (Saturday)

and Saturday. In addition, the traffics were heavy by the midnights.

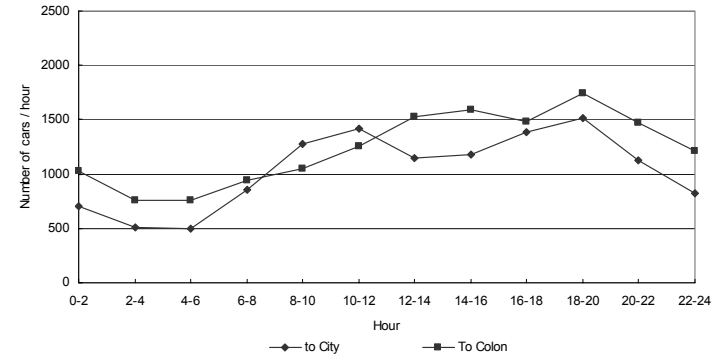

Figure C-16: Traffic Volume of Via Transistmica (Sunday)

a.3 Via Jose A. Arango

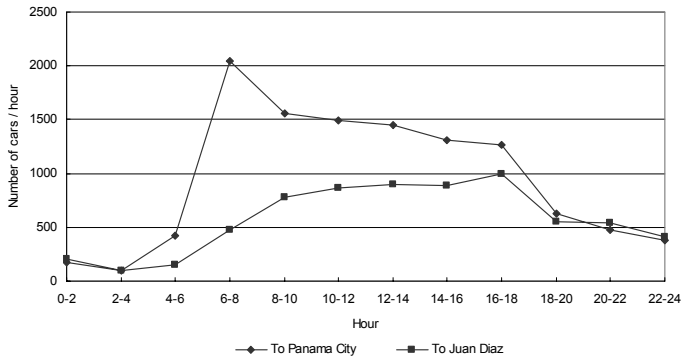

Figure C-17: Traffic Volume of Via Jose A. Arango (Weekday)

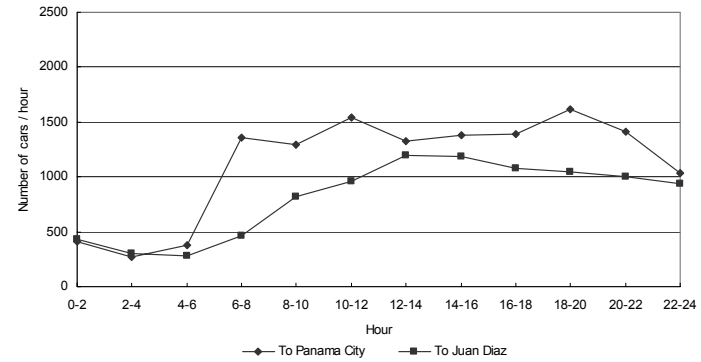

Figure C-18: Traffic Volume of Via Jose A. Arango (Saturday)

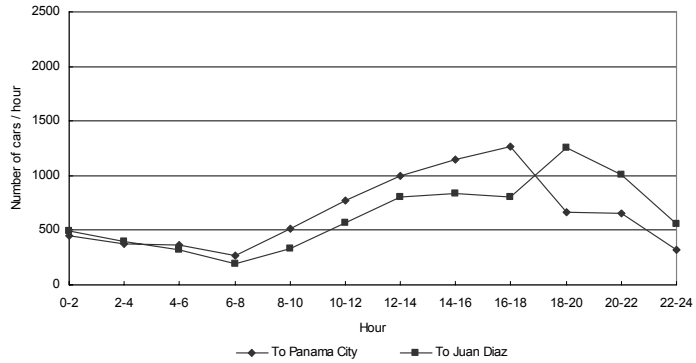

Figure C-19: Traffic Volume of Via Jose A. Arango (Sunday)

As Figure C-17 and Figure C-18 show, traffic to the city center on the weekday and Saturday were prominently heavy. Especially, it concentrated during 6 am and 8 am on weekday.

Meanwhile, traffic was not heavy in the morning and was heavy between 4 pm and 8 pm in the evening during Sunday, as Figure C-19 shows.

b. Calculated Traffic Volume and Actual Traffic Volume

Possible traffic volume in each road was calculated and compared with the actual traffic volume. It was obtained by a manner that is popular in Japan, USA and others. Detailed manner is presented below.

b.1 Intersection of Via Ricardo J. Alfaro and Ave. La Paz

i) Calculated Traffic Volume

Possible traffic volume of one side of Via Ricardo J. Alfaro was obtained as 2,455 pcu/h, as shown below.

- Basic traffic volume of one lane: 2,200 pcu/h (passenger car unit / hour)
- Possible traffic volume (C_C): This is obtained by multiplying the basic traffic volume by various corrections.
- Width of lane (γ_L): 1.0 is applied, as the width of lane (3.7m) is more than 3.5 m
- Conditions along the road (γ_I): 0,9 is applied, as it is urbanized area.
- Mix of heavy vehicle (γ_T) : $\frac{100}{(100-T)+E_T \times T} = \frac{100}{(100-7.1)+2.0\times 7.1} = 0.93$

Here, γ T: correction by mix of heavy vehicle

ET: conversion coefficient of heavy vehicle to passenger car. 2.0 is applied as it is urbanized area.

T: Mixed ratio of heavy vehicle, 7.1%

Mixed ratio of heavy vehicle (T) was obtained based on number of vehicles in each type for a week as follows.

Type of car	Weekday*	Saturday	Sunday	Total	%
Passenger car	272,360	58,469	43,687	374,516	92.9
Bus/Trucks	21,495	3,980	1,796	27,271	6.8
Waste collection truck	920	162	170	1,252	0.3
Total	294,775	62,611	45,653	403,039	100.0

* The value was obtained by multiplying one of a weekday by 5 days.

- Green indication ratio of traffic light (L): 2/3 (by actual time counting. Although there were certain differences in days and time zones, the green indication ratio was about 2/3)
- Number of lanes: 2

Consequently, the possible traffic volume of one side of Via Ricardo J. Alfaro was obtained as follows.

$$\begin{aligned} C_C &= C_B \times \gamma_L \times \gamma_I \times \gamma_T \times L \times N \\ &= 2{,}200 \times 1.0 \times 0.9 \times 0.93 \times \tfrac{2}{3} \times 2 \\ &= 2{,}455.2 \end{aligned}$$

ii) Comparison with actual traffic volume

Actual traffic volume at peaks in the morning and evening obtained by this survey was between 2, 000 and 2,500 pcu/h. Those are close to 2,455 pcu/h of the possible traffic volume. This would mean that the actual traffic volume reaches to the possible one at peaks. Actually, traffic congestions are often found at the intersection. In Figure C-12, the peak of the actual traffic volume is far beyond the possible one. This is likely to show heavy traffic congestion.

b.2 Via Transistmica

i) Calculated Traffic Volume

Possible traffic volume of one side of Via Transistmica was obtained as between 1,683 and 2,244 pcu/h, as shown below.

- Basic traffic volume of one lane: 2,200 pcu/h (passenger car unit / hour)
- Possible traffic volume (C_C): This is obtained by multiplying the basic traffic volume by various corrections.
- Width of lane (γ_L): 1.0 is applied, as the width of lane (3.7m) is more than 3.5 m
- Conditions along the road (γ_I): 0,9 is applied, as it is urbanized area.
- Mix of heavy vehicle (γ_T) : $\dfrac{100}{(100-T)+E_T \times T} = \dfrac{100}{(100-18.2)+2.0 \times 18.2} = 0.85$

Here, γ T: correction by mix of heavy vehicle

ET: conversion coefficient of heavy vehicle to passenger car. 2.0 is applied as it is urbanized area.

T: Mixed ratio of heavy vehicle, 18.2%

Mixed ratio of heavy vehicle (T) was obtained based on number of vehicles in each type for a week as follows.

Type of car	Weekday*	Saturday	Sunday	Total	%
Passenger car	235,780	54,732	47,285	337,797	81.8
Bus/Trucks	59,660	9,670	5,362	74,692	18.1
Waste collection truck	355	78	36	469	0.1
Total	295,795	64,480	52,683	412,958	100.0

* The value was obtained by multiplying one of a weekday by 5 days.

- Green indication ratio of traffic light (L): 1/2 to 2/3 (There is a crossing with traffic lights. However, it cannot be applied the green indication ration at the point, as the crossing is with over pass. Consequently, 1/2 to 2/3 for the ratio was assumed according to the actual conditions.)
- Number of lanes: 2

Consequently, the possible traffic volume of one side of Via Transistmica was obtained as follows.

In case of L = 1/2

$$C_C = C_B \times \gamma_L \times \gamma_I \times \gamma_T \times L \times N$$
$$= 2{,}200 \times 1.0 \times 0.9 \times 0.85 \times 1/2 \times 2$$
$$= 1{,}683$$

In case of L = 2/3

$$C_C = C_B \times \gamma_L \times \gamma_I \times \gamma_T \times L \times N$$
$$= 2{,}200 \times 1.0 \times 0.9 \times 0.85 \times 1/2 \times 2$$
$$= 1{,}683$$

ii) Comparison with actual traffic volume

The actual traffic volume at peaks were about 2,000 pcu/h. This is between 1,683 and 2,244 pcu/h of the possible traffic volume. Therefore, it is conjectured that actual traffic volume often exceeds the capacity of the road. Actually, traffic congestions are frequently found on the road.

b.3 Via Jose A. Arango

i) Calculated Traffic Volume

Possible traffic volume of one side of Via Jose A. Arango was obtained as between 1,675 and 2,233 pcu/h, as shown below.

- Basic traffic volume of one lane: 2,200 pcu/h (passenger car unit / hour)
- Possible traffic volume (C_C): This is obtained by multiplying the basic traffic volume by various corrections.
- Width of lane (γ_L): $0.24 \times W_L + 0.22 = 0.24 \times 3.0 + 0.22 = 0.94$

  Here, width of lane is 3.0m
- Conditions along the road (γ_I): 0,9 is applied, as it is urbanized area.
- Mix of heavy vehicle (γ_T) : $\frac{100}{(100-T)+E_T \times T} = \frac{100}{(100-11.2)+2.0 \times 11.2} = 0.90$

  Here, γ T: correction by mix of heavy vehicle

  ET: conversion coefficient of heavy vehicle to passenger car. 2.0 is applied as it is urbanized area.

  T: Mixed ratio of heavy vehicle, 11.2%

Mixed ratio of heavy vehicle (T) was obtained based on number of vehicles in each type for a week as follows.

Type of car	Weekday*	Saturday	Sunday	Total	%
Passenger car	158,820	41,852	28,705	229,377	88.8
Bus/Trucks	22,455	4,369	2,011	28,835	11.1
Waste collection truck	165	29	39	233	0.1
Total	181,440	46,250	30,755	258,445	100.0

* The value was obtained by multiplying one of a weekday by 5 days.

- Green indication ratio of traffic light (L): 1/2 to 2/3 (There are several traffic rights nearby. 1/2 to 2/3 for the ratio was assumed according to the actual conditions.)
- Number of lanes: 2

Consequently, the possible traffic volume of one side of Via Jose A. Arango was obtained as follows.

In case of L = 1/2

$$C_C = C_B \times \gamma_L \times \gamma_I \times \gamma_T \times L \times N$$
$$= 2{,}200 \times 0.94 \times 0.90 \times 0.90 \times 1/2 \times 2$$
$$= 1{,}675$$

In case of L = 2/3

$$C_C = C_B \times \gamma_L \times \gamma_I \times \gamma_T \times L \times N$$
$$= 2{,}200 \times 1.0 \times 0.9 \times 0.85 \times 1/2 \times 2$$
$$= 1{,}683$$

ii) Comparison with actual traffic volume

Actual traffic volume is about or below 1,500 pcu/h, which less than 1,675 pcu/h of the minimum possible traffic volume calculated, during the almost whole day. However, the actual traffic volume exceeded in the morning of weekday. This may indicate that traffic congestions happen during that time zone.

c. Present Status of Collection Vehicle

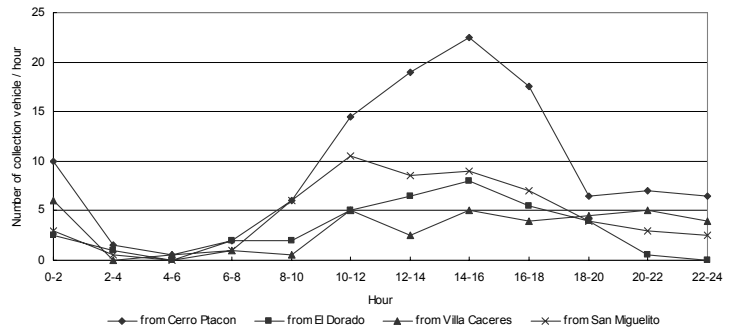

Figure C-20: Traffic Volume of Collection Vehicle at the Intersection of Via Ricardo J. Alfaro and Ave. La Paz (Weekday)

Figure C-20 shows the present status of collection vehicles going into the intersection of Via Ricardo J. Alfaro and Ave. La Paz. The intersection is the entrance of Cerro Patacon Final Disposal Site. Therefore, the figure shows number of collection vehicles coming into and going out of the site. The majority of vehicles pass through the intersection between 10 am and 8 pm where traffic is heavy. It indicates that waste transport efficiency is decreased by the heavy traffic.

d. Recommendation for Increasing Collection and Transport Efficiency

This survey targeted major roads which the collection vehicles use everyday. All of them have the actual traffic volume exceeding the possible one during the daytime. Actually, traffic congestions are frequently seen.

The majority of collection vehicles also run in the daytime. They bring waste to Cerro Patacon Disposal Site mainly between 10 am and 6 pm that overlaps the time zone of traffic congestion. Then, it is conjectured that the waste transport efficiency is lowered.

At present, direct transport method is applied where collection vehicles collect waste and transport it to a final disposal site by own means. Under this method, daytime collection work cannot avoid the traffic congestion. Especially, it is conjectured that collection works in the north and east where are far from Cerro Patacon Final Disposal Site are facing inefficiency of both transport and collection works.

Consequently, it will be recommended to consider increasing the efficiency of transport and collection by introduction of transfer transport which can move the transport works from daytime to nighttime.

Annex D

Current Situation of Municipal Solid Waste Management

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D Current Situation of Municipal Solid Waste Management

D.1 Service Coverage and Hygiene Conditions

Results of Public Opinion Survey (POS) shows that about 90% of citizens enjoy the benefits of waste collection service. More than 50 % of them receive it three times a week and more. As these figures shows, the city is kept clean. This is a strong point of the city. However, quality of collection service seems to be uneven, as the results of POS show, i.e., 12% of samples has once a week collection service and 25% has twice a week.

As the city is kept clean, it is conjectured that number of cases of diseases related to waste is not so many. Cases of dengue that is thought to be related to waste are less than 10 cases in 8 corregimientos, between 10 and 50 cases in 8 corregimientos and 392 cases in Pacora in 2001[1].

D.2 History of Municipal Solid Waste Management

First Stage – From colonial period to independence in 1903

During the colonial époque, Panama was part of Peru's Viceroyalty, and later on it become dependant from the Nueva Granada Viceroyalty, along with Colombia and Venezuela.

After the Colombian, Venezuelan, Ecuadorian and Central American independence processes in 1821, Panama decides to become attached to the Gran Colombia confederation, which was also formed by Colombia, Venezuela and Ecuador.

After the dissolution of the Gran Colombia confederation, Panama becomes integrated with the Republic of Colombia.

During this époque, the Panamanian territory is governed by the Spanish legislation; then the set of laws that ruled the confederation's juridical life; and the Colombian Police Code after that, which included sanitary provisions.

The fortified city, founded on January 21st, 1673, had its functions well defined: it performed as the New World's trading regent, yet the empire collapsed by the end of the thirties in the 18th century. That century also showed another obscure passage of Panama: three destructive fires that took place in 1737, 1756 and 1781, with uncountable losses.

Under the Colombian dominance, the city underwent relevant changes as of the second half of the 19th century. In 1848, the discovery of Californian gold mines changed the fate of the

[1] Departamento de Control de Vectores y Zoonosis, MINSA

isthmus and put an end to 30 years of decadence. This passing land caught a second breathing, particularly after a private American consortium built a railroad between 1850 and 1855.

In spite of the above, the arrival of foreign capital, which guaranteed the cosmopolitan nature of the small town, did not allowed it to provide support for its ruins. Panama conserved several vacant lots, ruins and thickets, in between of which commercial stalls, hotels and restaurants prospered.

During the eighties of the 19th century, the Frenchmen arrived to begin the construction of the inter-oceanic way. The city population grew from 13,000 in 1864 to 24,000 in 1896. In 1889, the French suspended the works.

Attention to the population's sanitary services were quite precarious and, in general terms, people disposed of their wastes within their properties (San Felipe's walled zone – people living within the premises), whereas the residents of the other zone (people living outside) littered wastes in the lands of what is known today as the *Corregimiento* of San Ana.

With the expansion of the city and the tearing down of walls, the first waste collection services are set up, which became consolidated by the workers' flow for the construction of the railroad (1850), and later with the beginning of the Canal works. Part of the wastes collected was burnt at the city's outskirts, and another portion was dumped in the sea.

Second stage – From the appearance of the Republic (1903) to the participation by the North American government (1926)

With the appearance of the Republic in 1903, the Americans arrived, and the *Casco Antiguo* (older downtown) in special and the rest of the city caught a new shine, yet only temporarily. The Americans built the sewerage system, they paved the streets and killed off the mosquitoes that transmitted tropical fevers (yellow fever and malaria). That is how modernity arrived.

In 1905, the Canal Commission established the Health Office, which took charge of the street cleaning, collection and disposal works.

The Health Office picked up garbage by means of the methods of that time: with animal-drafted carts; disposal was done at open dumping sites and part of the wastes were burned with a small incinerator.

In 1907, an agreement was reached between the Panama Canal Commission and the Panamanian government. The latter assumes the collection and disposal of wastes, for which

the commission will provide an amount of B/. 10,000.00 per year, and the Government contributed with the remainder to meet the cost of the service.

This agreement ended up in 1912. During that period, the collection system being used prevailed and wastes were burnt at Calidonia beaches.

In 1917 the administrative code begins to rule in the Panamanian legislation, which includes cleaning provisions. However, the American sanitary ordinances prevail in Panama and Colón, in virtue of the Canal Treaty.

Between 1926 and 1942, the American government takes over the street cleaning duties. During this period, three agreements stand out:

a) Through an exchange of memos on July 26th and 27th, 1926 between the Secretary of Foreign Affairs and the Executive Secretary of the Canal zone, it is agreed upon that the American government take over the cleaning of streets and collection of wastes in the cities of Panama and Colón.

b) A new exchange of memos occur in 1936, between the Secretary of Foreign Affairs and the Secretary of State (USA), to discuss the proposal made in October 1931 by the Sanity and Welfare Director and the Healthiness Officer of the Panama Canal to expand and modernize the sanitary services in the city of Panama.

c) In 1942, after the exchange of consecutive memos for a 12-point agreement between the Republic of Panama and the United States, the basis were laid for Panama to acquire land, buildings, water rights and other properties required for healthiness purposes, such as the collection and disposal of residues.

Previously in 1939, through Sanitary order No. 12 dated November 16th of that same year and approved by the Decree No. 17 of that year, the elimination of wastes and garbage is transferred to the municipalities, in order to control the proliferation of household flies and other insects.

In 1942, the Republic of Panama takes over the responsibility for the cleansing and collection of the garbage in the cities of Panama and Colón, and the properties listed in the 12-point agreement are transferred to it.

In 1953, by means of the Law No. 11 date May 8th of that year, the Aqueducts, Sewerage and Cleansing Department is created to render those services in the cities of Panama and Colón.

In 1962, by means of the Law No. 17 dated June 23rd, 1962, the Cleaning Patronage in the district of Panama is created, which takes charge of the cleaning, whereas waste collection duties become part of the municipality of Panama and the government allocates a budget of

B/. 400,000.00 for a five-year period. Later on, the government expands this subvention for an additional year.

In 1968, the Provisional Government Council, through Decree No. 229 dated December 26th, assigns the Institute of National Aqueducts and Sewerages (*IDAAN*) the responsibility of collecting the wastes in the district of Panama, and it is granted with powers to immediately regulate the service.

In 1970, through the Cabinet Decree No. 409 dated December 29th, the Cleaning Department is created under the immediate supervision of IDAAN's Executive Director.

In May 1981, the selection of a company to take over the study of the Cleaning Department was bid on, in order to turn it into an entity capable of offering solutions to the garbage issue. The study was conducted by the companies *Consultora Delta* (Panama) and *Saniplan* (Brazil) in 1982. As per governmental instructions, an autonomous body was outlined, by means of a Multi-sector Technical Commission, which proposed the term *Empresa Metropolitana de Aseo* (Metropolitan Cleaning Enterprise, or EMA).

Later on, the commission referred above recommended the creation of the Metropolitan Institute of Urban Cleansing, with a national coverage. The study carried out sets the required foundations for the conversion from a Cleaning Department to a dynamic and modern autonomous institution.

Third stage – From the creation of the DIMA to date

In 1984, a bill to create an autonomous entity to be in charge of the solid waste management in the metropolitan region was presented for the consideration of the Legislative Assembly.

By means of the Law No. 41 date November 8th, 1984, the *Dirección Metropolitana de Aseo* (Metropolitan Cleaning Office, or DIMA) is created, which takes over the waste management systems for the districts of Panama, San Miguelito and Colón.

The main purposes for the DIMA are the planning, research, direction, inspection, operation and exploitation of the services.

The first important step was to identify an alternative place for the disposal of solid wastes coming from the districts of Panama and San Miguelito, as the Panama Viejo dumping site was widely protested against by the neighbors of that place.

The site where Cerro Patacon sanitary landfill lies today was then chosen, and the discharge operations begin in June 1985. In that same year, Panama Viejo dumping site was closed.

The Ministry of Planning and Economic Policies and the National Environmental Commission took over the process to develop the Mocambo (nowadays Cerro Patacon) sanitary landfill studies. The latter are concluded in the first semester of 1987.

Between June 1985 and June 1995, wastes are disposed of in the denominated "Stage I" of the sanitary landfill, at the entrance of the site; later on, the "Stage II" is developed by phases. In "Stage II" impermeable membranes are used to protect the groundwater, leachate is collected and they are taken to a group of stabilization ponds for their treatment, and biogas is gathered by means of a piping system inserted in the mass of the wastes and evacuated towards the atmosphere.

The DIMA expands its operational ambit as the land properties and facilities of the Canal Zone are given back, as per the Torrijos – Carter treaty. Likewise, the DIMA receives the collection equipment that provided the service at the area mentioned above. Additionally, it takes charge of Mount Hope sanitary landfill that served the city of Colón.

During 15 years, the DIMA renders uninterrupted services to the three districts. On August 27th, 1999, the Legislative Assembly approved the Law No. 41, which creates the Urban and Domiciliary Cleansing Office (DIMAUD) for each of the municipalities of Panama, San Miguelito and Colón, and transfers the goods from the DIMA and the responsibility of the solid waste management at their respective districts.

As of the issuance of the above mentioned Law No. 41 dated August 27th, 1999, the municipality of Panama, through its Urban and Domiciliary Cleansing Office, has the exclusive responsibility of operating and exploiting the system, as well as administering Cerro Patacon sanitary landfill.

D.3 Waste Stream

D.3.1 Concept of Waste Stream

The present waste stream in the Study Area is formulated based on the following surveys and analysis:

- Waste Amount and Composition Survey (WACS)
- Interview survey at generation sources
- Analysis of existing disposal amount data (weighing data at final disposal site)

The concept of present waste stream is shown in Figure D-1.

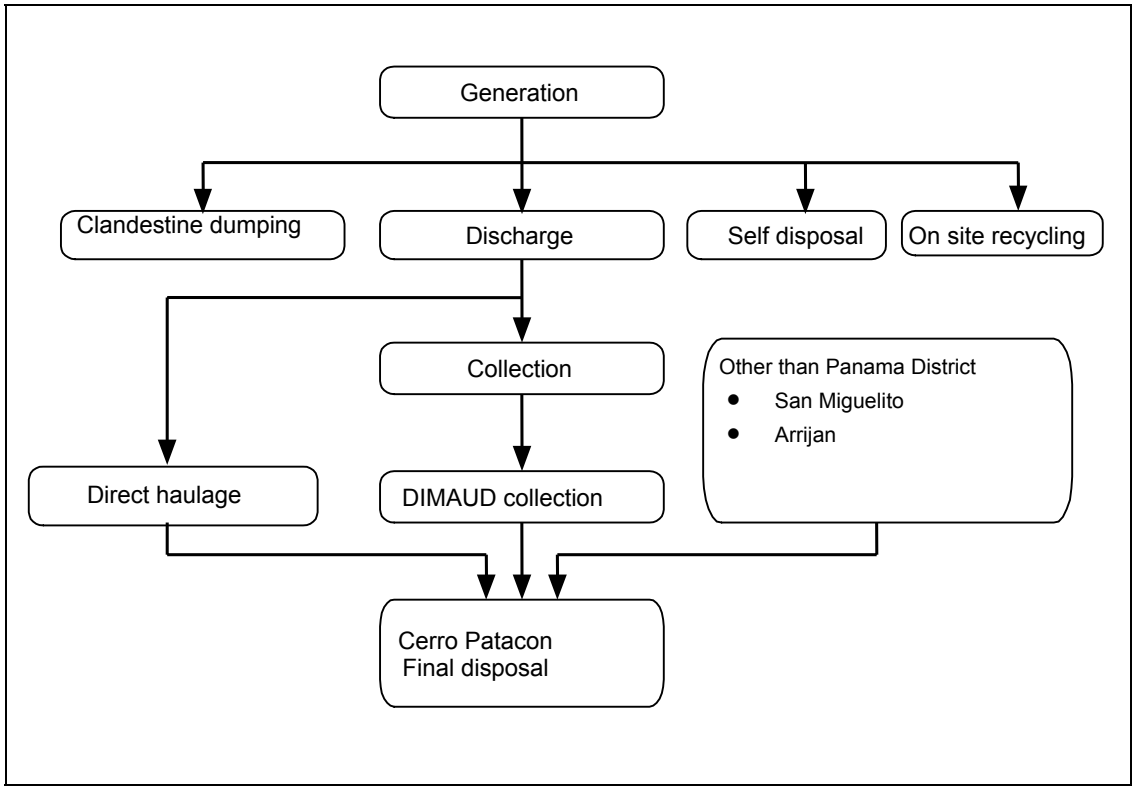


Figure D-1: Concept of Present Waste Stream

According to the concept above, the Study Team has quantified the waste amount in each component of the waste stream.

