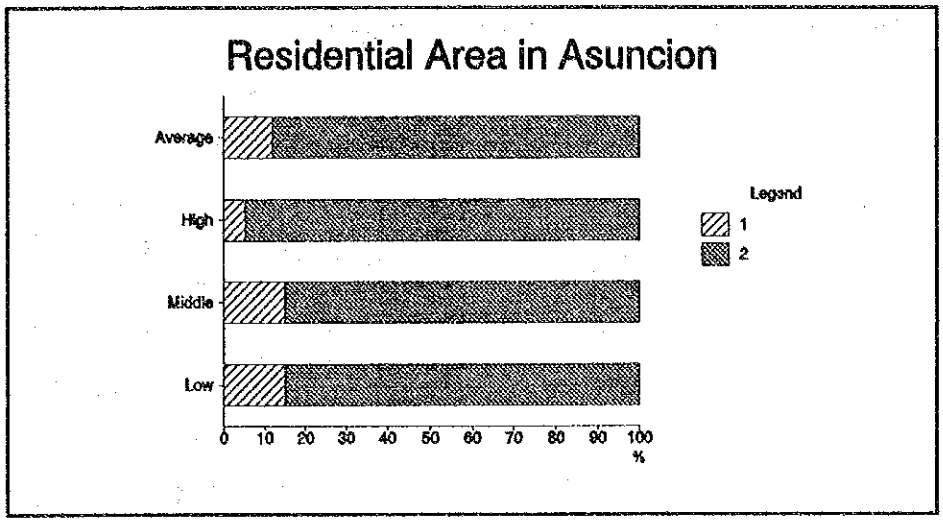
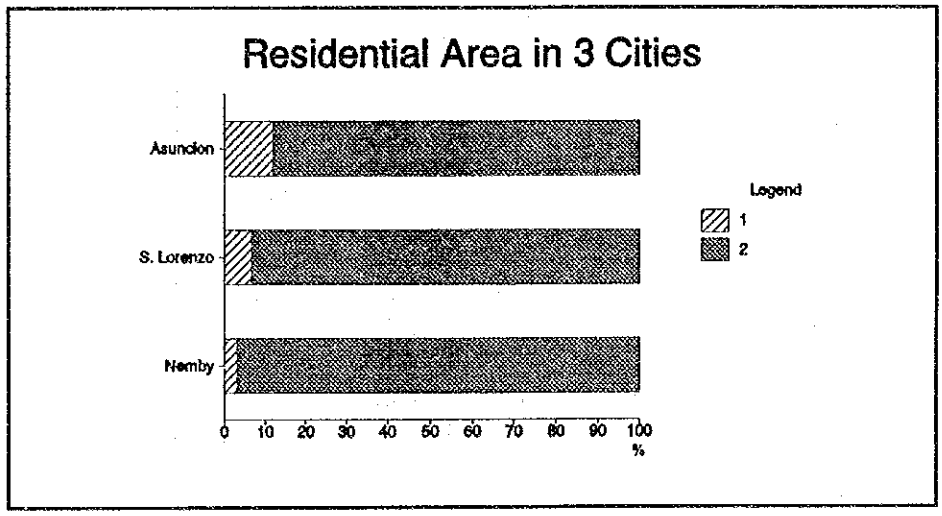

Residential Area in Asuncion
Average
High
Middle
Low
0 10 20 30 40 50 60 70 80 90 100
%
Legend
1
2


Residential Area in 3 Cities
Asuncion
S. Lorenzo
Nemby
0 10 20 30 40 50 60 70 80 90 100
%
Legend
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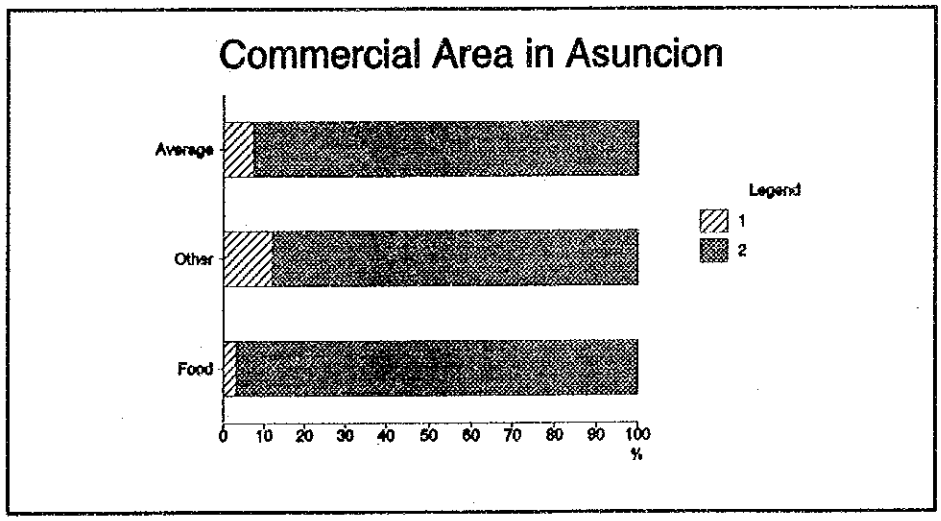

Commercial Area in Asuncion
Average
Other
Food
0 10 20 30 40 50 60 70 80 90 100
%
Legend
1
2

Q7-2 Do you think a "Clean Day" should be organized?

In Asuncion

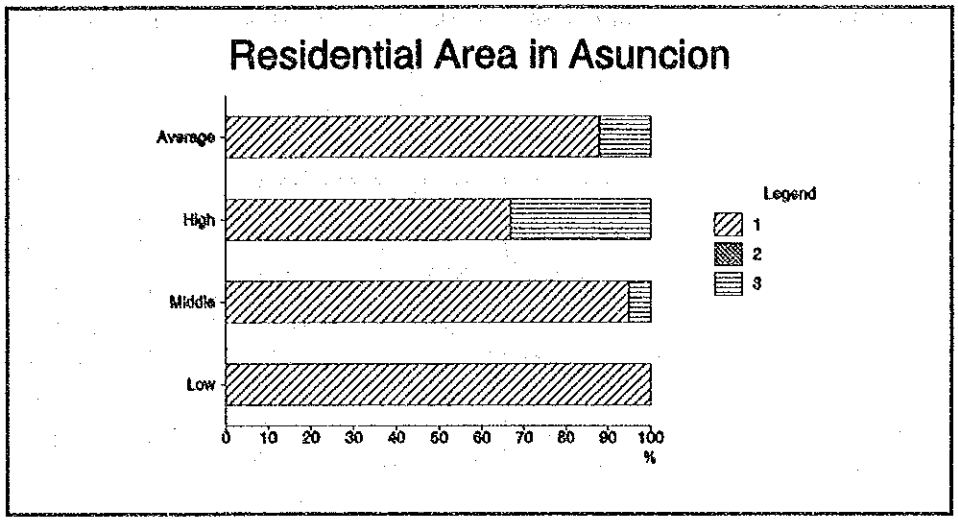
No.	Answer	Residential				Commercial		
		Low	Middle	High	Average	Food	Others	Average
1	Yes	100.0%	95.0%	66.7%	87.9%	73.3%	96.0%	83.7%
2	No	0.0%	0.0%	0.0%	0.0%	6.7%	0.0%	3.6%
3	I don't Know	0.0%	5.0%	33.3%	12.1%	20.0%	4.0%	12.7%

In San Lorenzo

No.	Answer	Residential			
		Low	Middle	High	Average
1	Yes	100.0%	90.0%	100.0%	96.7%
2	No	0.0%	10.0%	0.0%	3.3%
3	I don't Know	0.0%	0.0%	0.0%	0.0%

In Nemby

No.	Answer	Residential			
		Low	Middle	High	Average
1	Yes	100.0%	100.0%	100.0%	100.0%
2	No	0.0%	0.0%	0.0%	0.0%
3	I don't Know	0.0%	0.0%	0.0%	0.0%


Residential Area in Asuncion
Average
High
Middle
Low
0 10 20 30 40 50 60 70 80 90 100
%
Legend
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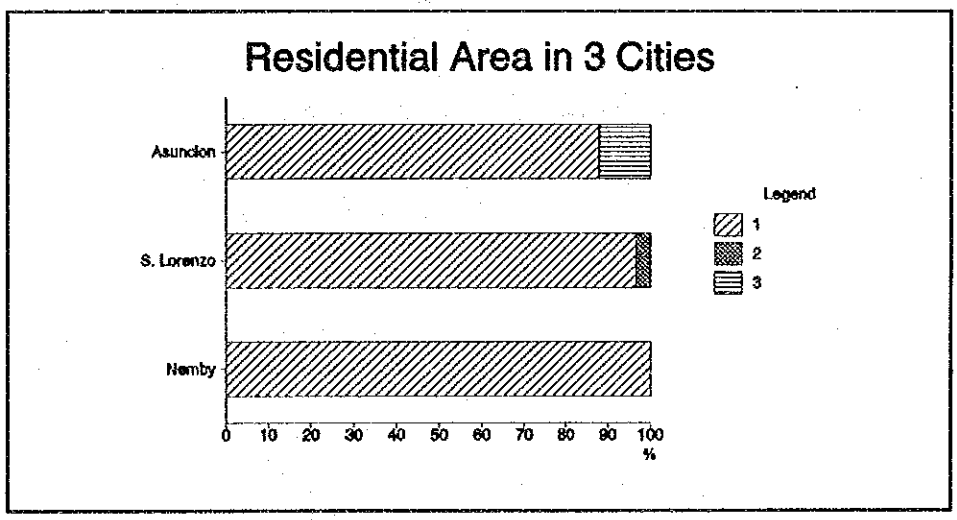
Residential Area in 3 Cities
Asuncion
S. Lorenzo
Nemby
0 10 20 30 40 50 60 70 80 90 100
%
Legend
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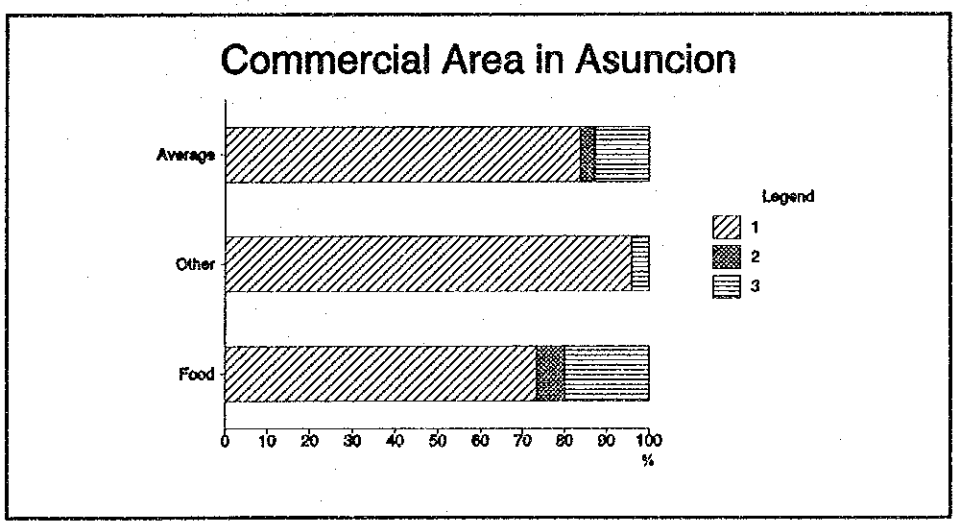

Commercial Area in Asuncion
Average
Other
Food
0 10 20 30 40 50 60 70 80 90 100
%
Legend
1
2
3

Q7-3 Does anyone in your family/shop clean the road shoulder or adjacent public area in front of your house/shop?

In Asuncion

No.	Answer	Residential				Commercial		
		Low	Middle	High	Average	Food	Others	Average
1	Yes, everyday	55.0%	88.2%	80.0%	73.7%	100.0	82.1%	91.4%
2	Yes, sometimes	35.0%	11.8%	20.0%	22.8%	0.0	17.9%	8.6%
3	No	10.0%	0.0%	0.0%	3.5%	0.0	0.0%	0.0%
4	I don't know	0.0%	0.0%	0.0%	0.0%	0.0	0.0%	0.0%

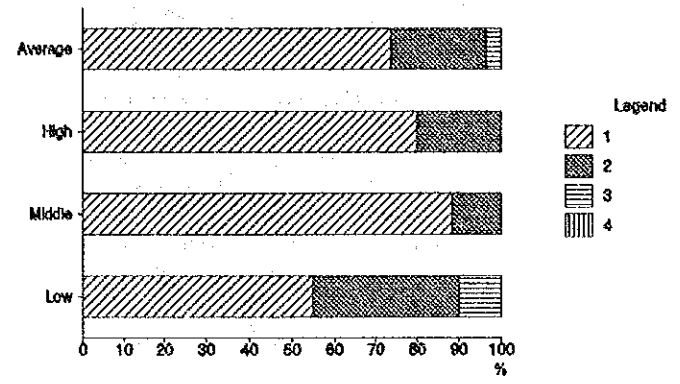
In San Lorenzo

No.	Answer	Residential			
		Low	Middle	High	Average
1	Yes, everyday	40.0%	50.0%	80.0%	56.7%
2	Yes, sometimes	20.0%	20.0%	20.0%	20.0%
3	No	40.0%	30.0%	0.0%	23.3%
4	I don't know	0.0%	0.0%	0.0%	0.0%

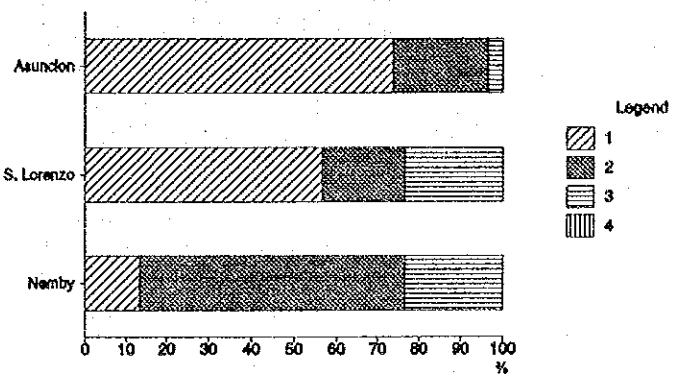
In Nemby

No.	Answer	Residential			
		Low	Middle	High	Average
1	Yes, everyday	0.0%	0.0%	40.0%	13.3%
2	Yes, sometimes	60.0%	80.0%	50.0%	63.4%
3	No	40.0%	20.0%	10.0%	23.3%
4	I don't know	0.0%	0.0%	0.0%	0.0%

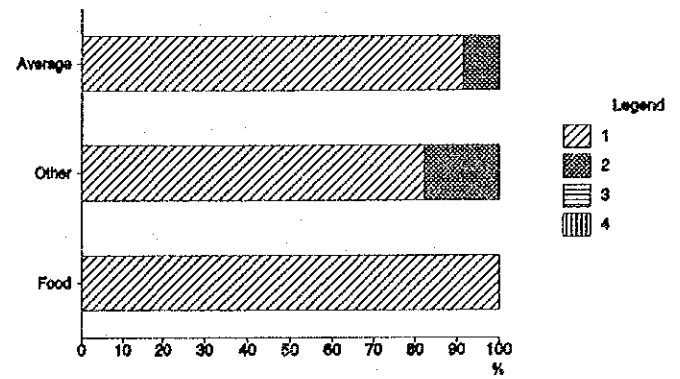
Residential Area in Asuncion



Residential Area in 3 Cities



Commercial Area in Asuncion



Q7--4 Do you think the public cooperation is necessary in order to maintain the beautiful city and its environment?

In Asuncion

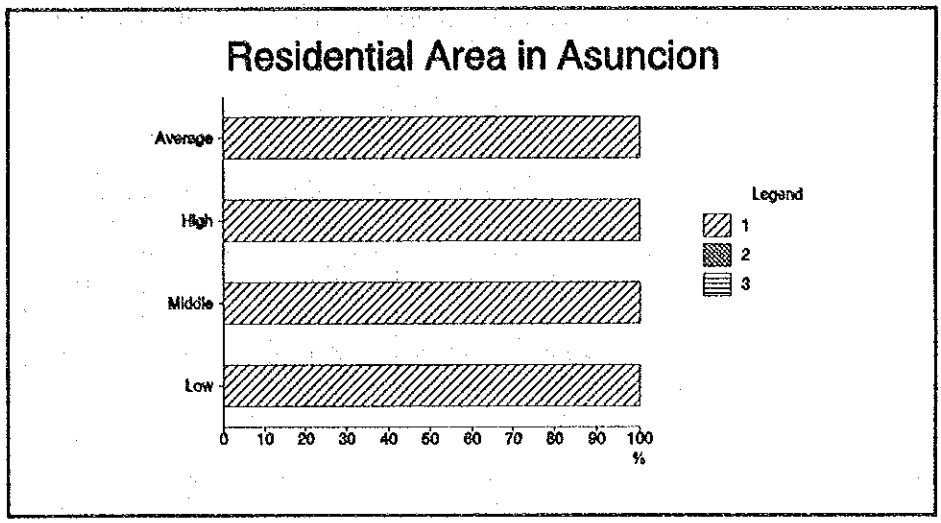
No.	Answer	Residential				Commercial		
		Low	Middle	High	Average	Food	Others	Average
1	Yes	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
2	No	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	I don't Know	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

In San Lorenzo

No.	Answer	Residential			
		Low	Middle	High	Average
1	Yes	100.0%	100.0%	100.0%	100.0%
2	No	0.0%	0.0%	0.0%	0.0%
3	I don't Know	0.0%	0.0%	0.0%	0.0%

In Nemby

No.	Answer	Residential			
		Low	Middle	High	Average
1	Yes	100.0%	100.0%	100.0%	100.0%
2	No	0.0%	0.0%	0.0%	0.0%
3	I don't Know	0.0%	0.0%	0.0%	0.0%


Residential Area in Asuncion
Average
High
Middle
Low
0 10 20 30 40 50 60 70 80 90 100
%
Legend
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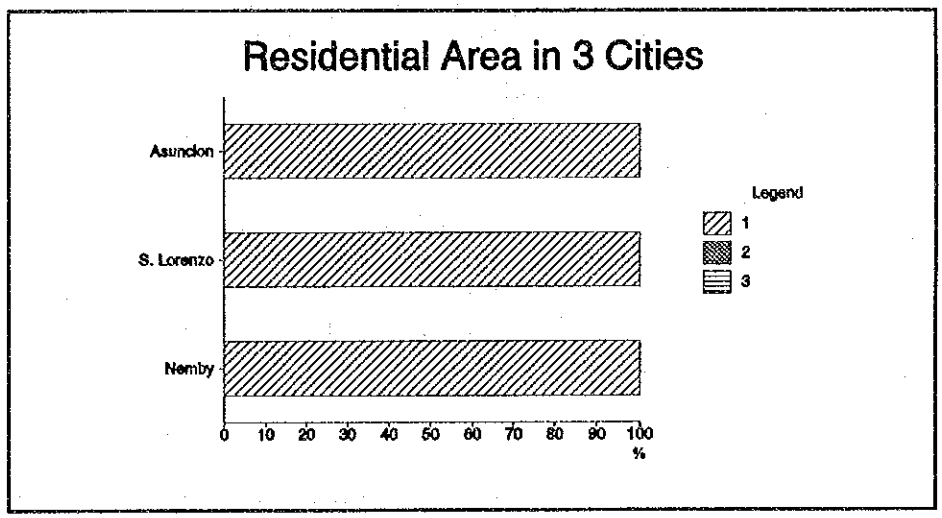
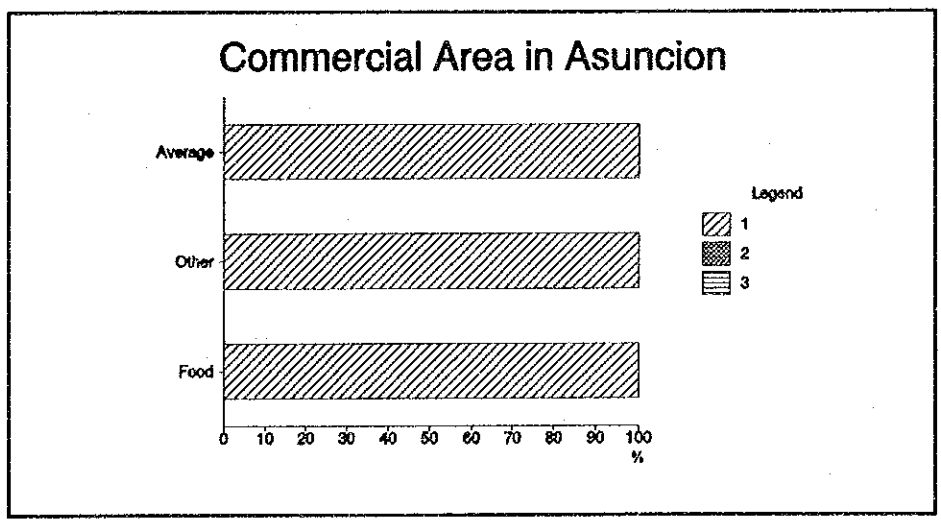

Residential Area in 3 Cities
Asuncion
S. Lorenzo
Nemby
0 10 20 30 40 50 60 70 80 90 100
%
Legend
1
2
3


Commercial Area in Asuncion
Average
Other
Food
0 10 20 30 40 50 60 70 80 90 100
%
Legend
1
2
3

Q7–5 If "Yes", could you cooperate in maintaining a beautiful city and its environment?

In Asuncion

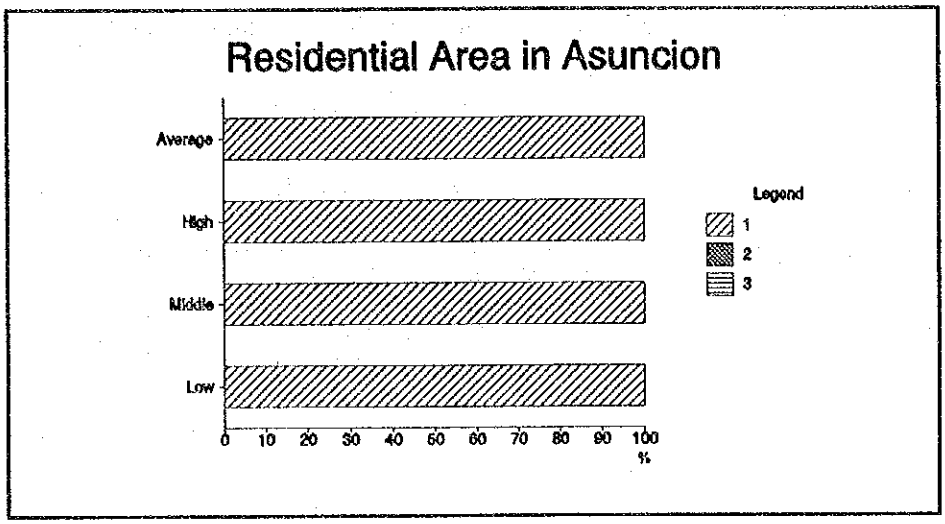
No.	Answer	Residential				Commercial		
		Low	Middle	High	Average	Food	Others	Average
1	Yes	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
2	No	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	I don't Know	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

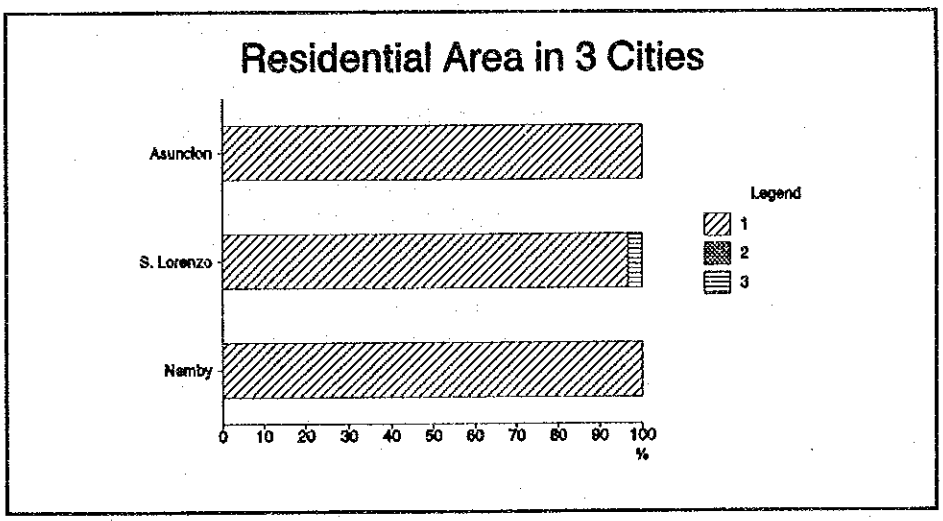
In San Lorenzo

No.	Answer	Residential			
		Low	Middle	High	Average
1	Yes	100.0%	100.0%	90.0%	96.7%
2	No	0.0%	0.0%	0.0%	0.0%
3	I don't Know	0.0%	0.0%	10.0%	3.3%

In Nemby

No.	Answer	Residential			
		Low	Middle	High	Average
1	Yes	100.0%	100.0%	100.0%	100.0%
2	No	0.0%	0.0%	0.0%	0.0%
3	I don't Know	0.0%	0.0%	0.0%	0.0%


Residential Area in Asuncion
Average
High
Middle
Low
0 10 20 30 40 50 60 70 80 90 100
%
Legend
1
2
3


Residential Area in 3 Cities
Asuncion
S. Lorenzo
Namby
0 10 20 30 40 50 60 70 80 90 100
%
Legend
1
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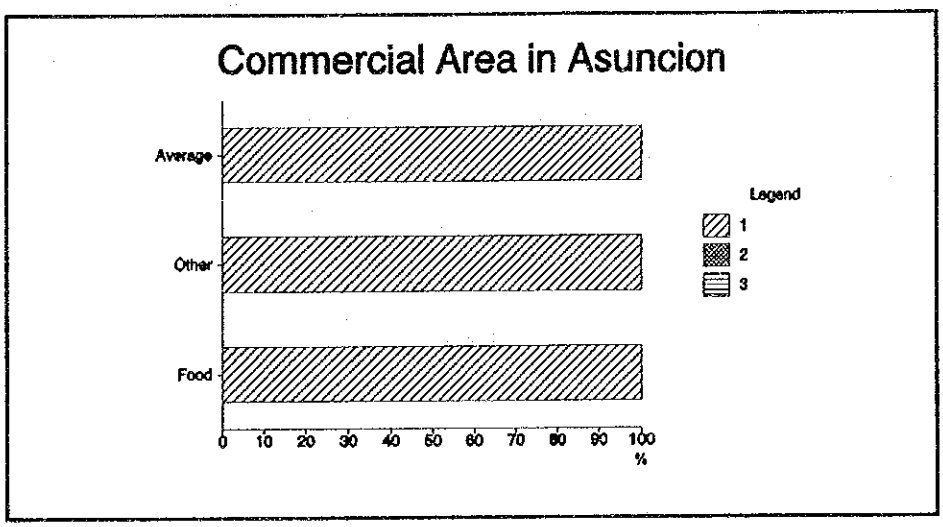

Commercial Area in Asuncion
Average
Other
Food
0 10 20 30 40 50 60 70 80 90 100
%
Legend
1
2
3

Q7-6 Do you think public education or campaign for maintaining the beautiful city and its environment is necessary?

In Asuncion

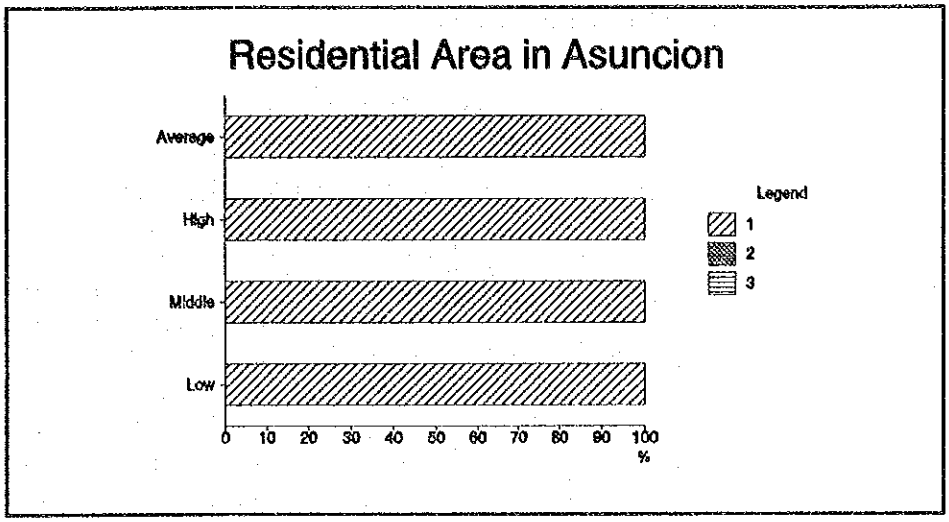
No.	Answer	Residential				Commercial		
		Low	Middle	High	Average	Food	Others	Average
1	Yes	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
2	No	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	I don't Know	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

In San Lorenzo

No.	Answer	Residential			
		Low	Middle	High	Average
1	Yes	100.0%	100.0%	100.0%	100.0%
2	No	0.0%	0.0%	0.0%	0.0%
3	I don't Know	0.0%	0.0%	0.0%	0.0%

In Nemby

No.	Answer	Residential			
		Low	Middle	High	Average
1	Yes	100.0%	100.0%	100.0%	100.0%
2	No	0.0%	0.0%	0.0%	0.0%
3	I don't Know	0.0%	0.0%	0.0%	0.0%


Residential Area in Asuncion
Average
High
Middle
Low
0 10 20 30 40 50 60 70 80 90 100
%
Legend
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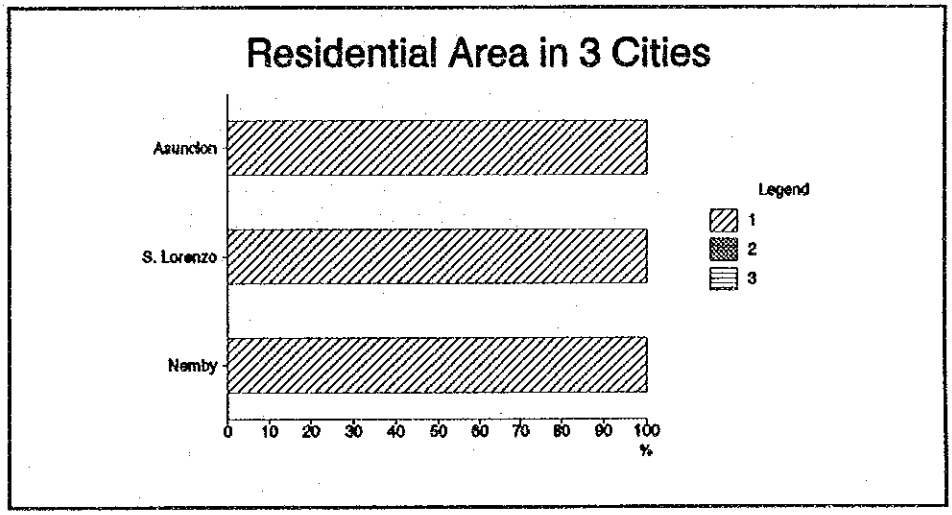
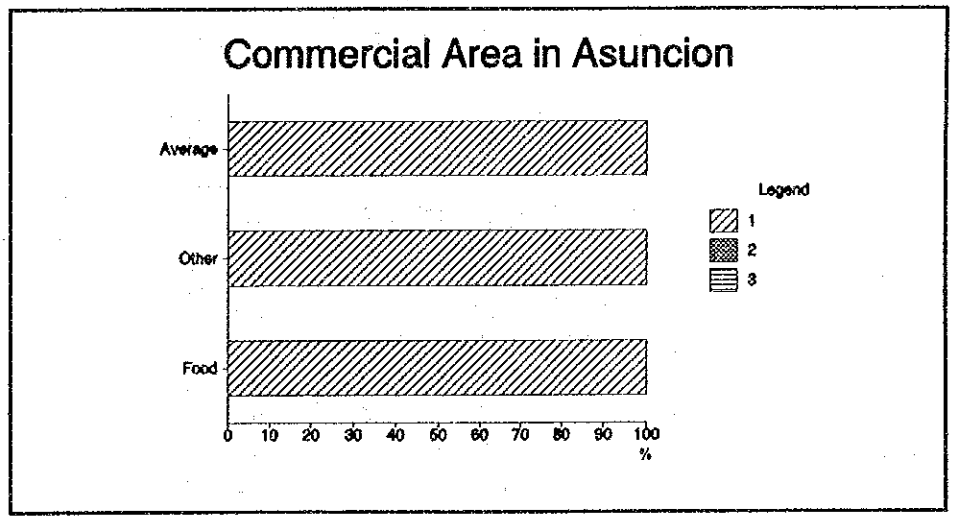

Residential Area in 3 Cities
Asuncion
S. Lorenzo
Nemby
0 10 20 30 40 50 60 70 80 90 100
%
Legend
1
2
3


Commercial Area in Asuncion
Average
Other
Food
0 10 20 30 40 50 60 70 80 90 100
%
Legend
1
2
3

Q7-7 If "Yes", who should take such action?

In Asuncion

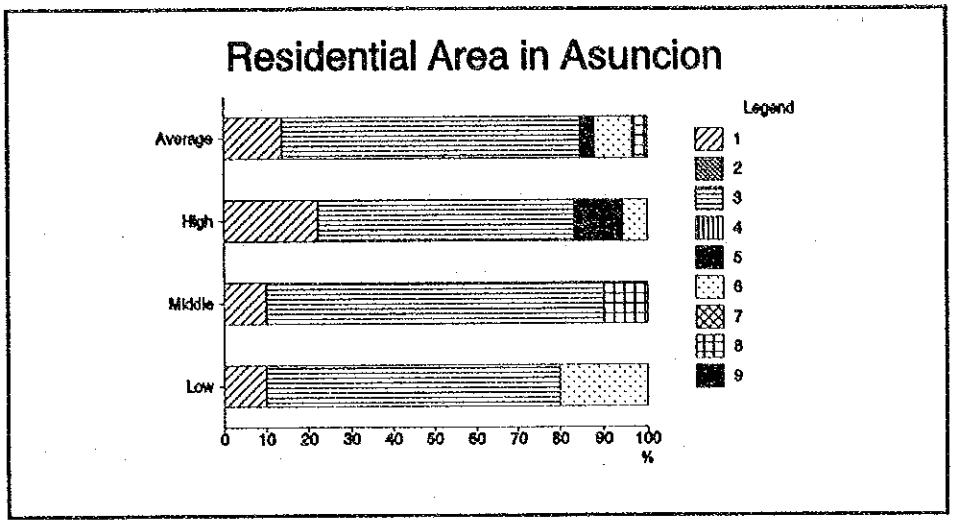
No.	Answer	Residential				Commercial		
		Low	Middle	High	Average	Food	Others	Average
1	Central government	10.0%	10.0%	22.2%	13.8%	33.3%	40.0%	36.4%
2	District government	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
3	Municipality	70.0%	80.0%	61.1%	70.8%	50.0%	48.0%	49.1%
4	AMUAM	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5	School	0.0%	0.0%	11.1%	3.4%	6.7%	4.0%	5.5%
6	Family member	20.0%	0.0%	5.6%	8.6%	10.0%	8.0%	9.1%
7	Church	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
8	Others	0.0%	10.0%	0.0%	3.4%	0.0%	0.0%	0.0%
9	I don't Know	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

In San Lorenzo

No.	Answer	Residential			
		Low	Middle	High	Average
1	Central government	10.0%	20.0%	20.0%	16.7%
2	District government	0.0%	0.0%	0.0%	0.0%
3	Municipality	0.0%	0.0%	50.0%	16.7%
4	AMUAM	0.0%	0.0%	0.0%	0.0%
5	School	20.0%	20.0%	20.0%	20.0%
6	Family member	70.0%	60.0%	10.0%	46.6%
7	Church	0.0%	0.0%	0.0%	0.0%
8	Others	0.0%	0.0%	0.0%	0.0%
9	I don't Know	0.0%	0.0%	0.0%	0.0%

In Nemby

No.	Answer	Residential			
		Low	Middle	High	Average
1	Central government	0.0%	10.0%	10.0%	6.7%
2	District government	0.0%	10.0%	0.0%	3.3%
3	Municipality	40.0%	40.0%	30.0%	36.7%
4	AMUAM	0.0%	0.0%	0.0%	0.0%
5	School	20.0%	10.0%	30.0%	20.0%
6	Family member	40.0%	30.0%	30.0%	33.3%
7	Church	0.0%	0.0%	0.0%	0.0%
8	Others	0.0%	0.0%	0.0%	0.0%
9	I don't Know	0.0%	0.0%	0.0%	0.0%


Residential Area in Asuncion
Average
High
Middle
Low
0 10 20 30 40 50 60 70 80 90 100
%
Legend
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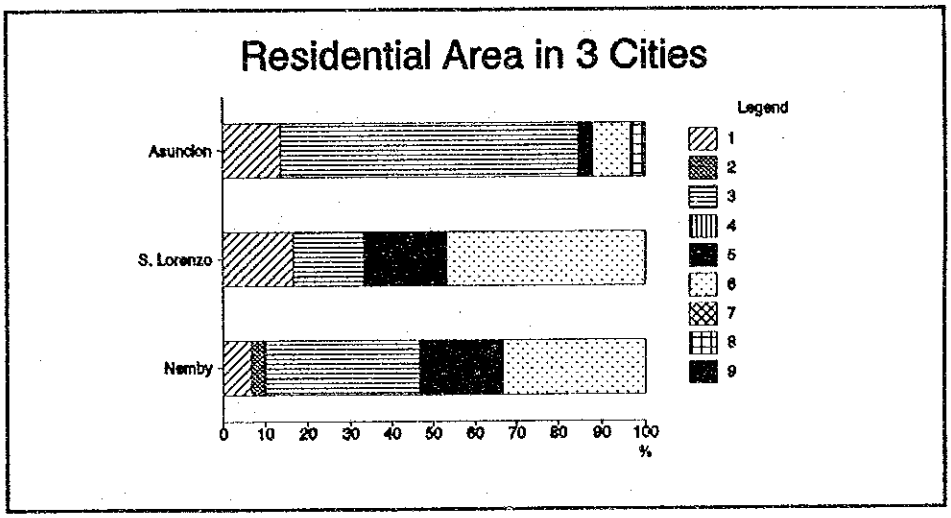
Residential Area in 3 Cities
Asuncion
S. Lorenzo
Nemby
0 10 20 30 40 50 60 70 80 90 100
%
Legend
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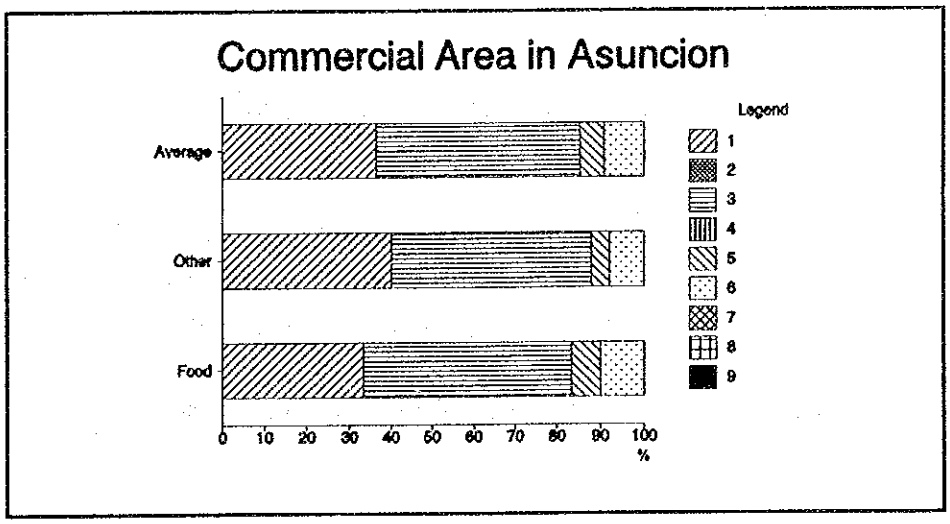
Commercial Area in Asuncion
Average
Other
Food
0 10 20 30 40 50 60 70 80 90 100
%
Legend
1
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C.3 Findings

a. Preliminary Questions

- 96.6 % of the interviewees lived in detached houses. (refer to Q1-4)

b. General Questions

- The range of family expenditure is very wide, from 350,000 to more than 3,500,000 Gs per month. (refer to Q2-3)
- The average land area of the house is very large, approximately 450 m^2. (refer to Q2-8)
- The stone pavement is prevailing in the residential areas. (refer to Q2-9)

c. Question on Waste Discharge from Your Householders/Shops.

- The percentage of garbage stands use is approximately 38 % in Asuncion, 21 % in San Lorenzo and 18 % in Nemby. (refer to Q3-3)
- Approximately 90 % of the interviewees are using plastic bags as waste containers, due to easy handling and most people are satisfied with it. (refer to Q3-4, 3-5, 3-7)
- More than 80 % of the interviewees intend to cooperate by carrying waste to the communal containers. (refer to Q3-9)
- More than 90 % of the interviewees of residential areas discharge garden wastes and 78.2 % of the interviewees in Asuncion discharge garden waste for regular collection service. (refer to Q3-11, 3-13)
- The majority of people sweep the road in front of their houses. (refer to Q3-15)

d. Questions on Waste Collection Services in Specific Areas

- Coverage rate of the waste collection in Asuncion is 78.3 %. (refer to Q4-1)

- The majority of people are satisfied with the present waste collection services. Especially in Asuncion, where it is 93.6 % in average. (Q4-3)

- The method of waste collection is curb collection in 3 municipalities. (Q4-5)

- Frequency of waste collection service is 3 times per week in Asuncion and 2 to 3 times per week in San Lorenzo and Nemby. (Q4-6)

e. Questions on Resource Recovery and Recycling

- Nearly 100 % of the interviewees answered with cooperate in recycling activities. (refer to Q5-1, 5-8)

- Nearly 100 % of the interviewees feel the necessity of resource recovery and recycling. (refer to Q5-3)

- As a measure of recycling and resource recovery, composting and heat recovery are not known and only sorting bottle and papers are known. It is found that people do not have certain knowledge on them. (Q5-4)

- There are door-to-door collectors but collection frequency is very low. (refer to Q5-5, 5-6)

- The system where the shops buy reusable material from common residents has not been provided yet. (refer to Q5-7)

f. Collection Fee and Financial Matters

- In Asuncion and San Lorenzo more than 90 % of the interviewees understand the municipalities are responsible for municipal solid waste management. In Nemby 50 % of the interviewees understand private contractors are responsible for it. (Q6-1)

- Approximately 70 % of the interviewees are satisfied with the present municipal solid waste management. (refer to Q6-2)

- The present average waste collection fee and amount of willing to pay are summarized in Table C.3a. (refer to Q6-4, 6-8)

Table C.3a Opinion to Waste Collection Fee

	Average amount of present collection fee per house (Gs/month)	Average amount of willingly pay (Gs/month)	Differences
Asuncion	7,825	8,227	5 % up
San Lorenzo	2,578	4,160	60 % up
Nemby	3,066	3,875	26 % up

- More than 90 % of the interviewees have an opinion that the governmental sectors should bear the extra cost to maintain the beautiful sight of the city. (Q6-6)

g. Public Cooperation

- Only 10 % of the interviewees have had guidance on proper method of waste discharge. (Q7-1)

- Nearly 100 % of the interviewees understand the necessity of public cooperation and express for participation. (Q7-2, 7-4, 7-5, 7-6)

- In Asuncion 70.8 % of the interviewees consider the municipality should take initiatives on public cooperation. (Q7-7)

ANNEX D

INVESTIGATION OF PRESENT LANDFILLS, PROPOSED INTER-MUNICIPAL DISPOSAL AND TRANSFER STATION SITES

LIST OF CONTENTS

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D.1 Investigation of the Existing Landfill Sites

In order to obtain the basic data for making a diagnosis on the existing disposal site in Cateura, topographical, geological and environmental surveys were carried out. The results of each survey are described here in detail. The location of the Cateura landfill site is shown in Figure D.1a.

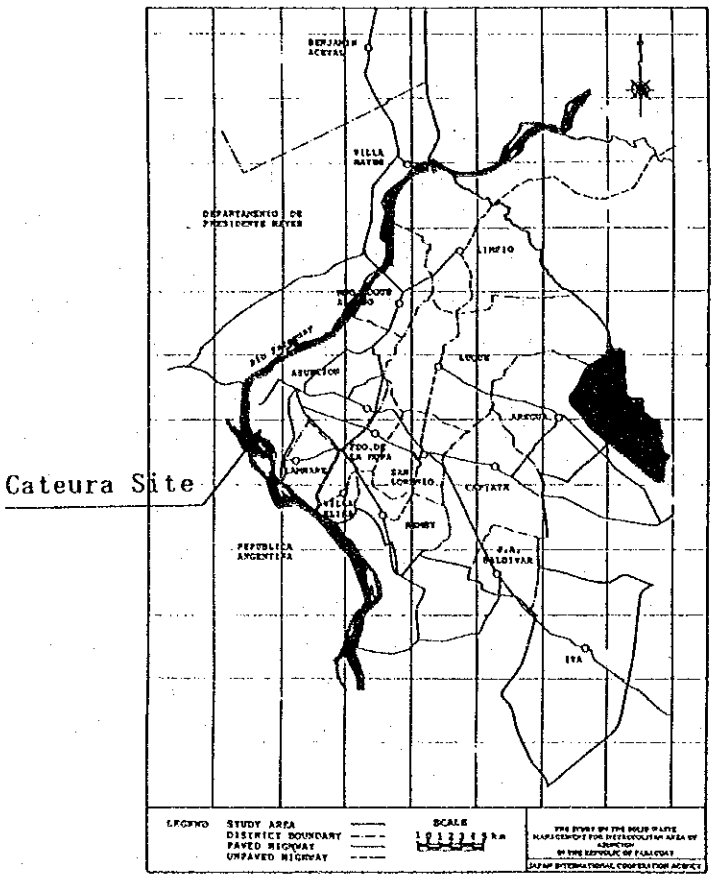


Figure D.1a Location of Cateura Landfill Site

D.1.1 Topographic Survey

A topographical map of the whole area of the Cateura final disposal site in the scale of 1 to 1000, was drawn by the Study team using the survey data.

The Cateura disposal site is situated on the riverbank of the Paraguay River in the southwestern side of Asuncion, and its present area is approximately 13.34 ha.

The topographical map drawn is in the Data Book.

D.1.2 Geological Survey

a. Location Map

The location of boreings is shown in Figure D.1.2a.

b. Work Method

- **Boreing:** Due to the fact that in the first boreing (P1) executed, there were no cohesive soil for the laboratory tests required, a second boreing (P2) was done 150 meters east from P1. In this second boreing cohesive soils were obtained making the execution of laboratory test possible.
  Boreings P1 and P2 were executed using a manual auger, bentonitic slurry, and wash boreing, making the Standard Penetration Test every meter or change of stratum.
  A third boreing was made for sampling undisturbed soils using a Rotative Auger, with hydraulic heading.

- **Sampling:** Disturbed samples were obtained every meter with a split tube sampler 2" OD and 1 3/8" ID following ASTM D-1586.
  Undisturbed samples were obtained with a thin wall tube sampler (Shelby Type), 3" OD and 2 1/8" ID., following ASTM 1587.
  It was impossible to obtain samples from 6.0 m to 8.0 m due to the extremely loose silt in that stratum.

- **Laboratory Test:** Disturbed samples were used to determine sieve analysis and Atterberg Limits in order to classify in the Unified Soil Classification System (USCS), Casagrande 1948.
  Undisturbed samples were used for:

  - Permeability Test
  - Unconfined Compression Test (q_u)
  - Triaxial Shear Test
  - Consolidation Test

- Permeability test was determined from the Triaxial equipment and additional pressure.

- Unconfined compression test was obtained in the Triaxial Apparatus. Detailed information is included in the respective sheet.

- Triaxial Undrained Shear Test (UU) was conducted using a WYKEHAN FARRANCE Compression Machine (WF 10052), Triaxial Cell (WF 10754). Monitoring and recording of measurements were done using an PC-XT Computer.

- Consolidation Test was conducted using a WYKEHAN FARRANCE EDOMETER (WF 24001) and the results are included in the Data book.

c. Work Results and Summary

Borehole logs are presented indicating the Standard Penetration Test results, water level, and geological stratigraphy.

Boreing P1 shows that the upper 6.25 m is a waste filling, followed by 0.40m of organic soil. From 6.65m to 10.0m, there is a layer of very fine silty quartz sand with a very uniform penetration number (from 8 to 10). From 10.0 m to the end of the boreing (20 m) there is a rise in the penetration number (exceeding 50). No cohesive soil was found in this boreing.

Boreing P2 presents very different results from P1, both in the penetration number and the type of soil. The upper 3.00 m is a waste filling. From 3.00 m to 6.00 m, there is silty sand or sandy silt with very low penetration number (from <1 to 4). From 6.0 m to 8.0 m there is an extremely soft organic and clayey silt (penetration number <1). From 8.0 m to 14.30 m very fine silty sand and light clay with penetration number running from 5 to 10. From 14.30 m to the end of the boreing there is a combined silty sand and sandy silt. Penetration numbers vary from 16 to >50.

d. Laboratory Results and Summary

Permeability test on cohesive soils show values ranging from 3.5 X 10^{-8} cm/seg. to 9.7 X 10^{-8} cm/seg.

Both unconfined compression test (q_u) results give values from 0.52 to 1.25 Kg/cm^2. Triaxial shear test result present uniform cohesion values but different friction angle. The difference visually is in the presence of Kaolinitic clay that does not conform with any order. This means that the tested samples don't present a structural and mineralogical uniformity.