D.3.2 Waste Generation Rate and Generation Amount

a. Waste Generation Rate

The study set up waste generation rates based on the results of WACS and data in Latin American countries (shown in Table D-1 and Table D-2).

Table D-1: Comparison of Waste Generation Rate in Latin American Countries

Sources		unit	Municipality of PANMA by WACS	San Salvador/ El Salvador[1]	Mexico[2] D.F/1998	Nicaragua principal cities[3] 1996	Nicaragua Managua[4] /1995	Paraguay Asuncion[5] /1994
House hold	High income	g/person/day	898.3(635.5 to 898.3)*	600	616	675	664	682
	Middle income		655.8(505.8 to 655.8)*	540				
	Low income		440.2(334.0 to 440.2)*	420				
Commercial	Restaurant	g/employee/day	6,373	NA	NA	NA	NA	NA
	Others		1,918	482	NA	1,676	NA	NA
Institutional			201	NA	NA	NA	NA	NA
Market			4,178	1,674	1,025	2,827	NA	NA
Street sweeping		g/m/day	16	198	NA	NA	50	NA

*: 95% reliable value, NA : not available

Source : [1] JICA study 2001, [2] JICA study 1999, [3] JICA study 1997, [4] JICA study 1995, [5] JICA study 1996

Table D-2: Waste Generation Rate

Source		unit	Generation rate
Household waste	High income	g/person/day	898.3
	Middle income		655.8
	Low income		440.2
Commercial waste	Restaurant	g/employee/day	6,372.5
	Others		1,918.2
Institutional waste			200.6
Market waste			4,178.3
Street sweeping waste		g/m/day	15.9

a.1 Household Waste Generation Rate

WACS gave household waste generation rates by income level. Then, weighted average of them with taking into account population distribution by income level obtained by POS is regarded as waste generation rate for the whole households. The table below presents the results of the calculation.

Table D-3: Household Waste Generation Rate

Income level	Share (%)	Generation rate (g/person/day)	Weighing average (g/person/day)
High income	11%	898.3	98.8
Muddle income	46%	655.8	301.7
Low income	43%	440.2	189.3
Total	100%		**590 (589.8)**

b. Waste Generation and Disposal Amount

Waste generation amount is calculated based on the data of WACS, POS and statistics data such as population, number of employee of commercial and institutional entities. As for institutional waste, number of employees in institutions in Panama District was obtained by multiplying number of employees in institutions in the whole country by ratio of budgets between Panama Municipality and the whole municipalities (Panama Municipality's budget / the whole municipalities' budget = 49.5%), because no data of number of institutional employees in Panama District was found. Waste generation amount estimated is presented in Table D-4.

The results of Public Opinion Survey say that collection coverage of household waste is 92 %. Table D-5 shows 678.9 ton/day of collection amount of household, commercial, institutional and market wastes with taking into account the collection coverage.

Meanwhile, weighbridge data at the Cerro Patacon Landfill say that total waste disposal amount is 965 ton/day and disposal amount of household, commercial, institutional and market waste is 823.8 ton/day as shown in Table D-6.

Table D-4:Waste Generation Amount

Generation sources		unit	Generation rate	Number of person or employee	Waste generation amount (ton/day)
Household waste		g/person/day	590	744,448	439.2
Commercial waste	Restaurant	g/employee/day	6,372.5	16,695	106.4
	Others		1,918.2	60,282	115.6
Institutional waste			200.6	146,051	29.3
Market waste			4,178.3	5,634	23.5
Total					714.0

Table D-5: Waste Collection Amount

Generation sources		unit	Waste generation amount (ton/day)	Collection ratio (%)	Waste collection amount (ton/day)
Household waste		g/person/day	439.2	92	404.1
Commercial waste	Restaurant	g/employee/day	106.4	100	106.4
	Others		115.6	100	115.6
Institutional waste			29.3	100	29.3
Market waste			23.5	100	23.5
Total			714.0	-	678.9

Table D-6: Weighing Data at Cerro Patacon (August 2001 to July 2002)

Item	Waste amount (ton/day)
Domestic waste	691.7
Commercial and business entities	118.4
Market	13.7
Sub total	823.8
Street sweeping waste	8.4
Hospital waste including common	20.1
Large bulky waste / Chatarra	2.9
Small bulky waste / Depojos	8.8
Demolition waste / Caliche	96.3
Sewer sludge / Agua negras	4.7
Total	**965.0**

As the tables above show, there is a difference of 144.9 ton/day of waste collected from households, commerce, industries and markets between estimated collection amount, 678.9 ton/day, and weighbridge data, 823.8 ton/day. The following facts are helpful to clarify the difference.

- At the Cerro Patacon Landfill, wastes are classified into three categories, i.e., households, commercial and business entities, and markets. However, this is not strictly carried out, as it is difficult to know sources of wastes correctly.
- There is no other landfill in the study area than the Cerro Patacon Landfill. All type of wastes generated in the study area will be brought to the landfill. Actually, it is observed that considerable amount of commercial and industrial (CI) wastes is contained in waste brought by collection vehicles from so-cold residential areas.

- A study[2] carried out by MEF in 1999 says that industrial waste amount generated in the study area was 159.6 ton/day (58,264.7 ton/year).

Consequently, it is estimated that the 144.9 ton/day would consist of industrial waste. The following figure schematizes the consideration mentioned above.

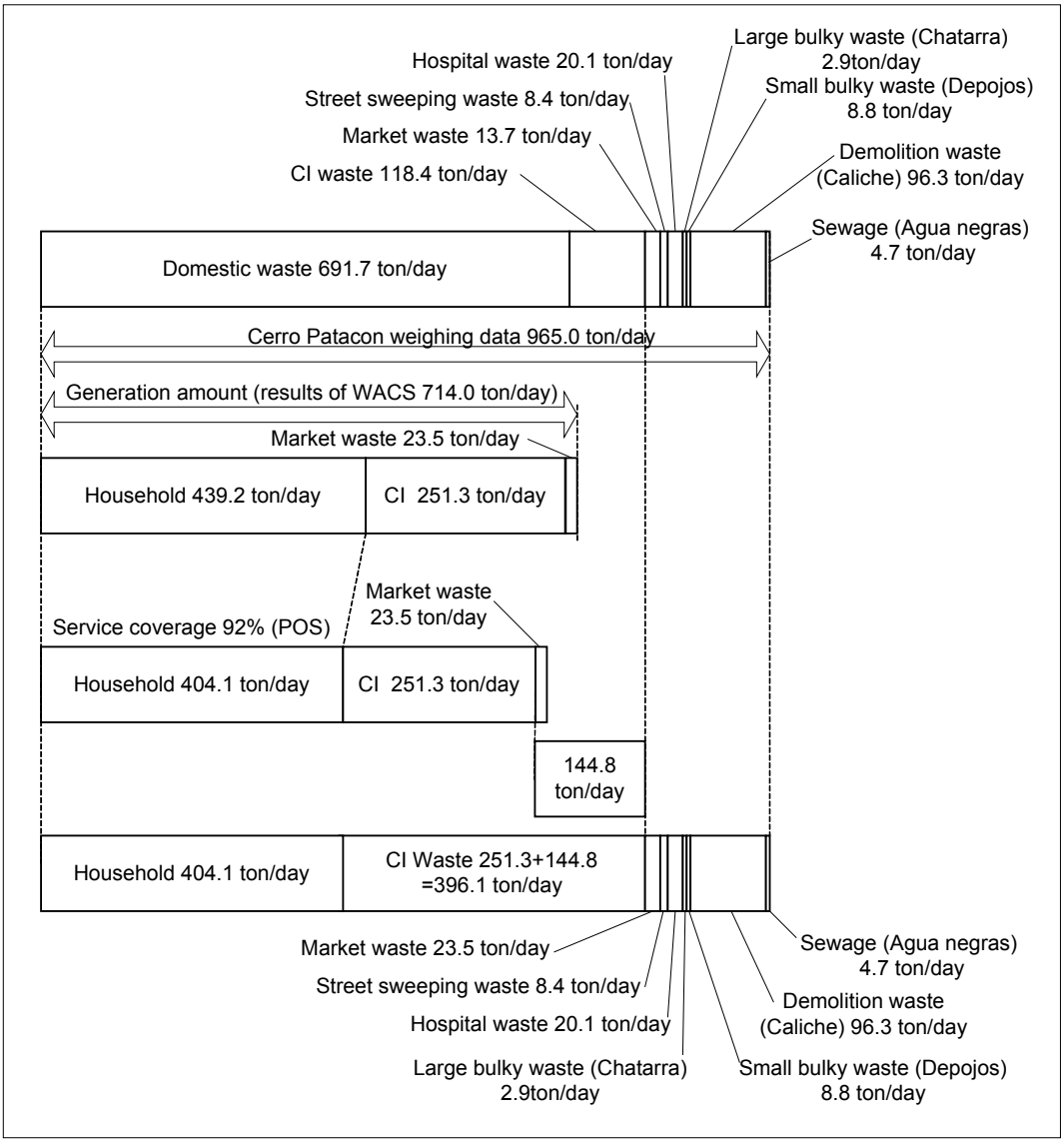


Figure D-2: Estimated Waste Generation Sources in the Study Area

[2] Diagnosis, Master Plan and Evaluation of Alternatives for Private Sector Participation in Hazardous Waste Management, MEF, 1999

D.3.3 Waste Disposal Amount

Table D-7and Table D-8 show final disposal amount of Cerro Patacon disposal site in August 2001 to July 2002.

Table D-7: Final Disposal Amount at Cerro Patacon in August 2001 to July 2003 (form Panama)

unit : ton/day

Collector	Year/M		Domestic	Street sweeping	C & I	Market	Hospital	Large bulky (Chatarra)	Small bulky (Despojos)	Demolition (Caliche)	Sewage (Agua negras)	Total
DIMAUD	2001	Aug.	632.8	12.3	41.5	20.5	25.6	1.1	7.7	0.6	0.0	742.1
		Sep.	585.2	12.2	38.0	20.6	25.7	0.4	7.5	0.3	0.0	689.9
		Oct.	648.0	6.3	46.3	19.9	25.4	0.4	6.9	0.2	0.0	753.3
		Nov.	609.4	5.4	47.9	18.3	22.7	0.7	10.4	2.1	0.0	716.9
		Dec.	724.2	7.0	60.7	12.5	24.0	0.4	8.8	1.0	0.0	838.6
	2002	Jan.	639.0	9.8	48.3	7.7	23.5	0.2	12.1	0.7	0.0	741.3
		Feb.	540.5	4.1	22.2	3.7	12.5	0.4	1.9	1.0	0.0	586.4
		Mar.	607.7	0.8	2.9	7.9	2.4	0.6	1.0	0.9	0.0	624.3
		Apr.	649.2	5.9	27.0	13.3	19.0	0.3	19.9	1.7	0.0	736.3
		May.	646.3	8.6	39.1	15.7	17.1	0.9	17.0	0.7	0.0	745.5
		Jun.	691.2	14.2	37.6	12.7	24.0	2.6	5.9	2.3	0.0	790.3
		Jul.	699.3	14.2	38.6	11.5	18.7	0.4	5.4	1.3	0.0	789.4
	Average		**640.3**	**8.4**	**37.6**	**13.7**	**20.1**	**0.7**	**8.8**	**1.1**	**0.0**	**730.7**
Junta com.	2001	Aug.	9.5	0.0	0.0	0.0	0.0	0.3	0.0	0.8	0.0	10.6
		Sep.	15.6	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	16.8
		Oct.	11.4	0.0	0.0	0.0	0.0	0.2	0.0	4.9	0.0	16.5
		Nov.	10.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	11.2
		Dec.	9.2	0.0	0.0	0.0	0.0	0.1	0.0	0.3	0.0	9.6
	2002	Jan.	7.5	0.0	0.0	0.0	0.0	0.2	0.0	0.4	0.0	8.1
		Feb.	9.5	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	9.9
		Mar.	11.4	0.0	0.0	0.0	0.0	0.1	0.0	1.6	0.0	13.1
		Apr.	12.3	0.0	0.0	0.0	0.0	0.2	0.0	107.2	0.0	119.6
		May.	9.9	0.0	0.0	0.0	0.0	0.3	0.0	2.4	0.0	12.6
		Jun.	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	7.7
		Jul.	7.7	0.0	0.0	0.0	0.0	0.2	0.0	2.0	0.0	9.8
	Average		**10.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.0**	**10.1**	**0.0**	**20.3**
Public inst.	2001	Aug.	6.4	0.0	0.0	0.0	0.0	0.1	0.0	3.1	0.0	9.5
		Sep.	5.1	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	7.2
		Oct.	5.4	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0	8.9
		Nov.	6.8	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	9.9
		Dec.	8.0	0.0	0.0	0.0	0.0	0.1	0.0	2.7	0.0	10.7
	2002	Jan.	6.7	0.0	0.0	0.0	0.0	0.2	0.0	4.1	0.0	11.0
		Feb.	7.0	0.0	0.0	0.0	0.0	0.4	0.0	2.8	0.0	10.3
		Mar.	6.7	0.0	0.0	0.0	0.0	0.4	0.0	3.9	0.0	11.0
		Apr.	6.6	0.0	0.0	0.0	0.0	0.2	0.0	4.7	0.0	11.4
		May.	8.8	0.0	0.0	0.0	0.0	0.2	0.0	7.5	0.0	16.5
		Jun.	6.8	0.0	0.0	0.0	0.0	0.2	0.0	12.0	0.0	19.0
		Jul.	11.5	0.0	0.0	0.0	0.0	0.2	0.0	15.9	0.0	27.7
	Average		**7.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.2**	**0.0**	**5.5**	**0.0**	**12.8**

unit : ton/day

Collector	Year/M		Domestic	Street sweeping	C & I	Market	Hospital	Large bulky (Chatarra)	Small bulky (Despojos)	Demolition (Caliche)	Sewage (Agua negras)	Total
Private collector	2001	Aug.	0.0	0.0	24.9	0.0	0.0	0.0	0.0	18.9	3.3	47.2
		Sep.	0.0	0.0	27.6	0.0	0.0	0.0	0.0	27.7	5.1	60.4
		Oct.	0.4	0.0	28.6	0.0	0.0	0.0	0.0	19.9	12.8	61.8
		Nov.	0.1	0.0	24.3	0.0	0.0	0.0	0.0	20.5	3.0	48.0
		Dec.	0.7	0.0	22.4	0.0	0.0	0.2	0.0	18.8	6.5	48.5
	2002	Jan.	0.4	0.0	25.0	0.0	0.0	0.1	0.0	16.2	1.4	43.1
		Feb.	0.1	0.0	20.6	0.0	0.0	0.0	0.0	10.0	2.8	33.5
		Mar.	0.1	0.0	22.4	0.0	0.0	0.0	0.0	9.7	4.7	36.8
		Apr.	0.0	0.0	25.9	0.0	0.0	0.0	0.0	34.1	1.8	61.8
		May.	0.3	0.0	25.7	0.0	0.0	0.0	0.0	25.6	3.2	54.8
		Jun.	0.1	0.0	22.5	0.0	0.0	0.0	0.0	33.0	2.4	58.0
		Jul.	0.0	0.0	25.7	0.0	0.0	0.0	0.0	37.3	8.4	71.4
	Average		**0.2**	**0.0**	**24.7**	**0.0**	**0.0**	**0.0**	**0.0**	**22.7**	**4.7**	**52.2**
Direct haulage	2001	Aug.	32.3	0.0	63.9	0.0	0.0	2.2	0.0	58.0	0.0	156.5
		Sep.	33.1	0.0	55.2	0.0	0.0	1.8	0.0	43.0	0.0	133.1
		Oct.	35.4	0.0	57.2	0.0	0.0	1.8	0.0	66.0	0.0	160.4
		Nov.	30.9	0.0	58.8	0.0	0.0	2.0	0.0	66.3	0.0	157.9
		Dec.	36.9	0.0	67.0	0.0	0.0	2.6	0.0	45.7	0.0	152.2
	2002	Jan.	36.5	0.0	66.1	0.0	0.0	1.6	0.0	43.0	0.0	147.2
		Feb.	36.3	0.0	47.3	0.0	0.0	1.8	0.0	45.8	0.0	131.2
		Mar.	32.4	0.0	53.7	0.0	0.0	1.2	0.0	54.2	0.0	141.5
		Apr.	35.7	0.0	53.5	0.0	0.0	1.8	0.0	70.9	0.0	161.9
		May.	32.5	0.0	56.4	0.0	0.0	1.9	0.0	63.1	0.0	153.9
		Jun.	32.6	0.0	46.6	0.0	0.0	1.9	0.0	73.8	0.0	154.9
		Jul.	33.2	0.0	46.3	0.0	0.0	1.9	0.0	53.6	0.0	134.9
	Average		**34.0**	**0.0**	**56.1**	**0.0**	**0.0**	**1.9**	**0.0**	**57.0**	**0.0**	**148.9**
Average			**691.7**	**8.4**	**118.4**	**13.7**	**20.1**	**2.9**	**8.8**	**96.3**	**4.7**	**964.9**

Table D-8: Final Disposal Amount at Cerro Patacon in year 2001 (San Miguelito & Arraijan)

unit : ton/day

	Year/M		Domestic	Street sweeping	C & I	Market	Hospital	Large bulky (Chatarra)	Small bulky (Despojos)	Demolition (Caliche)	Sewage (Agua negras)	Total
Sum Miguelito	2001	Aug.	209.9	0.0	0.0	0.0	0.0	0.1	0.0	0.3	0.0	210.3
		Sep.	195.9	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	196.1
		Oct.	222.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	222.7
		Nov.	212.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	212.9
		Dec.	265.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	265.2
	2002	Jan.	232.5	0.0	0.0	0.0	0.0	0.3	0.0	0.2	0.0	233.0
		Feb.	175.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	175.3
		Mar.	192.3	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	192.4
		Apr.	203.4	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	204.0
		May.	218.6	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	219.0
		Jun.	226.6	0.0	0.0	0.0	0.0	2.3	0.0	0.5	0.0	229.4
		Jul.	235.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	235.9
	Average		**216.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.3**	**0.0**	**0.2**	**0.0**	**216.7**
Arraijan	2001	Aug.	50.5	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	50.5
		Sep.	20.2	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	20.2
		Oct.	21.7	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	21.7
		Nov.	46.4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	46.8
		Dec.	36.7	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	36.7
	2002	Jan.	46.9	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	46.8
		Feb.	30	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	30
		Mar.	31.4	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	31.4
		Apr.	16.8	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	16.8
		May.	8.1	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0	8.1
		Jun.	9.5	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	9.7
		Jul.	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	9.4
	Average		**27.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.1**	**0.0**	**27.4**

D.3.4 Waste Stream

Table D-14 shows a waste stream through out the whole year on the basis of the results described above.

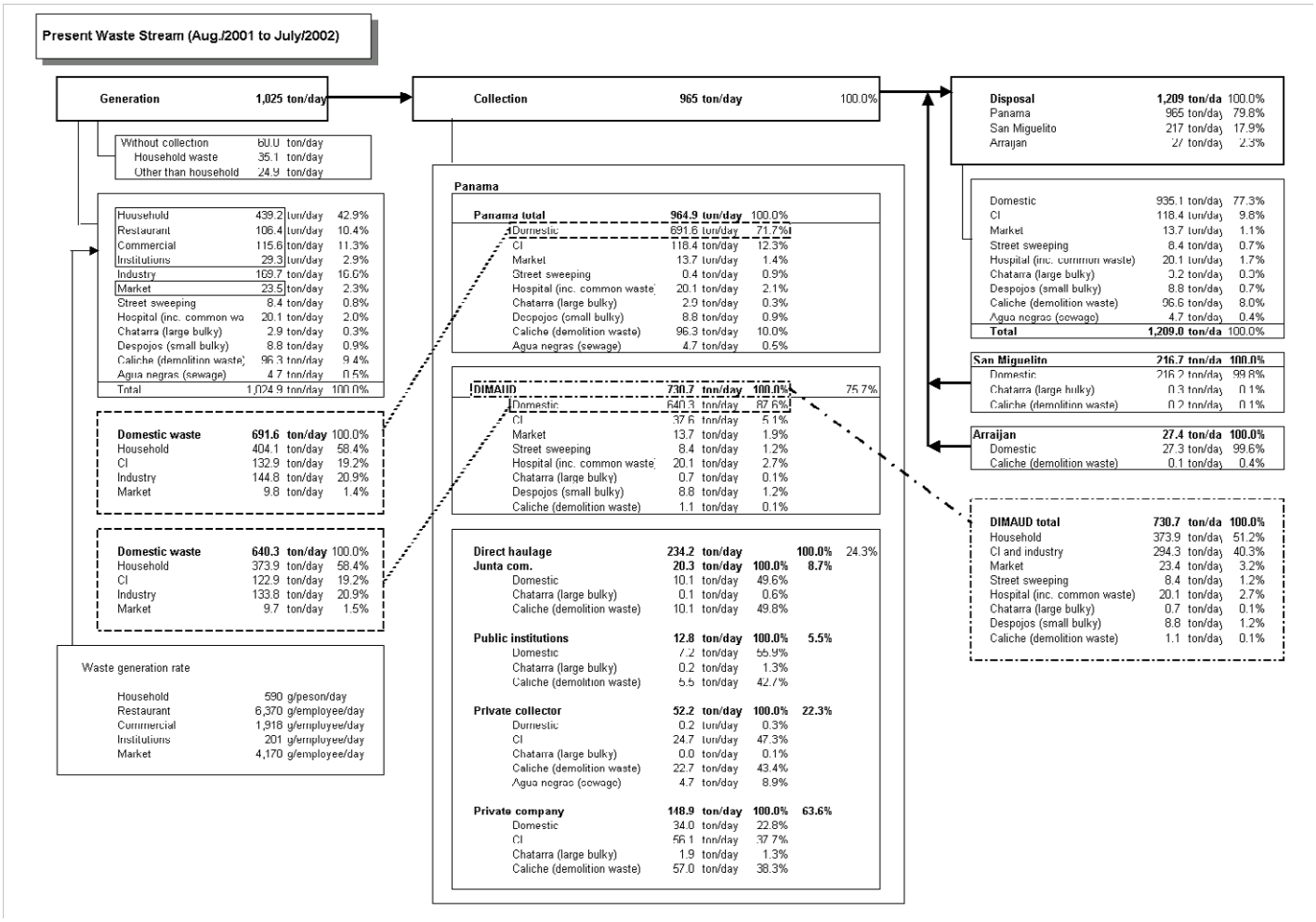


Figure D-3: Current Waste Stream (daily average Aug.2001 to Jul. 2002)

D.4 Technical System

D.4.1 Discharge and Storage System

Currently, the handling of residential solid waste is done in plastic bags that are generally placed in *tinaqueras* (metallic baskets lifted above ground located near the sidewalks or the houses). Additionally, plastic or metallic bins are used to store the wastes; among them, there are full or cut in half 55 gallons drums.

The use of tinaqueras to discharge waste produces many problems, especially bad odors which give an impression that wastes have not been collected because a lot of waste is found scattered in the vicinity. Part of this waste is scattered by persons dedicated to recover valuable materials.

The users currently do not separate any type of waste; several categories of wastes are found in the bags, even those considered as hazardous.

The use of plastic bags and their discharge at any time of the day, lead to waste being scattered by animals or urban scavengers (*piedreros*). This situation also causes an adverse impact on the landscape and produces sanitary problems.

Storage in public roads is done through metallic containers (2 and 8 yd^3) installed by DIMAUD; users usually deposit their waste in plastic bags inside the container. Commonly, in places where these types of containers are located, a lot of bulky waste is also disposed (electrical appliances, mattresses, construction materials, etc.). In many cases, the containers are empty; however, a lot of waste is disposed around them.

From the field trips, it was observed that in some sectors, the containers are located far away one from the other; additionally, there are few of them. Often times, these containers are located too far from the houses that they are supposed to serve which leads to waste accumulation.

Metallic containers have a disadvantage: they do not have wheels. Consequently, it is difficult to move and handle them, specially the biggest ones.