Consolidation curves present a well-defined curvature. The result of samples from

13.00 m - 13.65 m present a higher overconsolidation ratio than the samples from 11.00 m - 11.30 m. Samples from 0.25 m - 0.80 m shows a normal consolidation curve.

Results for classification of soil are as follows:

Table D.1.2a Result of Soil Classification

Sample Number	Depth (m)	P.#200 (%)	W_L (%)	W_P (%)	I_P (%)	U.S.C.S.
P2	11-11.35	93.8	41.5	18.5	23	CL
P2	13.10-13.65	100	49.2	22.6	26.6	CL
P2	6.00-6.45	61	55.1	34.1	21	OH
P1	6.25-6.65	83.2	163.2	94.2	69	OH
P1	7.00-7.45	27.1	—	—	—	SM
P1	19.55-20.00	5	—	—	—	SP-SM
P1	10.00-10.45	10.6	—	—	—	SP-SM
P2	4.00-4.45	73.9	—	—	—	ML
P2	16.00-16.45	86.2	—	—	—	ML
P2	19.00-19.45	29.9	—	—	—	SM
M3	0.25-0.80	97.3	32.8	15.2	17.6	CL

Table D.1.2b Summary of Laboratory Test Result

Laboratory Test	unit	No.1	No.2	No.3
Depth	m	11.70-12.30	13.10-13.65	0.25-0.8
Permability	cm/sec.	5.0×10^{-8}	9.7×10^{-8}	4.5×10^{-8}
Unconfined Compression (q_u)	kg/cm^2	1.11	1.25	0.54
Triaxial Shear	kg/cm^2 degree	c = 0.35 ϕ = 11.35	c = 0.37 ϕ = 5.59	O = 0.37 ϕ = 1.08
Consolidation	refer to consolidation test result			

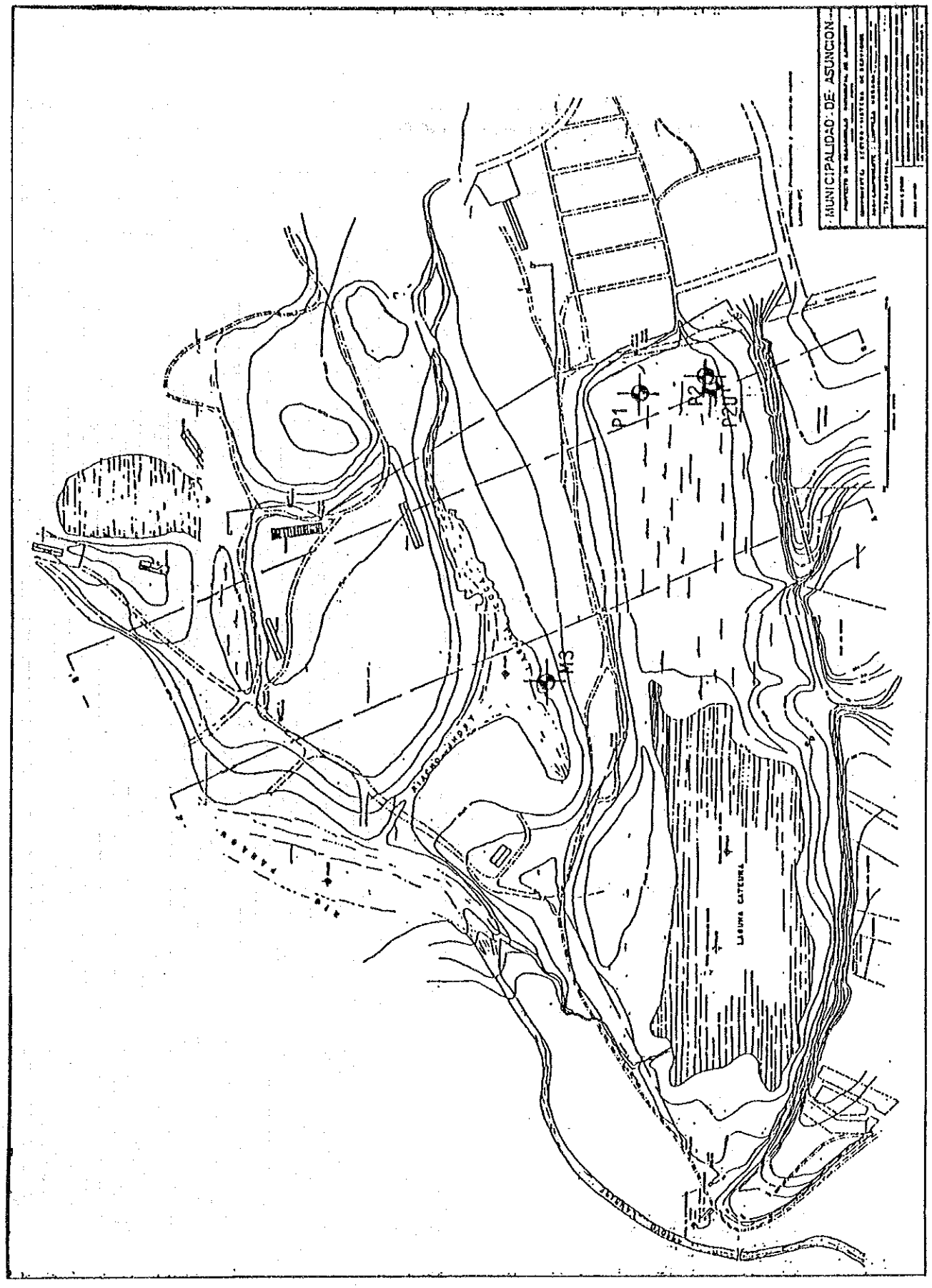


Figure D.1.2a Location Map of Boreing

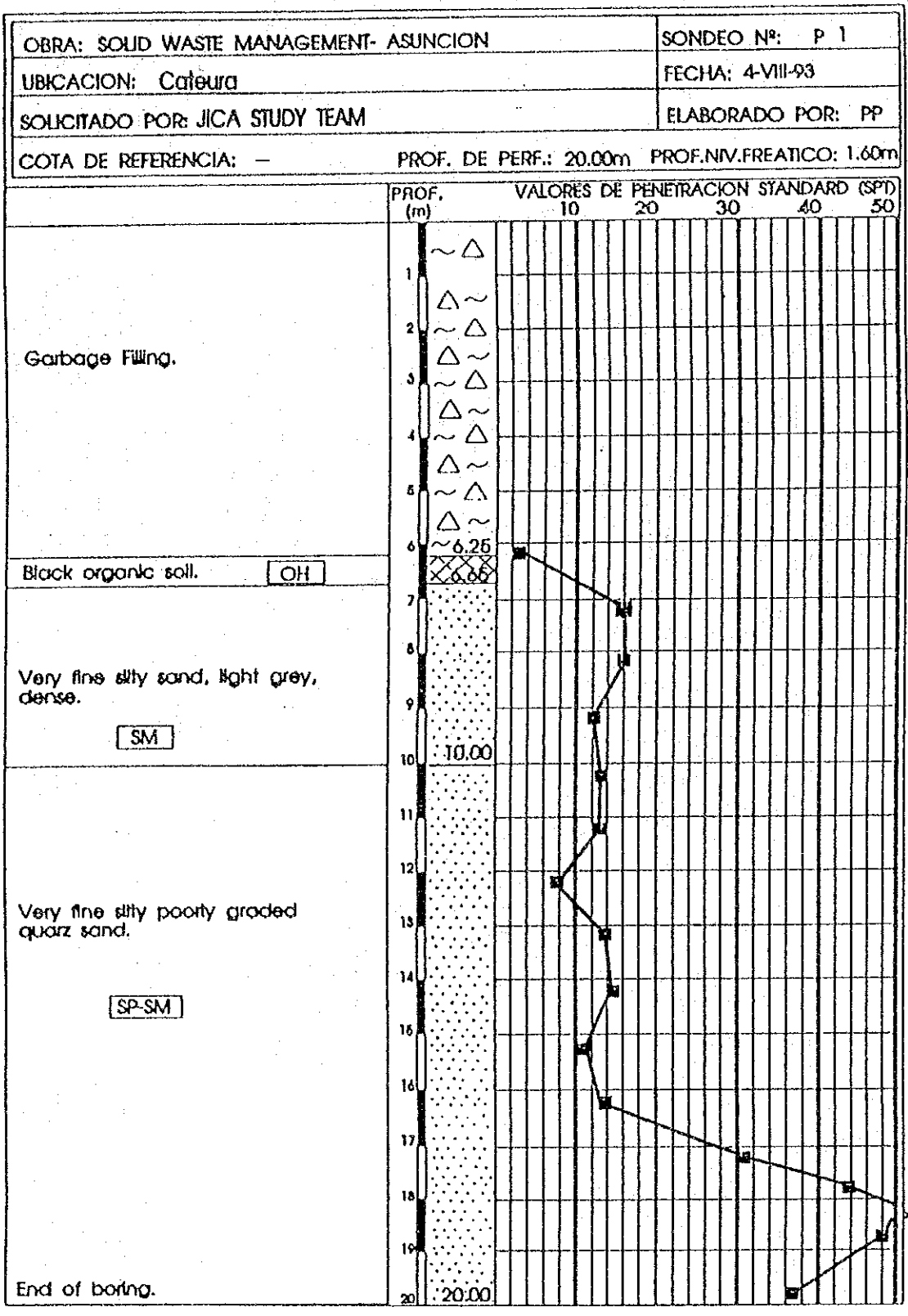


Figure D.1.2b Borehole Log No.1

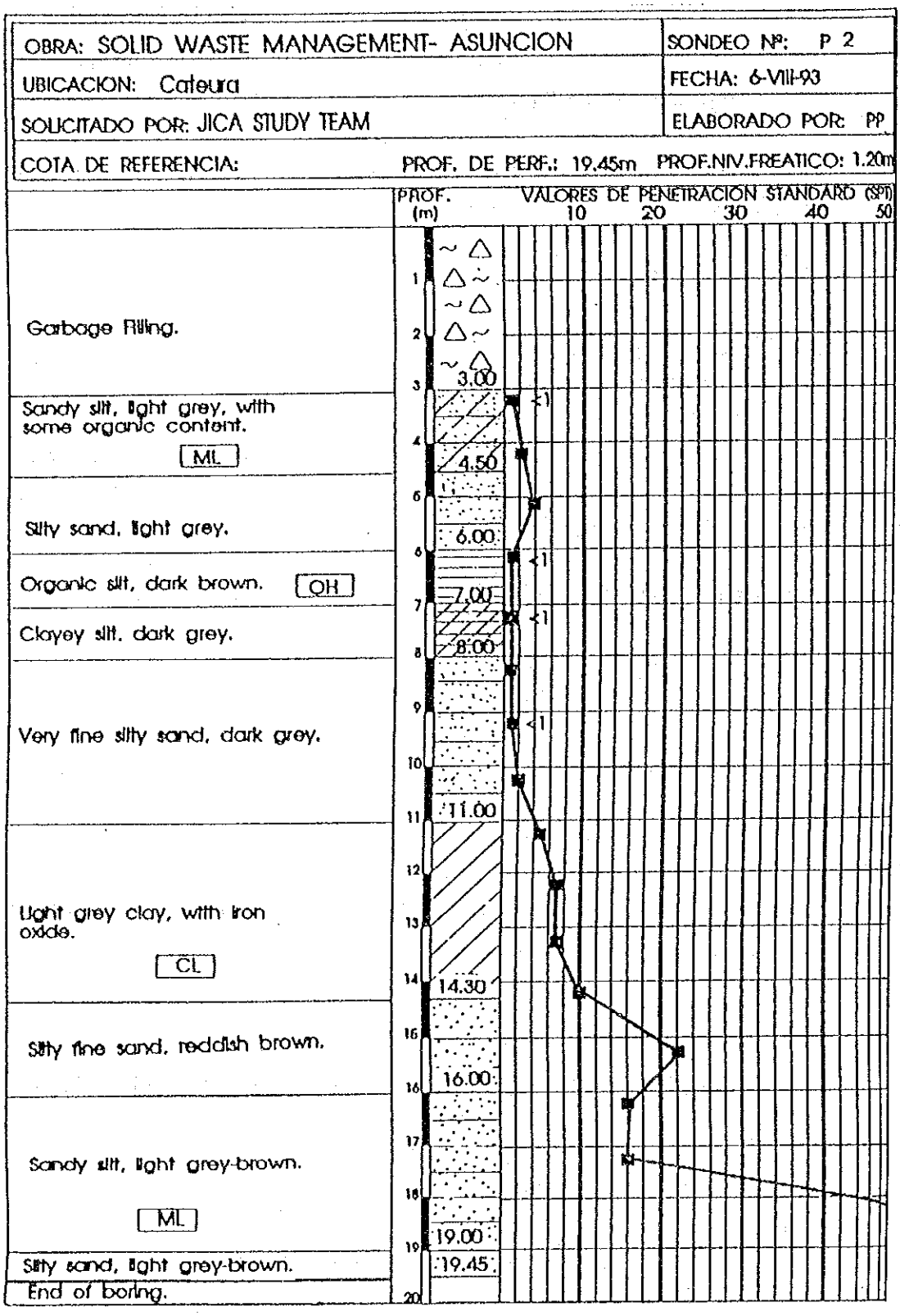


Figure D.1.2c Borehole Log No.2

D.1.3 Land Use Survey

a. Objectives of the Survey

The objective of the land use survey is to understand the present land use conditions of the existing landfill sites and its surroundings.

b. Survey Areas

- 9 existing disposal sites
- within 500 m from the sites

The locations of the existing disposal sites surveyed are shown in the Data Book.

c. Categories of Land Use

The land use categories for this survey are as follows:

-	Residential area:	Houses and their sites
-	Agricultural area:	Pasture land and cultivated land
-	Forest area:	Area having trees
-	Others:	Areas excluded in the above categories

d. Survey Method

The land use maps were prepared based on the data obtained through the field surveys.

e. Survey Period

The field survey for land use was carried out from 17 August until 10 September, 1993

f. Results of the Survey

The land use maps prepared are presented in the Data Book.

The common characteristics of the present land use are that houses are located near the many existing disposal sites.

D.1.4 Environmental Survey on Present Landfills

The environmental survey was conducted to understand the present environmental condition of the disposal sites in the study area. The environmental survey consists of water quality survey, ambient survey, noise survey, traffic volume survey and land use survey.

D.1.4.1 Water Quality Survey

a. Objective of the Survey

The objective of the water quality survey is to understand the present quality of:

- leachate discharged from the existing final disposal sites,
- ground water near the existing disposal sites, and
- river water near the existing disposal sites.

b. Location of Water Sampling Points

Water samples were taken from the sites where feasible among the existing disposal sites in the Study Area.

Location of water sampling points are shown in Figure D.1.4.1a.

c. Analysis Items

The following items were analyzed.

- Concerning people's health
  Pb, As, Cd, Cr^{+6}, Hg
- Others
  pH, COD, BOD, Total Nitrogen, SO_4^{-2}, Cl^-

d. Analysis Method

Water analysis is carried out in accordance with "Standard Methods, for the

examination of water and wastewater, fifteenth edition", prepared and published jointly by the American Public Health Association, AMER, and Water Pollution Control Federation.

e. Dates of Water Sampling

Water samplings were carried out twice on the following days.

- 1st sampling: 17 and 18 August in 1993
- 2nd sampling: 1 and 2 September in 1993

f. Results of Water Quality Analysis

The results of water quality analysis are presented in Table D.1.4.1a. The results are summarized as follows.

- Hg was measured for both water samples taken at the outlet of the drain in the Cateura landfill site.
- Cr^{+6} was measured for the both water samples of leachate in the Ñemby landfill site.
- The items related to people's health except Hg and Cr^{+6} were not measured.
- Highly concentrated BOD and COD were measured for water in the well near the Ñemby landfill site.
- The minimum and maximum values measured are summarized in Table D.1.4.1b.

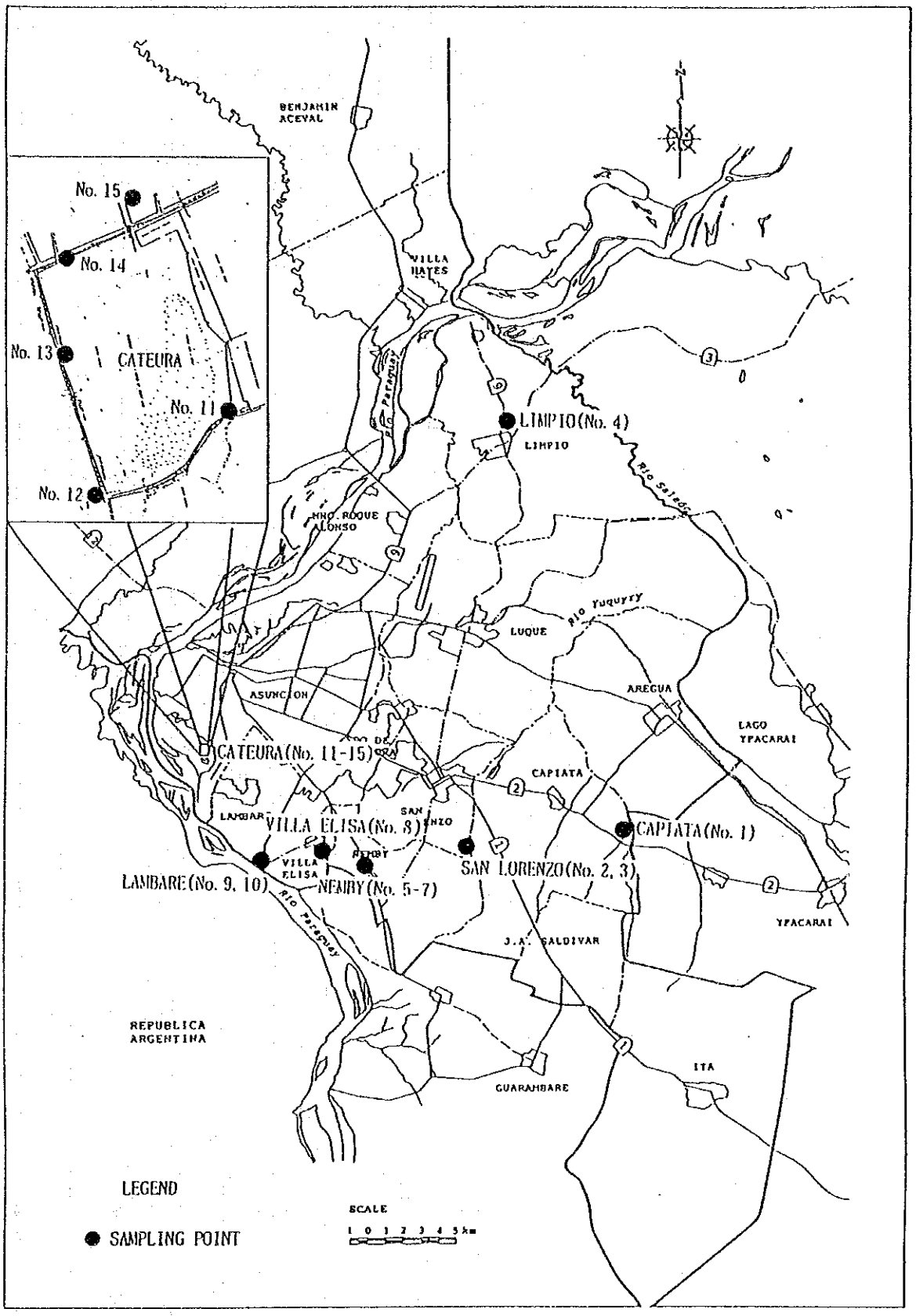


Figure D.1.4.1a Location Map of Water Quality Survey Point

Table D.1.4.1a Result of Water Quality Analysis

	Place of Site	Date of Sampling	Type of Water	Water Temp. ℃	pH	COD mg/l	BOD mg/l	SO_4^{2-} mg/l	Cl^- mg/l	T-N mg/l	Pb mg/l	As mg/l	Cd mg/l	Cr^{6+} mg/l	Hg mg/l
1	Capiata	17 Aug 1993	Leachate	14.6	5.7	2,300	720	264	192	4.1	N.D.	N.D.	N.D.	N.D.	N.D.
		01 Sep 1993	Leachate	15.5	5.6	21,000	>3,000	520	710	9.8	N.D.	N.D.	N.D.	N.D.	N.D.
		Average		15.1	5.7	11,650	-	392	451	6.9	N.D.	N.D.	N.D.	N.D.	N.D.
2	San Lorenzo	17 Aug 1993	Leachate	14.2	5.9	4,200	1,900	300	231	52	N.D.	N.D.	N.D.	N.D.	N.D.
		01 Sep 1993	Leachate	12.7	6.4	900	660	250	7.4	12	N.D.	N.D.	N.D.	N.D.	N.D.
		Average		13.5	6.2	2,550	1,280	225	119	32	N.D.	N.D.	N.D.	N.D.	N.D.
3	San Lorenzo	17 Aug 1993	Well	21.1	7.6	2	0.1	9	67.5	1.1	N.D.	N.D.	N.D.	N.D.	N.D.
		01 Sep 1993	Well	21.7	7.8	2	0.6	25	67.4	0.59	N.D.	N.D.	N.D.	N.D.	N.D.
		Average		21.4	7.7	2	0.4	17	67.4	0.82	N.D.	N.D.	N.D.	N.D.	N.D.
4	Limpio	17 Aug 1993	Leachate	14.7	6.7	180	15	21	156.2	3.8	N.D.	N.D.	N.D.	N.D.	N.D.
		01 Sep 1993	Leachate	12.3	8.0	90	24	23	125.3	0.77	N.D.	N.D.	N.D.	N.D.	N.D.
		Average		13.5	7.4	135	20	22	140.8	2.3	N.D.	N.D.	N.D.	N.D.	N.D.
5	Nemby	17 Aug 1993	Leachate	13.1	8.2	8,400	675	2,000	3,053	3,744	N.D.	N.D.	N.D.	4.8	N.D.
		01 Sep 1993	Leachate	17.4	8.3	12,400	1,200	1,250	5,325	27	N.D.	N.D.	N.D.	3.2	N.D.
		Average		15.3	8.3	10,400	938	1,625	4,189	1,886	N.D.	N.D.	N.D.	4.0	N.D.
6	Nemby	17 Aug 1993	Well	20.7	6.5	40	2.8	17	121	5.5	N.D.	N.D.	N.D.	N.D.	N.D.
		01 Sep 1993	Well	21.1	6.4	50	4.8	24	124	0.82	N.D.	N.D.	N.D.	N.D.	N.D.
		Average		20.9	6.5	45	3.8	21	123	3.1	N.D.	N.D.	N.D.	N.D.	N.D.
7	Nemby	17 Aug 1993	River	22.1	6.5	30	10.5	27	56.8	28	N.D.	N.D.	N.D.	N.D.	N.D.
		01 Sep 1993	River	23.0	6.9	20	7.6	23	47.9	0.75	N.D.	N.D.	N.D.	N.D.	N.D.
		Average		22.6	6.7	25	9.1	25	52.4	14	N.D.	N.D.	N.D.	N.D.	N.D.
8	Villa Elisa	17 Aug 1993	Well	20.4	6.4	20	0.1	23	10.7	0.9	N.D.	N.D.	N.D.	N.D.	N.D.
		01 Sep 1993	Well	20.8	6.6	1	0.6	27	8.8	0.5	N.D.	N.D.	N.D.	N.D.	N.D.
		Average		20.6	6.5	11	0.4	25	9.7	0.7	N.D.	N.D.	N.D.	N.D.	N.D.
9	Lambare	18 Aug 1993	Leachate	17.3	7.4	6,300	300	80	568	104	N.D.	N.D.	N.D.	N.D.	N.D.
		01 Sep 1993	Leachate	16.4	7.4	800	525	90	249	0.77	N.D.	N.D.	N.D.	N.D.	N.D.
		Average		16.9	7.4	3,650	413	85	408	52	N.D.	N.D.	N.D.	N.D.	N.D.
10	Lambare	18 Aug 1993	Well	20.8	9.1	4	1.4	10	67.5	0.42	N.D.	N.D.	N.D.	N.D.	N.D.
		01 Sep 1993	Well	20.6	9.3	2	1.2	50	53.3	1.4	N.D.	N.D.	N.D.	N.D.	N.D.
		Average		20.7	9.2	3	1.3	30	60.4	0.9	N.D.	N.D.	N.D.	N.D.	N.D.
11	Cateura	18 Aug 1993	Leachate	16.7	7.4	1,800	550	65	462	45	N.D.	N.D.	N.D.	N.D.	N.D.
		02 Sep 1993	Leachate	15.1	8.0	1,000	1,075	425	532	74	N.D.	N.D.	N.D.	N.D.	N.D.
		Average		15.9	7.7	1,400	812	245	497	60	N.D.	N.D.	N.D.	N.D.	N.D.
12	Cateura	18 Aug 1993	Leachate	19.6	7.1	500	126	18	252	167	N.D.	N.D.	N.D.	N.D.	0.02
		02 Sep 1993	Leachate	20.4	7.3	560	192	150	284	1.6	N.D.	N.D.	N.D.	N.D.	0.023
		Average		20.0	7.2	530	159	84	268	84	N.D.	N.D.	N.D.	N.D.	0.022
13	Cateura	18 Aug 1993	Leachate	16.2	8.1	2,000	150	208	2,059	1,330	N.D.	N.D.	N.D.	N.D.	N.D.
		02 Sep 1993	Leachate	18.2	8.4	1,950	135	110	3,408	469	N.D.	N.D.	N.D.	N.D.	N.D.
		Average		17.2	8.3	1,975	143	159	2,734	900	N.D.	N.D.	N.D.	N.D.	N.D.
14	Cateura	18 Aug 1993	Leachate	15.6	8.5	2,500	1,600	288	3,302	180	N.D.	N.D.	N.D.	N.D.	N.D.
		02 Sep 1993	Leachate	14.7	8.5	1,900	180	280	3,266	326	N.D.	N.D.	N.D.	N.D.	N.D.
		Average		15.2	8.5	2,200	890	284	3,284	253	N.D.	N.D.	N.D.	N.D.	N.D.
15	Cateura	18 Aug 1993	Well	22.2	6.1	12	0.4	16	7.1	0.55	N.D.	N.D.	N.D.	N.D.	N.D.
		02 Sep 1993	Well	22.7	6.7	1	0.7	27	10.6	0.35	N.D.	N.D.	N.D.	N.D.	N.D.
		Average		22.5	6.4	7	0.6	22	8.9	0.45	N.D.	N.D.	N.D.	N.D.	N.D.