Additionally, there are larger containers (between 20 and 30yd^3). This service does not work well because these containers are too high and the discharge turns out to be a difficult task. Additionally, these containers are placed too far from the generation source (houses or buildings) which does not favour discharge. Everywhere these containers are placed, adjacent areas are contaminated with waste which are generally considered locations with the lowest cleansing service in the city.

There is not an intermediate treatment for organic waste, such as, compost production. All the waste is collected and disposed in the sanitary landfill or they are disposed illegally in several idle places or creeks.

D.4.2 Collection and Haulage System

a. Generalities about the Organization of the Haulage and Collection Systems

a.1 DIMAUD´s Organization

Through law No. 41 dated on 27/08/1999, it is transferred to the municipalities in the metropolitan area (Panama, Colon, and San Miguelito districts), the administration, operation, and exploitation of services related to urban and household cleansing and the sanitary landfills in that area. In each municipality of the Metropolitan Region, it is created the Municipal Department for Urban and Household Cleansing in order to direct, plan, inspect, operate, and exploit all the services related to urban and household cleansing in their respective districts; as well as to manage all the human, material, financial, and budgetary resources, as it is established in the attributions and faculties of the law aforementioned.

This Department has a Director who is an officer appointed by the mayor and he/she is responsible of the service in the administrative, operative, and budgetary areas.

The Municipal Department of Urban and Household Cleansing of the Panama District (DIMAUD) operates with the following organizational structure, according to the manual of functions of November 2001 which generally is satisfied.

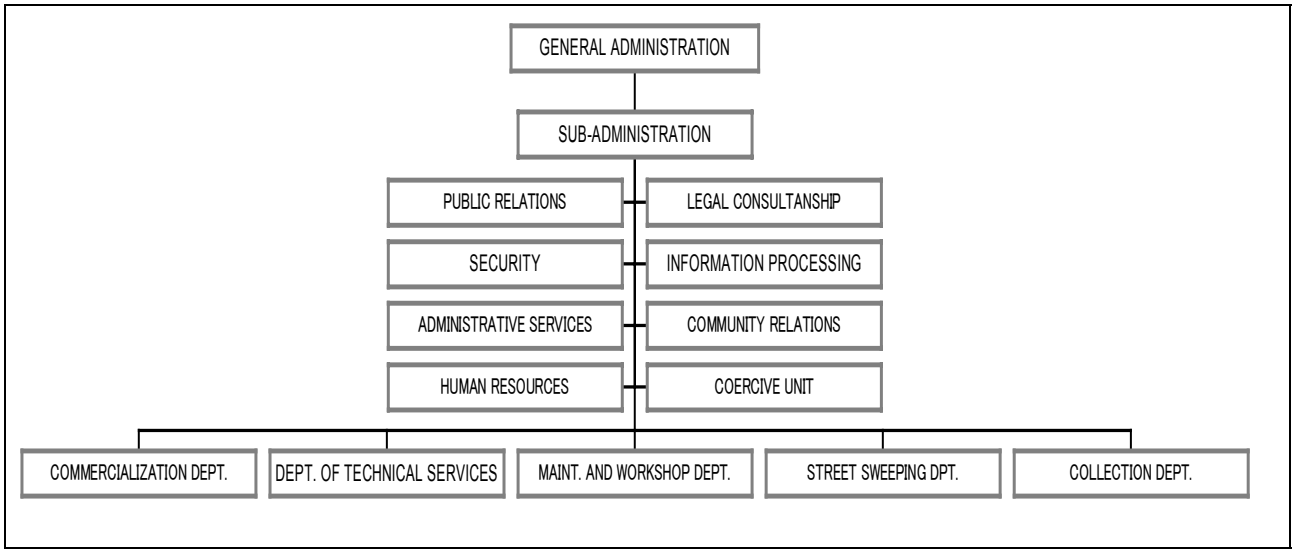


Figure D-4: DIMAUD´s Organizational Flow Chart

This flowchart shows four levels: the first one is the Directive level; the second one is the coordination level which involves units of consultantship and administrative support; the third one corresponds to the supervision which involves operative units, and the fourth one corresponds to execution which includes the corresponding work sections and areas.

The units found in the third level of the organization, which depends directly from the General Administration and Sub-administration are in charge to develop, supervise, and monitor operative activities which are required to provide an adequate urban and household cleansing service, final disposal, and to charge for these services. The activities developed by these departments require a strong coordination among them in order to maintain a continuous operation; this should be reflected in the efficiency of the service.

It is important to know the role of each department because there is a close relationship between the activities developed by each one of them; and generally, all these activities summed up make operative the service.

a.2 Description of the Operative Departments

The objectives, functions, and relationships of coordination of each one of the departments, defined by DIMAUD in the functions manual (November 2000) are presented in the following paragraphs.

a.2.1 Department of Technical Services

The department's main objective is to plan, execute, and control the activities related with the operation of projects and the sanitary landfill by guaranteeing the technical and administrative support for the fulfillment of these responsibilities.

This department has two sections called Project section and Sanitary landfill project.

Functions

- To plan and coordinate technical actions related to engineering calculations and design, and sanitary works
- To coordinate with the private sector the maintenance of the works executed or under execution.
- To inspect the execution of projects so that they are executed according to norms and specifications already defined.
- To advise and guide the superior authorities about planning and execution of works related to projects and sanitary landfill.

- To establish an adequate system to update and maintain topographical and polygon maps of the sanitary landfill.
- To participate in investigations works related to the preparation and approval of plans for projects and sanitary landfill.
- To coordinate and participate in the execution of topographical and maintenance works in the sanitary landfill areas.
- To coordinate the execution of works and projects with organizations of internal cooperation.
- To participate in meetings, seminars, and workshops where norms, regulations, decrees for environmental conservation, and technology transfer are discussed.
- To plan, coordinate, and direct technical and administrative activities that are undertaken by the units under its responsibility.
- To plan and coordinate technical training related to solid waste management.
- To verify that working hours are registered statistically in order to be presented correctly and the accounts are processed adequately.
- To present reports on activities made by the department.
- To undertake all the other functions under its jurisdiction.

Relationships of Horizontal Coordination

This department is related horizontally with the comercialization, maintenance and workshops, street sweeping, and collection departments in different activities that are coordinated at the political directive level in the entity and for other common actions at the department levels.

a.2.2 Commercialization Department

Its main objective is to guarantee that income derived from services provided in the solid waste collection, final disposal, and usage of the landfill site is collected. Additionally, it should provide the customer with optimum conditions to make their transactions.

This department has two sections which correspond to Collection and Customer service.

Functions

- To plan the department activities and give instructions to the subordinate units.
- To define and manage the policies for sale and collection of services provided based on statistical monthly income; reports should verify the ratio collection/billing.
- To coordinate the activities of fee collection that are done by different agencies within the entity.
- To analyze delinquent accounts and actions that can be implemented to recover these delinquent accounts.
- To participate in the consolidation and analysis related to fee collection in order to define policies and actions to be implemented in this area.
- To present a report of income received derived from services provided.
- To establish working methods in the commercialization area to improve the customer service system.
- To evaluate and control the activities of administrative subordinated units.
- To coordinate the coercive unite for delinquent accounts.
- To coordinate the process for checks that are returned by the bank and possible forged money received by the entity.

Relationships of Horizontal Coordination

This department should be coordinated with technical services, maintenance and workshops, street sweeping and collection departments regarding the common administrative activities undertaken by the entity.

a.2.3 Maintenance and Workshops Departments

The department´s main objective is to guarantee the preventive and corrective maintenance service to all vehicles in the entity´s fleet (light, medium, heavy-duty, and hydraulic) making sure that they are working adequately on a daily basis.

This department has the mechanical, preventive maintenance, and other maintenance service sections.

Functions

- To plan the activities of the subordinated administrative units.
- To coordinate and participate of all planned activities in order to ensure the success of the works that have been entrusted to the entity.
- To approve the purchase of pieces and spare parts to repair the fleet.
- To coordinate everything related to vehicle collisions, stickers, insurance policy, and others.
- To supervise and control the activities related to the operation of the fleet which are undertaken in different sections.
- To evaluate the repair works in order to confirm that the damages in the vehicles have been fixed.
- To produce an inventory of all the vehicle fleet and its current state.
- To supervise pieces and spare parts that the entity purchases so that they adjust to the technical specifications requested to repair the working fleet.

Relationships of Horizontal Coordination

This department has horizontal relationships with the technical services, commercialization, street sweeping and collection departments mainly in tasks related to the use of the fleet.

a.2.4 Collection Department

The department has the main objective to undertake the collection activities and to guarantee that the streets, avenues and other areas within all the corregimientos of the Panama District are kept clean.

This department has two sections A and B.

Functions

- To plan and coordinate the collection activities of organic and inorganic wastes, keep the streets and avenues clean within the Panama District.
- To have a collection program control and make sure it is followed in order to keep the streets and avenues of the city clean.
- To communicate and present to the superior authorities the difficulties found in the field due to collection operations.

- To participate in the collection assignments that are planned for any given corregimiento within the District.
- To coordinate with the chiefs in the different areas the regular and special collection assignments.
- To present monthly reports on the collection operations undertaken in the corregimientos.
- To procure material resources required to fulfil efficiently the collection operations.
- To undertake the other functions within its competency.

Relationships of Horizontal Coordination

This department has relationships with the street sweeping, maintenance and workshops, technical services, and commercialization departments related to the support provided mutually during the execution of operative and administrative activities within the entity.

a.2.5 Street Sweeping

The department´s main objective is to undertake the street sweeping activities and guarantee that streets, avenues, and other areas in all corregimientos within the Panama District are kept clean.

It has two Sections: Nighttime street sweeping and Daytime street sweeping.

Functions

- To plan and coordinate the cleansing, street and avenue sweeping activities in all corregimientos within the Panama District.
- To keep a control on programs for cleansing and street and avenue sweeping, and make sure it is followed.
- To communicate and present to the superior authorities the difficulties found in the field as a result of cleansing and sweeping operations.
- To participate in cleansing and sweeping assignments that are planned for the corregimientos within the District.
- To coordinate with the chiefs from the nighttime and daytime shifts the regular and special cleansing and sweeping assignments.
- To present monthly reports on cleansing, street and avenue sweeping activities executed.

- To procure resources and materials required to fulfill efficiently the cleansing and sweeping operations.

Relationships of Horizontal Coordination

The department has relationships with the Collection, Maintenance and Workshops, Technical Services, and Commercialization Departments related to the support provided mutually during the execution of administrative and operative activities within the entity.

a.2.6 Analysis of the Structure

According to the previously defined functions, the Technical Services, Maintenance and Workshops, Collection, and Sweeping departments require to keep a direct contact with each other in order to provide efficiently the solid waste collection, sweeping, and final disposal services. The commercialization department´s work is more related to the accounting administrative activity; nonetheless, part of its work depends on the information generated at other departments.

However, notwithstanding the proposed organization, the current situation indicates that each department coordinates deficiently its activities with the other ones; reports are not exchanged among departments which leads in most cases to misinformation on the works they are undertaking. This situation has a direct impact on the quality and efficiency of the service.

This situation is evident between the collection, and maintenance and workshop departments. Neither of them have a program to coordinate their activities, as a result, several situations take place. Among the most important ones, there are:

- Misinformation in the collection department related to vehicles available to provide the service.
- The collection routing design does not allow enough time to undertake preventive maintenance in the fleet; this leads to provide only repair maintenance which consequently leads to damage on the vehicles.
- Because only repair maintenance is provided, it is not possible to have vehicles in reserve in case there is a failure within the route.

On the other hand, it is difficult to evaluate, in general, the service because there are not any daily or monthly activity reports.

The previous information indicates that although the coordination relationships have been established among the departments, this has not been implemented. There is not a

communication and prioritization structure; this can be remediated by creating an operation management department that would be in charge of the other four departments mentioned previously. Design and quality control of the services would be among the functions of this new department.

a.3 Organization of the Collection Department

The collection department has been organized according to the current operation service. Consequently, there are two well-defined collection areas (A and B). Both sections depend directly from the Collection Department through the collection chief.

All the required infrastructure (vehicles, equipment, personnel, etc.) to provide service to each area is physically located in Curundú depot (Curundú corregimiento) and Carrasquilla depot (San Francisco corregimiento).

The two Areas are divided in shifts: Area A Daytime shift, Area A Nighttime shift, Area B Daytime shift, and Area B Nighttime shift. Each collection shift has a chief which depends directly from the Collection chief.

Each one of the areas, previously mentioned, are divided into sectors which are also divided into collection routes. Each one of the sectors has a supervisor.

In addition to the two sections aforementioned, there is a third section which depends directly from the General Administration. This section is in charge of the trucks Roll on/Roll off type which operates totally independent from the other two sections.

The following organizational chart shows the current organization in the collection department.

Organizational Chart

The collection department operates according to this organizational chart:

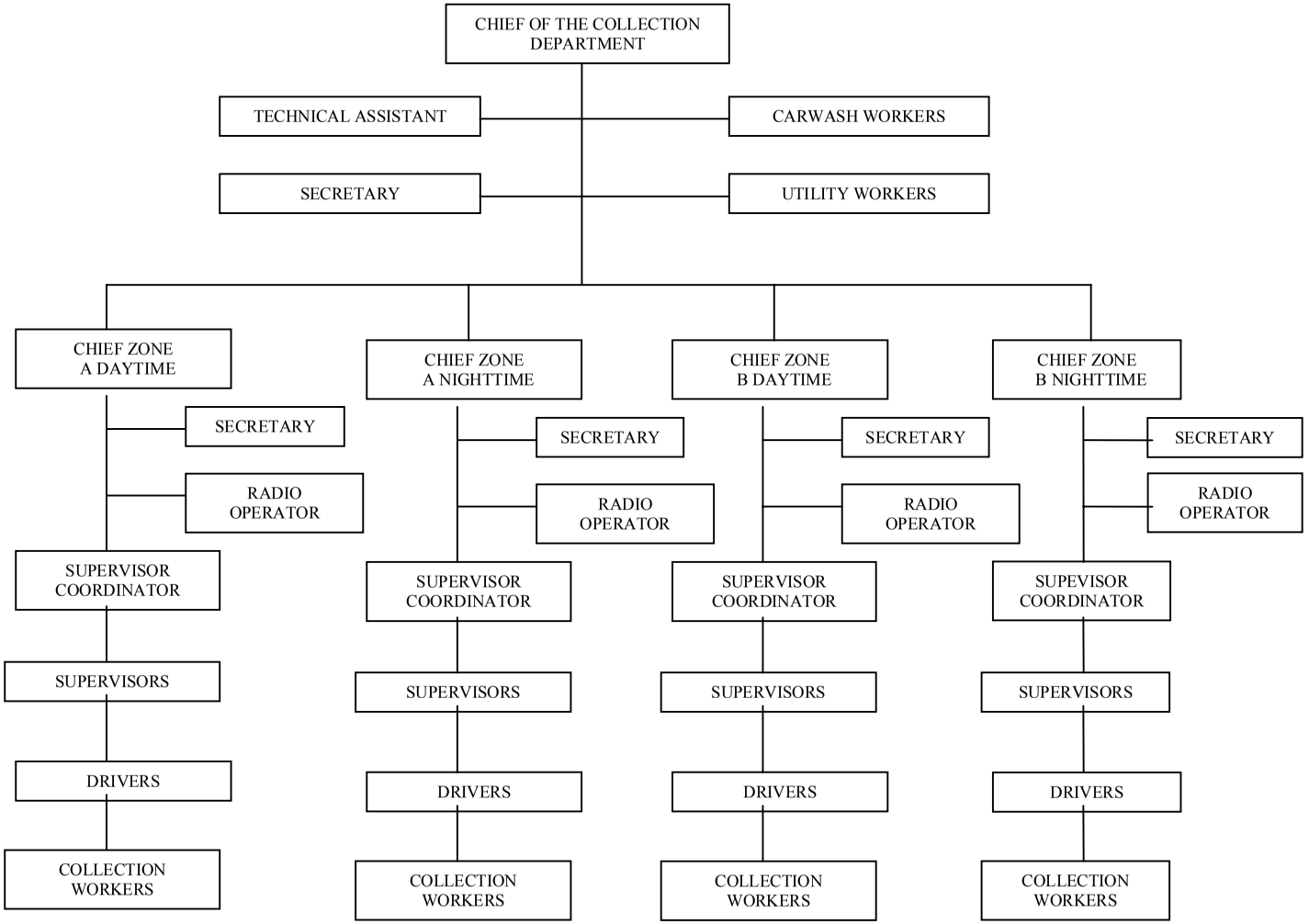


Figure D-5: Collection Service Organizational Flow Chart

b. Personnel

The collection department has a total of 804 workers which are distributed as follows

Table D-9: Workers Distribution per Shift

Position	Zone A Daytime	Zone B Nighttime	Zone B Daytime	Zone B Nighttime	Total
Chief of Department	1				1
Chief of Zone	1	1	1	1	4
Technical Assistant	1				1
Department Secretary	1				1
Supervisor coordinator	1	1	1	1	4
Supervisors	10	4	12	6	32
Radio-operators	1	1	1	1	4
Drivers	46	23	88	31	188
Collection workers	148	64	232	104	548
Utility workers	6				6
Carwash workers	11				11
Total personnel per Area	228	95	336	145	804

Among this personnel, it is included the relief personnel.

b.1 Description of the Positions

Chief of Department: he/she is the professional in charge of the service and his/her main function is to coordinate and control the collection activities of organic and inorganic waste as well as the implementation of street and avenues cleansing within the Panama District. Among his/her responsibilities, there are:

- To have a control of the collection programs and to make sure they are executed in order to keep clean the streets and avenues in the city.
- To keep permanently informed the superiors about the service development and, in special, to timely communicate about the difficulties that are found during the collection operations.
- To coordinate with the superiors and other related entities the execution of cleansing assignments.
- To procure the required material resources to undertake efficiently the collection operation.
- To present monthly reports about the collection operations undertaken by the corregimientos.
- To coordinate with other departments the activities required to undertake the collection.

Technical Assistant: he/she is the person who provides technical support to the chief of the department in everything related to service and planning development.

Chief of the Zone: he/she is the person in charge to manage, distribute, and supervise the collection works in his/her section.

Supervisor Coordinator: he/she is the person in charge to coordinate with the supervisor of each planning zone the works, vehicle, and others. He/she is in charge to handle all the combustible orders and to control the work done by the supervisors.

Supervisor: He/she is in charge to develop the collection service in a zone; he/she should monitor that collection works are executed as planned and with the required quality. He/she in charge to review the data on the work orders, deliver reports, and others.

Radio Operator: He/she is responsible to transmit information/complaints from the users in the different collection routes to the coordinators, supervisors, chief of sections. He/she is also responsible to collect all messages and complaints from users through telephone as well as to coordinate with each supervisor that the complaints are responded accordingly. He/she is in charge to compile work orders from each zone or route, and to process the information.

Secretary: he/she undertakes secretarial tasks in each one of the sections and departments; she also undertakes administrative tasks in the assigned section.

Driver: He/she is in charge to drive the assigned collection vehicle. He/she is also responsible to verify the correct working condition of the assigned vehicle and to control the work performed by the collection workers.

Collection workers: they are the personnel in charge of collecting waste in the assigned collection route.

Utility workers: they are in charge to request the tools assigned to each truck from the shop; they should provide these tools to the driver and request them back when the truck has finished its shift. They are also responsible to review the current state of the tools.

Carwash workers: They generally used to be collection workers who previously performed collection work and due to an accident they were disabled. Their function is to wash light vehicles within Carrasquilla.

b.2 Personnel Characteristics

Most of the workers assigned to the collection department have permanent contracts (67% of drivers and 65% of collection workers). On the other hand, drivers with eventual contract have an average of 0,5 years working for the institution; those workers with permanent contract have an average of 7,3 years working for the entity.

The workers were distributed according to the years they have worked for the institution as follows:

Table D-10: Percentage of Workers by Range of Years of Service

Years of Service	Driver		Collection Workers	
	Eventual	Permanent	Eventual	Permanent
0 to 2 years	84%	3%	89%	11%
2 to 5 years	16%	23%	11%	21%
5 to 10 years	0%	40%	0%	24%
10 to 20 years	0%	16%	0%	20%
20 to 30 years	0%	13%	0%	21%
More than 30 years	0%	5%	0%	3%
Percentage per type of contract	33%	67%	35%	65%

More than 44% of collection workers and 34% of drivers with permanent contracts have more than 10 years of service in the institution. Most of the eventual workers have less than 2 years of service.

Those persons with eventual contracts have a higher employment turnover because they are always searching for new sources of employment.

c. Work System (Shifts, Work Schedule, Days Worked per Month)

c.1 Description of the Collection System

The collection system that currently is performed by DIMAUD includes the collection of household, urban, commercial, and institutional waste; this work is done on a daily basis through different routes that cover most of the Panama District.

These routes have generally been designed to conduct a daily waste collection, including Sundays; consequently, not too many routes have a frequency smaller than three times a week. This situation has caused that the collection service takes place during 7 days week; as a result, there is not a single spare day which is a common practice for services of this type (usually takes place between Monday and Saturday).

Currently, the collection service only considers three spare day which leads to have a total of 362 working days. On the other hand, the work schedule is distributed in 5 days a week with 8 effective hours per week, i.e., in a year, there are 260 working days that is equivalent to 71% of effective working days in the institution. As a result, there are 104 additional working days which represent an increment of personnel employed for this service.

The collection service is designed based on Daytime and Nighttime shifts. The Daytime shift is made of two type of schedules that cover a total of 16 hours. The Nighttime shift is made of a single schedule which cover only 8 hours. The table shows the work shift.

Shift	Type	Schedule
Daytime	Daytime	06:00 to 14:00 hrs.
	Noon time	12:00 to 20:00 hrs.
Nighttime	Nighttime	18:00 to 02:00 hrs.

In general, the collection vehicles work three types of shifts which results in only 4 available hours to make the preventive maintenance for all the fleet.

For every collection vehicle, there are usually 1 driver and 3 collection workers, which generally work 8 hours a day. On the other hand, for a working week of 5 days a week, 1,4 of a crew is required to cover all seven days of the week (daily collection) which represents an increment of 16.6% in labor costs compared to a collection system based on 6 days a week.

With the purpose to verify the real work schedule of the collection vehicles, an analysis of the service for November 2001 and January 2002 was made. The following tables and graphs show a summary of the information obtained.

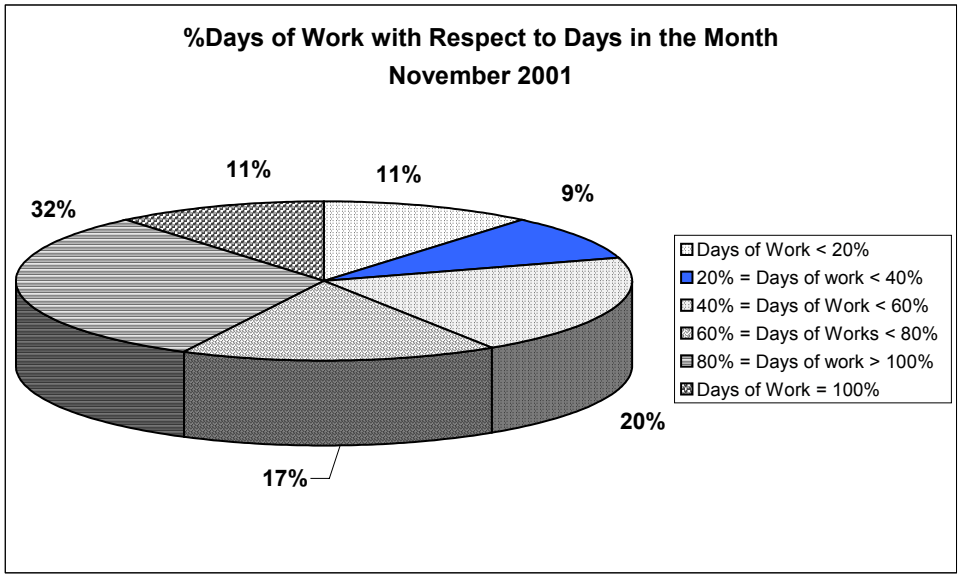


Figure D-6: Percentage of Days of Work with Respect to Days in the Month for November 2001

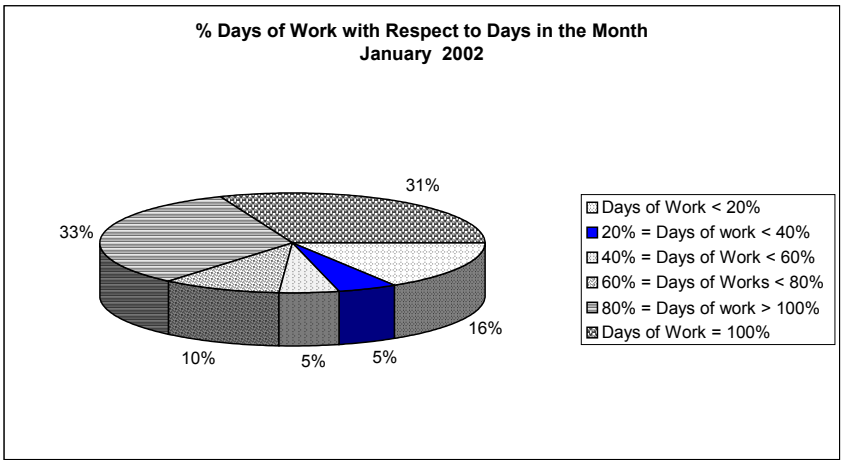


Figure D-7: Percentage of Days of Work with Respect to Days in the Month for January 2002

In November 2001, a total of 56 vehicles operated; however, only 11% of them kept operating continuously during the whole month, i.e., 7 vehicles. A total of 14.496 tons were collected during November 2001. On the other hand, in January 2002, the total number of vehicles was increased to 62; however, only 31% of them kept working continuously during the month, i.e., 20 vehicles. A total of 19.920 tons were collected during January 2002.

In January, there is an important increment of number of working days by the fleet which represents around 11% of additional use; this is due to a reduction on tons collected by rented vehicles, as it is shown in the following tables:

Table D-11:No. of Trips and Tons Collected by Rented Vehicles in November

PLATE N°	N° OF TRIPS/MONTH	TON/MONTH
9304	1	6.78
19230	83	385.76
19231	93	516.19
19232	102	548.39
19233	52	292.14
19234	79	416.38
19237	75	398.74
29490	64	382.35
29491	84	404.24
29492	56	294.98
29493	86	485.44
29499	53	307.52
TOTAL	**828**	**4438.91**

Table D-12: No. of Trips and Tons Collected by Rented Vehicles in January

PLATE N°	N° OF TRIPS/MONTH	TON/MONTH
42200	3	11.75
42202	3	6.24
185513	20	166.32
208222	2	18.88
219593	2	6.57
219978	13	42.06
229207	4	27.77
261501	51	250.39
268610	2	12.89
275535	24	78.31
327366	4	5.41
364323	1	1.38
365409	1	4.1
520990	27	96.68
524275	5	12.2
524690	16	63.65
546674	6	30.41
546675	2	10.65
661872	2	3.18
673904	1	2.14
673906	4	7.21
673907	3	2.85
Total	**196**	**861.04**

During January, the total amount of tons collected by trucks that do not belong to DIMAUD was 861.04 tons which represent only 19,4% of the total tons collected in November with the same system. This reduction is due to the incorporation of a larger number of trucks to the service which probably were being repaired in November.

If we analyze the collection system, specifically the routes, there are 53 routes in the Daytime shift with a daily frequency (Monday to Sunday) which suggests that, at least, 53 vehicles would be required to work continuously; this will lead to 1.590 days of operation in a month. This assessment does not match the information shown in the previous pages; for example, there were 1.110 days of operation in November and 1.412 days of operation in January, both values reflect the whole collection service and not only the daily frequency. Consequently, the daily collection frequency is done for some routes only; the design collection service is not being followed, as a result, the routes should be adjusted to the real frequency. The real waste accumulation days should be considered for every sector when the new routing design is done.

c.2 Estimate of the total number of hours of work per month per route

In addition to analyze the use of the fleet, the different routes have been studied with the purpose to define the real time used for the service and how this time affects the use of the resources.

The collection department has an order of work format which should be filled out daily by the driver for the different routes he/she worked; this order of work serves to control the service provided. The supervisors elaborate a report of collection service per route with the information from the order of work. This report is submitted monthly to the Chief of Collection; the report reflects the tons, number of trips, human resources used, total of hours used on a daily basis and per route.

Based on this report, the different collection routes were analyzed; the following information was derived.

The following graphs show the worksheets per month and tons collected, per route, and per total collection area.

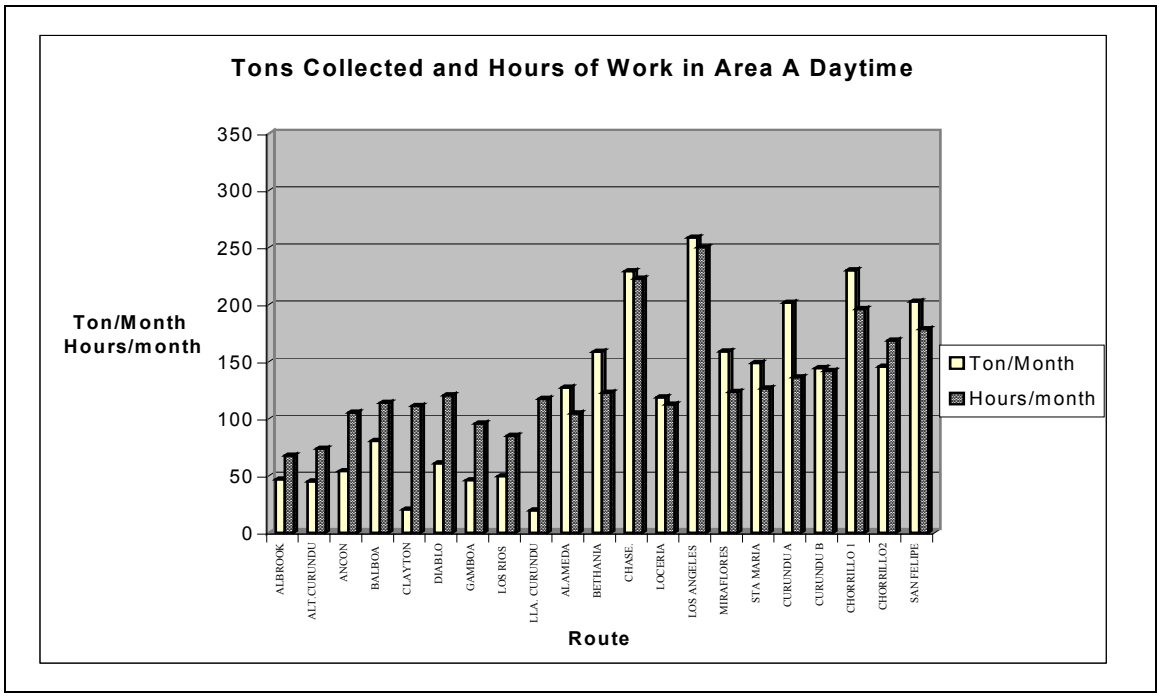


Figure D-8: Tons Collected per Month and Hours of Work in Area A Daytime

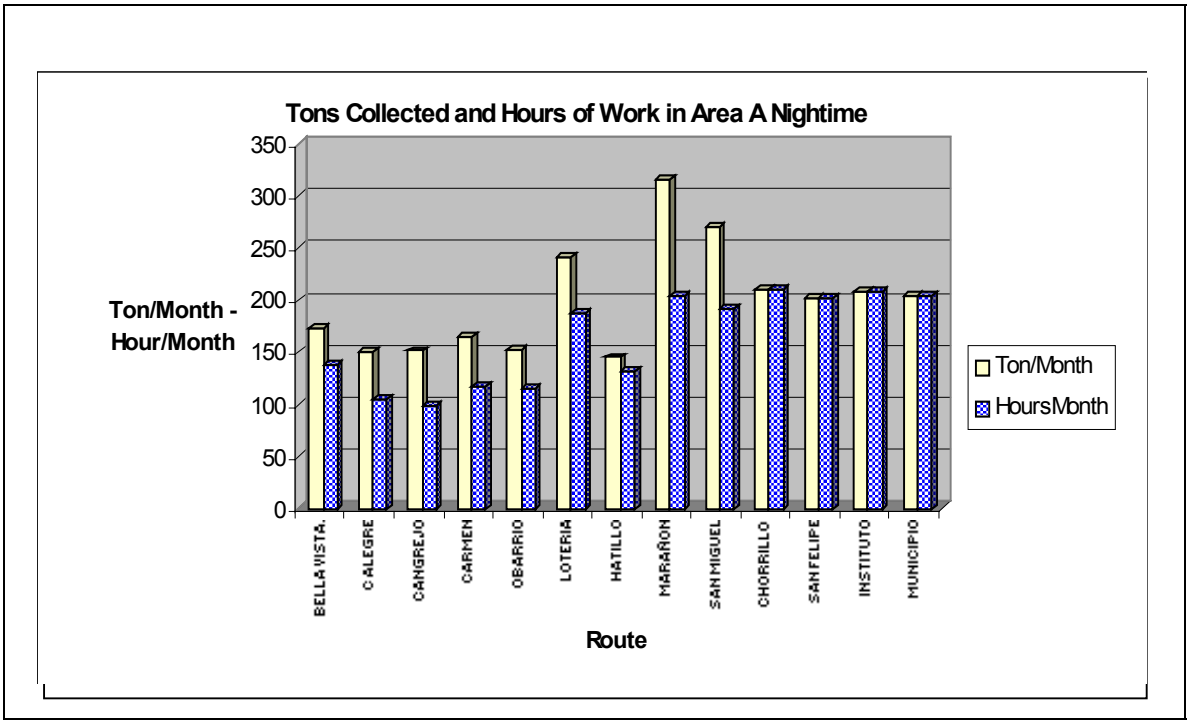


Figure D-9: Tons Collected per Month and Hours of Work in Area A Nighttime

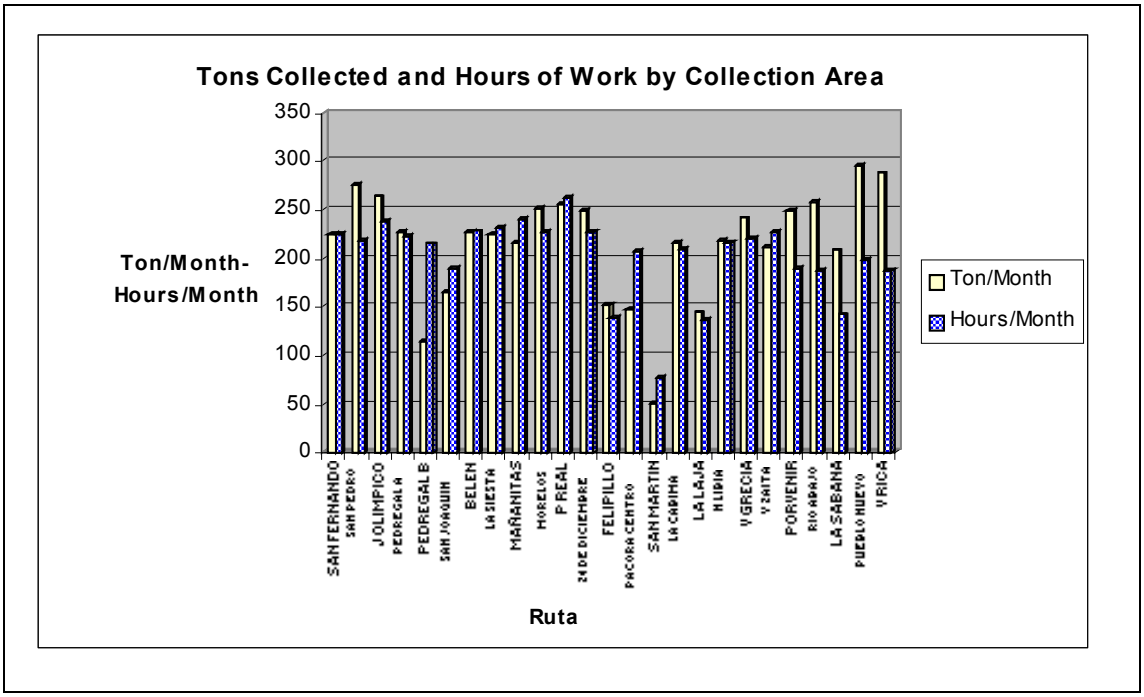


Figure D-10: Tons Collected per Month and Hours of Work in Area B Daytime

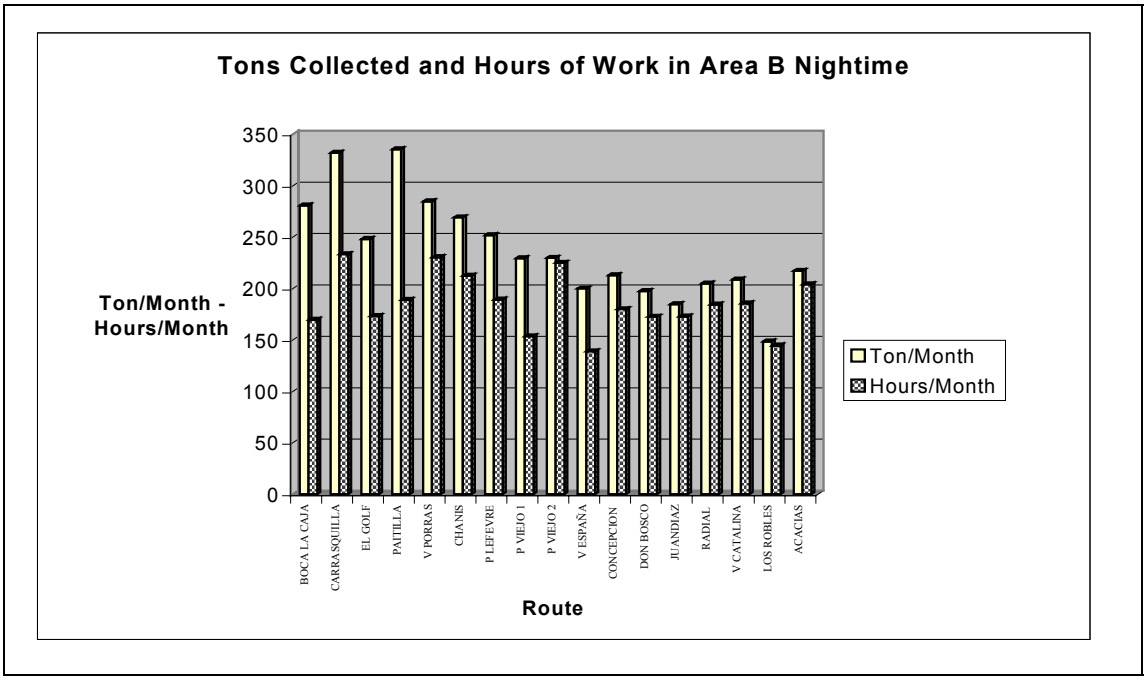


Figure D-11: Tons Collected per Month and Hours of Work in Area B Nighttime

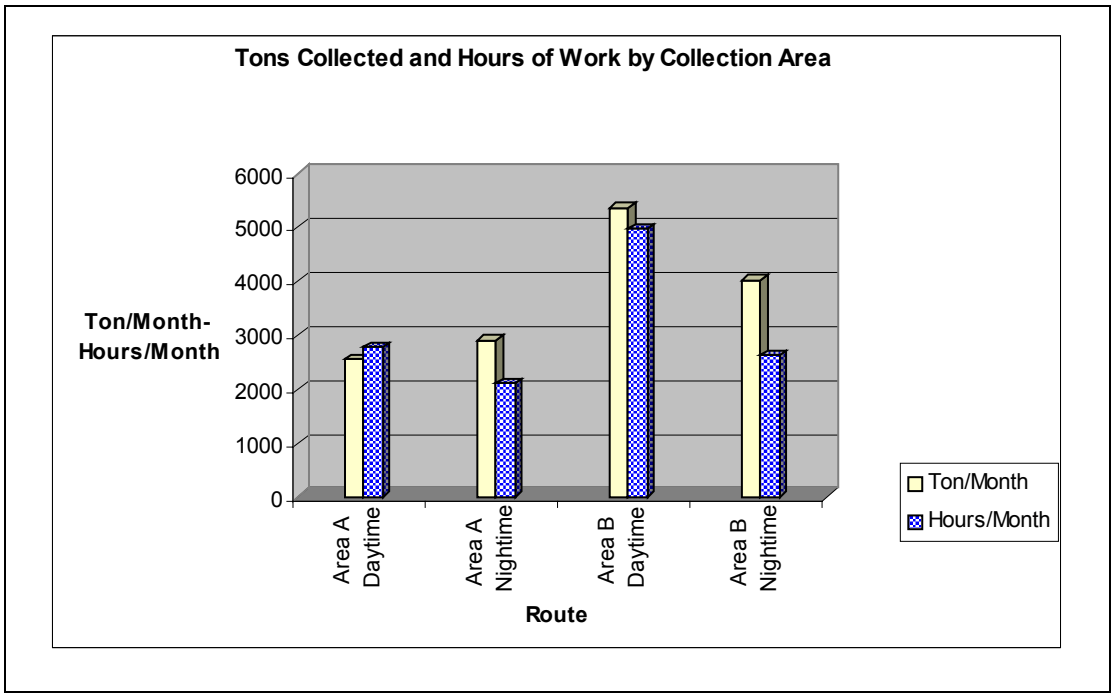


Figure D-12: Tons Collected per Month and Hours by Collection Area

The graphs show clearly that collections made during the daytime shift, specially for area A and more specifically for Ancon, require more hours; this should be due mainly to the large surface area of the corregimiento and the low population density. This value is critical, particularly for routes Llanos de Curundú and Clayton where only an average of 0,17 Tons/hour are collected.Both routes show, according to the records from Patacon, an average travel time between 3,5 to 4 hours/trip, with two trips per day; however, the truck load is smaller than 2,0 tons. Consequently, the routes should be modified in order to make a better use of the resources; in this particular case, two options can be explored. One option would consider reducing the number of trips to 1 per day, but ensuring to collect twice as much (4 tons) per trip; the other option would consider a reduction of collection frequency that would cause an increment of accumulated waste and, consequently, increase the load per trip. It has to be noted that these routes where designed following the direction of the Panama Canal Commission and it used to serve probably a larger population in the so-called Reverted-Areas.

In Area B Daytime, the performance is higher, with an average of 1.09 tons/hour of work.However, there are routes with performance less than 1ton/hour, e.g., Pedregal B with has a performance of 0,53.The largest value for Area B is 1.28 tons/hour.

For each one of the collection areas, the overtime hours where calculated per month per crew.Overtime hours are those worked after the regular eight hours per day per

route.Overtime does not account for 7 days a week working periods, holidays or others because it is assumed that there are regular crews available for that type of situations.

The following graph shows the number of monthly overtime hours per Area and their percentage with respect to the total number of overtime hours.

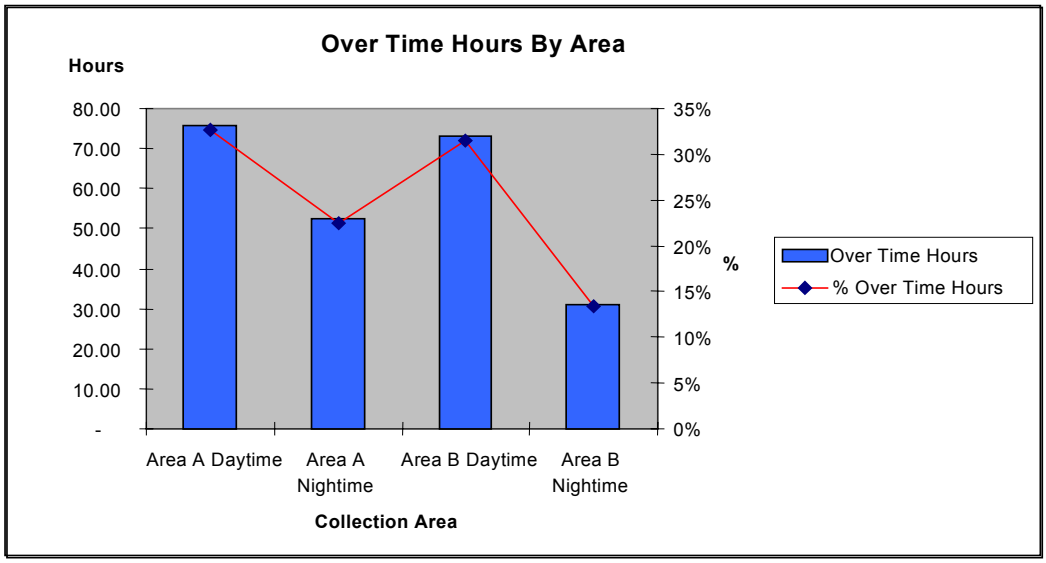


Figure D-13: Overtime Hours per Collection Area

During the Daytime shifts more overtime hours take place (64% of the total of overtime hours) around 149 hrs./month.On the other hand, Nighttime Area B produces less overtime hours (13% of the total of overtime hours).

The total number of overtime hours generated is approximately 232 hrs./month, if the crew is made of 3 collection workers and 1 driver, the total number of overtime hours is 928.

d. Section of the Collection Areas

d.1 Description of the Collection Areas and Zones

The collection service is directed to collect the household, urban, commercial, and institutional solid wastes that are the responsibility of DIMAUD.The service is divided into two large areas ¨Area A¨ and ¨Area B¨ which cover most of Panama District; the service collects from 18 corregimientos out of a total of 19 corregimientos.

Area A has its headquarters in Curundu, beginning from January 2002 it serves 8 corregimientos.The service area has a total of 173.405 persons and a surface of 683 km^2.The total amount of waste collected is 7.300 ton/month.

Area B has its headquarters in Carrasquilla, San Francisco corregimiento.Area B´s infrastructure is larger than Area A´s, consequently, Area B´s serve 10 corregimientos.The population served is 494.558 and the surface is 900 kms^2.Currently, 10.400 tons/month of waste is collected in that area.

Each one of the areas is divided into two sections, reflecting the two work shifts; on the other hand, each section is divided into collection zones.

Collection zones are made of collection routes.The following diagram shows the operative organization of the collection service.

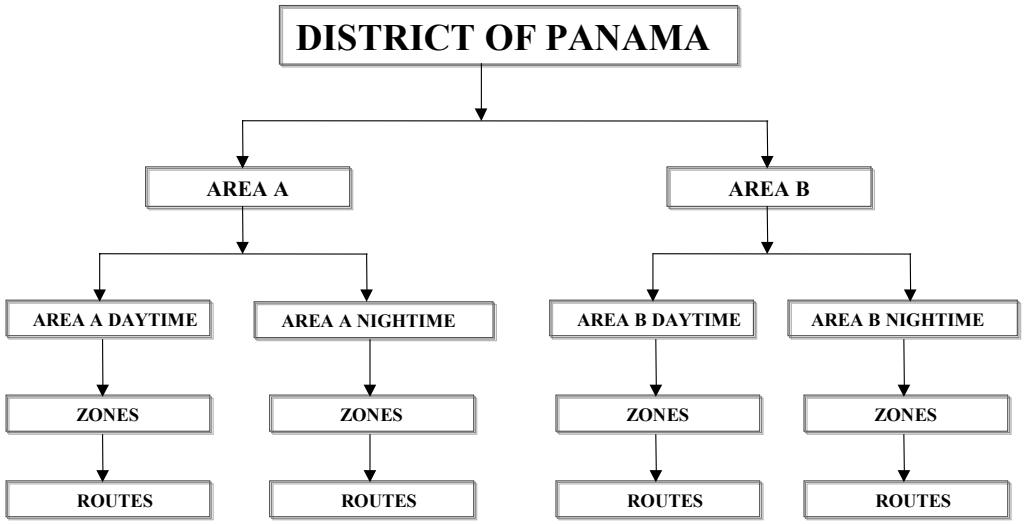


Figure D-14: Collection Service Operative Flow Chart

Daytime area A has 7 zones; each one has a maximum of 7 routes; nighttime area A has a total of 3 zones, each one of them with 5 collection routes.

Daytime area B has a total of 7 zones with 7 routes each one; nighttime area B has a total of 4 zones, each one of them with 4 collection routes.

d.2 Definition of Routes

Route is defined as the path followed by the collection vehicle to service 100% the assigned area during a shift; more than a trip to the final disposal site can be made to cover all this area.A specific path with an initial point and a final point should define the route; it should also include all control points to verify how it is performing.

For Panama District, the route is only defined by the sector to be serviced.The path to service this sector is not defined; the driver truck is the person who mostly define the path; as a result, the path is constantly modified and it is difficult to control, specially, if more than one trip is made to the landfill site.

As it was mentioned previously, the collection by DIMAUD includes not only household waste, but also industrial, commercial, hospital, and institutional waste.In order to collect all these different types of waste, the collection department has defined specific routes which includes:

Residential collection route: these are routes that generally are named after the sector it serves; they are designed to collect all the household waste from residential areas.However, occasionally some commercial waste is also collected in the service area.Compactors are usually used in this type of routes.

Frontal 1 and Frontal 2: these are routes within area A that require collection of containers of 4, 6, and 8 $yd.^3$.These containers are placed in specific sites, mainly in Ancon corregimiento, and allow the storage of organic, vegetables, urban wastes.The collection frequency is daily and commonly during the daytime shift.

Special i: the routes called Special i are designed to collect specially commercial, industrial, and institutional waste.The routes are defined as a function of the premises and institutions to be serviced.Through these routes, wastes from workshops, universities, schools, commercial establishments, food industries, etc. are collected.The collection is made during the daytime shift with compactors and dump trucks.

Hospital i: these routes are designed specially to collect wastes from hospitals, clinics, and health centres.However, some commercial and restaurant waste is also collected.Waste from Hospitals consists mostly of household type waste (leftovers from dining-rooms, administrative activities, etc.); organic pathological waste should not be included (it is unknown whether it is also being disposed or not).It belongs to the Daytime shift.

Yellow Bags i: these are routes designed to collect street sweeping waste.The routes are defined based on the urban cleansing program; generally, it takes place during the Daytime shift.The type of waste is urban.

Franchise: these routes serve mostly food companies with several branches, e.g., hamburger joints, big restaurants, etc.The route takes place during the night shift to prevent scavengers from dispersing this waste.Generally, waste is collected from inside the premises; this increases the collection time.

Pueblos i: the route covers mainly two important malls and some industries.The type of waste is commercial; they are collected during the daytime shift.

Airport: this is a collection route that covers exclusively Tocumen international airport.The collection shift is during the Daytime.