N.D. : No Detected

Table D.1.4.1b Maximum and Minimum Value of Water Quality Analysis

Item	Unit		Leachate	Well	River
pH		Maximum	8.5	9.3	6.5
		Minimum	5.6	6.1	6.9
COD	mg/l	Maximum	21,000	50	30
		Minimum	90	1	20
BOD	mg/l	Maximum	>3,000	4.8	10.5
		Minimum	15	0.1	7.6
SO_4^{-2}	mg/l	Maximum	2,000	50	27
		Minimum	18	9	23
Cl^-	mg/l	Maximum	5,325	124	56.8
		Minimum	7.4	7.1	47.9
Total Nitrogen	mg/l	Maximum	3,744	5.5	28
		Minimum	0.77	0.35	0.75

D.1.4.2 Ambient Survey

a. Objectives of the Survey

The objective of the survey is to understand the present air pollution generated by the operation of the disposal site near the disposal site.

b. Location of the Survey

The survey was carried out at the Cateura landfill site. The location of the survey is shown in Figure D.1.4.2a.

c. Analysis Items

The following items were analyzed.

- dust fall
- suspended particular matter (SPM)
- ammonia gas
- methane

d. Analysis Method

The all items were analyzed in accordance with ORSAT.

e. Survey Period

The survey was carried out during the following periods.

- Dust fall and SPM:
  from 11 to 18 August 1993.
- Ammonia and Methane:
  on 11 August 1993.

f. Results of the Ambient Survey

The results of the ambient survey are presented in the Data Book and Figure D.1.4.3b. The results are summarized as follows.

- Ammonia and Methane could not be detected.
- The dust fall data ranges from 0.00 g/m^2 to 7.64 g/m^2.
- The S.P.M. data ranges from 0.00 g/m^3 to 3.04 g/m^3.

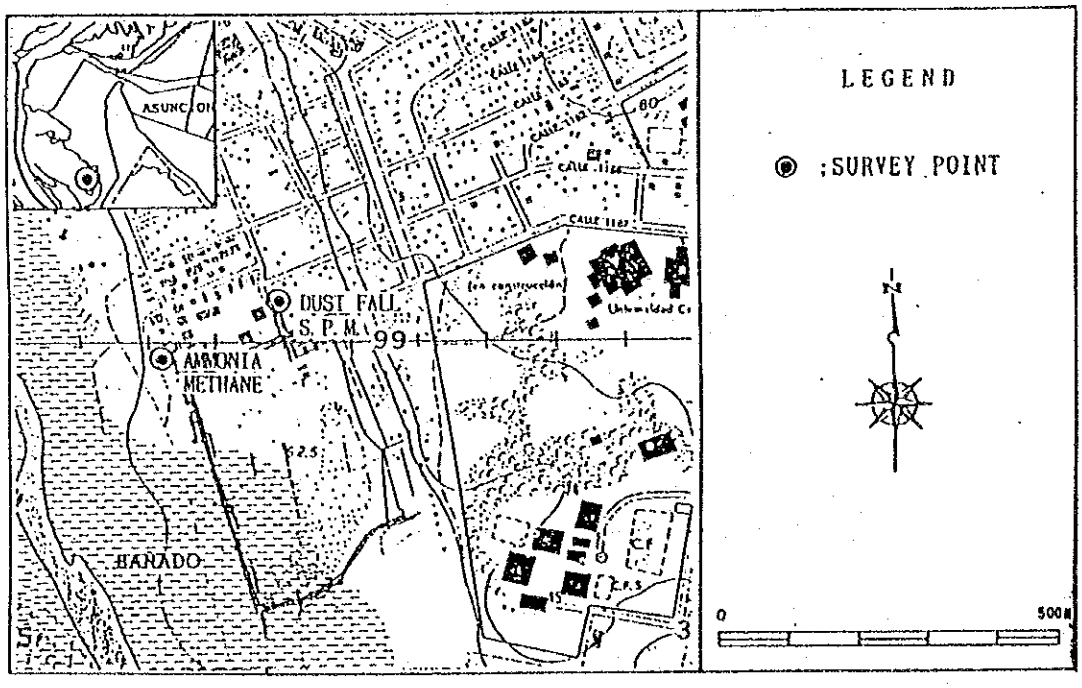


Figure D.1.4.2a Map of Ambient Survey Points

Table D.1.4.2a Result of Air Pollution Analysis

Place: Cateura Disposal Site

Period: from 16:00 11th August 1993 until 12:00 18th August 1993

Items	Unit	11th	12nd	13rd	14th	15th	16th	17th	Average	Maximum	Minimum
Ammonia	ppm	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Methane	ppm	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Dust fall	g/m^2	4.06	3.28	4.72	0.00	4.33	3.13	7.64	3.88	7.64	0.00
S.P.M.	mg/m^3	0.21	0.33	0.25	0.21	1.13	3.04	0.00	0.74	3.04	0.00
Air Temperature	°C	11.6	15.5	15.6	16.1	20.5	22.0	10.8	16.0	22.0	10.8
Humidity	%	67	60	77	84	74	72	88	75	88	60
Wind velocity	m/s	1.7	3.1	2.5	2.5	3.1	9.9	9.2	4.4	9.2	1.7
Wind direction	-	S	S	S	NE	E	S	S	-	-	-
Rainfall	mm/d	-	-	-	-	-	-	0.7	-	-	-

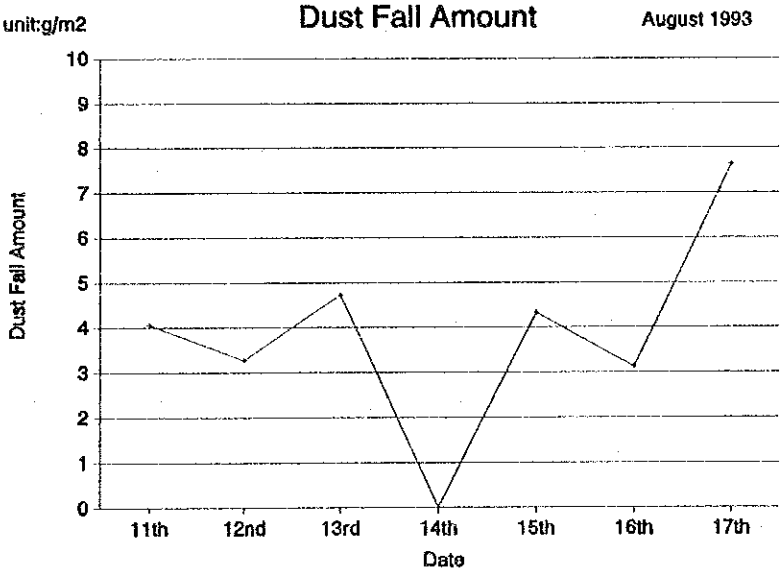


Figure D.1.4.2b Dust Fall Amount

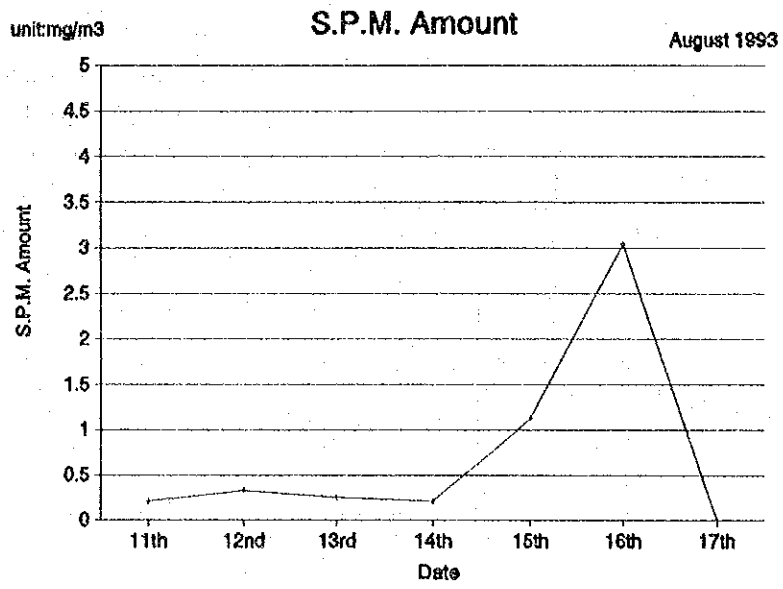


Figure D.1.4.2c S.P.M. Amount

D.1.4.3 Noise Survey

a. Objectives of the Survey

The objective of the noise survey is to understand the present noise level around the landfill site caused by the landfill operation.

b. Location of the survey point

The noise survey was carried out for the Cateura landfill site in Asuncion because most of the heavy equipment and waste collection trucks operate at this site.

The survey point is shown in Figure D.1.4.3a.

c. Survey Items

The level of noise around the landfill site including noise of heavy equipment and trucks was measured.

d. Survey Method

- Instruments used : Noise meter
- Survey Time : Every 5 seconds for 10 minutes every hour for 24 hours

e. Survey Period

The survey was carried out from 9:00 August 3rd until 9:10 August 4th in 1993

f. Results of the Survey

The survey results are shown in Table D.1.4.3a and b and Figure D.1.4.3b. The results are summarized as follows.

- The values of L_{50} range between 50 and 70 dB.
- Fluctuation was observed for L_{50} in the morning, but L_{50} was quite constant around 60 dB from the afternoon until midnight.

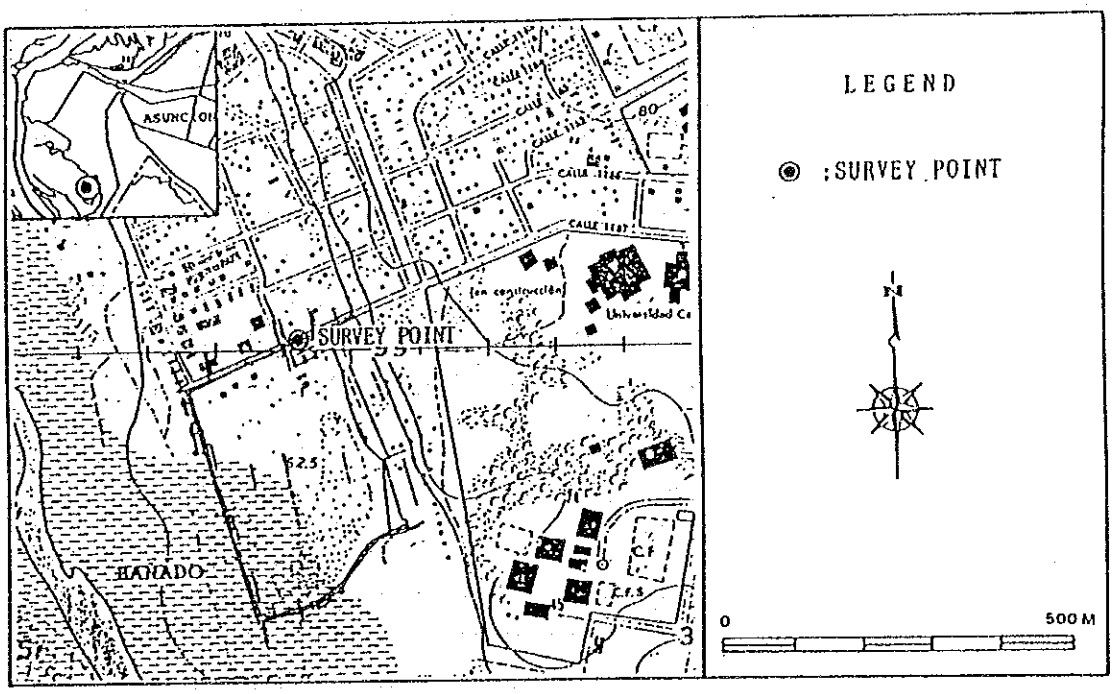


Figure D.1.4.3a Location Map of Noise Survey

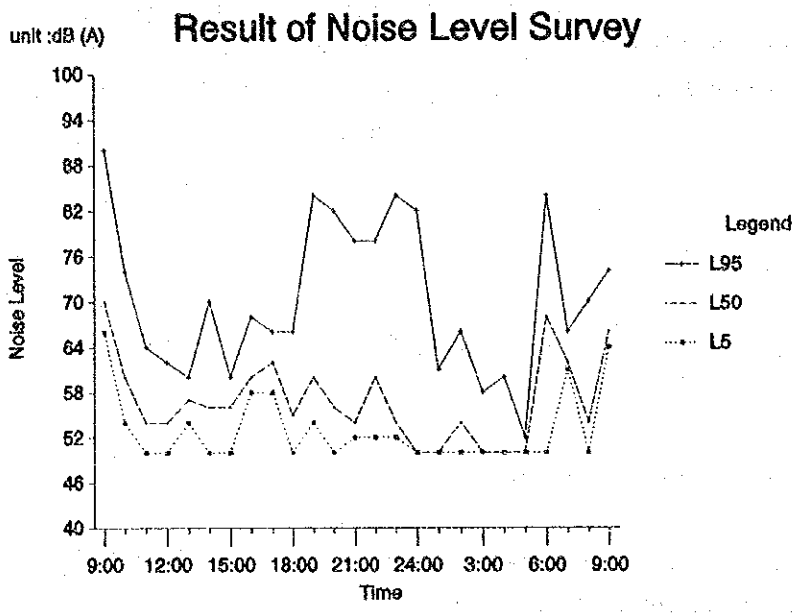


Figure D.1.4.3b Result of Noise Level Survey

D.1.4.4 Traffic Volume Survey

a. Objective of the Survey

The objectives of the Traffic Volume Survey are:

- To understand the present impact on the traffic by the waste collection trucks, and
- To understand the time fluctuation of the present traffic as the basic data to formulate the collection and haulage plan.

b. Location of the Survey

The survey was carried out for the traffic passing the Jose Felix Bogado Avenue near the intersection with Japan Avenue where most waste collection trucks pass to enter the Cateura landfill site. The location is shown in figure D.1.4.4a.

c. Vehicle Category

The vehicles are measured by the following three categories.

- Large vehicles
- Small vehicles
- Waste collection trucks

d. Survey Method

The number of vehicles was measured with an eye counter.

e. Time of the Survey

The traffic volume survey was carried out from 13:00 August 2nd until 13:00 August 3rd in 1993.

f. Results of the Survey

The results of the traffic volume survey are shown in Table D.1.4.4a and Figure D.1.4.4b. The results are summarized as follows:

- The traffic volume of the waste collection trucks was 92 trucks.
- The percentage of the waste collection truck to the total traffic was 0.3 %.
- The maximum waste collection truck volume per hour was 12 trucks.
- The maximum percentage of the waste collection truck to the total traffic per hour was 2.4 %
- The total traffic volume per day was 32,844 vehicles
- The maximum traffic volume per hour was 2,790 between 20:00 and 21:00
- In the morning the traffic from north to the south was more, but in the afternoon the traffic from south to north was prevailing.

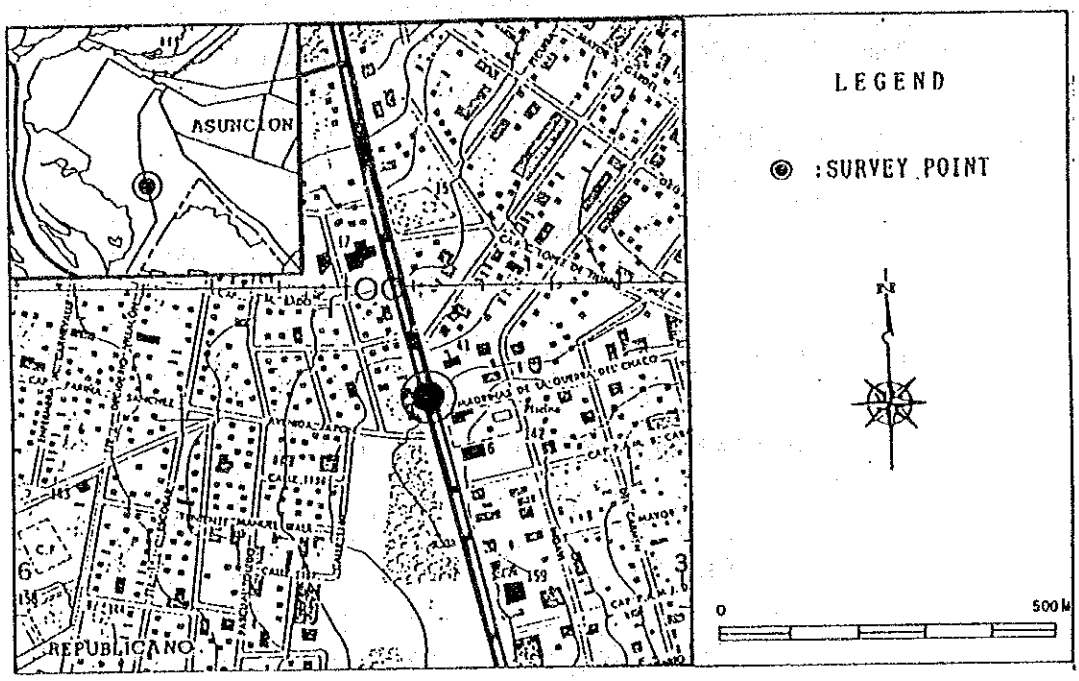


Figure D.1.4.4a Location of Traffic Volume Survey Point

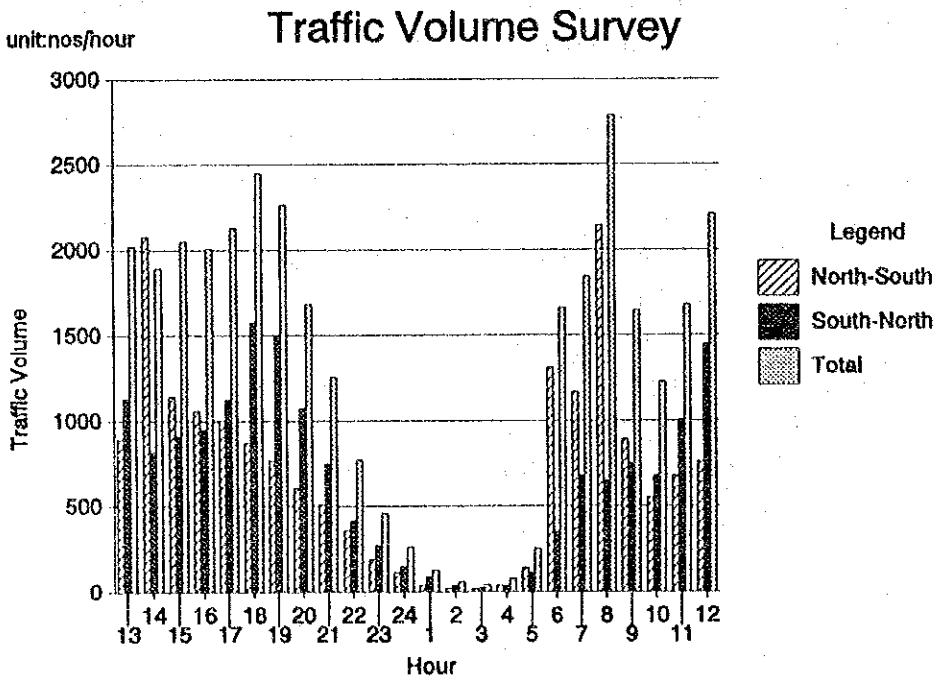


Figure D.1.4.4b Result of Traffic Volume Survey

D.1.4.5 Findings

a. Water Quality Survey

The comparison table of water quality survey data and permissible values specified by the Paraguayan standards is presented in Table D.1.4.5a.

The results are summarized as follows.

- All leachate qualities exceeded the permissible values, specified by the Environmental Water Quality Standard, in all items.

- All well water qualities exceeded the permissible values, specified by the Water Quality Standard for Drinking Water, in all items.

Table D.1.4.5a Evaluation of Result of Water Quality Analysis

Item	Unit		Leachate	Well	River	Standard	
						A	B
pH		Maximum Minimum	8.5 5.6	9.3 6.1	6.5 6.9	5–10	5–10
COD	mg/l	Maximum Minimum	21,000 90	50 1	30 20	2.5	2.5
BOD	mg/l	Maximum Minimum	>3,000 15	4.8 0.1	10.5 7.6	–	–
SO_4^{-2}	mg/l	Maximum Minimum	2,000 18	50 9	27 23	N.D.	N.D.
Cl^-	mg/l	Maximum Minimum	5,325 7.4	124 7.1	56.8 47.9	–	–
Total Nitrogen	mg/l	Maximum Minimum	3,744 0.77	5.5 0.35	28 0.75	–	–
Cr^{6+}	mg/l	Maximum Minimum	4.8 3.2	– –	– –	0.05 total	0.05 total
Hg	mg/l	Maximum Minimum	0.023 0.02	– –	– –	0.001	0.001

Standard A: Environmental Water Quality Standard (Class 1) (source: SENASA)
Standard B: Water Quality Standard for Drinking Water (source: SENASA)
Standard A and Standard B are Maximum Value
N.D.: No Detected

b. Ambient Survey

There is no environmental standard and regulation concerning ambient quality in Paraguay. It is being prepared by SENASA. Therefore, the survey results were checked using the Japanese Standard.

- **S.P.M.**
  - Range of survey data measured:
    From 0.00 mg/m^3 to 3.04 mg/m^3
  - Permissible values specified by the Japanese ambient air quality standards: less than 0.10 mg/m^3 (daily average per hour)

- **Ammonia**
  - Ammonia was not detected.
  - Permissible values specified by the Japanese offensive odor control law: from 1 to 5 ppm (range of standards on boundary line)

The some data measured exceeded the permissible values.

c. Noise Survey

There is no environmental standard and regulation concerning noise. It is being prepared by SENASA. Therefore, the survey results were checked using the Japanese Standard.

- Range of survey data measured:
  From 50 to 70 dB (A)(L_{50})

- Japanese environmental standard for noise:
  From 50 to 60 dB (A)(area category B)
  Note: *Area category B are the areas which are used considerably for residential purposes and which are also used for commercial and industrial purposes.*

- Noise regulation law in Japan
  85 dB (A) (standards on boundary line)

The some data measured exceeded the permissible values.

d. Traffic Volume Survey

The percentage of the waste collection vehicles among all vehicles were 0.3 % per day on average and 2.4 % per hour maximum. Since the rates were very low, it was judged that the effects of the waste collection vehicles compared with the other vehicles was very little.

e. Conclusions

The impact produced by the waste collection vehicles compared to the other vehicles were found to be very little.

Some data of ambient quality and noise produced exceeded the permissible values specified in Japan.

Water quality were found to be extremely poor. Particularly the low quality of the well water is a serious problem.

A large amount of houses are located near most of the existing disposal sites, as mentioned in the land use survey. It is expected that many people near the disposal sites have to use water from wells due to the lack of water supply. Two wells, No. 8 in Villa Elisa and No. 15 in Cateura, among 5 wells which had its water quality analyzed in the survey, are being used even for cooking.

Water is being bought for drinking, at the N° 8 point in Villa Elisa. Water from N° 15 in Cateura is used by many neighbors as a public well.

In other well water sampling points, the wells are not being used.

High level of BOD and COD and gray well water were observed. Many neighbors of the disposal sites seems to worry about well water quality because several people asked us to examine their well water during the survey.

The following matters are suspected as the cause of well water deterioration.