Bulky waste: this route collects big size waste from public roads, e.g., electrical appliances, rubbish, vegetal waste, etc.Generally, these routes are serviced by dump trucks due to volume of the waste.Containers are also used for this purpose; they are located according to the information provided by the community and inspectors.These routes can cover more than one corregimiento per trip.

Detailed information about routes (based on the previous characteristics) that currently provide a collection service is shown in the following table.The corregimientos associated to routes that are designed exclusively for residential waste are also shown.

Table D-13: Work Program for Area A

Area	Section	Zone	Routes		Corregim.	Frequency	Schedule
A	**Daytime**	1	01 Chase	02 Locería	Bethania	Every Other Day	06:00 - 14:00
			03 La Alameda				
			04 Viejo Veranillo	05 Curundú	Curundu	Daily	06:00 - 14:00
		2	01 Los Angeles	02 Miraflores	Bethania	Daily	06:00 - 14:00
			03 Bethania	04 Santa Maria			
		3	01 El Chorrillo	02 Barraza	El Chorrillo	Daily	06:00 - 14:00
			03 San Felipe	04 Mercado	San Felipe		
		4	01 Ancón	02 Balboa	Ancon	Every Other Day	06:00 - 14:00
			03 Diablo	04 Amador			
			05 Los Ríos	06 Albrook			
			07 Frontal 1				
		5	01 Altos de Curundú	02 Llanos de Curundú	Ancon	Every Other Day	06:00 - 14:00
			03 Paraíso	04 Clayton			
			05 Frontal 2				
		6	01 Especial 1	02 Especial 2		Daily	06:00 - 14:00
			03 Especial 3	04 Hospital 1			
			05 Especial 4	06 Hospital 2		Daily	12:00 - 20:00
		7	01 Bolsas Amarillas	02 Bolsas Amarillas		Daily	12:00 - 20:00
			04 Bolsas Amarillas	05 Bolsas Amarillas			
	Nighttime	1	01 Hatillo	02 Lotería	Calidonia	Daily	18:00 - 02:00
			03 Marañon	04 San Miguel			
			05 Franquicias				
		2	01 Instituto	02 Municipio	Santa Ana	Daily	18:00 - 02:00
			03 San Felipe		San Felipe		
			04 El Chorrillo		El Chorrillo		
			05 Despojos				
		3	01 El Cangrejo	02 Obarrio	Tocum en	Daily	18:00 - 02:00
			03 Campo Alegre	04 El Carmen			
			05 Bella vista				

Table D-14: Work Program for Area B

Area	Section	Zone	Routes		Corregim.	Frequency	Schedule
B	Daytime	1	01 San Fernando	02 San Pedro	Juan Díaz	Daily	06:00 - 14:00
			03 Jardín Olimpico				
			04 Los Pueblos 1	05 Los Pueblos 2			
		2	01 Pedregal A	02 Pedregal B	Pedregal	Daily	06:00 - 14:00
			03 San Joaquín				
			04 Hospitales 1	05 Especial 1			
		3	01 Parque Real	02 Belén	Tocumen	Daily	06:00 - 14:00
			03 Morelos	04 La Siesta			
			05 Mañanitas				
		4	01 24 de Diciembre	02 Felipillo	Pacora	Daily	06:00 - 14:00
			03 Pacora Centro	05 Tataré			
			04 San Martín		San Martin		
		5	01 Villa Grecia	02 Las Lajas	Las Cumbres	Daily	06:00 - 14:00
			03 Villa Zaita	04 Nueva Libia			
			05 La Cabima				
		6	01 Río Abajo	03 El Porvenir	Rio Abajo	Daily	12:00 - 20:00
			02 Las Sabanas	04 Villa Rica	Rio Abajo - Pueblo Nuevo		
			05 Pueblo Nuevo		Pueblo Nuevo		
		7	01 Bolsas Amarillas A	02 Bolsas Amarillas B		Daily	12:00 - 20:00
			03 Bolsas Amarillas C	04 Hospitales 2			
			05 Especial 2	06 Aeropuerto			
	Nighttime	1	01 Carrasquilla	02 Boca la Caja	San Francisco	Daily	18:00 - 02:00
			03 El Golf	04 Vía Porras			
			05 Paitilla				
		2	01 Panama Viejo 1	02 Panama Viejo 2	Parque Lefevre	Daily	18:00 - 02:00
			03 Chanis	04 Parque Lefevre			
			05 Vía España				
		3	01 Villa Catalina	02 Don Bosco	Juan Diaz	Daily	18:00 - 02:00
			03 Los Robles	04 Las Acacias			
		4	01 Concepción	02 La Radial	Juan Diaz	Daily	18:00 a 02:01
			03 Juan Diaz				
			04 Franquicias				

Consequently, the collection service includes: 79 residential collection routes, 2 Frontal routes, 6 Special routes, 4 Hospital routes, 7 Yellow Bags routes, 2 Franchise routes, 2 Pueblos i routes, 1 airport route.

The average tons collected in both areas are 22.000; 60% corresponds to waste collected in area B.Collection in residential routes during the night shift is 80% of that collected during

the daytime. Residential wastes collected in their corresponding routes represent the highest percentage of the wastes collected monthly.

The following tables the total waste collected by DIMAUD in the Panama District.

Table D-15: Total Waste Collected in the Panama District in November 2001 and January 2002

	November	January
	Ton/month	Ton/month
RESIDUOS DOMICILIARIOS	14600,9	16784,48
FRONTAL	274,49	542,7
ESPECIAL	582,06	488,39
HOSPITAL	681,96	721,42
BOLSAS AMARILLAS	478,03	596,27
FRANQUICIA	261,72	241,63
DESPOJO	255,87	253,76
LOS PUEBLOS	397,35	381,9
OTROS	477,06	982,99
TOTAL	18009,53	20993,54

The graphs show the percentages collected in every type of route.

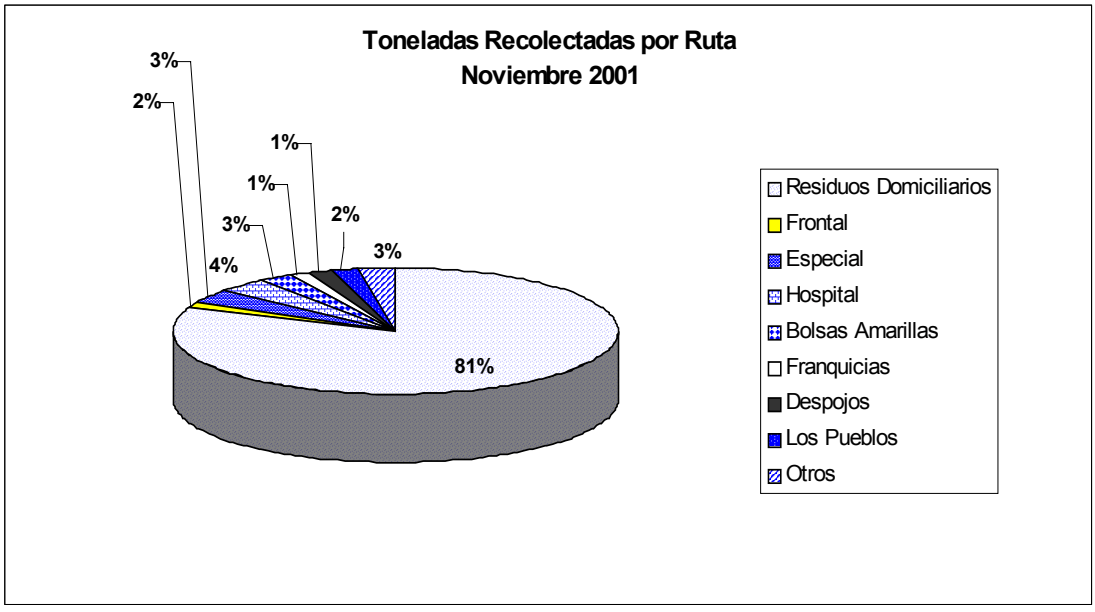


Figure D-15: Tons Collected per Route in November 2001

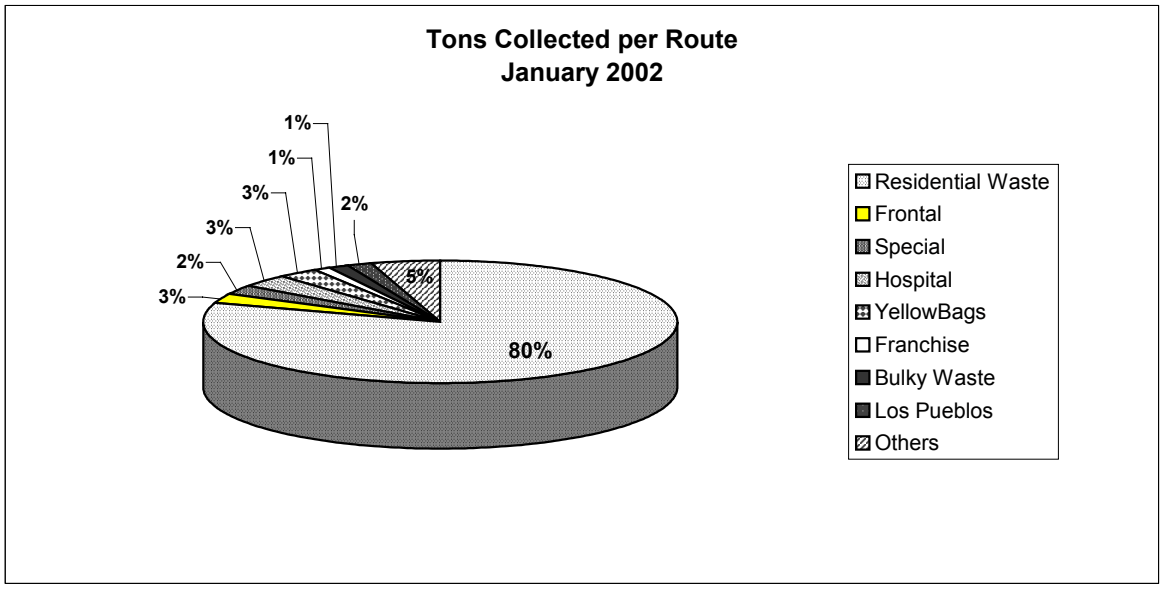


Figure D-16: Tons Collected per Route in January 2002

The collections service provided by DIMAUD covers 18 corregimientos out of a total of 19 corregimientos in the Panama District.In Chilibre, where the service is not provided, the Junta Comunal makes the collection and the wastes are disposed in the sanitary landfill of Cerro Patacon.

DIMAUD provides service to 667,963 persons, considering only the corregimientos where service is provided; this means a service coverage of 94%.

Table shown in the Data Book present background information corresponding to January 2002 for Area A and B (Daytime and Nignt-time for both of them). From these tables, it can be observed that only San Felipe and V. Porras routes were serviced during 31 days of the month as it is established by the collection program (daily frequency includes Sundays).The routes that were serviced less frequently are Albrook (11 days) and San Martin (9 days) which DIMAUD has designed as alternate routes with service (3) three times a week , and one organic collection. Most of the routes are serviced less frequently than what has been established; this can be confirmed by reviewing the collection days.Corregimientos Ancon and San Martin have a lower collection frequency (less than three times per week).Most of the routes provided service more than 22 days during the month; this indicates that collection frequency is higher than three times per week.

The following graphs show the daily tendency for areas with high and low collection frequency.

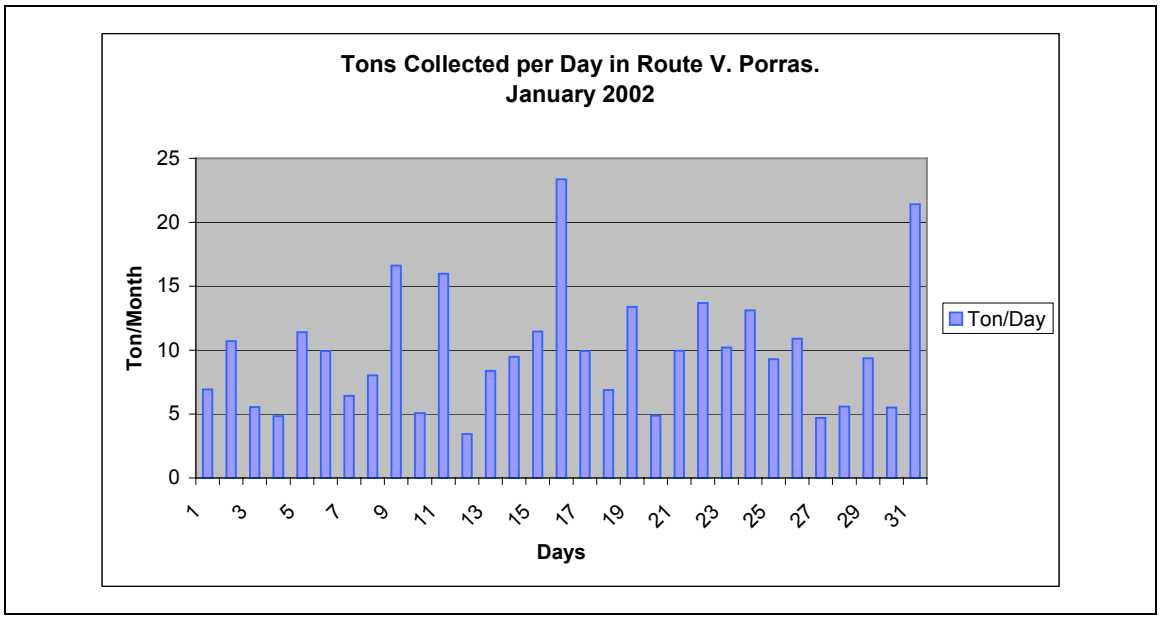


Figure D-17:Tons Collected per Day in Route V. Porras

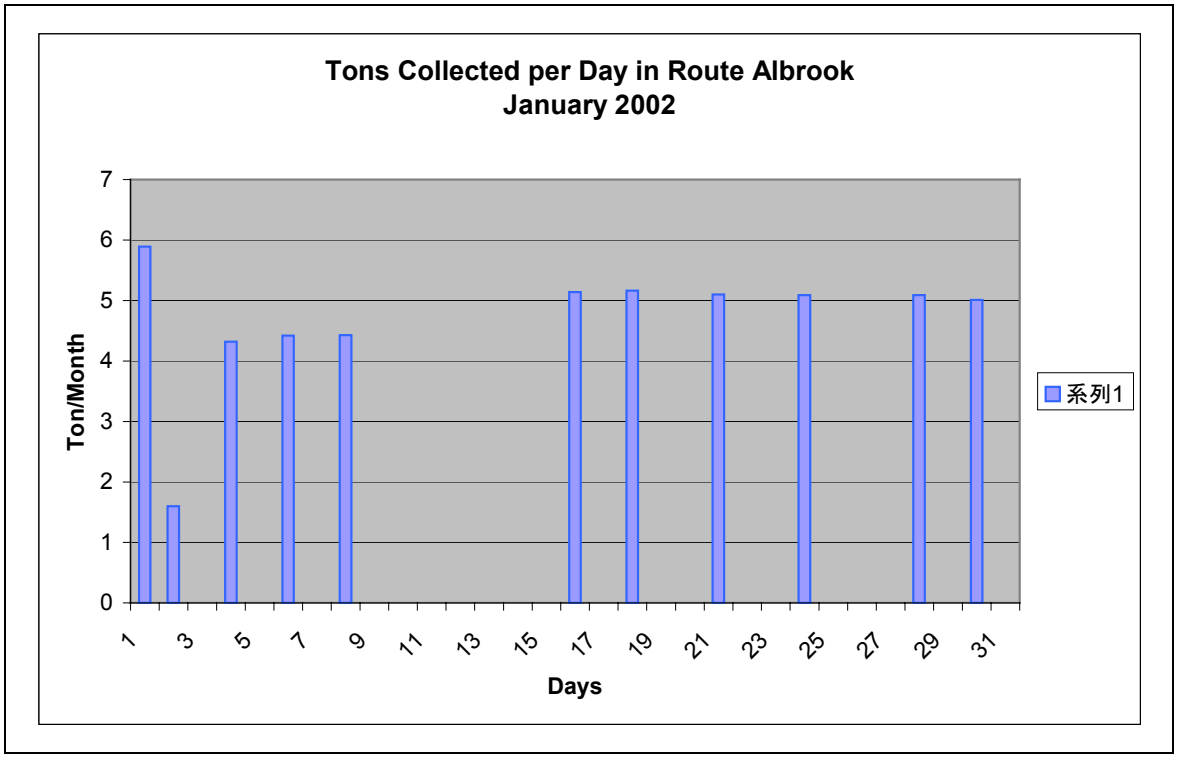


Figure D-18: Tons Collected per Day in Route Albrook

The first graph corresponds to routes with daily collection frequency. There are sharp variations of daily waste amount collected; these variations suggest that the same route is not followed everyday, specially if it is considered that this route service only residential waste.

In the Albrook route, there is an established frequency, however, it is affected by lack of equipment. In some cases, the collection service is not provided for up to one week and this

does not cause a sharp variation on the amount collected during the following days. Just in one occasion the service is provided every other day in Albrook during January.

On the other hand, according to Cerro Patacon´s record, the routes are generally finished within the established shift; however, there are large variations of travel time for the same route.

From the previous information, it is clear that the routes are not well defined; they provide service as they are required in an given sector.Frequencies are not followed as they were established mainly due to a lack of equipment.Although, the routes do not reach a daily frequency, there is only one corregimiento which does not provide service with a frequency of at least three times per week (Ancon).All the other corregimientos, in average, have frequencies higher than three times per week; they even reach a collection frequency higher than 4 days a week.

On the other hand, the average tons collected per trip are well below the loading capacity of the collection vehicle.Occasionally, there is more than one trip per route and for each trip the load does not reach 3 tons.If we assume the truck maximum loading capacity is 8 tons, one can conclude that the routes are not well designed and the collection efficiency is very low.

e. Collection Method

e.1 Collection Method within the Routes

Currently, there are three collection methods used by DIMAUD within the routes; they are the following:

- Collection Door to Door
- Collection Point to Point
- Mixed Collection

Door to door collection is done in most routes and where the collection truck can access without inconvenient.If the collection truck can not access easily, then the customer takes the wastes in bags to the nearest collection point.

Generally, wastes are stored in plastics bags which are placed in *tinaqueras* (metallic baskets lifted above ground located near the sidewalks or the houses).Additionally, plastic or metallic bins are used to store the wastes; among them, there are full or cut in half 55 gallons drums. From the field trips, it was observed that residents discharge their wastes at any time of the day; this situation favours waste scattering by scavengers (persons and animals) along the public roads.This type of discharge is caused by an irregular service.

Consequently, this daily and untimely collection leads to sharp variations of waste collected (as it was previously shown); waste collected can be the result of one day or just hours of waste generation.

Collection is made with compactor trucks and a crew of 4 persons (1 driver and 3 assistants).

Occasionally, waste collection workers go inside the house to collect the waste; this situation delays unjustifiable the collection works.Additionally, it is common to find waste scattered after collection works; this takes place because collection workers do not clean wastes on the streets and near the bins or plastic bags, as a result, the service quality is negatively affected because the streets look dirty even after collection works took place.

Collection point to point is done mostly through metallic containers that are collected by frontal or rear loading trucks.In the first case, the truck is equipped with a lifter for containers; in the second case, a hook has been adapted to lift the container that is not the most adequate system to load them.The containers capacity varies from 2 to 8 $yd.^3$.

For the container type of collection, the accumulation of waste turns out to be more evident; many containers were observed at full or above capacity because, generally,a large amount of bulky waste is disposed in this type of containers.On the other hand, for many cases, the containers were observed empty or half full; nonetheless, waste was observed around the container.This is closely related to environmental education among residents.

Additionally, for this type of collection, waste collection workers do not clean the container´s surroundings, that reflects poorly on the community´s image and shows low service quality.

A few months ago, plastic containers started to be used in San Felipe corregimiento.This new system might be more efficient and might have a positive effect on the landscape compared to the use of metallic containers.Additionally, the plastic container might be easier to handle and easier to wash than the metallic container; because of the foregoing DIMAUD is exploring the possibility to add new plastic containers to the system.

Mixed collection consists of door-to-door and point-to-point collection; this collection is preferably done in areas where both one floor and multilevel residential constructions are found.This system is also used in sectors where narrow streets are also found and collection vehicles are unable to access the houses.

e.2 Special Collection

Large Capacity Containers

There is another point-to-point collection system which consists of large capacity containers of 20 to 30 yd^3 which are lifted by roll-on/roll-off trucks.

This collection is done independently from the collection routes already defined; it is planned based on requests by the community (specially low income sectors where security is a factor to be accounted for).

Until January, there were two private companies which collected some of those containers (Corpinsa and Panama Nat Clean); currently, only Nat Clean is providing this service.

The containers are removed when the community informs or requests it or when the inspectors, during their field trips, assess there is a need to remove them.

Generally, this system causes the most problems because their sides reach around 2 mts. high; this causes difficulties to the community when disposing its wastes.During the field trips, it was observed how inadequate this system might be; most of these type of containers where observed empty; however, waste was observed surrounding these containers.This waste remained around the container even after the containers were removed.

For the Roll-on/Roll-off service, DIMAUD has two trucks and a total of 10 containers (9 containers of 30 yd^3 and 1 container of 20 yd^3).

Special Assignments (Operativos)

The collection department plans special assignments (*operativos*) during the year; the main objective is to eliminate illegal dumpsites, cleansing in rivers and creeks, cut any overgrowth, and cleansing of public roads.

Planning for these special assignments is done with several weeks in advance and their undertakings involve many weeks, but focusing on specific days.

The special assignments are undertaken in all corregimientos in the Panama District and human and material resources from DIMAUD are used.

Through these special assignments, the cleansing of specific areas is achieved, specially rural and low density areas; this improves overall sanitary conditions and minimize diseases produced by vectors.

f. Analysis of Collection Service

f.1 Control on Register Information

Background data from the sanitary landfill (incoming trucks) and from the Collection Department was gathered with the purpose to know how the Collection Service takes place in the Panama District. For the sanitary landfill case, the background data gathered through the software working in conjunction with the weighbridge was used; on the other hand, data was obtained from the daily and monthly reports of the Work Orders that the Collection Department manages.

The Work Order (W.O) is a register document that the Collection Department has implemented to control the service; this W. O. allows to collect background data on each trip made by every truck during the shift. For every trip the W.O. registers date, area, assigned zone and route, time to enter and exit from discharging in the sanitary landfill, identification of the personnel assigned to the truck, tons collected by trip, background of the collection vehicle and observations. This W.O. is given to the driver by the supervisor at the beginning of the service shift. When the shift is finished, the driver returns the W.O. to the inspector.

A report is elaborated daily based on the W.O.; on this report, the number of trips, tons, number of personnel, and hours of work are registered. Every section submits, on a monthly basis, a similar report with the same information.

The landfill site has two electronic weighbridges which allow to weigh all the trucks that transport waste and to control all the incoming waste into the site. The weighing is done only for incoming trucks because the database includes the weight of the empty trucks. These weighbridges are connected to a computer system which has a program that collects and stores the weighing data.

During the background data collection, it was confirmed that the sanitary landfill data is not kept according to codes, route number or name, waste origin, corregimiento, etc. Generally, this data is collected based on the individual criteria of the weighbridge operator; in many cases, this data is either incomplete or incorrect. Moreover, there are trips where the origin is not defined, in some cases, it was assumed that they belonged to DIMAUD. However, in some instances, it was not possible to define the origin. Additionally, there are records of the same truck with different numbers; this situation is due to the recent change of the internal number of the fleet; and it seems that neither the landfill personnel nor the drivers are aware of this change. Consequently, it is urgent to unify in the short term the criteria about the incoming vehicle data and to unify them with the collection department in order

conduct easily and in short time the collection service control. Furthermore, it is necessary to report on a daily basis to the collection department about the incoming DIMAUD vehicles with the purpose to verify their background and be able to solve any discrepancy within 24 hours.

The register of incoming vehicles to the landfill site is a useful tool because not only allows to have the number of trips and tons collected, but it also helps to verify time elapsed within the sanitary landfill and between trips; additionally, this register can help to establish whether the wastes collected are originated from the established routes (type or origin of waste established through visual inspection).

In order to verify if collection control data is similar from the two sources (weighbridge data and W.O. derived data), the tons and number of trips for November 2001 and January 2002 were established.

Specifically, the data corresponding to residential collection routes were analyzed; they should correspond to the program previously defined. The background information obtained is summarized in tables shown in the Data Book.

The data obtained from the Sanitary Landfill includes all those trips into the site which have been identified to be originated in those specific routes. The data from the Collection Department corresponds exclusively to the Work Orders elaborated during the respective study months.

From the tables, it is easy to establish a clear difference between the information used in the sanitary landfill and by the collection department. However, until today a system to coordinate both areas has not been established; this system would verify the certainty of the data and would assist to define the cause of the discrepancies.

The following table summarizes the controls for each one of the corregimientos.

Table D-16: Tons and Trips derived from the Collection Department and Landfill Data for November 2001 and January 2002

Corregimiento	Tons				N° Trips			
	Collection Control		Landfill Control		Collection Control		Landfill Control	
	November	January	November	January	November	January	November	January
ANCON	440.31	421.88	427.22	455.32	135	135	127	147
BETHANIA	1202.62	1199.38	1195.15	1692.62	205	231	223	343
CURUNDU	324.53	345.80	440.57	397.74	67	119	99	89
CHORRILLO	615.15	686.13	637.78	789.89	124	81	130	160
SAN FELIPE	267.01	447.45	397.67	390.94	73	103	101	87
BELLAVISTA	1355.51	789.47	1396.84	1527.27	244	145	253	285
CALIDONIA	907.84	973.44	1034.77	1083.55	172	194	207	222
SANTA ANA	505.64	582.51	491.58	597.18	46	115	94	116
JUAN DIAZ	1764.61	2137.51	1699.35	2179.93	321	428	311	429
PEDREGAL	584.22	506.70	650.27	687.50	111	134	122	145
TOCUMEN	1123.36	1172.61	1245.41	1208.16	202	241	222	251
PACORA	526.77	548.46	586.28	602.30	78	109	100	128
SAN MARTIN	42.30	50.14			8	8		
LAS CUMBRES	840.28	1032.14	918.68	1099.19	166	217	170	228
RIO ABAJO	405.34	506.99	471.44	443.91	77	91	89	84
PUEBLO NUEVO	577.18	790.70	551.59	687.14	108	151	99	127
SAN FRANCISCO	1278.44	1480.44	1279.52	1512.10	189	260	222	285
P LEFEVRE	1114.88	1179.72	1176.87	1429.74	174	224	205	269
GRAND TOTAL	13875.99	14851.47	14600.99	16784.50	2590	2997	2774	3395

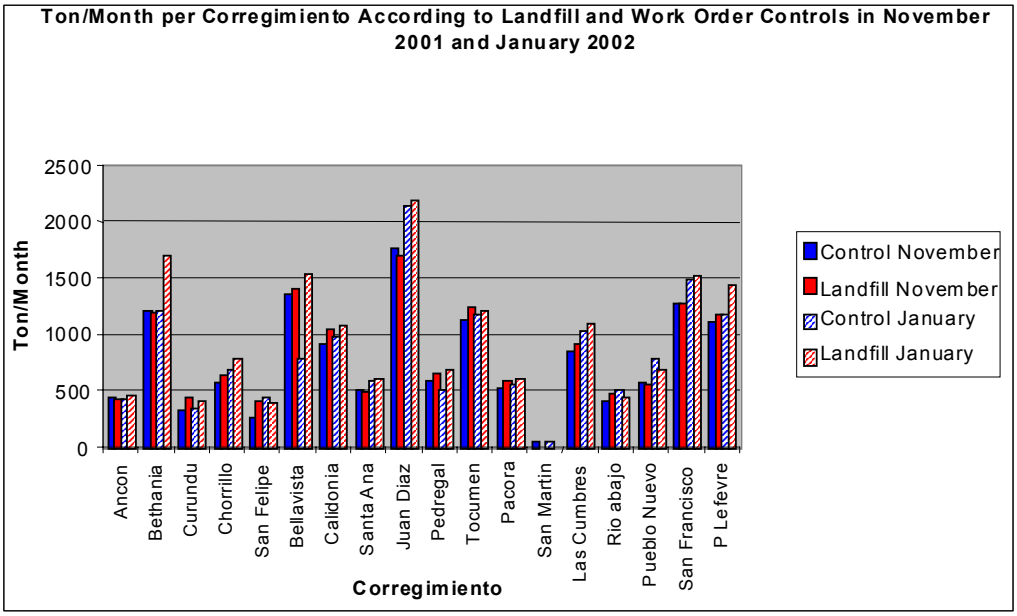


Figure D-19: Ton/month per Corregimiento According to Landfill and Work Order Controls for November 2001 and January 2002

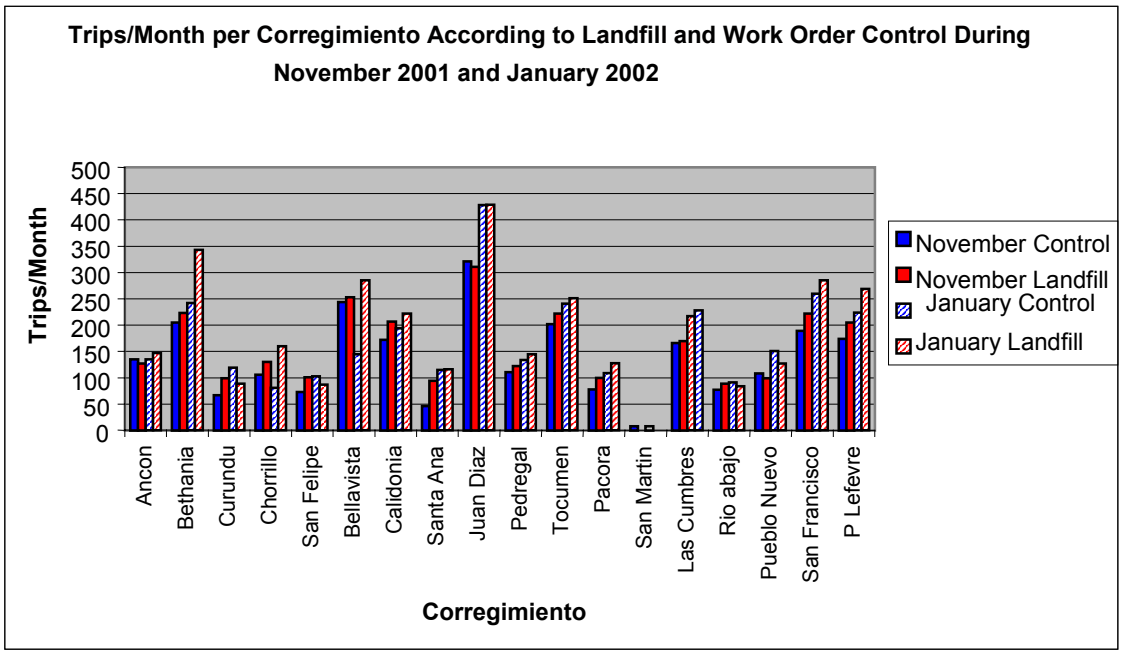


Figure D-20: Trips/month per Corregimiento According to Landfill and Work Orders Control for November 2001 and January 2002

For the Curundú, Chorrillo, Bella Vista, Calidonia, Santa Ana, Pedregal, Tocumen, Pacora, Las Cumbres, and P. Lefevre routes, for both months (November 2001 and January 2002), the tons measured in the sanitary landfill are larger than that shown in the Work Orders. For example, in November, 6% more tons are reported from the landfill records than from the Work Orders; on the other hand, in January, it is reported 13% more tons from the landfill records than from the Work Orders. The discrepancy is also reflected in the number of trips on which the same tendency is reflected (see the next graph). The data analyzed reflects only the routes, it has not been included the contribution from rented vehicles or other services. The figures between the Collection Control and the Landfill Control should be equal. Consequently, it is clear that the controls are not being kept correctly and this can interfere in the evaluation of the service (for instance, San Martin route is not reflected in the Landfill control). Moreover, this situation can have a strong impact on the costs and income.

It is evident that it is required as soon as possible to establish a coordination between the sanitary landfill and the collection department with the purpose to control effectively the amount of wastes collected. Additionally, it is required to modify the monitoring of the service and the work order formats; this should be done jointly with the personnel training which is responsible to reflect this information on the formats.

f.2 Collection Routes Analysis

The collection routes performance was analyzed from the daily and monthly reports obtained from the W.O. Control Efficiency Indicators were defined for both November 2001 and January 2002. Efficiency indicator tables which were derived from Work Order Data are shown in the Data Book.

The indicators defined in those tables correspond to:

Days of work/week (1): This information helps to define the number of days when wastes are collected during the week; this indicator assists to verify if the frequency defined for the route is being followed.

Collected Tons/trip (2) : This information helps to define if the sectors and collection routes have been established adequately and to control overload of the vehicles. It serves as a base for measuring and charge for the service.

Tons/Man/day (3): This information helps to define the daily performance of the collection workers with respect to the amount of wastes collected.

Men/day(4): This information helps to define the number of collection workers that are required on a daily basis for each collection unit. An increment or reduction of this figure is reflected on the cost of the service.

Tons collected versus hours of work (5): This information is used to know and make a projection of the service operative costs (direct costs-labor) as well as to verify monthly if the relationship of tons collected correspond to the amount of hours paid to execute the service.

Hours/days (6): This information is used to verify that the route is completed as scheduled. An increment or reduction of this figure with respect to the legal working hours is reflected clearly on the service costs. An increment of this figure is reflected on the labor costs because it might imply an increment of overtime hours. On the other hand, a reduction of this figure shows clearly an inadequate route program because non-productive times are generated on a daily basis.

Indicators for each one of the routes Tables in the Data Book show indicators for Areas A and B (Daytime and Night-time).

Once these indicators have been calculated, the average values were defined for each corregimiento. For those corregimientos with night-time and daytime collection, the indicators were defined for each situation because the traffic conditions change.

Regarding the Days of Work per Week indicator, it was confirmed that there is one corregimiento with real daily service (San Felipe). However, only the daytime shift has daily collection in San Felipe because the night-time shift has a collection service of 6 days per week.

All the corregimientos have a collection frequency larger than three times per week except San Martin which only has a frequency of two times per week. By analyzing each corregimiento, it can be determined that Llanos de Curundu route has only one day of service per week.

The previous values correspond to averages within a route. If the background information for each route is reviewed, it can be observed that there are sectors where there is not a definitive collection frequency pattern; consequently, the residents have some uncertainty regarding the waste discharge and, as a result, they tend to discharge the wastes in the public road at any time of the day.

Taking into account that the daily collection frequency is not followed as planned, the routes' collection frequency can be modified by considering a variation of daily collection (daily except on Sundays) or by considering a collection of three times per week. This new route

design would reduce costs and would allow to keep a maintenance program for the fleet. Additionally, as the route design is closely followed, a better response from the service user will be received because the residents will have certainty that the service will be executed at the day and hour established.

The following graph shows the indicator's values for the corregimientos.

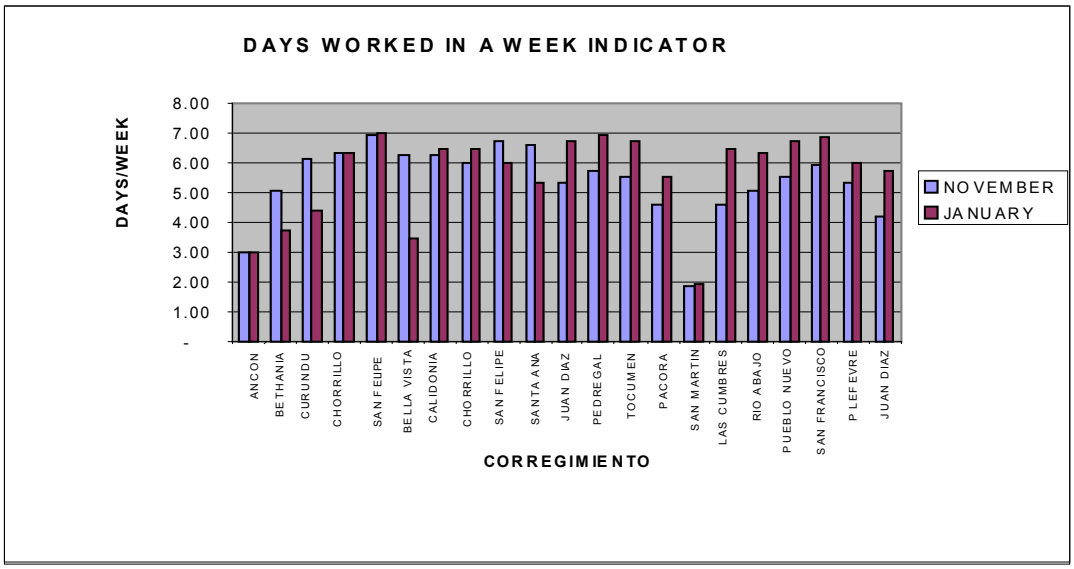


Figure D-21: Days Worked in a Week Indicator

Similar to the previous case, the indicator of tons collected per trip per route was determined for each route and each corregimiento as an average.

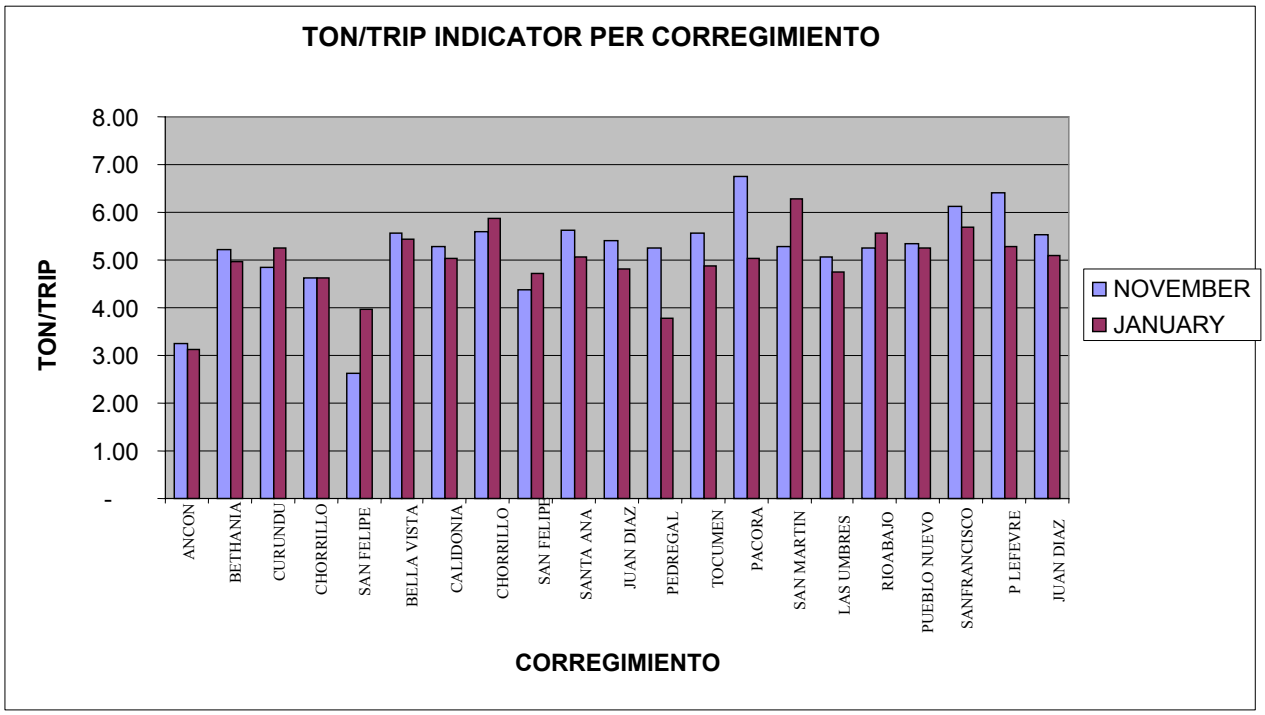


Figure D-22: Ton/Trip Indicator per Corregimiento

The results show that most of the corregimientos have an average value of 5 to 6 tons per trip. The corregimientos of Pacora, San Martin, San Francisco, and Parque Lefevre have average values higher than 6 tons/trip which is shown mainly during November for three of the corregimientos

Closely reviewing the index value for each route, it can be observed that there are some routes with average values between 4 to 5 tons/trip. The values for Ancon where most of the waste is collected with dump truck are not included.

In order to have a better knowledge about the tons transported per trip, the average of tons/trip for each collection vehicle was calculated for November and January from the weighing control in the landfill site. The tables which reflect the Fleet use for November 2001 and January 2002 are included in the Data Book.

With the background data available, it was determined the tons transported and the total number of trips during the months under study. With this data, it was calculated the average tons transported and the percentage of load with respect to the vehicle capacity.

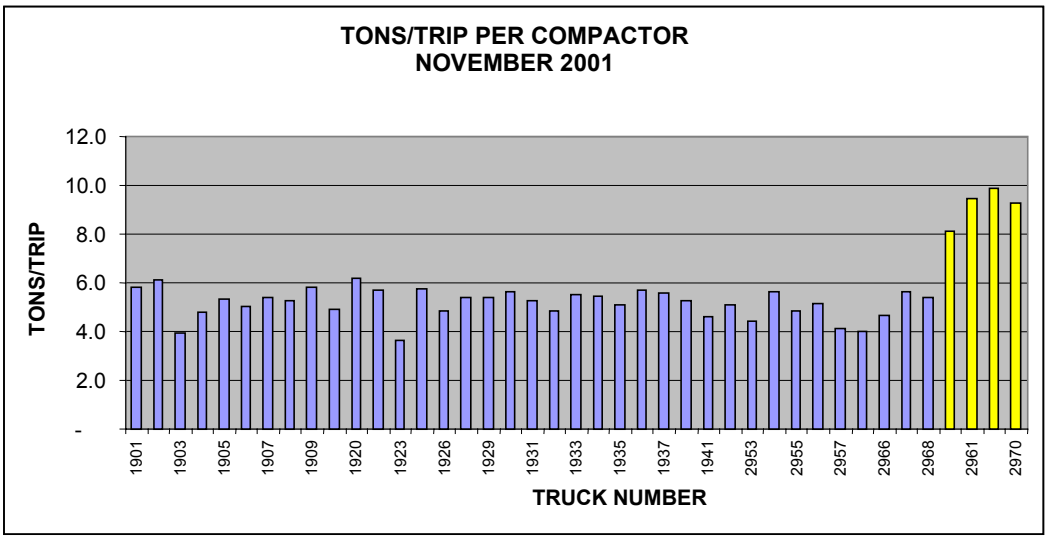


Figure D-23: Tons/trip per Compactor for November 2001

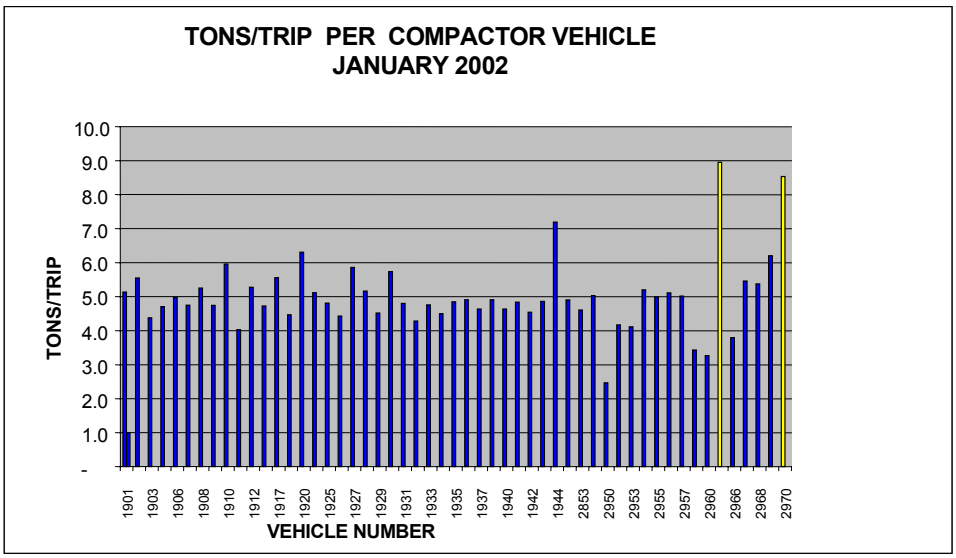


Figure D-24: Tons/trip per Compactor for January 2002

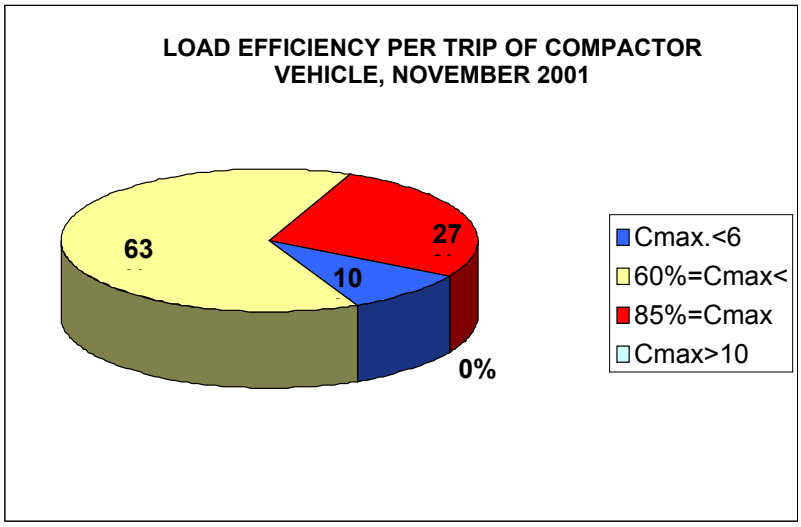


Figure D-25: Load Efficiency per Trip for Compactor Vehicle in November 2001

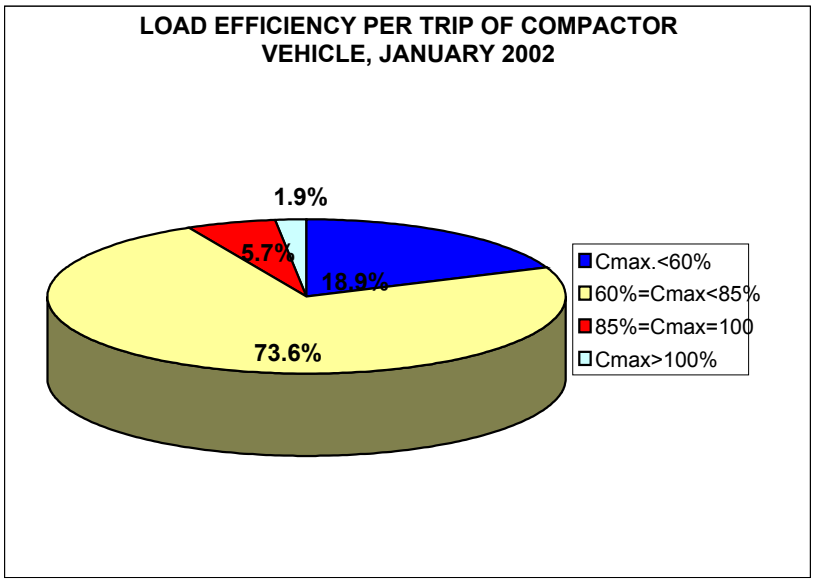


Figure D-26: Load Efficiency per Trip for Compactor Vehicle in January 2002

For the case of the indicator tons/man/day, 2.6 tons collected per man per shift was obtained as an average. There are many routes with values between 1 and 2 tons/man/day and the most critical route was Los Rios with 0.5 tons/man/day. The best performance was obtained in the Carrasquilla route with 4.5 tons/man/day.

It was verified that the crew is made up of three collection workers and one driver.

The mean values obtained per corregimiento for the last two indicators (tons collected versus hours of work and Hours of work/day) are shown in the following graphs.

The indicator hours of work/shift shows that 38% of corregimientos have more than 8 hours of work per shift during November 2001, this percentage increased to 43% in January 2002 which represents an increment of overtime hours. If both indicators are analyzed, it can be concluded that the collection workers have a low performance regarding tons collected, however, they have to work more hours than those defined in a regular shift. This situation leads to an increment of labor costs due, in first place, to the inability of the collection workers to collect the amount of waste typically collected under normal conditions. Additionally, if we consider that the crew has to follow a work plan which is not completely satisfied during the regular shift; they have to compensate this situation with ove JANUARY rs. The current situation might be improved by designing new routes with fixed paths, but this measure has to be done in conjunction with more monitoring of the tasks performed by collection workers and drivers.