- manure and urine from farm animals
- domestic sewage
- leachate from disposal sites
- combination of the above-mentioned matters

The cause is unknown at present, because it is necessary to carry out the geological

survey around the disposal site and monitoring underground water, to identify the cause.

Therefore, the detailed geological survey and underground water survey are required prior to the implementation and also the protection measures from leachate have to be fully taken into account.

D.2 Investigation of the Proposed Inter-municipal Disposal Site "Chaco-i"

In order to obtain the required basic data to carry out a feasibility study for the Chaco-i site as a proposed inter-municipal disposal site, topographical, geological, land use and environmental surveys were carried out. These results are presented in this section. The location of Chaco-i site is shown in Figure D.2a.

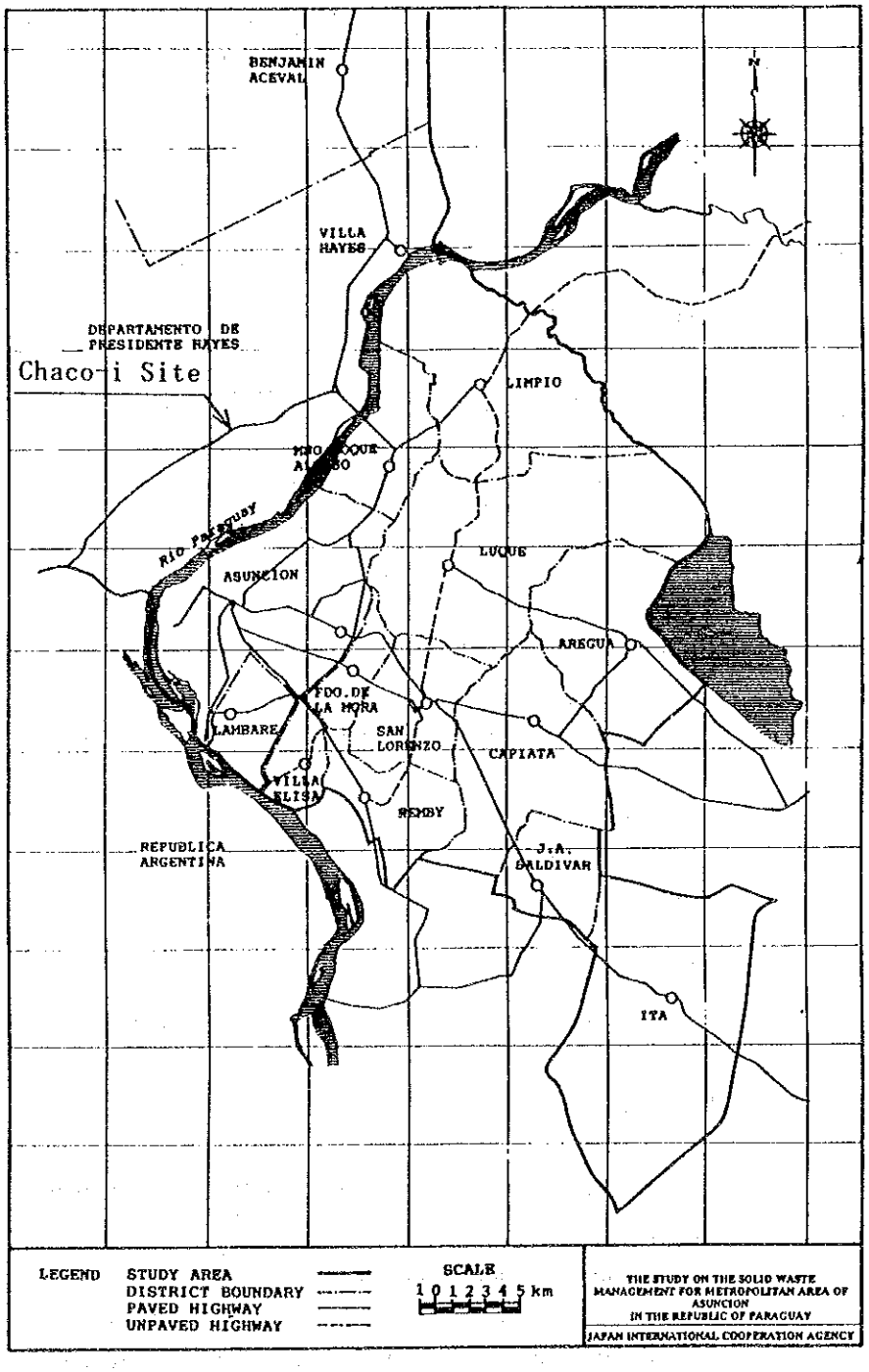


Figure D.2a Location of Chaco-i Site

D.2.1 Topographical Survey

The topographical map covering the whole area of the Chaco-i site was drawn in the scale of 1 to 1000 based on the survey data obtained. This is included in the Data Book.

The Chaco-i site is situated 1.2 km west of the River Negro, Villa Hayes, Chaco and is on the northern side along the Route No.12 road. The area of the Chaco-i site is 196 ha. and its terrain is flat. At present it is a meadow.

D.2.2 Geological Survey

a. Purpose of the Geological Survey

The purpose of the geological survey is as follows:

- to understand the geological features
- to judge applicability of soil as filling material

b. Quantities and Method of Survey

The location of geological survey is shown in Figure D.2.2a.

ba. Survey of Geological Features

baa. Boreing in soil

a.	Number of Borcholes	:	2 borcholes
b.	Depth of the borcholes	:	15 meters

bab. Penetration Test

The penetration test was carried out within 1 m from the proposed boreing location.

-	Number of penetration test	:	2 points
-	Depth of test	:	15 meters
-	Interval of penetration test	:	every 1 meter

The boreholes 15 meters deep were executed using manual auger, bentonitic slurry, and wash boreing, making the standard penetration test every meter.

bac. Sampling

Three samples from three different layers were taken at each borehole for the laboratory tests.

bad. Laboratory Tests

The following tests were conducted for six samples.

a. Permeability test
b. Unconfined compression test
c. Triaxial compression test
d. Consolidation test

bb. Survey of Applicability of Soil as Filling Material

bba. Sampling of Soil

One sample was taken at 5 points. Two points were taken from 3 m in depth of each boreing hole and 3 samples were taken from 0.5 m in depth from 3 points instructed by the Study Team.

bbb. Laboratory Test

The following tests were carried out for every sample.

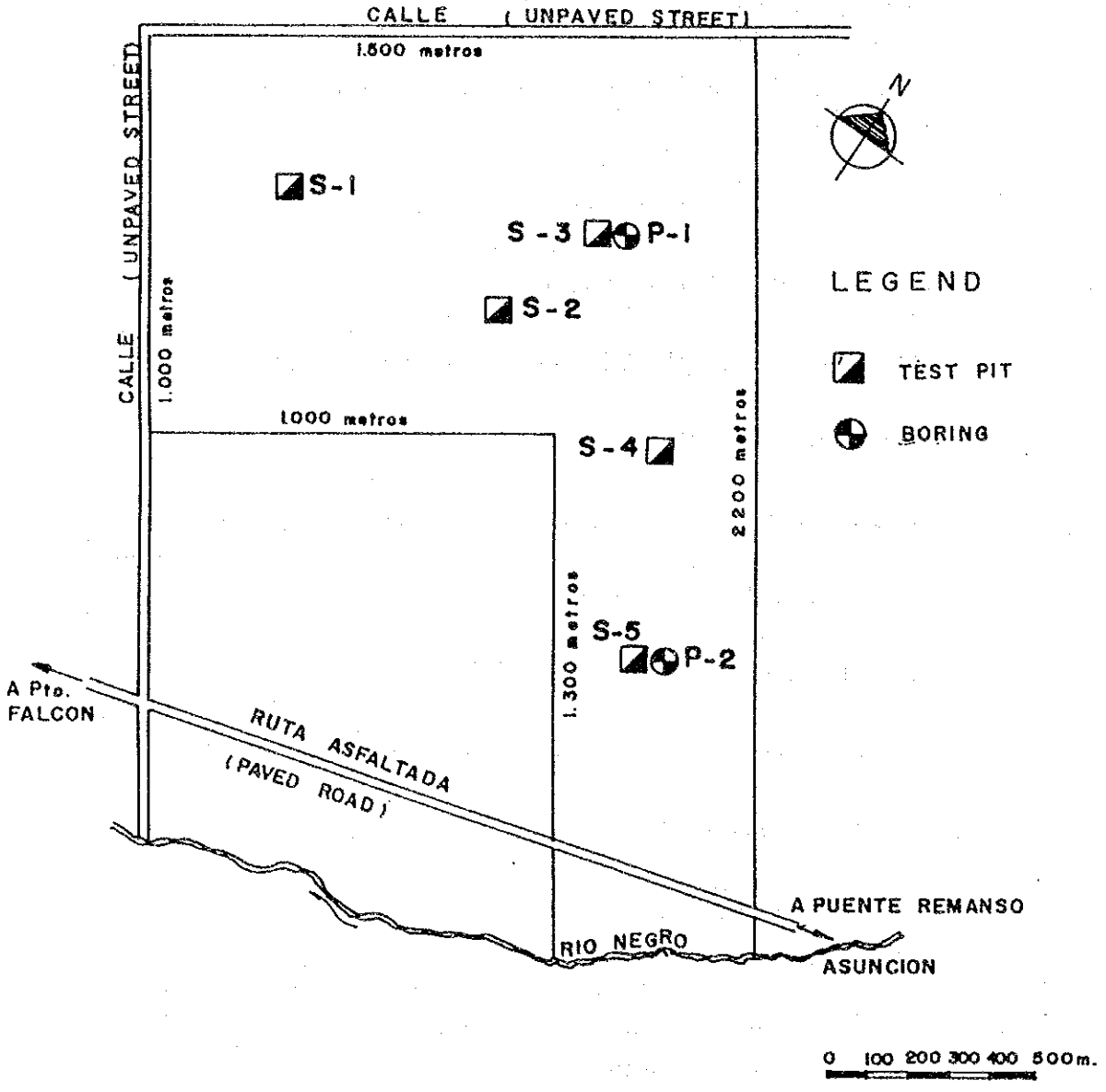
- Moisture Content Test
- Grain Size Analysis
- Proctor Curve Test (Test for Moisture-Density Relation of Soil)
- Cone Penetration Test:
  This test was carried out while the sample was being tested for proctor curve analysis. The cone penetration test shall be carried out 6 times for each proctor curve test.

c. **Results of Survey**

ca. **Results of Geological Features Survey**

The results of the laboratory test of 6 samples taken from the boreings are presented in Table D.2.2a.

SITE A



PROPIETARIO: DIONISIO CABELLO
LUGAR: COLONIA JOSE FALCON
DISTRITO: VILLA HAYES
SUP.APROX.: 214 Has.

Figure D.2.2a Location Map of Boreing

Table D.2.2a Summary of Laboratory Test Result

Laboratory Test	unit	P1			P2		
Depth	m	1.0–1.3	2.0–2.3	3.4–3.7	1.0–1.3	2.0–2.3	2.8–3.1
Permeability	cm/sec.	5 E-9	1.8 E-8	4.7 E-7	2.1 E-6	1.3 E-6	1.2 E-6
Unconfirmed Compression (q_u)	kg/cm^2	6.87	7.00	1.18	7.93	5.31	3.44
Triaxial Shear	kg/cm^2 degree	2.80 21.81	2.73 16.03	1.06 12.83	2.73 16.03	2.40 27.66	0.94 33.37
Consolidation	See consolidation curve in the Data Book.						

The results of the penetration test are shown in Figure D.2.2b and 2c.

cb. Results of Applicability of Soil as Filling Material

The results of the laboratory test of 6 samples taken from the boreings are presented in Table D.2.2b.

Table D.2.2b Summary of Laboratory Test Result

	unit	S1	S2	S3	S4	S5
Depth	m	0.5	0.5	3	0.5	3
Optimum water content	%	19.7	15.7	16.0	12.55	12.5
Maximum Density	g/cm^3	1.61	1.755	1.750	1.830	1.810

The results of the standard penetration test are shown in Table D.2.2c.

Table D.2.2c Results of Standard Penetration Test

PR 1	**Moisture Content**		**15.00%**	**16.60%**	**18.60%**	**27.80%**	**22.30%**	**24.70%**
	q_u(kg/cm²)	1	4.5	3.5	3	1.5	1	0.5
		2	4.25	3.5	3	1.5	1	0.5
		3	4.25	3.75	3	1.25	1	0.5
		4	4.4	4	3	1.5	1	1
		5	4.5	4	3.25	1.75	0.75	1
		Ave.	4.38	3.75	3.05	1.5	0.95	0.7
PR 2	**Moisture Content**		10.20%	12.00%	13.30%	15.60%	18.20%	19.00%
	q_u(kg/cm²)	1	>4.5	>4.5	>4.5	2.5	1	0.5
		2	>4.5	>4.5	>4.5	2.5	1	0.5
		3	>4.5	>4.5	>4.5	2.5	1	0.5
		4	>4.5	>4.5	>4.5	2	1	0.5
		5	>4.5	>4.5	>4.5	2.75	0.75	0.6
		Ave.	>4.5	>4.5	>4.5	2.45	0.95	0.52
PR 3	**Moisture Content**		11.70%	13.50%	15.10%	16.80%	18.10%	19.10%
	q_u(kg/cm²)	1	>4.5	>4.5	>4.5	4	3	2.75
		2	>4.5	>4.5	>4.5	4.5	3	2.75
		3	>4.5	>4.5	>4.5	4.5	3	2.75
		4	>4.5	>4.5	>4.5	>4.5	3	2.75
		5	>4.5	>4.5	>4.5	4.25	3.25	3
		Ave.	>4.5	>4.5	>4.5	>4.35	3.05	2.8
PR 4	**Moisture Content**		7.40%	10.40%	12.20%	13.50%	14.80%	16.00%
	q_u(kg/cm²)	1	>4.5	>4.5	4.25	2.5	1.15	0.6
		2	>4.5	>4.5	4.25	2.5	1	0.6
		3	>4.5	>4.5	4	2.5	1	0.5
		4	>4.5	>4.5	3.9	2	1.5	0.5
		5	>4.5	>4.5	3.9	2	1.25	0.75
		Ave.	>4.5	>4.5	4.06	2.3	1.18	0.59
PR 5	**Moisture Content**		7.70%	9.30%	10.40%	11.90%	14.50%	16.60%
	q_u(kg/cm²)	1	4	3.25	3	3	1.25	0.5
		2	4.5	3.25	3	3	1.25	0.5
		3	3.75	3.25	3	2.75	1.25	0.5
		4	3.75	3	3.25	2.75	1.25	0.5
		5	3.75	3.5	3.25	2.25	1.25	0.75
		Ave.	3.95	3.25	3.1	2.75	1.25	0.55

Note: Sampling for Protect Test equivalent to "S"
Moisture Content in %
Penetration Values: (Kg/cm²)

d. Findings

da. Results of Geological Features Survey

The borehole logs of P1 and P2 shown in Figure D.2.2b and D.2.2c show presence of cohesive soil from the surface until 4.0 m and 3.5 m respectively and penetration values from 11 to 26. Below this, there is a stratum of a silty sand. Water level varies from 4.45 m to 5.8m.

db. Results of Applicability of Soil as Filling Material

It is assumed that soil is suitable for filling material, only if the unconfined compression (q_u) of samples exceed 4 kg/cm^2 at more than 95% of its maximum density because these values are commonly used in Japan. The result was shown in Table D.2.2d.

Table D.2.2d Results of Standard Penetration Test

Sample No.	Maximum Density	Optimum Water Content	95 % of Maximum Density	Water Content at 95% of Density	q_u at 95% of Maximum Density	Result
	gr/cm^3	%	gr/cm^3	%	kg/cm^2	
PR1	1.610	10.7	1.530	17.5	3.05–3.75	Applicable with treatment
PR2	1.755	15.7	1.667	12.0	>4.5	Suitable
PR3	1.750	16.0	1.663	11.7	>4.5	Suitable
PR4	1.830	12.55	1.739	8.3	>4.5	Suitable
PR5	1.810	12.5	1.720	6.5	<4.5	Applicable with treatment

This result indicateds that all soil in the site are applicable for filling with or without treatment such as mixing with sandy material because two soil samples which were lower than 4 kg/cm^2 are still close to the required strength.

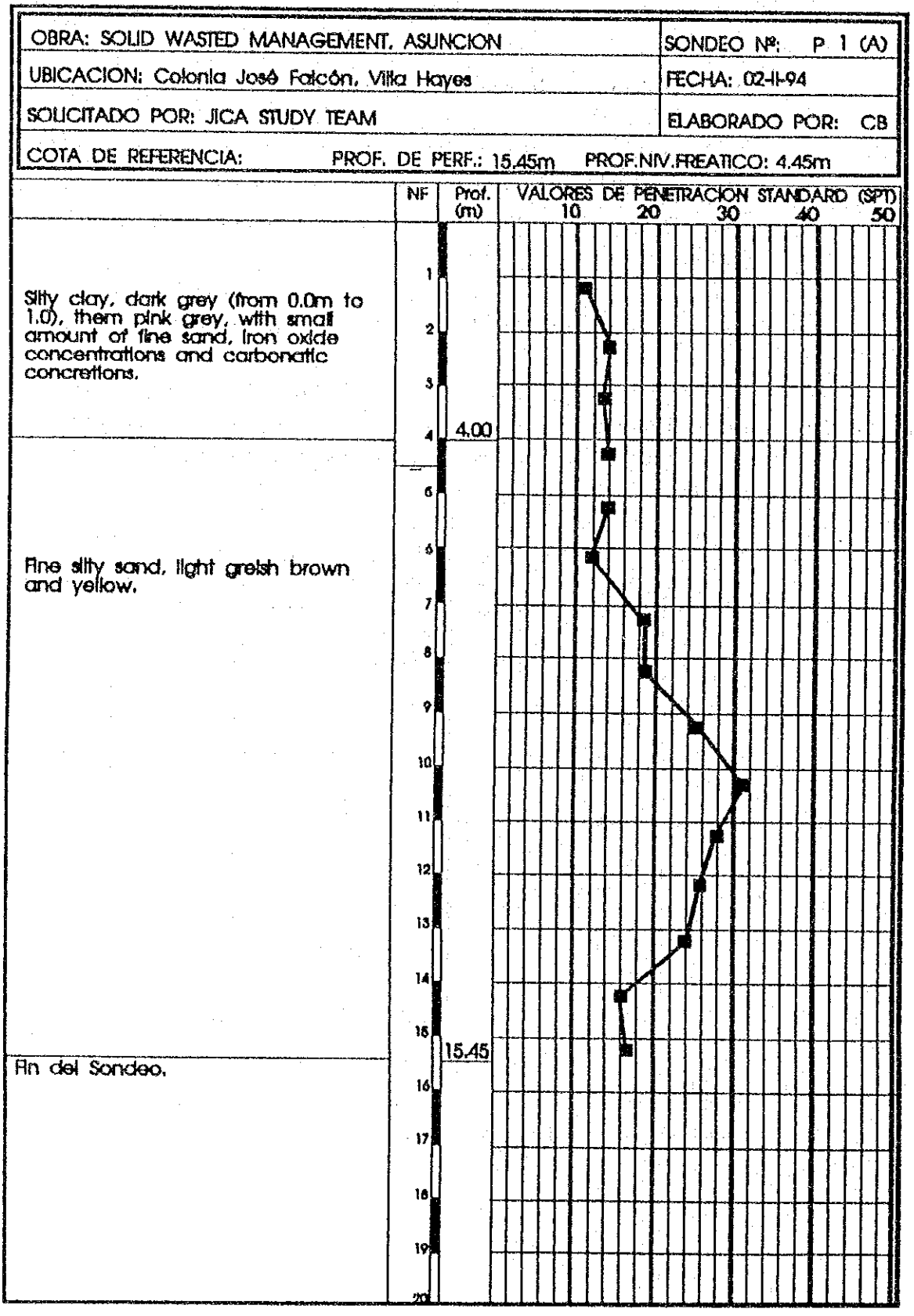


Figure D.2.2b Borehole Log No.1

OBRA: SOLID WASTED MANAGEMENT. ASUNCION	SONDEO Nº: P 2 (A)
UBICACION: Colonia José Falcón, Villa Hayes	FECHA: 04-II-94
SOLICITADO POR: JICA STUDY TEAM	ELABORADO POR: CB
COTA DE REFERENCIA: PROF. DE PERF.: 15.45m	PROF.NIV.FREATICO: 5.80m

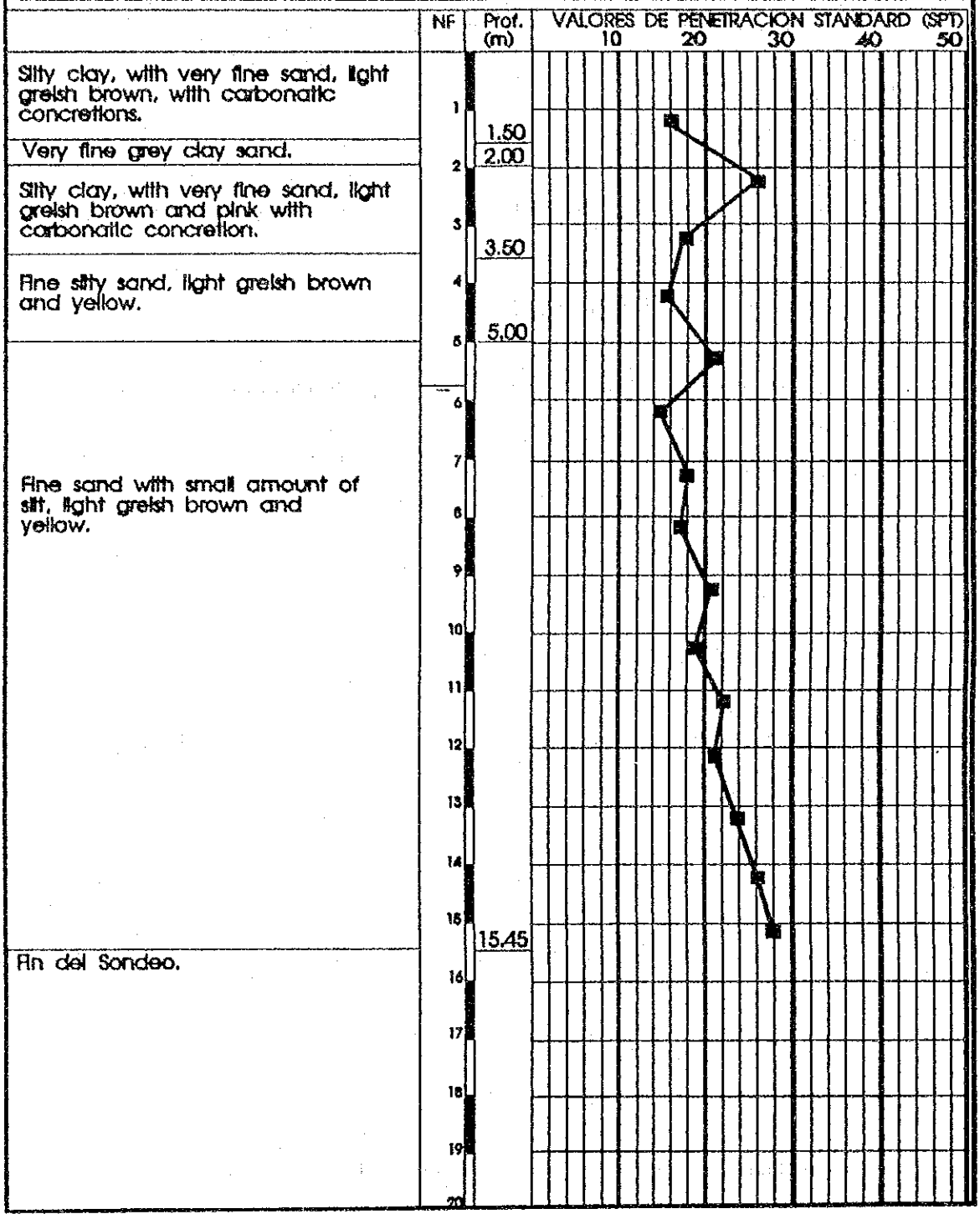


Figure D.2.2c Borehole Log No.2

D.2.3 Land Use Survey of the Surrounding Area

a. Objectives of the Survey

The objective of the land use survey is to understand the present land use conditions of the proposed disposal site and its surroundings.

b. Survey Areas

Survey area is within approximately 500 m from the site.

c. Categories of Land Use

The land use categories used for this survey are as follows.

- Residential area: Houses and their sites
- Agricultural area: Pasture land and cultivated land
- Forest area: Area having trees
- Others: Areas excluded in the above categories

d. Survey Method

The land use maps were prepared based on the data obtained through the field surveys.

e. Survey Period

The field survey for land use was carried out from 24 February until 5 March in 1994

f. Results of the Survey

The land use map prepared is presented in the Data Book.

The characteristics of the proposed disposal site are as follows:

- Most of land used are Agricultural and Forest Areas.
- There is no Residential area, but there are few houses within and surrounding the site. The house that is inside the site is the land keeper's house.