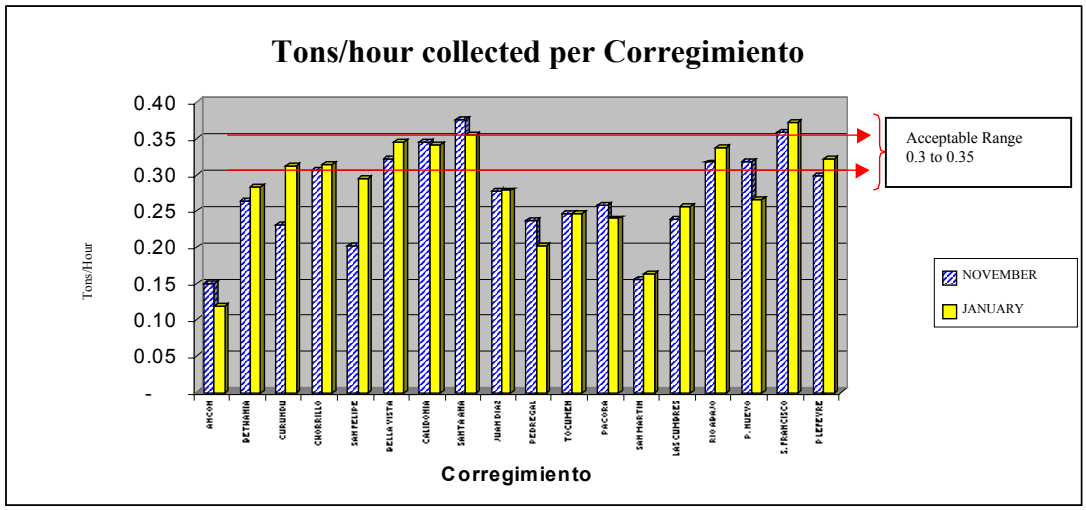


Figure D-27: Tons/hour Collected per Corregimiento

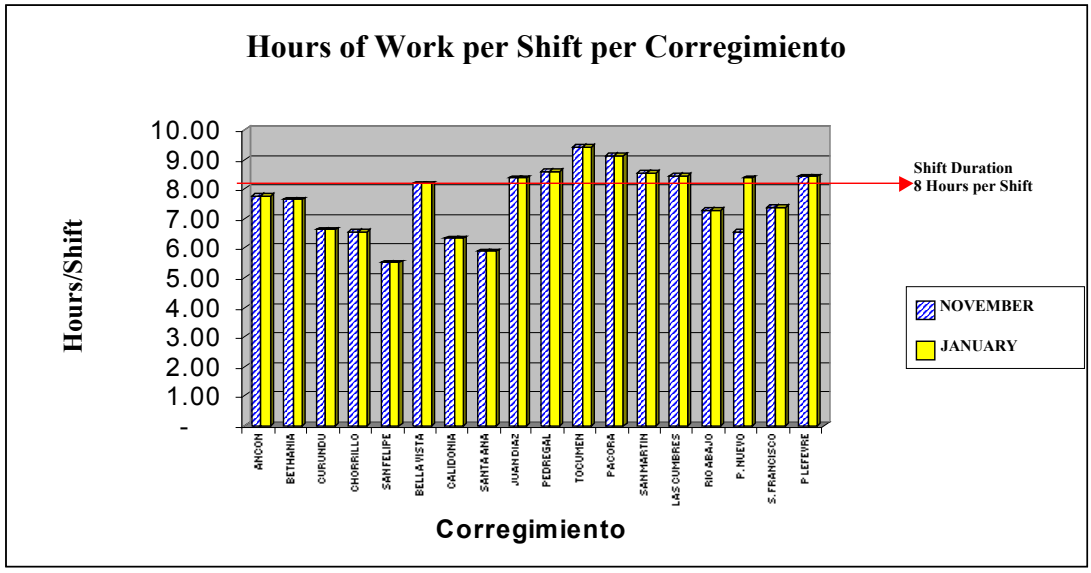


Figure D-28: Hours of Work per Shift per Corregimiento

The indicator hours of work/shift shows that 38% of corregimientos have more than 8 hours of work per shift during November 2001, this percentage increased to 43% in January 2002 which represents an increment of overtime hours. If both indicators are analyzed, it can be concluded that the collection workers have a low performance regarding tons collected, however, they have to work more hours than those defined in a regular shift. This situation leads to an increment of labor costs due, in first place, to the inability of the collection workers to collect the amount of waste typically collected under normal conditions. Additionally, if we consider that the crew has to follow a work plan which is not completely satisfied during the regular shift; they have to compensate this situation with overtime hours. The current situation might be improved by designing new routes with fixed paths, but this measure has to be done in conjunction with more monitoring of the tasks performed by collection workers and drivers.

f.3 Comments

The collection service is planned to service 18 corregimientos out of a total of 19 which make up the Panama District. In order to provide service, there are 103 routes which are distributed in three daily shifts.

The system design establishes 15 routes with collection service three times per week, and 88 routes with daily collection service, including Sundays.

The routes are defined by sectors and do not correspond to a specific path.

As a result of the study, it can be concluded that the service does not follow the program neither for the days scheduled nor for the hours. This situation becomes more critical in places where no container is located, but specially those places where large containers are placed (over 20 yd^3).

In spite of the fact that the planned frequencies are not followed, the service days are high. This figure is reflected when we evaluate the percentage of days serviced in each corregimiento. A 28% of corregimientos is serviced 7 days a week, 39% is serviced 6 days a week, and only 6% of the corregimientos is serviced less than three times per week.

It has also been established that there are an important number of vehicles being repaired. The most critical situation was registered in November when 43% of the fleet could not provide service; additionally, 19% of the remaining vehicles went to the landfill site less than 5 days. The condition of the trucks prevents the municipality to provide a service as planned, specially considering that they should work everyday during a month and three times a day.

The service shows important delays due to mechanical failures within the route. There are not either enough replacement vehicles; consequently, the collection can not be completed on occasions or the collection would continue after other truck has finished its assignment.

This previous condition would be improved in the short term because DIMAUD is considering to acquire 16 back loading compactor trucks (16 yd^3 capacity).

On the other hand, the routes would have to be redesigned because the trucks are currently making trips to the landfill site below capacity. This situation causes that more trips are made to the landfill site than necessary; consequently, less time is spent on collection works and also this leads to a deficient monitoring of the service. The routes can be expanded with a new design which would reduce the total number of routes and, consequently, the number of trucks. Additionally, the haulage time would be reduced because the number of trips would decrease. Lastly, the personnel can be controlled on the site to verify if they have fulfilled their duties.

The service control system undertaken by the collection department requires maintaining constant information with the sanitary landfill. This permanent exchange of communication would allow to check all the information related to tons, hours the trucks go into or exit the landfill site; specially, if we take into account that background information do not match today.

It is also important to review the service planning in order to maximize the use of resources. Currently, the service quality (from the user perspective) has improved. The community

commonly express that a positive change has occurred; however, now it is vital to adjust the service to achieve better performances.

g. Haulage, Quantity and Characteristics of every vehicle

g.1 Background of the Fleet

DIMAUD has a fleet of 174 vehicles; among these vehicles, we can find the collection vehicles. The active equipment is the following:

Table D-17: Active Equipment and Number of Units

Description	Number of units
PANEL	6
SWEEPER	2
SMALL BUS	2
MEDIUM VEHICLE	7
WATER TANK	1
COASTER	2
COMPACTOR	62
FRONTAL	9
CRANE	2
JEEP	1
MONTERO	1
MOTORCYCLE	2
PICK UP	44
EXCAVATOR	6
ROLL ON	2
SEDAN	4
DUMP-TRUCK	23

Note: This information reflects the situation up to March 2002

For the good development of the collection service, DIMAUD has a fleet of 62 back loading compactors, 9 front loading compactor, 26 dump-trucks, 2 roll-on roll-off trucks.

As support equipment, DIMAUD has six excavator which are used mostly for small dump sites; additionally, there are 2 cranes and pick-up vehicles for supervision.

In the Data Book, there are tables which show the characteristics of compactors and dump-trucks which are used for the service.

Summarizing, the collection department has the following compactor vehicles:

Table D-18: Compactor Vehicles in the Collection Department

Name		Quantity	Year	Characteristics
Compactor	16 yd3	34	1999	Backloading Heil F-4000, International chassis 4700, 2 axis.
Compactor	16 yd3	13	1998	Backloading Heil F-4000, International chassis 4700, 2 axis.
Compactor	20yd3	8	1997	Backloading Heil F-4000, International chassis 4900, 3 axis.
Compactor	16 yd3	6	1998	Backloading EZ-Pack Peabody, Ford chassis F-800, 2 axis.
Frontal Compactor 25	25 yd3	4	1994	Frontal loading Demspter, Mack chassis RD600, 3 axis.
Compactor	16 yd3	4	1992	Backloading EZ-Pack Peabody, Ford chassis F-800, 2 axis.
Compactor	16 yd3	1	1994	Backloading Heil F-4000, International chassis 4700, 2 axis.
Compactor	11 yd3	1	1994	Backloading Heil F-4000, Ford chassis 800, 2 axis.
Compactor	16 yd3	2	1995	Backloading Heil F-4000, International chassis 4700, 2 axis.
Compactor	25 yd3	2	1996	Frontal loading EZ-Pack Front Loader, chassis Volvo Wx64, 3 axis.
Compactor	16 yd3	1	1996	Backloading Heil F-4000, International chassis 4700, 2 axis.
Compactor	16 yd3	1	1997	Backloading Heil F-4000, International chassis 4700, 2 ejes.
Compactor	36 yd3	2	2000	Frontal loading Mack chassis MR6885.
Compactor	11 yd3	1	2201	Backloading Heil F-4000, International chassis 4700, 2 axis.
Compactor	16 yd3	1	1997	Backloading Heil F-4000, International chassis 4700, 2 axis.

g.2 Operation Capability of Collection Vehicles

One of the vital aspects of the solid waste collection service is the vehicle condition and its operation capability. The service quality will be affected if the trucks are not available on time as required because the scheduled program already established can not be followed as planned. Other factor that can affect the service quality is the number of vehicles per fleet which should correspond to the number of routes and shifts during the day.

Generally, the collection systems consider the operation of vehicles to be done during two shifts in the day with 8 hours each shift. One day during the week is considered for preventive maintenance.

With the objective to know how the current collection fleet operates, an analysis of the condition and operation level for the equipment was done. In this analysis, it was verified

the number of days the vehicle has operated in the two months of study; this information helps to measure the real number of vehicles that operate during a month, the percentage of trucks which have had failures, and the time that they require to be repaired.

On the other hand, an estimate of the fleet required for the service can be calculated with the amount of waste collected; this estimate can be compared to the current number.

The background information from the vehicle accessing to the landfill site was used. In this control, it is recorded the vehicle number, the time to enter the landfill site, the origin, and tons of waste transported.

The first step was to verify the number of vehicles that provided the service during the investigation period; this was done independently from the number of days of work. Based on the previous criteria, it was determined that during November only 56 vehicles worked (44 compactors and 12 dump-truck) which represent 57% of the fleet. During January, the number of vehicles that worked was 62 which represent 62% of the fleet.

It was also confirmed that from the total fleet which seems to be active, there are 10 dump-trucks and 8 compactors that do not appear to provide service during the two study months.

If the operative days are reviewed for each vehicle, we can verify that there is an important number of failures during the month; in fact, during November the average number of days of work was 19.8, in January this number decreased to 18.8.

In order to have a better understanding, the percentage distribution of vehicles as function of days of work was calculated. Seven time ranges were defined; the graph shows the results.

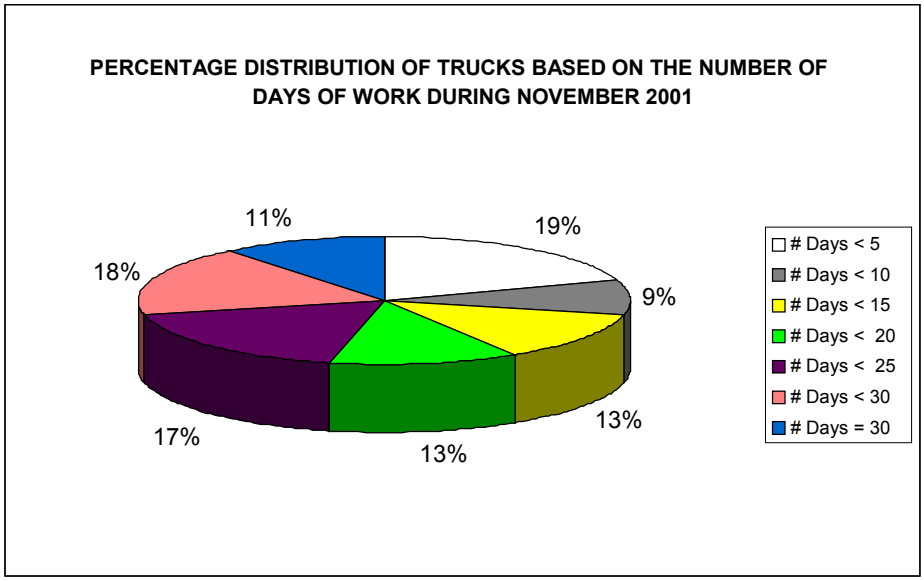


Figure D-29: Percentage Distribution of Trucks Based on the Number of Days of Work During November 2001

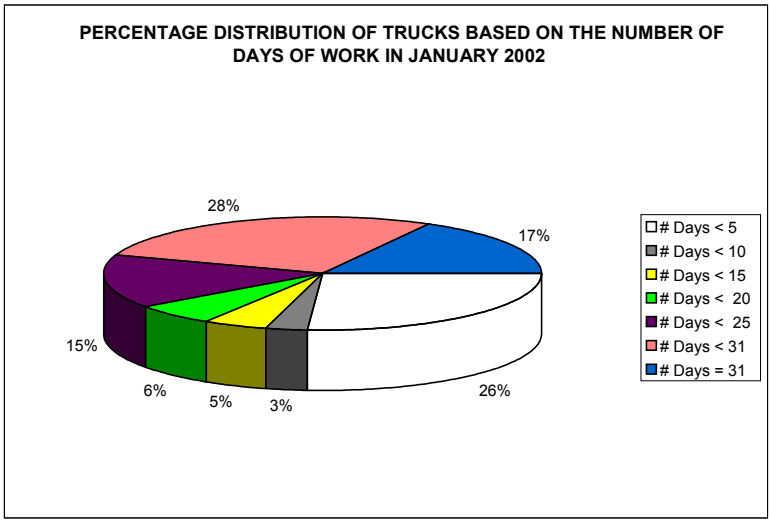


Figure D-30: Percentage Distribution of Trucks Based on the Number of Days of Work During January 2002

In both graphs, the white color shows the percentage of vehicles that worked less than 5 days per month; this figure reaches 26% of the fleet in January. During this same period, it is shown the highest percentage of vehicles which worked continuously during a month; it is logic to assume that those vehicles which are not damaged should cover more routes.

With the purpose to have more details with respect to the performance of the vehicles, graphs were produced for some of them which reflect the days of work in a month. These graphs were associated to the number of trips made in a day in order to observe how this resource is used.

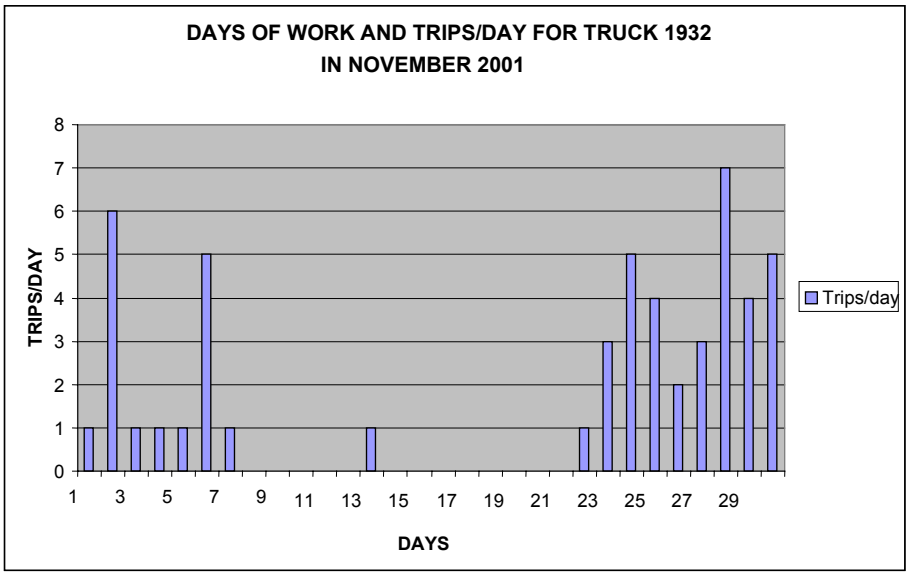
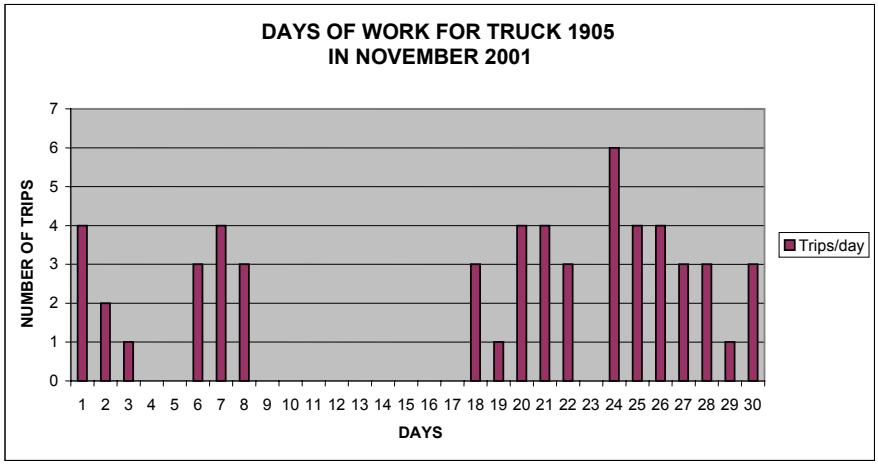


Figure D-31: Irregular Operation Schedule and Trips/Day for Truck 1932 in November 2001

Figure D-32: Irregular Operation Schedule and Trips/Day for Truck 1905 in



November 2001

The previous graphs show the performance of two backloading compactors which were manufactured in 1999. In the two graphs, it is clear how irregular the days of work are; both of them show alternate days of work and inactive periods longer than a week; it is evident that these periods correspond to some sort of mechanical problem. On the other hand, these trucks show days with high workload (making between 7 to 6 trips to the sanitary landfill); this situation reflects a deficiency of trucks during that specific month.

If we consider the average number of days that the fleet work, there is a considerable number of trucks which are damaged and do not operate; consequently, it is presumed that this is the main cause why they can not satisfy the planned service.

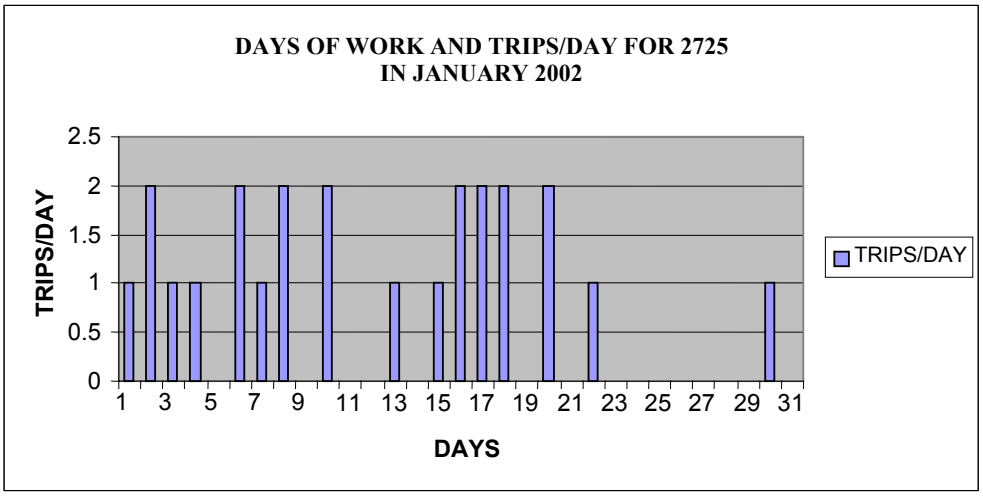


Figure D-33: Irregular Operation Schedule and Trips/Day for Truck 2725 in January 2002

This graph corresponds to a 1996 dump truck which collects wastes in area A. Similar to previous cases, it has many irregularities for the collection days and shows more than 9 days without activity. As opposed to other cases, this vehicle shows a minimum number of trips per day.

Most of the vehicles have been manufactured in 1999, i.e., they do not have more than three years of operation. Consequently, these vehicles should not have important mechanical problems; generally, their service life is between 5 to 6 years considering two shifts per day.

h. Maintenance of Collection Vehicles

h.1 Maintenance Program for the Fleet and Related Personnel

Maintenance labors are done in the operational centers in Curundu and Carrasquilla where a Maintenance and Shops Department exists and its function is to guarantee preventive and corrective maintenance of the whole vehicle fleet (light, medium, heavy, and hydraulic) which belongs to DIMAUD in order to ensure that they function correctly on a daily basis.

This maintenance and Shops Department is organized in three sections which are Mechanical, Preventive Maintenance, and other Maintenance Services.

The Mechanical section has three units; each one of them in charge of maintenance and repair of heavy equipment, light equipment, and vehicle maintenance. This section is managed by the Chief of Mechanics.

The mechanical section works 24 hours a day which has been divided in three shifts of 8 hours as the following table shows.

Table D-19: Shifts and Schedule for the Mechanical Section

Shift	Schedule
Daytime	07:00 to 15:00 hours
Noon time	15:00 to 23:00 hours
Nighttime	23:00 to 07:00 hours

The repair and maintenance works are done by the following personnel:

Table D-20: Personnel in Charge of the Repair and Maintenance Works

Position	Number of persons in Carrasquilla	Number of persons in Curundú
Mechanics	26	9
Assistants of Mechanics	23	7
Welder operators	8	4
Greasing personnel	9	4
Electromechanics	6	3
Assistants of Electromechanics	3	3
Personnel in charge to Vulcanize	15	7
Sheet Metal Worker	2	4
Lathe operator	3	2
Lathe operator assistant	2	3
Data collector	2	
Radio operator	1	
Crane	4	
Buyer of parts	1	
Supervisor	1	
Total	106	46

Most of the personnel is concentrated in the daytime shift with 61 workers, the Noon shift has 30 workers, and the night-time shift has 11 workers.

The activities that are done by the personnel according to their positions are defined as follows:

Mechanics: He/she is in charge to repair and maintain the vehicles brought to the facility for repair.

Assistants of Mechanics: Support the mechanic in the works to repair and maintain the vehicle.

Lathe operator: He/she is in charge to produce pieces that break and which are difficult to procure.

Welder operators: They are in charge to weld any cracks, to produce screws, and to weld broken parts in the tires; additionally, they should weld any other part that requires to be welded.

Electromechanical: He/she is responsible to provide maintenance to the electrical system of the vehicles; it includes the lights, batteries, alternators, and starting motor.

Personnel in charge to vulcanize: They are in charge to repair and install the tires.

Greasing personnel: He/she is in charge to provide maintenance on a daily basis to the equipment, transmission, hydraulic system, etc.

Sheet Metal Worker: He/she is in charge to remove the dents from vehicles.

Currently, no preventive maintenance program is taking place for the fleet. Most of the vehicles are working three shifts and they only have 3 hours a day to make preventive maintenance; however, this time is only used for repair maintenance. Additionally, occasionally a large number of vehicles in the fleet (higher than 40%) require to be fixed which reduce even more the time available to conduct preventive maintenance.

On a daily basis and before the route initiates, the vehicle is inspected; it includes to review the levels of fluid, light conditions, breaks, and other minor aspects. The drivers also have the responsibility to check and inform any problem with the collection vehicles.

Twice a month, the change of oil and filter is done; this activity is controlled in the service sheet of the truck which is filled out by the Chief of Mechanics.

When the vehicles are new, the maintenance program which includes the guarantee is followed strictly. This type of maintenance is halted when the responsibility is assumed by DIMAUD.

h.2 Follow up process for work orders

As it was mentioned previously, there is no preventive maintenance program and, consequently, attention is provided only when the vehicle has a failure.

Repair control is done through a private register which is elaborated for each vehicle when this one begins to operate.

The procedure to repair is the following:

- The chief of mechanics receives from each shift a report that reflects the mechanical damage for each vehicle and based on it the priorities are defined. Subsequently, according to the type of repair, a mechanic is assigned for the vehicle. Additionally, he/she assigns the works to be done by the electromechanical, turnery, greasing, and metal sheet sections.
- The mechanic reviews the truck and informs about the need of spare parts. The listing of spare parts is provided to the chief of mechanics who should check it and sign it.
- Once the parts are available, the repair is initiated.
- In case the work is not finished within the shift, it is continued on the next shift.
- As the repairs are finished, each mechanic informs on the work order about the maintenance details, work done, quantity of second hand and new pieces which were used. Additionally, a report is sent to the maintenance office.
- Once the repair is finished, the vehicle is returned to the department or section where it belongs.

Taking into account the workload that these vehicles have, they generally require to be repaired once a month. Currently, there is not a statistical control about how many times a vehicle has undergone repairs.

The time that for each repair varies, most of them are done within 24 to 48 hours. Major works which require spare parts not found in the warehouse will last as long as it takes to procure the spare parts which usually go through a long administrative process.

For periods with a heavy workload, DIMAUD has chosen to repair some vehicles outside the organization. This is done with the objective to reduce the repair time and meet the collection routes requirements.

h.3 Spare parts stock, procurement procedure

The Maintenance and Shops Department keeps only a stock of oils, greases, and lubricants. All the elements required to maintain the fleet are requested to the Warehouse which is the unit that manages all the materials needed to repair the vehicles.

While the vehicle is being repaired, it is defined the spare parts that are required which are reflected on a ´request for materials and spare parts´ form which should be signed by the chief of mechanics and, subsequently, transferred to the warehouse.

With the purpose to keep a stock in the warehouse, the chief mechanic elaborates a request of materials and spare parts on a monthly, every three months, every six months or annual basis for those spare parts or materials which are more frequently used, such as, filters, starting motors, tires, coils, etc. These orders are repeated whenever the warehouse is running out of stock. Preferably, the orders are requested between periods no longer than every three months because the time it takes to arrive depends on the amount of the purchase.

Once the request is done, this one is transferred to the warehouse which has the responsibility to acquire what it is being requested according to the following scheme:

With the request of materials and spare parts, the warehouse produces a ´Requisition order´ which is a document that serves to obtain authorization from the Director and the Management Director

With the corresponding authorizations, the document is sent to the Purchase Department which proceeds to obtain at least three quotations.

Once the quotation process finishes, a comparative table is produced according to what Law 56 establishes; this is the law that regulates public contracts in the Panama Republic. This table is the base to elaborate the ´Purchase Order´ which is an official document and has a correlative number.