D.2.4 Environmental Survey

The environmental survey was conducted to understand the present environmental condition of the proposed disposal site. The environmental survey consists of water quality survey, ambient survey, noise survey and traffic volume survey.

D.2.4.1 Water Quality Survey

a. Objective of the Survey

The objective of the water quality survey is to understand the present quality of:

- ground water near the proposed disposal site, and
- river water near the proposed disposal site.

b. Location of Water Sampling Points

Water samples were taken in the proposed sites where feasible among the proposed disposal site.

Location of water sampling points are shown in Figure D.2.4a.

c. Analysis Items

The following items were analyzed.

- Concerning people's health
  Pb, As, Cd, Cr^{+6}, Hg
- Others
  pH, COD, BOD, Total Nitrogen, SO_4^{-2}, Cl^-

d. Analysis Method

The water analysis is carried out in accordance with "Standard Methods, for the examination of water and waste water, fifteenth edition", prepared and published jointly by the American Public Health Association, AMER, Water Pollution Control Federation.

e. Dates of Water Sampling

Water samplings were carried out twice on the following days.

1st sampling: 2 February in 1994

2nd sampling: 24 February in 1994

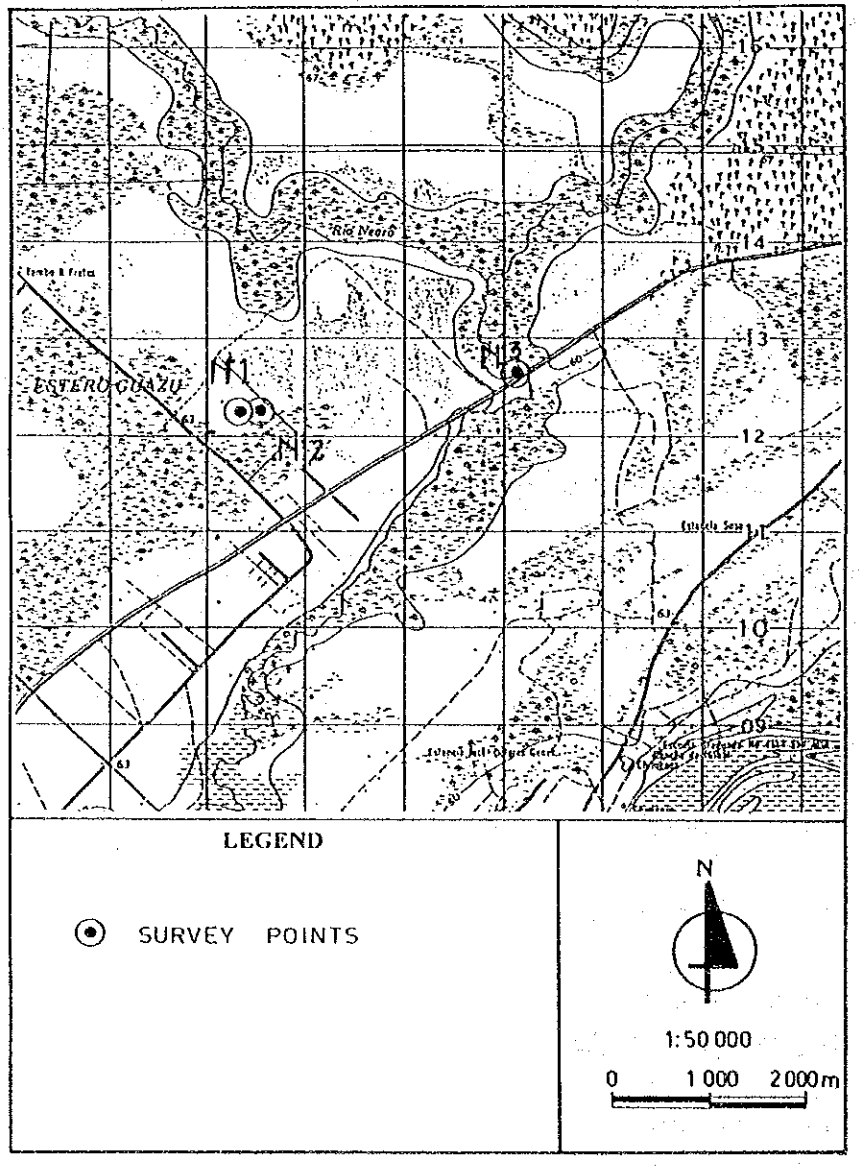


Figure D.2.4.1a Map of Water Quality Survey Point

D.2.4.2 Ambient Survey

a. Objectives of the Survey

The objective of the survey is to understand the present air pollution around the proposed disposal site.

b. Location of the Survey

The survey was carried out at the Chaco-i proposed disposal site. The location of the survey is shown in Figure D.2.4.2a.

c. Analysis Items

The following items were analyzed.

- dust fall
- suspended particular matter (SPM)
- ammonia gas
- methane

d. Analysis Method

The all items were analyzed in accordance with ORSAT.

e. Survey Period

The survey was carried out during the following periods.

- Dust fall and suspended particular matter:
  from 7 to 13 February 1994.
- Ammonia and Methane:
  on 7 February 1994.

f. Results of the Ambient Survey

The results of the ambient survey are presented in Table D.2.4.2a.
The results show that all of items could not be detected.

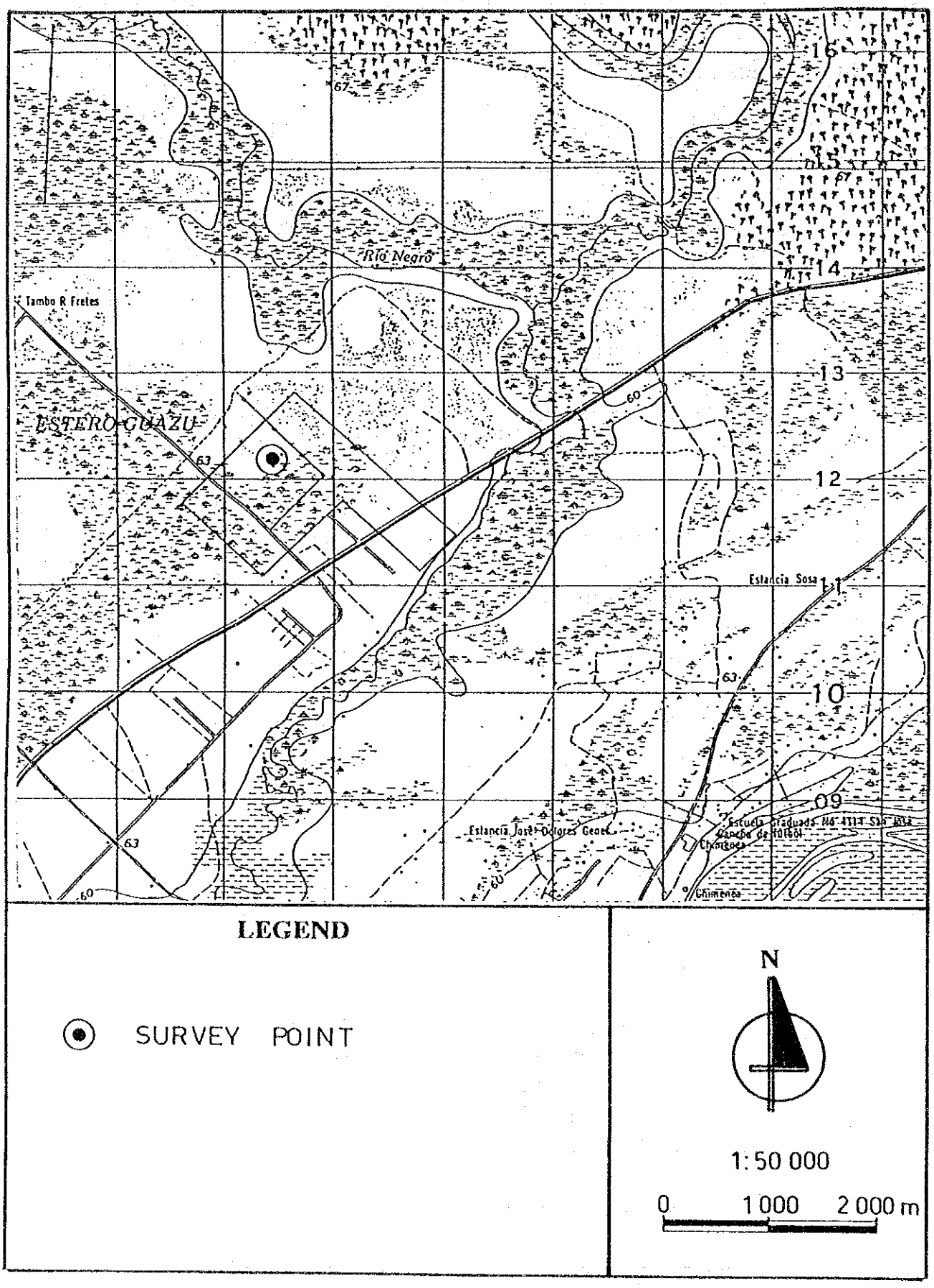


Figure D.2.4.2a Map of Ambient Survey Points

Table D.2.4.2a Result of Ambient Survey

Survey period: from 14:00 on February 7th, 1994
until 10:00 on February 14th, 1994

Items	unit	7th	8th	9th	10th	11th	12th	13th	Average	Maximum	Minimum
Ammonia	ppm	0	-	-	-	-	-	-	0	0	0
Methane	ppm	0	-	-	-	-	-	-	0	0	0
Dust fall	g/m2	0	0	0	0	0	0	0	0		
S.P.M.	mg/m3	0	0	0	0	0	0	0	0		
Air Temp.	C	24.9	28.0	28.4	25.2	25.6	25.9	25.4	26.2	28.4	24.9
Humidity	%	80.0	75.5	72.0	89.0	91.0	84.0	92.0	83.4	92	72
Wind velocity	m/s	1.8	4.0	3.8	2.1	0.8	2.1	0.5	2.2	4	0.5
Wind direc-tion		S	E	N	E	N	S	C	-	-	-
Rainfall	mm/day	5.4			12.3	0.9		44.4	53.0	44.4	0.9

D.2.4.3 Noise Survey

a. Objectives of the Survey

The objective of the noise survey is to understand the present noise level around the proposed disposal site.

b. Location of the survey point

The noise survey was carried out for the Chaco-i proposed disposal site.
The survey point is shown in Figure D.2.4.3a

c. Survey Items

The level of noise around the proposed disposal site including noise of traffic vehicles was measured.

d. Survey Method

- Instruments used : Noise meter

- Survey Time : Every 5 seconds for 10 minutes every hour for 24 hours

e. Survey Period

The survey was carried out from 12:00 February 2nd until 11:10 February 3rd in 1994

f. Results of the Survey

The survey results are shown in Table D.2.4.3a and Figure D.2.4.3a. The results are summarized as follows.

- The values of L_{50} range between 24 and 61 dB(A).
- The fluctuation of L_{50} was less than 40 dB(A) at around midnight, 60 dB(A) in the afternoon and morning.
- Its fluctuation is related to fluctuation of traffic volume on National Road No.12.

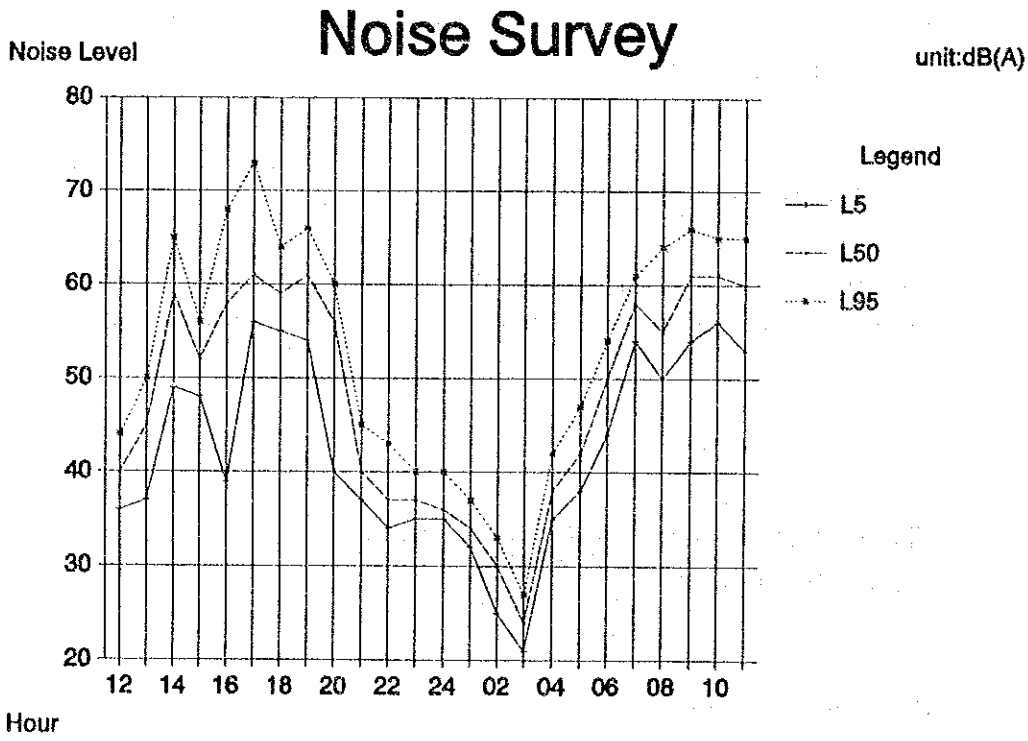


Figure D.2.4.3a Result of Noise Survey

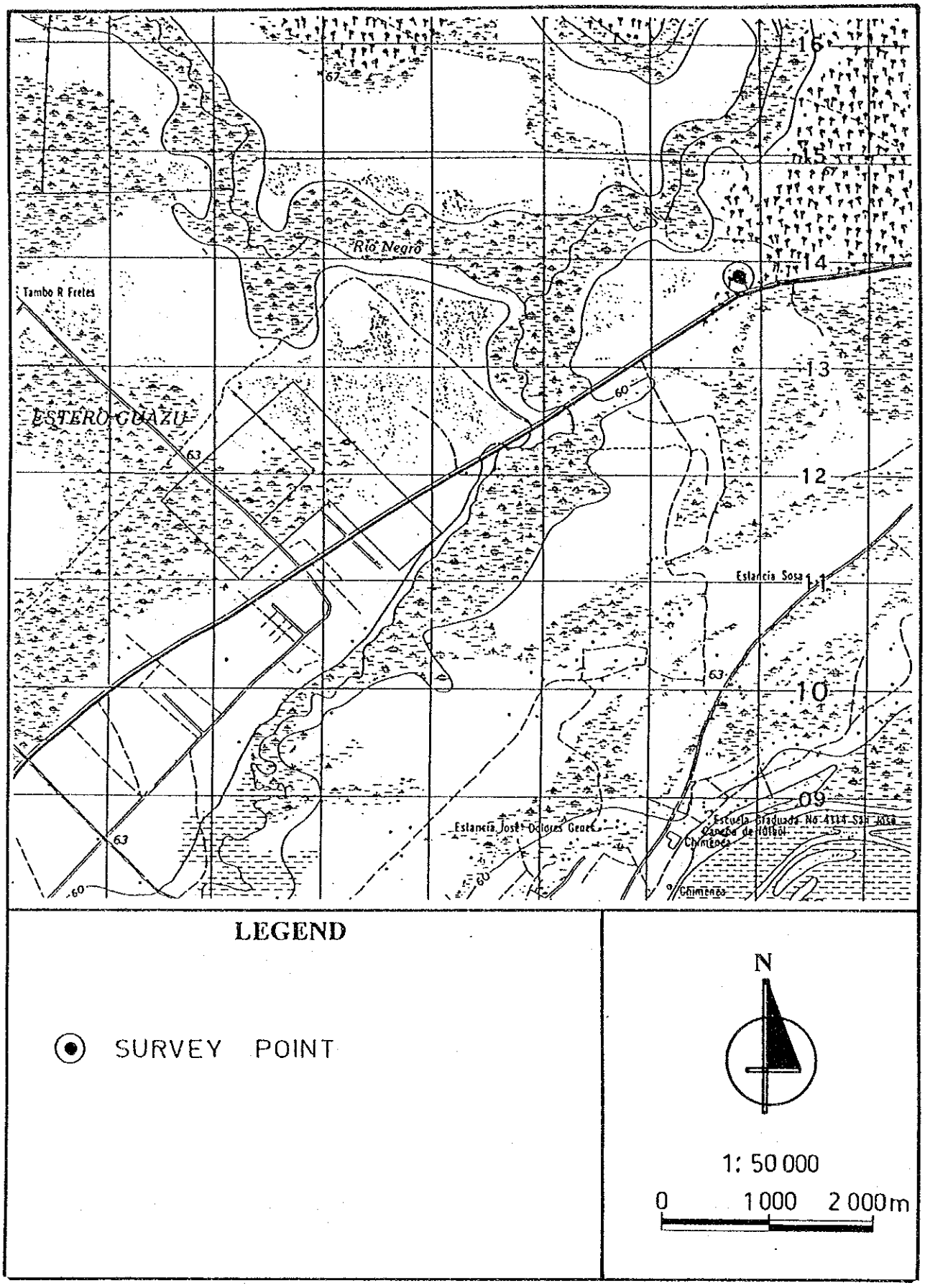


Figure 2.4.3a Map of Noise Survey Point

D.2.4.4 Traffic Volume Survey

a. Objective of the Survey

The objectives of the Traffic Volume Survey are:

- To understand the present impact on the traffic by the waste collection trucks, and
- to understand the time fluctuation of the present traffic as the basic data to formulate the collection and haulage plan.

b. Location of the Survey

The survey was carried out for the traffic passing the National Road No.12. The locations are shown in figure D.2.4.4b.

c. Vehicle Category

The vehicles are measured by the following three categories.

- Large vehicles
- Small vehicles
- Waste collection trucks

d. Survey Method

The number of vehicles was measured with an eye counter.

e. Time of the Survey

The traffic volume survey was carried out from 12:00 February 2nd until 12:00 February 3rd in 1994.

f. Results of the Survey

The results of the traffic volume survey are shown in the Data Book and Figure D.2.4.4a. The results are summarized as follows:

- The total traffic volume per day was 2,739 vehicles
- The maximum traffic volume per hour was 204 between 08:00 and 09:00
- In the morning the traffic from Asuncion to Puerto Falcon was more, but in the afternoon the traffic from Puerto Falcon to Asuncion was prevailing.
- The traffic volume of the waste collection trucks was negligible.

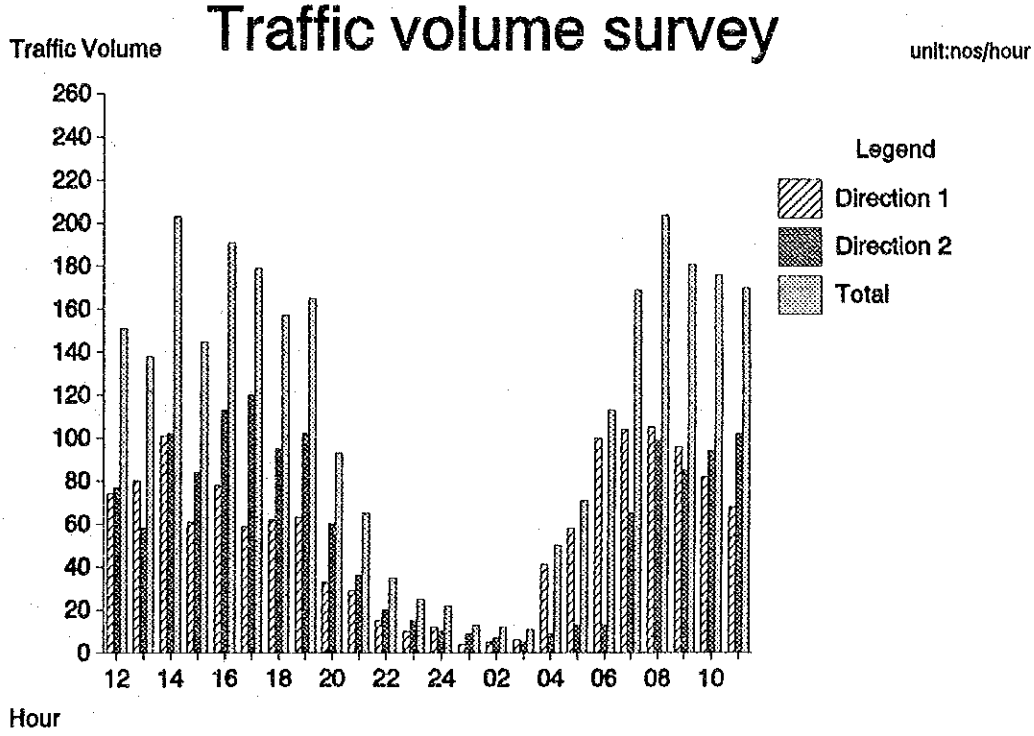


Figure D.2.4.4a Result of Traffic Volume Survey

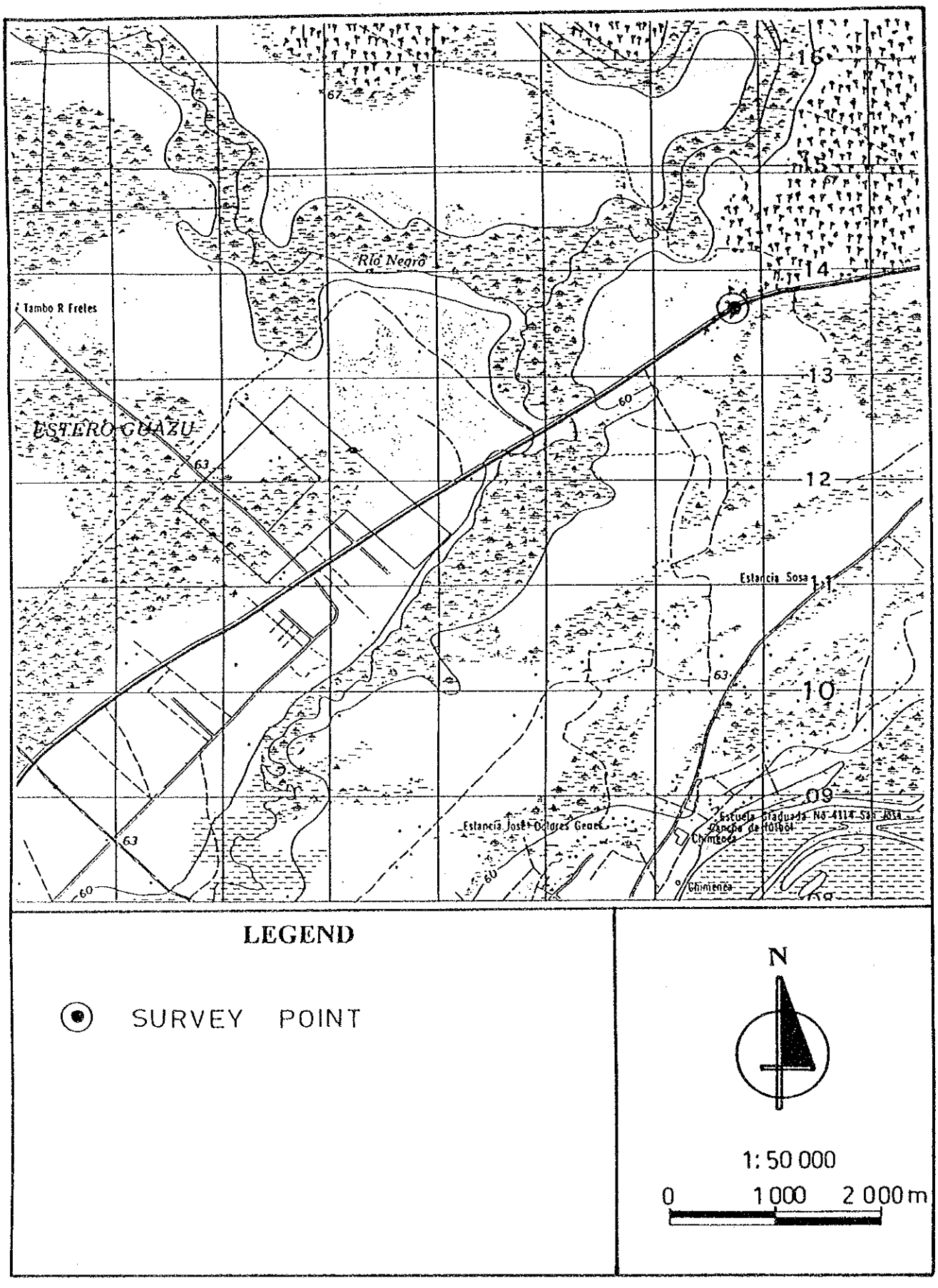


Figure D.2.4.4b Location of Traffic Volume Survey Point

D.3 Investigation of Proposed Transfer Station Site "Vinas Cue"