After the Purchase Order is obtained, the administrative process begins in order to obtain the corresponding authorization. The authorizations include those from:

- Chief of the Budget Department
- Manager
- Director
- Management

Once the Purchase Order is authorized, it is returned to the Purchase Department and from this department it is sent to the Budget Department of the Panama Municipality in order to make its budgetary consolidation. Subsequently, the Purchase Order is sent to the Treasury Control Office which is located in the Panama Municipality.

In case the Auditing Office observes an error, the purchase order is returned to the Management Department of DIMAUD which transfers this purchase order to the responsible department.

If there are not any comments, the purchase can proceed; in this case, the Management sends this order to the Purchase Department. If the purchase is done with cash then it requires the Mayor´s signature.

In case it is required to acquire some piece urgently then petty cash under the Management Department can be used. A certain amount of money is assigned as petty cash.

Once the purchase is done, the materials are received by the warehouse. The warehouse sends daily reports to the General Direction and weekly to the Management Department with information on materials stored in the site.

Approximately, every six months an inventory is done in the warehouse; the inventory is made by the accounting office.

In the warehouse, there is also a register of the gas consumption.

h.4 Operation when failures occur in the route

In case the vehicle has a failure during the operation in the route, the driver reports to control office by telephone because the trucks do not have radios.

From control, the Maintenance and Shops department is notified about the failure.

After the Maintenance and Shops department has been notified, a mechanics is assigned to check the failure in the vehicle. This activity could last several hours depending on the workload at that time.

If the failure is identified as not significant, then the vehicle is repaired on the site. Otherwise, the vehicle is taken to the shops by a crane if the vehicle can not be moved by its own means.

When the vehicle arrives to the shop, a normal repair procedure is followed.

If there are available vehicles, the chief mechanic informs the supervisor about it; this available truck can be used to finish the routing initiated by the damaged one.

In case the damaged vehicle is loaded with wastes, they are discharged into containers and hauled to the sanitary landfill where they are registered as patio owners´waste. If the vehicle can be repaired in short time, the wastes are kept in the vehicle and once it is fixed, the wastes are taken to the sanitary landfill.

D.4.3 Processing, Treatment and Recycling System

At present, there is neither formal intermediate treatment nor formal recycling system in Panama District. Waste collected in a manner of mixed collection goes to Cerro Patacon final disposal site directly and is disposed of there.

However, there exists informal material recovery system. Waste-pickers recover recyclable materials on the streets and Cerro Patacon landfill. According to the results of Recycle Market Survey, there are some recycling companies and Cerro Patacon is a major source of recyclable materials for such companies. Processed materials are mainly exported to USA, Costa Rica, Colombia, Asian Countries and others (See Annex C).

D.4.4 Street Sweeping System

With the purpose to keep the streets and avenues clean in the Panama District, DIMAUD conducts the manual and mechanical street sweeping program.

The responsibility to undertake manual street sweeping falls with the Street Sweeping Department which depends directly of the Director Office.

The functions of this department include basically to undertake the street sweeping activities in order to guarantee that the streets, avenues, and other areas remain clean in the Corregimientos of Panama District.

The mechanical street sweeping is under the responsibility of Area A of the Collection Department.

a. Manual Street Sweeping

In order to develop street sweeping, the Street Sweeping Department has organized the tasks according the work shift when the service takes place. Two sections are considered, one for the day time and another one for the night-time.

The day-time shift covers a total of 11 hours and night-time covers 12.5 hours; each shift is divided into work periods as described in the following table.

Shift	Work period	Schedule
Daytime	A	06:00 a 14:00
	B	09:00 a 15:00
	C	12:00 a 17:00
Nighttime	A	16:00 a 22:30
	B	22:30 a 04:00

Not all the work periods last 8 hours, this is due to some personnel who does not have the required physical conditions to develop this type of work; consequently, physical wear down is reduced by decreasing working hours per day.

Each section has a street sweeping chief, administrative personnel chief, crew chief, and street sweeping personnel who are distributed according to the following figure:

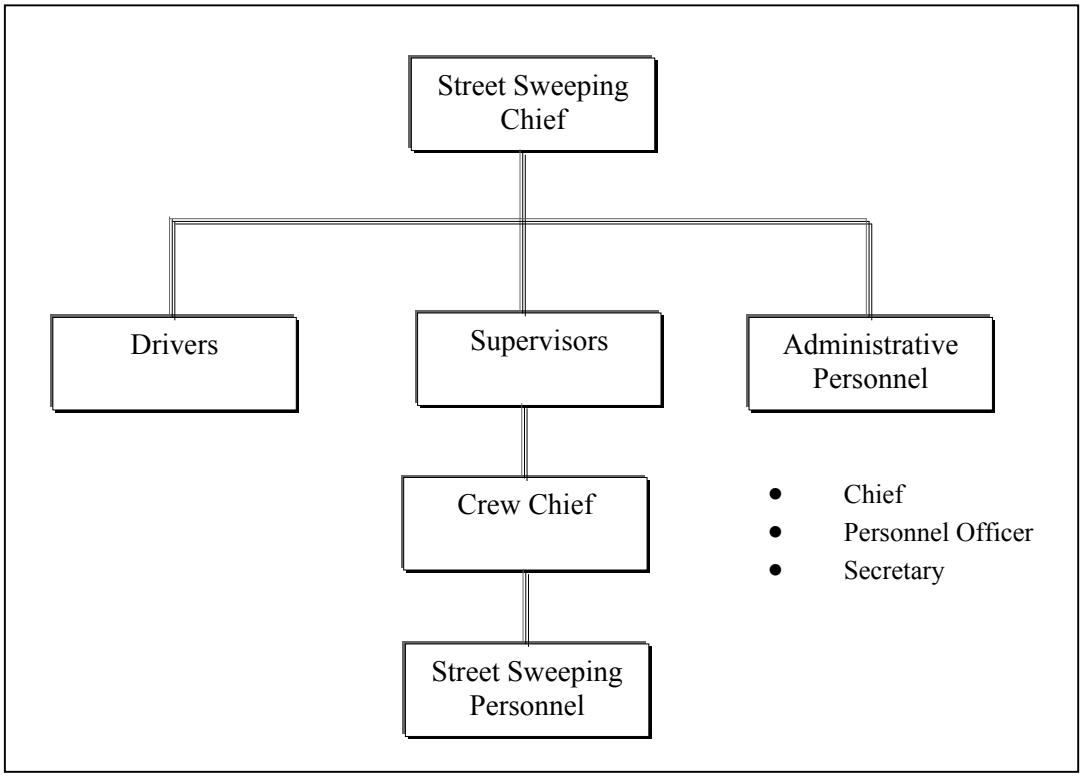


Figure D-34: Organizational Structure of the Street Sweeping Department

a.1 Definition of Each Job Position

The functions of every position are as follows:

Department Chief: its main function is the direction of street sweeping service consisting of the following activities:

- To program and coordinate the cleansing, street and avenue sweeping tasks in the respective Corregimientos.
- To keep the control and meet the programs of maintenance for street and avenue sweeping.
- To communicate and present to the superiors the difficulties which can arise during the development of the service.
- To develop different *Operativos* which are undertaken in the Panama District.
- To present monthly reports of the service development to the superiors.
- To procure resources and materials to fulfil satisfactorily with the cleansing and sweeping operations.

Drivers: this is the personnel in charge of driving the buses which transport the rest of the personnel from one place to another.

Su*pervisor*: this is the person in charge to inspect the different street sweeping areas assigned to the street sweeping personnel. The supervisor solves the difficulties which can arise on the site; additionally, he/she defines the street sweeping areas which are considered initially. He/she is also in charge to transport the personnel and coordinate the works undertaken directly by the Crew chief.

Crew chief: This officer is in charge to supervise the street sweeping routes which have been assigned to the crew; he/she verifies the correct use and maintenance of tools and establish communications between the worker and the supervisor.

Street Sweeping Personnel: He/she develops the street and avenue sweeping activities.

Administrative Chief: He/she develops the administrative functions related to the control of personnel and all those activities which require a correct use of labor.

Personnel Officer: He/she is in charge to control the assistance roll to the Administrative Chief.

Secretary: He/she performs the general tasks of secretaryship.

a.2 Frequency of the Service Areas

The service area for the Daytime covers 19 routes which are detailed in the following table. The night-time shift street sweeping service covers 14 routes in six corregimientos as shown in Table D-22.

Table D-21: Daytime Shift Street Sweeping Service

Route	Service Area	Shift – Working Days	N° of Supervisors	N° of Street Sweepers
1 A	San Felipe Corregimiento	Shift A from Monday to Sunday	1	12
1-B	San Felipe Corregimiento	Shift C from Monday to Sunday	1	8
2	Corregimiento Calidonia	Shift B from Monday to Sunday	1	8
3	Corregimiento de Santa Ana	Shift B from Monday to Sunday	1	10
4	Corregimiento de El Chorrillo	Shift A from Monday to Sunday	1	12
5	Corregimiento de Calidonia	Shift B from Monday to Sunday	1	12
6	Corregimiento de Bellavista	Shift A from Monday to Friday	1	10
7	Corregimiento de Bellavista – San Francisco	Shift A, the main routes from Monday to Friday, secondary streets from Monday to Friday with a frequency of twice per week.	2	32
8	Work group which replace the personnel in other routes during their days off.	Shift A from Thursday to Monday	2	36
9	Group which works from Wednesday to Saturday in the Operativos which are planned by the Collection Department. On Sunday, this personnel replace personnel from other routes. On Sunday, this group replaces the personnel of route 10.	Shift A from Wednesday to Sunday	2	20
10	Río Abajo, Pueblo Nuevo, Parque Lefevre, and Bethania Corregimientos	Shift A, Main road from Monday to Sunday, secondary roads from Monday to Friday.	3	42
11	The Group which supports route 9 on Monday, Tuesday, and Wednesday. On Saturday and Sunday, the group conducts street sweeping in España Ave., Calle 50, and Balboa Ave., all the main roads.	Shift A from Saturday to Wednesday	1	10
12	Calidonia and Curundú Corregimientos	Shift B from Monday to Friday	1	10
13	Replacement personnel on routes 1 and 4	Shift C	1	8
14	Reverted area: cleansing operativos are programmed by Area A of the Collection Department.	Shift A from Monday to Friday	1	8
15	Office and support cleansing	Shift A from Monday to Friday	1	35
16	Personnel who support the Operativos on Monday, Tuesday, Wednesday, and replace personnel from Group 2 and 10 on Saturday and Sunday.	Shift A from Saturday to Wednesday	1	8
17	Pacora Corregimiento	Shift A from Monday to Friday	1	5
18	Personnel in charge to support other routes weed out the area	Shift A from Monday to Friday	1	2

Table D-22: Night-time Street Sweeping Shift

Route	Service Area	Shift – Working Days	N° of Supervisors	N° of Street Sweepers
1	Presidency Sector	Shift A	1	4
2	Market Sector	Shift A	2	4
3	Santa Ana Peatonal Corregimiento	Shift A	1	4
4	Calidonia Corregimiento	Shift A	2	6
5	Santa Ana Parques Corregimiento	Shift A		2
6	Calidonia MarañónCorregimiento	Shift A	2	6
7	Santa Ana Corregimiento Street 16, 17 – Ancon Avenue – A Avenue	Shift A	2	6
8	Presidency Sector	Shift B	1	4
9	Market Sector	Shift B	2	4
10	Santa Ana Peatonal Corregimiento	Shift B	1	4
11	Calidonia Central and Perú Corregimiento	Shift B	2	6
12	Corregimiento Santa Ana Parques	Shift B		2
13	Calidonia MarañónCorregimiento	Shift B	2	6
14	Santa Ana Corregimiento Street 16, 17 – Ancón Avenue– A Avenue	Shift B	2	6

Characteristics of the Routes

Routes per Corregimiento: Correspond to routes which are destined for street and avenue sweeping with daily frequency from Monday to Sunday. Generally, the main avenues are serviced every day; lateral roads are swept every other day alternatively.

Operativo$_i$: The Street Sweeping Department plans its *Operativos* every Saturday of every month; one specific Corregimiento is chosen and the volunteers and personnel from DIMAUD proceed to clean the public areas. The Street Sweeping Department begins to work in the *Operativo* Area on Wednesday and its tasks should finish on Saturday jointly with collection.

Main Roads: Corresponds to this road to cover the main roads of Panama District and it has a daily frequency.

Reverted Area: This route covers Ancon Corregimiento in one week. Consequently, the different areas which make up this Corregimiento are swept with a once a week frequency.

Support: Corresponds to the crew which is made up of male personnel because they undertake the heaviest tasks such as weeding out. This crew supports other crews as they are required.

a.3 Personnel in charge of service

The day-time section has a total of 336 workers as it is detailed in Table D-23. On the other hand, the night-time section consists of the personnel that is shown in Table D-24.

Table D-23: Number of Personnel in the Street Sweeping Department (Day-time)

Position	N° workers
Section Chief	1
Administrative Area	12
Supervisors	3
Crew Chief	24
Drivers	10
Street Sweepers	286
Total	336

Table D-24: Number of Personnel in the Street Sweeping Department (Night-time)

Position	N° of workers
Section Chief	1
Administrative Area	5
Supervisors	37
Drivers	10
Street Sweepers	130
Tool Responsible	13
Total	196

Out of the total, 96% has permanent contract and has an average working period of 5 years. Among the street sweepers, 83% has a permanent contract and has an average working period of 5 years.

On the other hand, out of the total personnel that belongs to the daytime section, 86% is generally working, the rest of the workers are mostly on vacations (8%) or in compensatory payment (5%). The compensatory payment corresponds to the time off that the worker has as payment for overtime hours done by him/her.

As the routes are defined, there are crews which work 3 days from Monday to Friday. Additionally, it is mandatory that these crews work Saturday and Sunday in order to cover other routes. During the day-time shift from Monday to Friday a total of 169 persons are working. The previous figure does not include the personnel that work three days a week that adds up to 117 persons who provide the service also on Saturday and Sunday. Consequently, on Saturday and Sunday, there is a reduction of personnel who represent around 31%; as a result, it can be concluded that the street sweeping is not done on a daily basis as it is shown in the planning.

a.4 Amount of Wastes Collected

The wastes derived from street sweeping are collected on a daily basis through the collection routes which are destined for that purpose. For those routes which correspond to the program of the *operativo*, the Street Sweeping Department reports every morning through fax to the Collection Department regarding the sectors that were served with the purpose that the collection department makes a plan to collect those bags.

The Street Sweeping Department does not have information related to the amount of wastes derived from street sweeping; consequently, in order to define a figure in this matter, it was necessary to resort to data of entrance records from Cerro Patacon and the controls established through the Collection Department Work Orders.

According to the background information from Cerro Patacon, in November 2001, a total of 478.03 tons were collected and in January 2002 the total amount reached 596.27 tons; additionally, the data gathered shows that 609.37 and 840.42 tons were collected in November 2001 and January 2002 respectively.

Similar to the collection case, there is a discrepancy between the two types of control; the largest tonnage figure is produced by the Collection Department.

The street sweeping department does not have control over the kilometers that are swept, the percentage coverage per Corregimiento. The routes have not been drawn through a rational design which can help to evaluate them; constantly, the design is modified and this modification depends largely on the supervisor who is in charge of the work group.

a.5 Manner to Implement the Service

When the shift begins, each street sweeper is provided of his/her tools which commonly are made up of shovel, regular broom or large broom. The bags to store wastes are distributed directly by the crew chief on the site.

Street sweepers do not have a car to transport and install the bags with wastes; consequently, it should be done manually. The bags that are distributed have a capacity of 25 pounds for the case of specific routes and the bag is 50 pounds for those sectors where a *operativo* is undertaken.

Once the tools are distributed, they are transported by the personnel to the corresponding work place. This is done by buses or pick ups.

On the route site, each worker is assigned a task which consists of certain amount of meters that they should sweep. In the routes, the street sweeping tasks cover the area between the

construction line and the road; however, the workers also sweep the parking areas and surrounding areas to the *tinaqueras* which are found in their path.

In the sectors where weed is found which prevents an adequate street sweeping, the crew is reinforced by male personnel in order to cut it out.

As the street sweeping continues collecting wastes, he/she would place the bags which are already full on the sideway after the bag has been closed; this bag is subsequently collected by the collection truck.

a.6 Service Analysis

Some street sweeping routes were analyzed with the purpose to know the performance of the street sweepers. For the daytime section, routes 3, 4, and 5 were studied and it was determined performance indicators between 0.45 and 1.96 km/street sweeper/day for an average of 1.3 km/street sweeper/day. For the night-time section, the routes Presidency and Santa Ana were analyzed and performance indicators between 1.2 and 1.52 km/street sweeper/day were obtained; for this last case, an average of 1.34 km/street sweeper/day was obtained. Meanwhile, the average performance value for Latin-American cities is 1.8 km/street sweeper/day, in other words, Panama city street sweeping falls 26% below the normal average.

Other performance indicators were not possible to be determined due to lack of information. It was identified that low performances were due lack of planning, definition and identification of sweeping areas. Even in some cases, areas beyond public areas were swept, especially idle properties were swept. In many cases, the tasks were performed by persons whose physical fitness does not match the requirements of this type of work.

Additionally, no quality control is done for street sweeping and there is not a definition which can help to evaluate it.

b. Mechanical Street Sweeping

According to what DIMAUD informs, mechanical street sweeping is done in the District. There are two mechanical street sweepers which conduct mostly the street sweeping on bridges; however, this could not be confirmed on the field.

According to information provided, the planning of the tasks for mechanical street sweeping is done by Section A chief. The program includes a total of 7 operative days per week; they cover a total of 8 working hours per day.

D.4.5 Final Disposal System

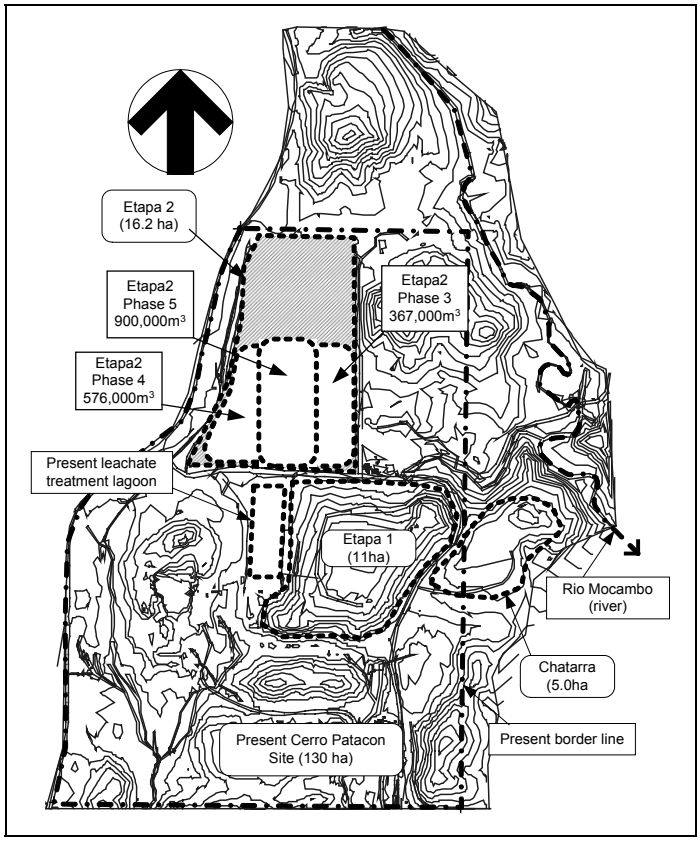
a. Outline of the Cerro Patacon Landfill Site

The final disposal site for solid waste in Panama Municipality is located in Cerro Patacon. This final disposal site is consisted of a part for inorganic waste and a part for organic waste. The part of organic waste is divided into two, i.e., 'Etapa I' that was used from June 1985 to June 1995 and 'Etapa II' that has been operated from July 1995 up to now. The table bellows summaries the final disposal site.

Table D-25:Outline of Cerro Patacon Landfill Site

	Operation period		Landfill capacity	Disposed amount	Liner system	Leachate treatment system
	From	To				
Etapa I	June/1985	June/1995	1,998,002 m^3	2,327,400 ton	clay	lagoon
Etapa II	July/1995	-	[3]3,541,918 m^3	-	Synthesis liner	Lagoon

Etapa II has certain environmental impact mitigation measures such as liner, gas extraction facilities and a series of lagoons for leachate treatment. However, there is a room to improve, e.g., pumps to lift up leachate to the lagoons are under repair and the leachate is discharged to a nearby river without treatment.



Meanwhile, the part for inorganic waste that does not have liner and leachate collection facilities receives scrapped personal computers, home electric appliances, empty cans of paints, scrapped gas cylinders and so forth. Then, it generates leachate that goes to Cardenas River directly. Taking into account

[3] Diagnóstico, Plan Maestro, Caracterización de Activos y Evaluación de Alternativas de Participación del Sector Privado para el Manejo de los Desechos Sólidos en el Area Metropolitana, Colón, Areas Revertidas y Panamá Oeste
INFORME DE AVANCE, DIAGNOSTICO, JOBEFRA SANIPLAN, Noviembre 1999

type of waste disposed of, the part gives a larger impact on the surroundings than the part for organic waste.

b. Landfill Capacity

Etapa 2 of Cerro Patacon final disposal site are the operated landfill at present. Its remaining capacity is estimated as about 1,800,000m^3 as of the end of 2002. Then, it would be full within 3 to 4 years. Cerro Patacon final disposal site has a large area enough to expand the present landfill. Therefore, formulation of a plan to expand the landfill in the site is urgently necessary. Meanwhile, proper disposal of inorganic waste disposed of other area and medical waste is other urgent issue. (Annex H Landfill)

Table D-26: Remaining Landfill Capacity

Location	Volume (m^3)
Etapa 2, Phase 3	367,000
Etapa 2, Phase 4	576,000
Etapa 2, Phase 5	900,000

D.4.6 Other SWM Activities (NGO, community groups)

In the Country, there are several non governmental organizations (NGOs) that develop actions on environment.

The main activities of these NGOs are summarized next:

- Organization of seminars and conferences related to environmental sector.
- Ecological projects and recycling.

a. ANCON

The National Association for Nature Conservation (ANCON) is an non governmental organization founded in 1985 by a group of prominent businessmen, scientific and community leaders.

The mission of ANCON is to conserve the biodiversity and the natural resources of Panama for benefit of the present and future generations.

In their conservation efforts, ANCON has worked from the beginnings, very closely, with national and international organs as well as with academic, commercial entities and local communities.

ANCON makes emphasis mainly on environmental education at schools, which makes students notice a importance of a harmonised relationship between the human being and the

environment based on the understanding of natural processes and the sustainable resource management.

ANCON concentrates efforts on the community development programs and in the search of solutions for the marginal communities, through training and agroforestal extension, giving cultivation alternatives using established models in agroforestal demonstrative properties of Panama Canal hydrographic basin and other country zones.

b. APRONAD

The Association for Promotion of New Alternatives of Development (APRONAD) is an non governmental organization that promotes strategies of sustainable local development, the creation of new employment sources and the generation of revenues, by means of finding new alternatives and profitable investments for urban and rural communities.

The main objectives of APRONAD are:

- Contribution to generate employment and to improve the quality of the present employment in low-income communities.
- To cooperate on environmental improvement through an effective management of the productive processes and in rendering of services.
- To promote enforcement of the organizations of society, especially of community base organizations.
- To promote new development alternatives creating employment, generation of revenues, participation and protection of the environment.

c. CEASPA

CEASPA (Center of Studies and Panamanian Social Action) is a non-profit association created in 1977. This association works for the sustainable human development and improvement of the democracy through the civic "empoderamiento" and participation of diverse sectors of the society.

The activities of the organization are:

- To impel and support national proposals that contributes justness to the economic growth, participation for democracy and sustainable environmental development.
- To cooperate with organization effort, participation and civic management, especially with marginal sectors and excluded communities to improve their quality of life.
- To support the creation of a modern citizenship, endowed with democratic political culture, civic responsibility and action capacity to transform the reality.

CEASPA focus its work in three programs, developing investigations and education processes and popular communication which are:

- Sustainable development, whose objectives are to contribute to the formation of public policies that operates the principles of sustainable development and to promote the participation and dialogue of the civil organizations, with the government and the private sectors, for decision taking that affects their quality of life.
- Gender and development whose objectives are: to strengthen the movement of women to impel proposals of integral development and to sensitize on gender condition, in women, men and mixed groups, to advance and contribute in the transformation of the relationships of power among genders.
- Democracy and participation whose objectives are:
  - To contribute for construction of civic power in connection with the use and destination of the Canal and reverted areas.
  - To strengthen the democracy with the civic participation in the political and economic processes.
  - To support enforcement, participation and democratic administration of social organizations.
  - To support the State process of decentralization, through local and regional development, like a redistribution form of income and power.

FAS-Panama

FAS Panama is an NGO and non-profit organization that provides the promotion and execution of sustainable human development projects. Founded by a group of young professionals and university students that look for to contribute in the solution of the problems that the Panamanian youth lives.

This organization also carries out multiple activities as seminars, chats, and consultantships in the integral SWM and other topics of environmental nature. These actions are focused so much to government organizations as to private companies, schools, universities and the community, trying to aware these groups on the domestic environmental problem and the form how they can contribute to the solution of the problems.

FAS-Panama advises to 4 schools in Recycling Projects where students and teachers participate.