In order to obtain the required basic data to carry out a feasibility study for the proposed sites as a transfer station site, topographical, geological, land use and environmental surveys were carried out. These results are presented in this section. The location of Vinas Cue site is shown in Figure D.3a

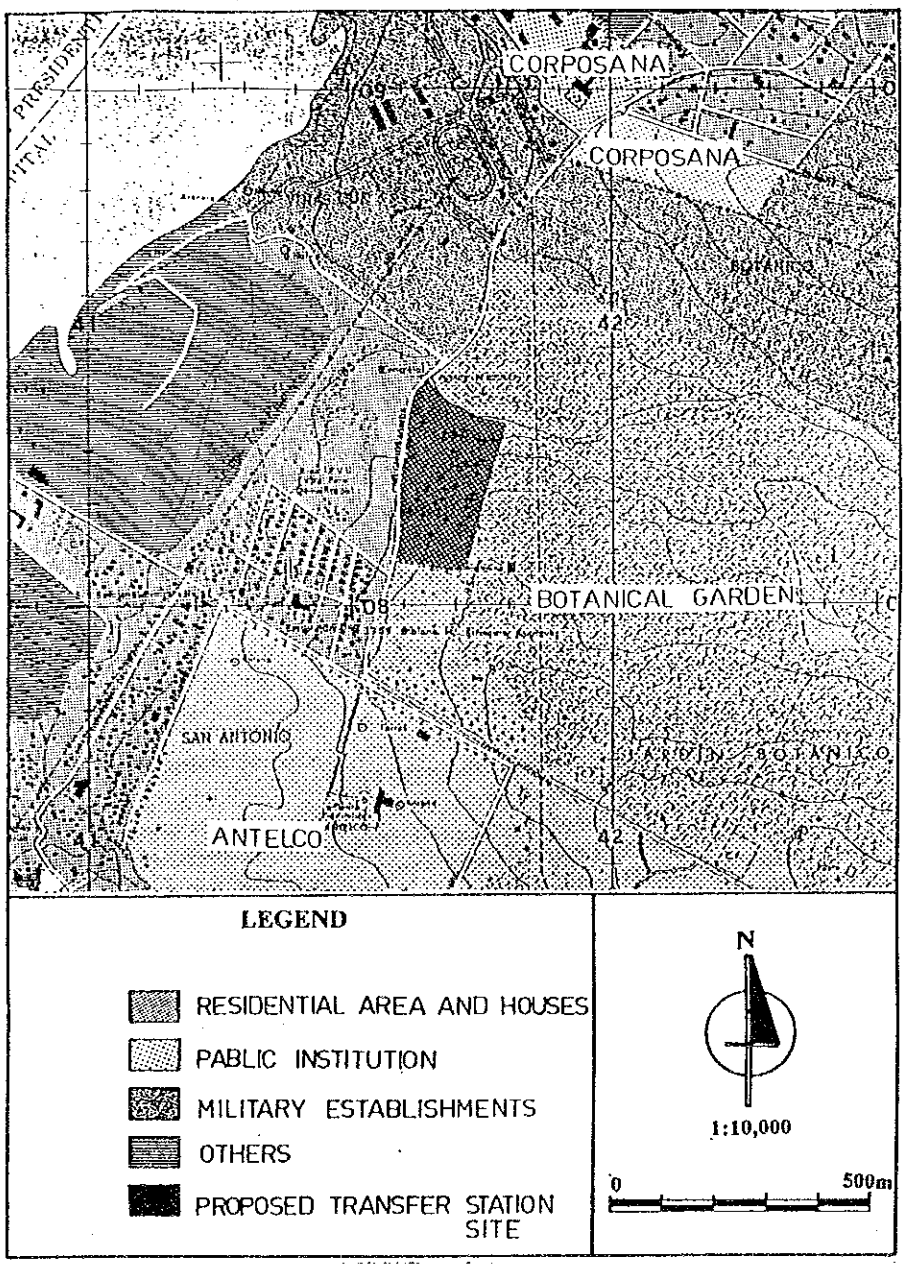


Figure D.3a Location of Vinas Cue Site

D.3.1 Topographical Survey

The topographical map covering the whole area of Vinas Cue site was drawn in the scale of 1 to 1000 based on the survey data obtained. This is included in the Data Book.

The Vinas Cue site is situated north of the Botanical Garden. The area of the proper site in Vinas Cue for the transfer station is approximately 10 ha. Its present land use is a meadow.

D.3.2 Geological Survey

a. Purpose of the Geological Survey

The purpose of the geological survey is to understand the geological features and to obtain the basic data to design the foundation of the proposed transfer station.

b. Quantities and Method of Survey

The location of geological survey is shown in Figure D.3.2a.

- Number of penetration test : 2 points
- Depth of test : 15 meters
- Interval of penetration test : every 1 meter

Boreholes 15 meters deep were excavated using manual auger, bentonitic slurry, and wash boreing, conducting the standard penetration test every meter.
The result of the penetration tests are shown in Figure D.3.2b and 2c.

c. Findings

Borehole logs of No.P5 and P6 shown in Figure D.3.2b and D.3.2c indicated cohesive soils from surface to 3.0 m to 4.0 m. Below this, there is a stratum of very dense silty sand. Water level was registered only in boreing P5 3.25 m deep.

SITE C

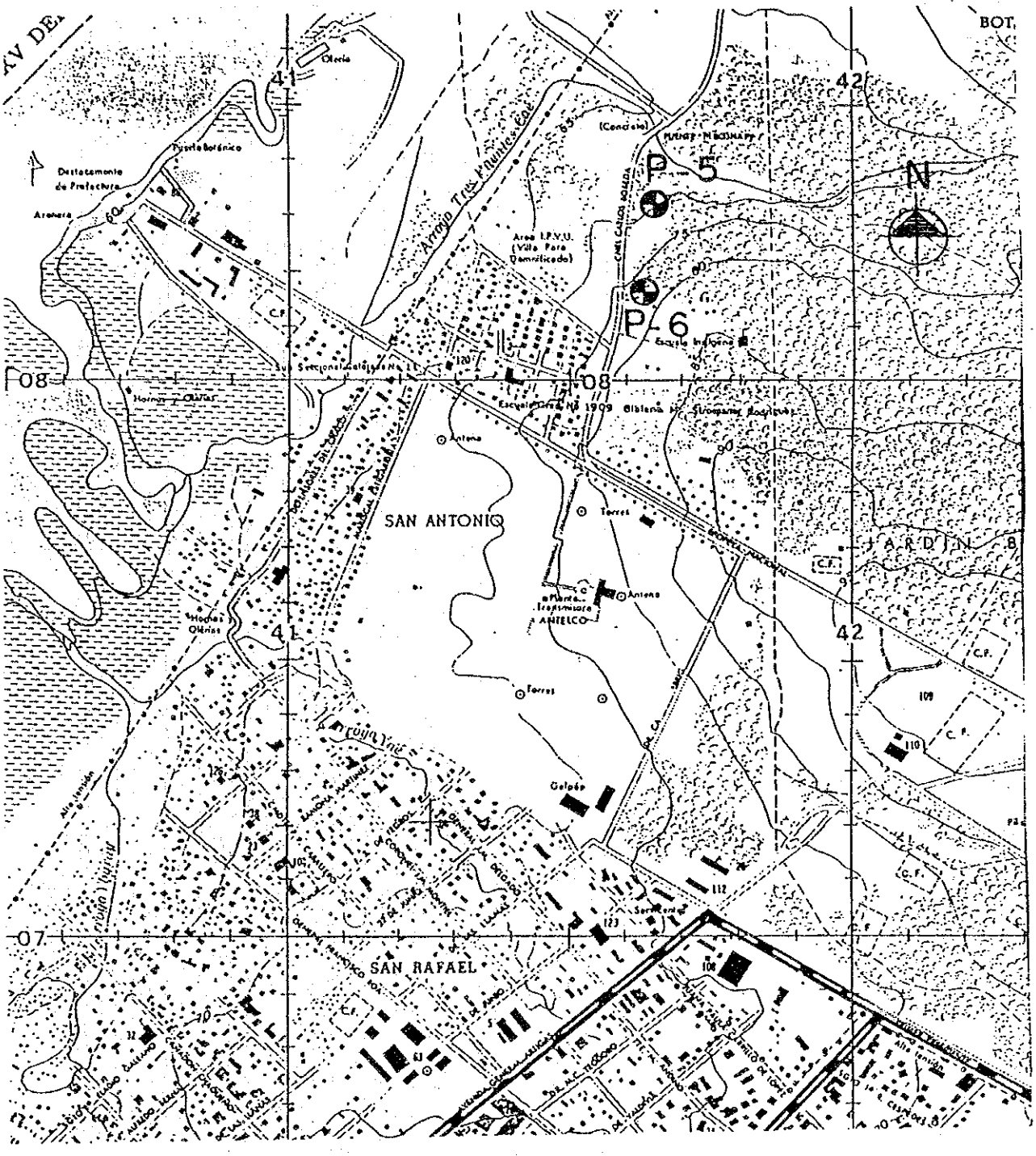


Figure D.3.2a Location Map of Penetration Test No.P5 and No.P6

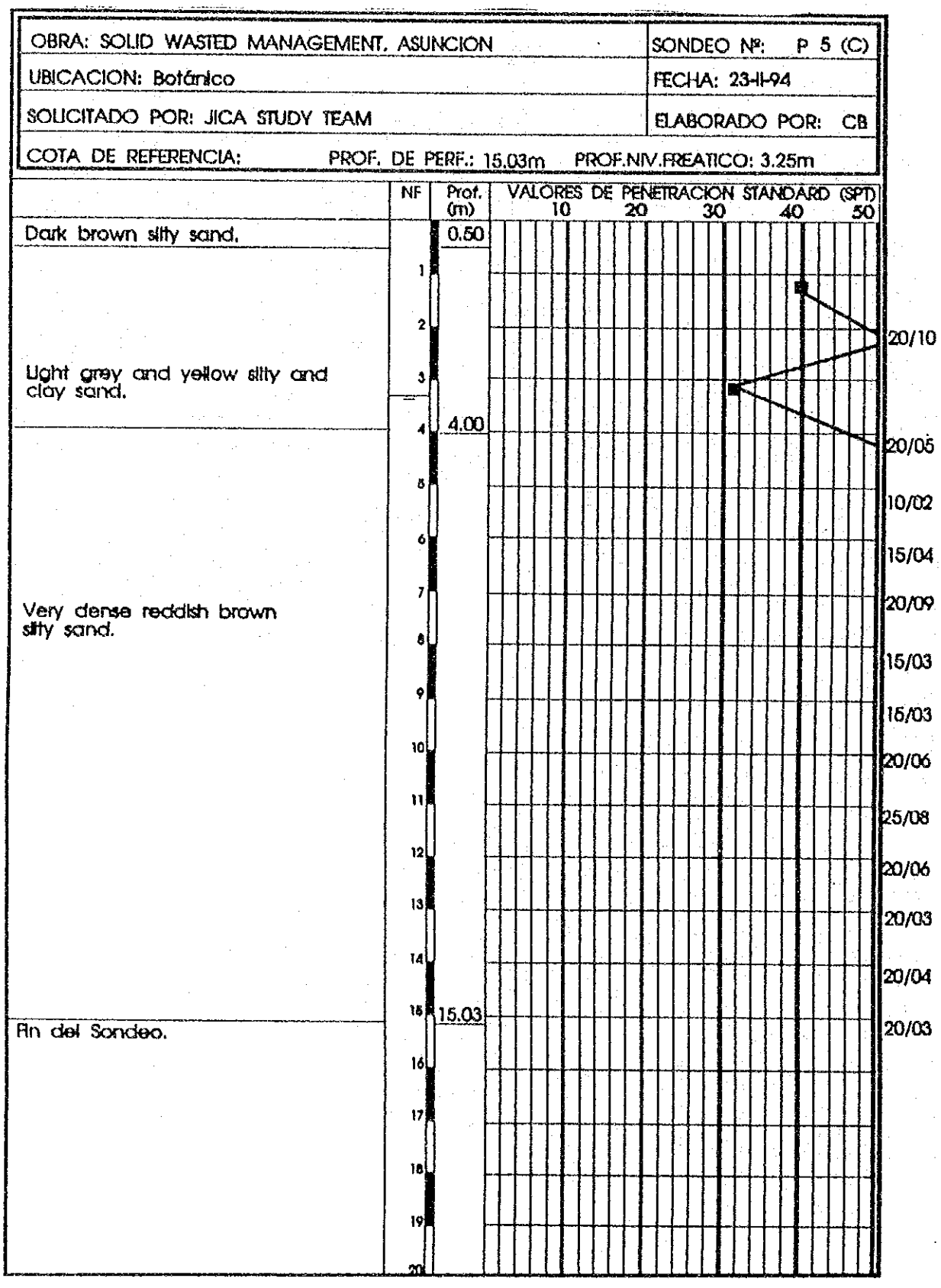


Figure D.3.2b Result of Penetration Test No.P5

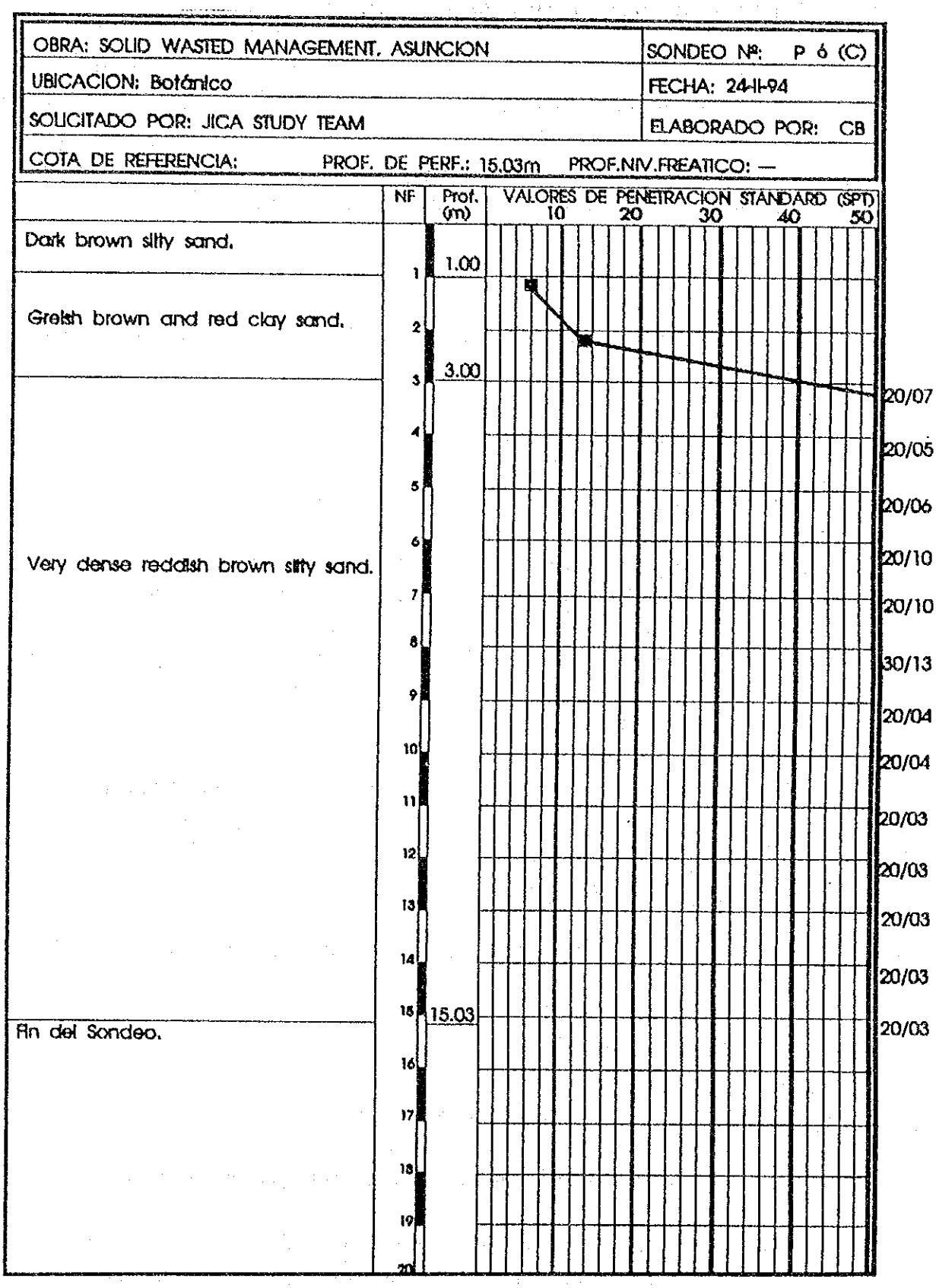


Figure D.3.2c Result of Penetration Test No.P6

D.3.3 Land Use Survey of the Surrounding Area

a. Objectives of the Survey

The objective of the land use survey is to understand the present land use conditions of the Vinas Cue site and its surrounding area.

b. Survey Areas

The survey area is within approximately 500 m from the proposed transfer station site.

c. Categories of Land Use

The land use categories used for this survey are as follows.

-	Residential area:	Houses and their sites
-	Public Institution:	Parks etc. where is for citizen
-	Military Establishment:	Military area
-	Others:	Areas excluded in the above categories

d. Survey Method

The land use maps were prepared based on the data obtained through the field surveys.

e. Survey Period

The field survey for the land use was carried out from 24 February until 5 March in 1994

f. Results of the Survey

The land use maps prepared are presented in the Data Book.

The common characteristics of the proposed transfer station sites are as follows.

The proposal transfer station site is in the Botanical Garden where it is mostly arboreous. The west of the proposed transfer station is a residential area.

D.3.4 Environmental Survey

The environmental survey was conducted to understand the present environmental condition of the proposed transfer station site, Vinas Cue. The environmental survey consists of water quality survey, offensive odor survey, noise survey and traffic volume survey.

D.3.4.1 Water Quality Survey

a. Objective of the Survey

The objective of the water quality survey is to understand the present quality of:

- ground water near the proposed transfer station sites, and
- river water near the proposed transfer station sites.

b. Location of Water Sampling Points

Water samples were taken in the proposed transfer station sites where feasible among the proposed transfer station sites.

Location of water sampling points are shown in Figure D.3.4.1a.

c. Analysis Items

The following items were analyzed.

- Concerning people's health
  Pb, As, Cd, Cr^{+6}, Hg
- Others
  pH, COD, BOD, Total Nitrogen, SO_4^{-2}, Cl^-

d. Analysis Method

The water analysis is carried out in accordance with "Standard Methods, for the examination of water and waste water, fifteenth edition", prepared and published

jointly by the American Public Health Association, AMER, Water Pollution Control Federation.

e. Dates of Water Sampling

Water samplings were carried out twice on the following days.

1st sampling: 2 February in 1994

2nd sampling: 24 February in 1994

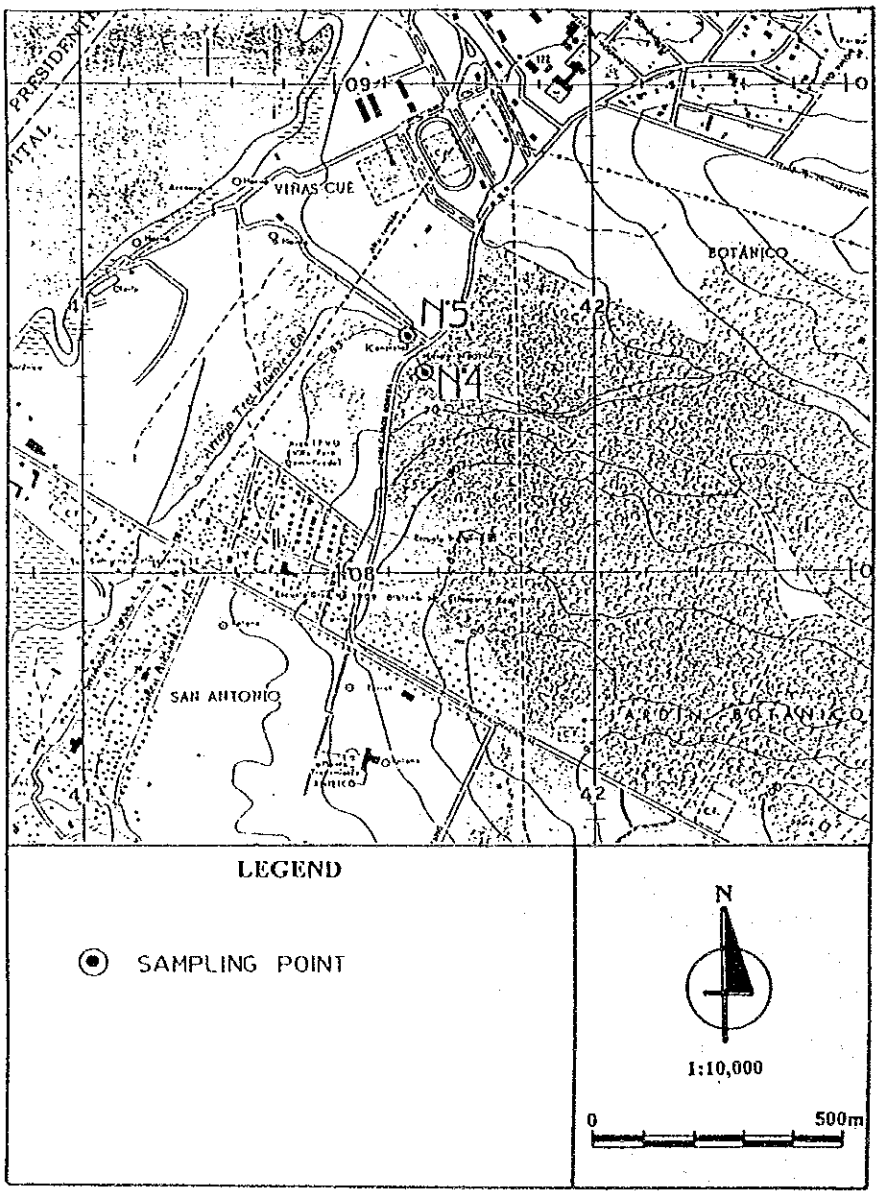


Figure D.3.4.1a Location Map of Water quality Survey Point for Vinas Cue Site

D.3.4.2 Offensive odor Survey

a. Objectives of the Survey

The objective of the survey is to understand the offensive odor present around the proposed transfer station sites.

b. Location of the Survey

The location of the survey point is shown in Figure D.3.4.2a.

c. Analysis Items

The analysis item is ammonia which is a typical offensive odor substance.

d. Analysis Method

Its item was analyzed in accordance with ORSAT.

e. Survey Period

The survey was carried out on the 8th March 1994.

f. Results of the Ambient Survey

The ammonia was not detected.

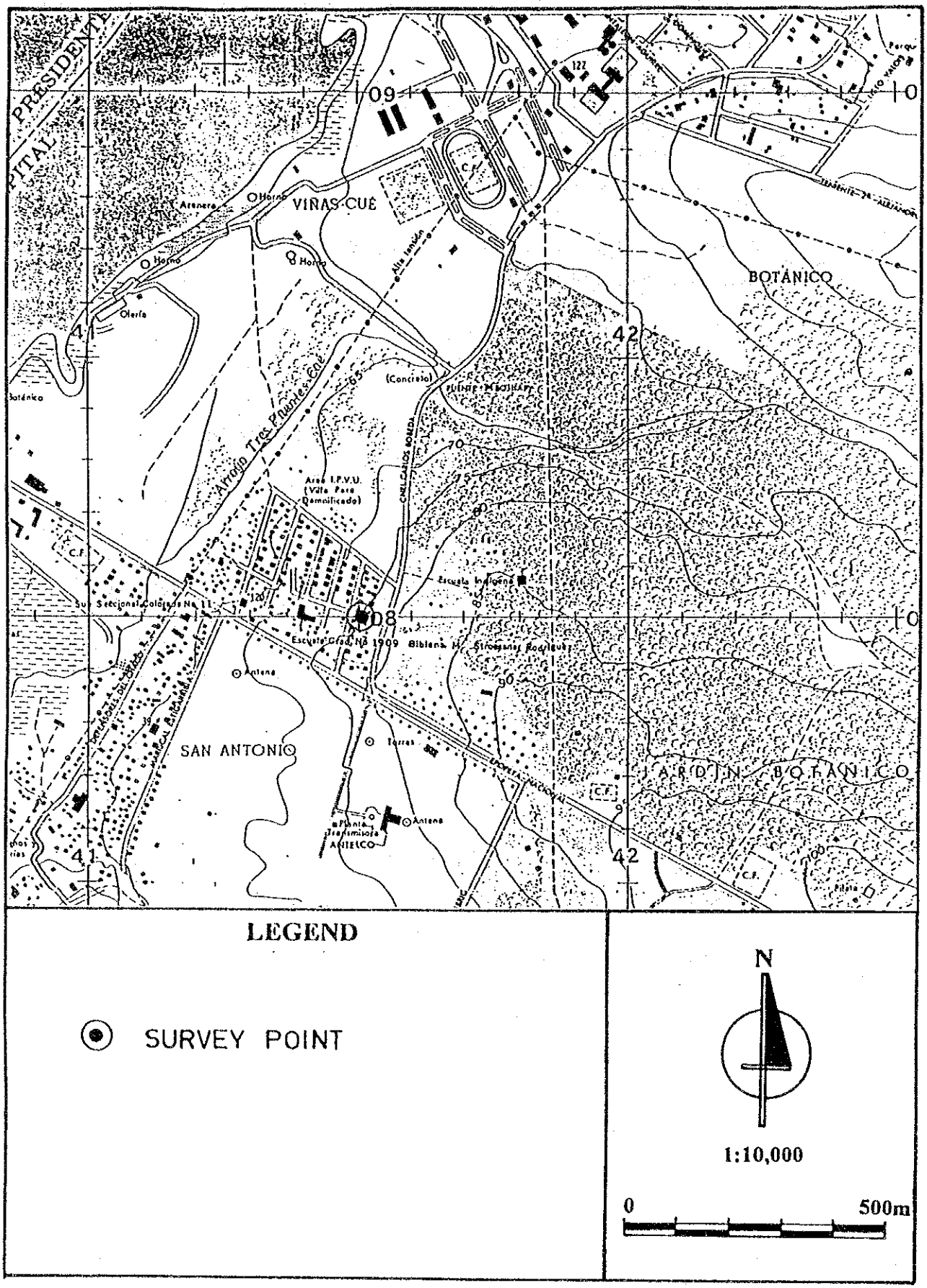


Figure D.3.4.2a Location Map of Offensive Odor Survey Points for Vinas Cue Site

D.3.4.3 Noise Survey

a. Objectives of the Survey

The objective of the noise survey is to understand the present noise level around the proposed transfer station site, Vinas Cue.

b. Location of the survey point

The survey point is shown in Figure D.3.4.3a.

c. Survey Items

The level of noise around the proposed transfer station site including noise of traffic vehicles was measured.

d. Survey Method

- Instruments used: Noise meter
- Survey Time: Every 5 seconds for 10 minutes every hour for 24 hours

e. Survey Period

The survey was carried out from 12:00 February 7th until 11:10 February 8th, 1994 at Vinas Cue.

f. Results of the Survey

The survey results are shown in Table D.3.4.3a and Figure D.3.4.3b.

The values of L_{50} range between 36 and 62 dB(A).

The fluctuation of L_{50} was less than 50 dB(A) around midnight until early morning, and was around 60 dB(A) in the afternoon.

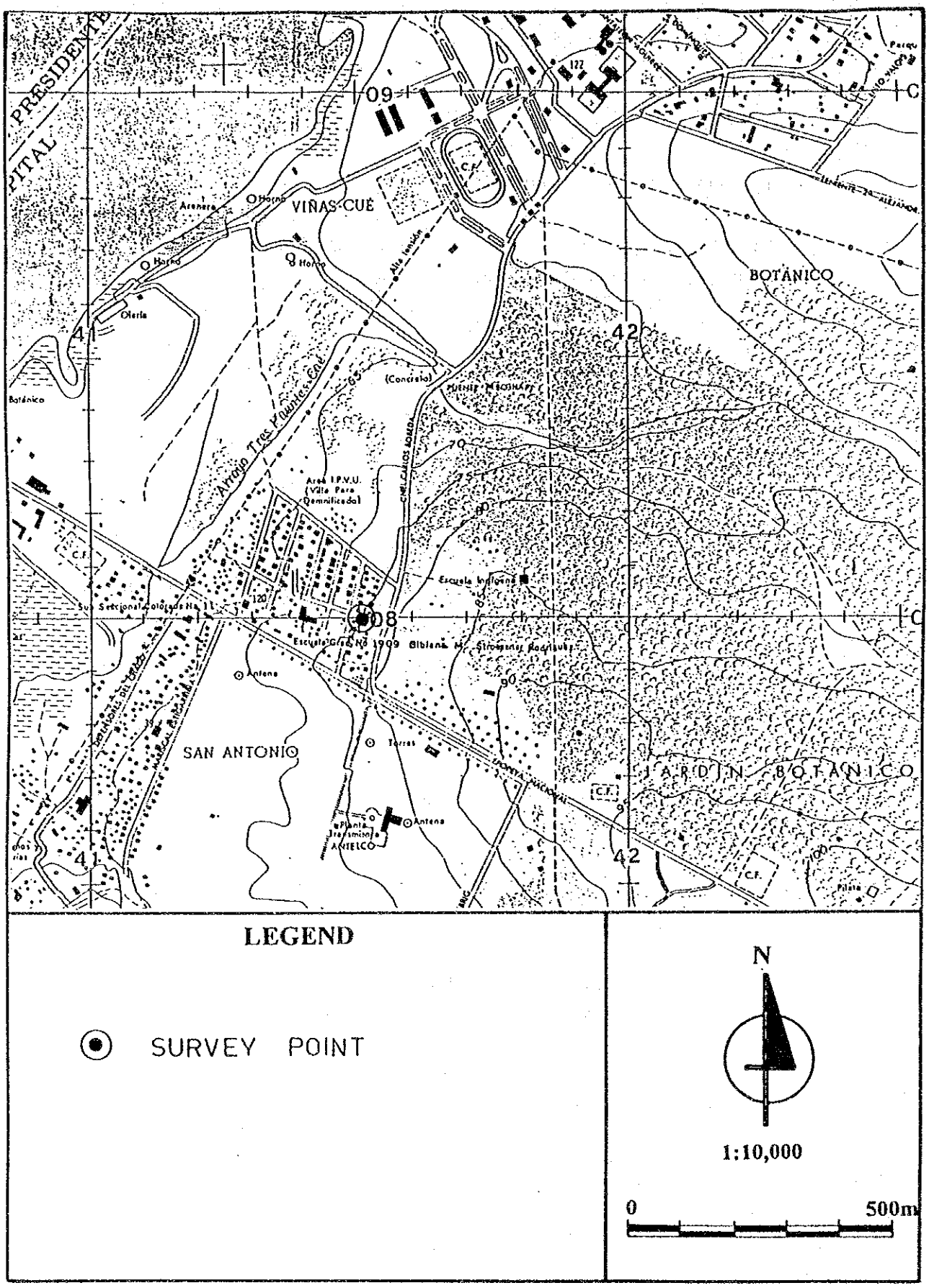


Figure D.3.4.3a Location Map of Noise Survey Point for Vinas Cue Site

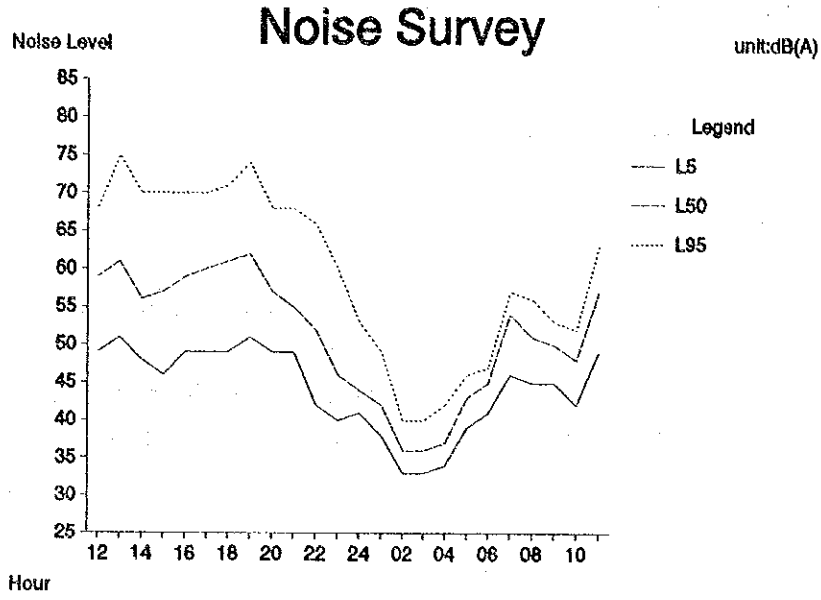


Figure D.3.4.3b Result of Noise Survey at Vinas Cue Site

D.3.4.4 Traffic Volume Survey

a. Objective of the Survey

The objectives of the Traffic Volume Survey are:

- To understand the present impact on the traffic by the waste collection trucks, and
- to understand the time fluctuation of the present traffic as the basic data to formulate the collection and haulage plan.

b. Location of the Survey

The location of the traffic survey is shown in Figure D.3.4.4a.

c. Vehicle Category

The vehicles are measured by the following three categories.

- Large vehicles
- Small vehicles
- Waste collection trucks

d. Survey Period

The traffic volume survey was carried out from 12:00 February 2nd until 12:00 February 3rd, 1994 at Vinas Cue.

e. Results of the Survey

The results of the traffic volume survey are shown in the Data Book, Figure D.3.4.4a and D.3.4.4b. The results are summarized as follows.

The total traffic volume per day was 16,663 vehicles. The maximum traffic volume per hour was 1,365 between 19:00 and 20:00. In the morning the traffic from the Botanical Garden to Centro was more, but in the afternoon the traffic from Centro to Botanical Garden was prevailing. The traffic volume of the waste collection trucks were only 3 trucks per day in the afternoon.

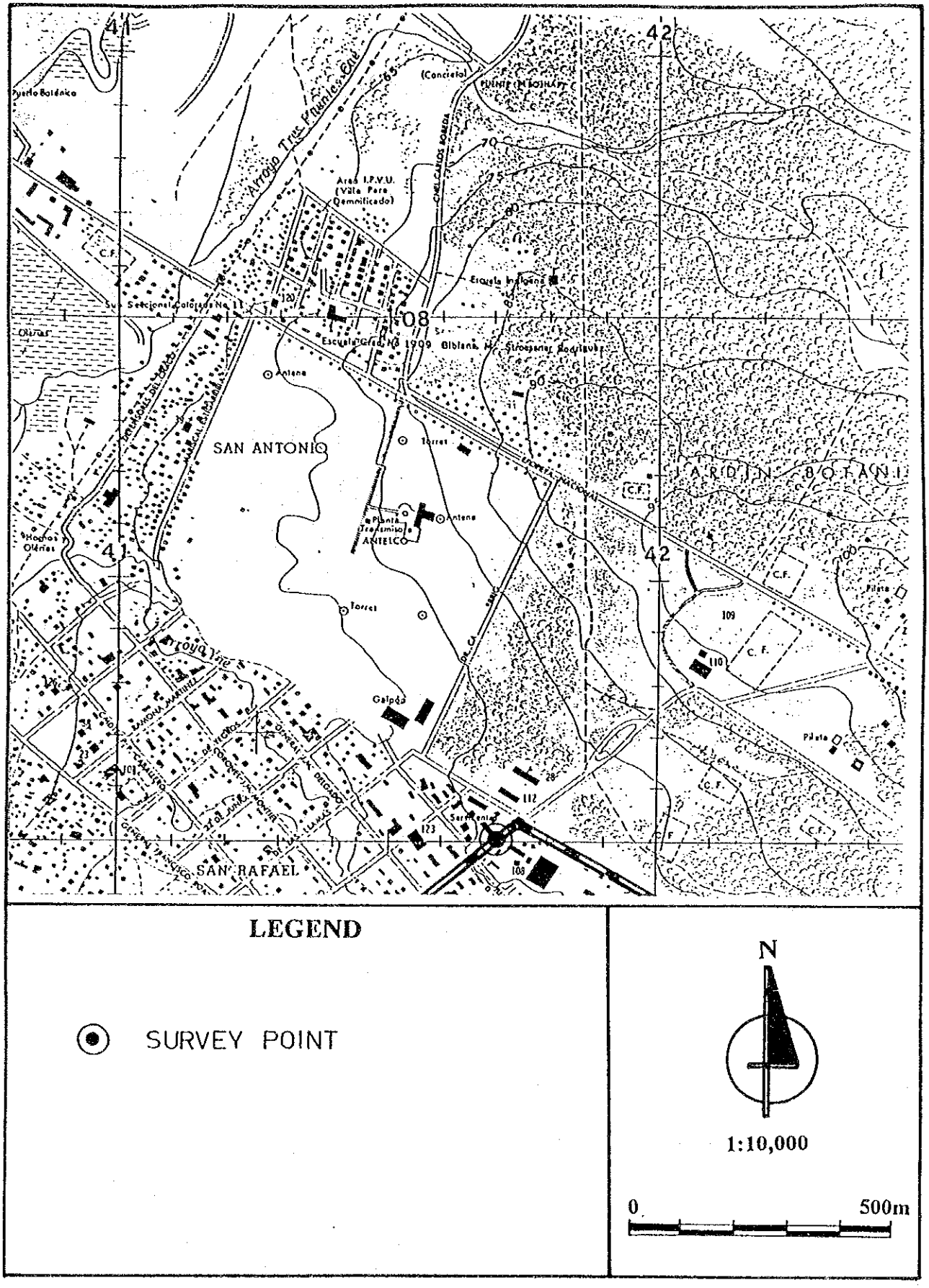


Figure D.3.4.4a Location of Traffic Volume Survey Point for Vinas Cue Site

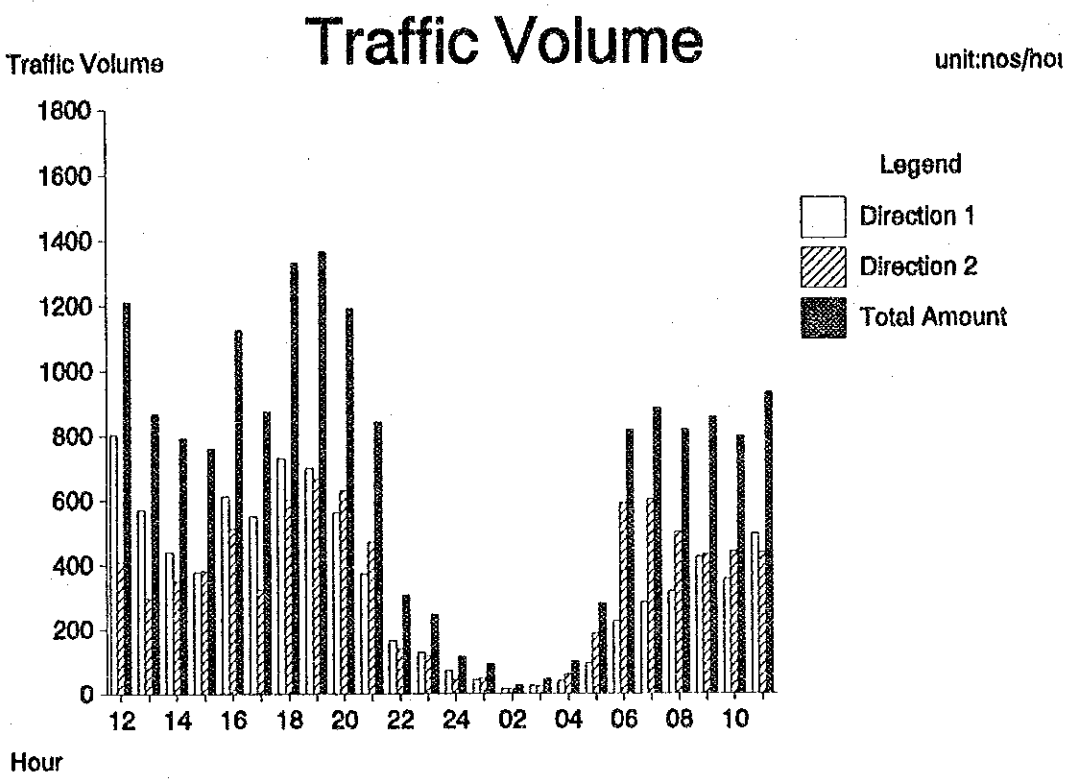


Figure D.3.4.4b Results of Traffic Volume Survey (Vinas Cue)

D.4 Investigation of Proposed Transfer Station Site "Madame Lynch Ave."

In order to obtain the required basic data to carry out a feasibility study for the proposed sites as a transfer station site, topographical, geological, land use and environmental surveys were carried out. These results are presented in this section. The location of Madame Lynch Ave. site is shown in Figure D.4a

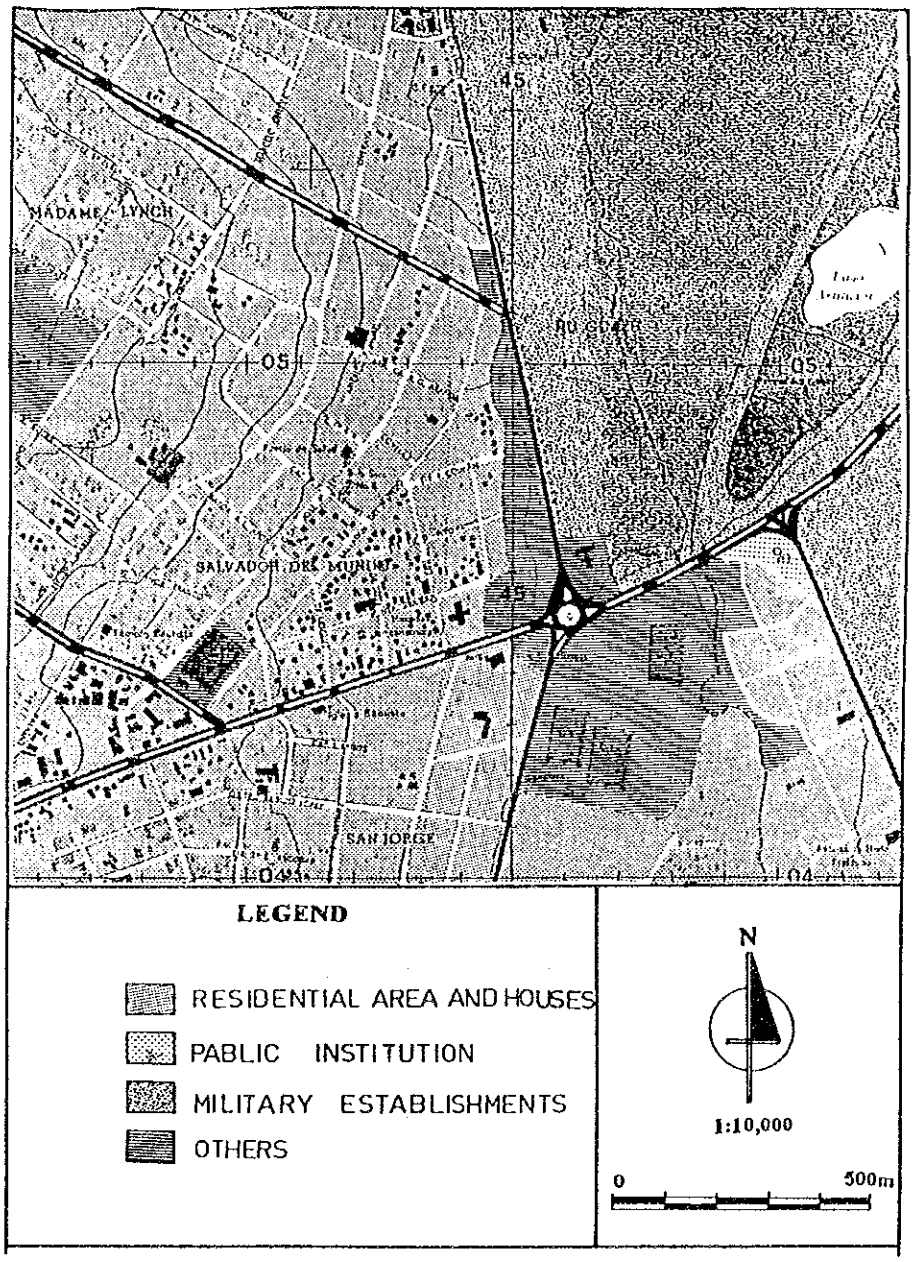


Figure D.4a Location of Madame Lynch Ave. Site

D.4.1 Topographical Survey

The topographical map covering the whole area of Madame Lynch Ave. site was drawn in the scale of 1 to 1000 based on the survey data obtained. This is included in the Data Book.

The Madame Lynch Ave. site is situated near the eastern boarder of Asuncion City. The area of Madame Lynch Ave. site available for the transfer station is very large but the most suitable area, approximately 10 ha, was surveyed as the site. Its present land use is a meadow.

D.4.2 Geological Survey

a. Purpose of the Geological Survey

The purpose of the geological survey is to understand the geological features and to obtain the basic data to design the foundation of the proposed transfer station.

b. Quantities and Method of Survey

The location of geological survey is shown in Figure D.4.2a.

- Number of penetration test : 2 points
- Depth of test : 15 meters
- Interval of penetration test : every 1 meter

Boreholes 15 meters deep were excavated using manual auger, bentonitic slurry, and wash boreing, making the standard penetration test every meter.
The results of the penetration test are shown in Figure D.4.2b and 2c.

c. Findings

Borehole logs shown in Figure D.4.2b and D.4.2c indicated cohesive soils from surface to 3.0 m to 5.0 m deep and penetration values of 3 to 22. Below this, there is a stratum of very dense silty and clay sand. Water level varies from 1.85 m to 3.5 m.

SITE B

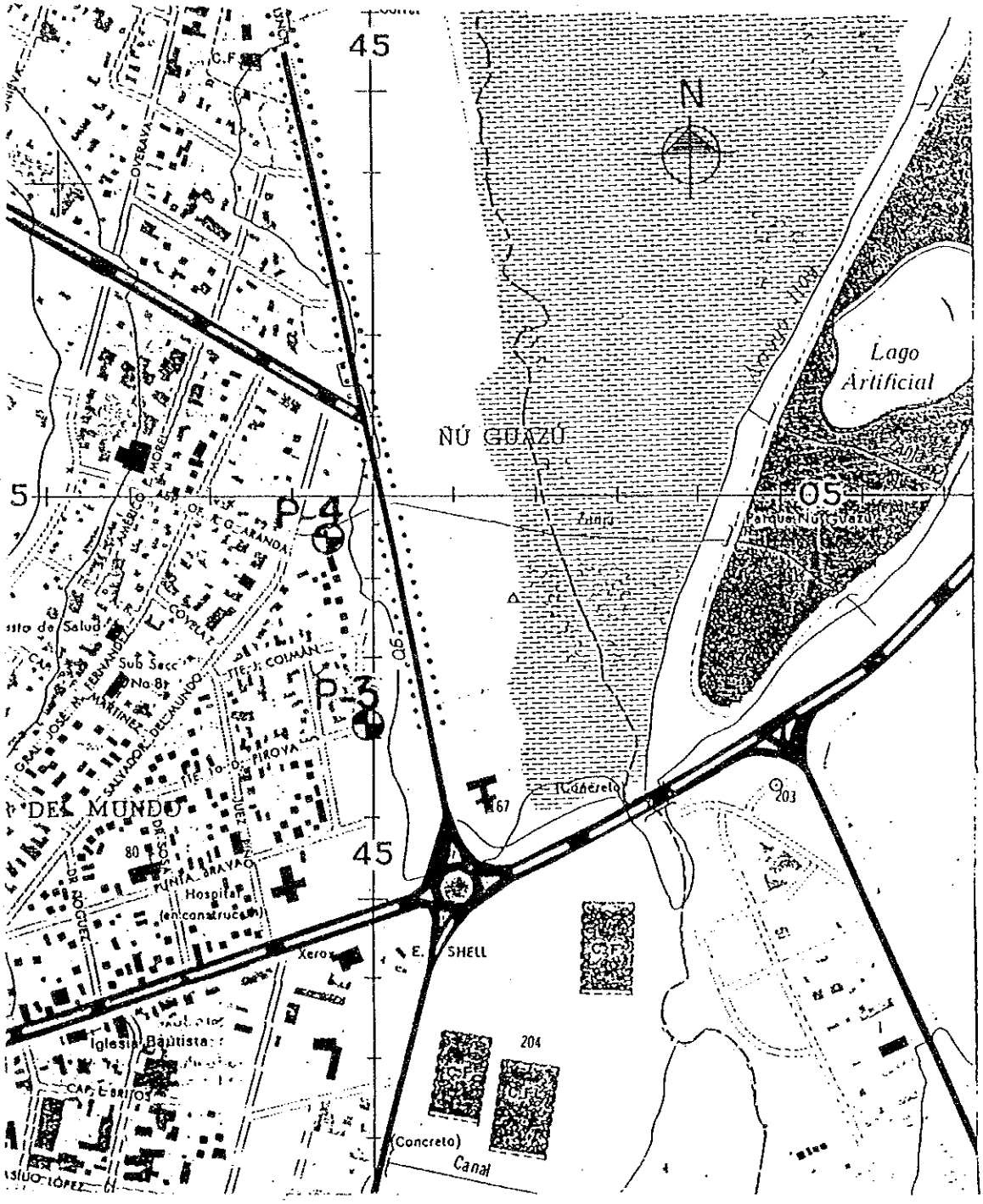


Figure D.4.2a Location Map of Penetration Test No.P3 and No.P4

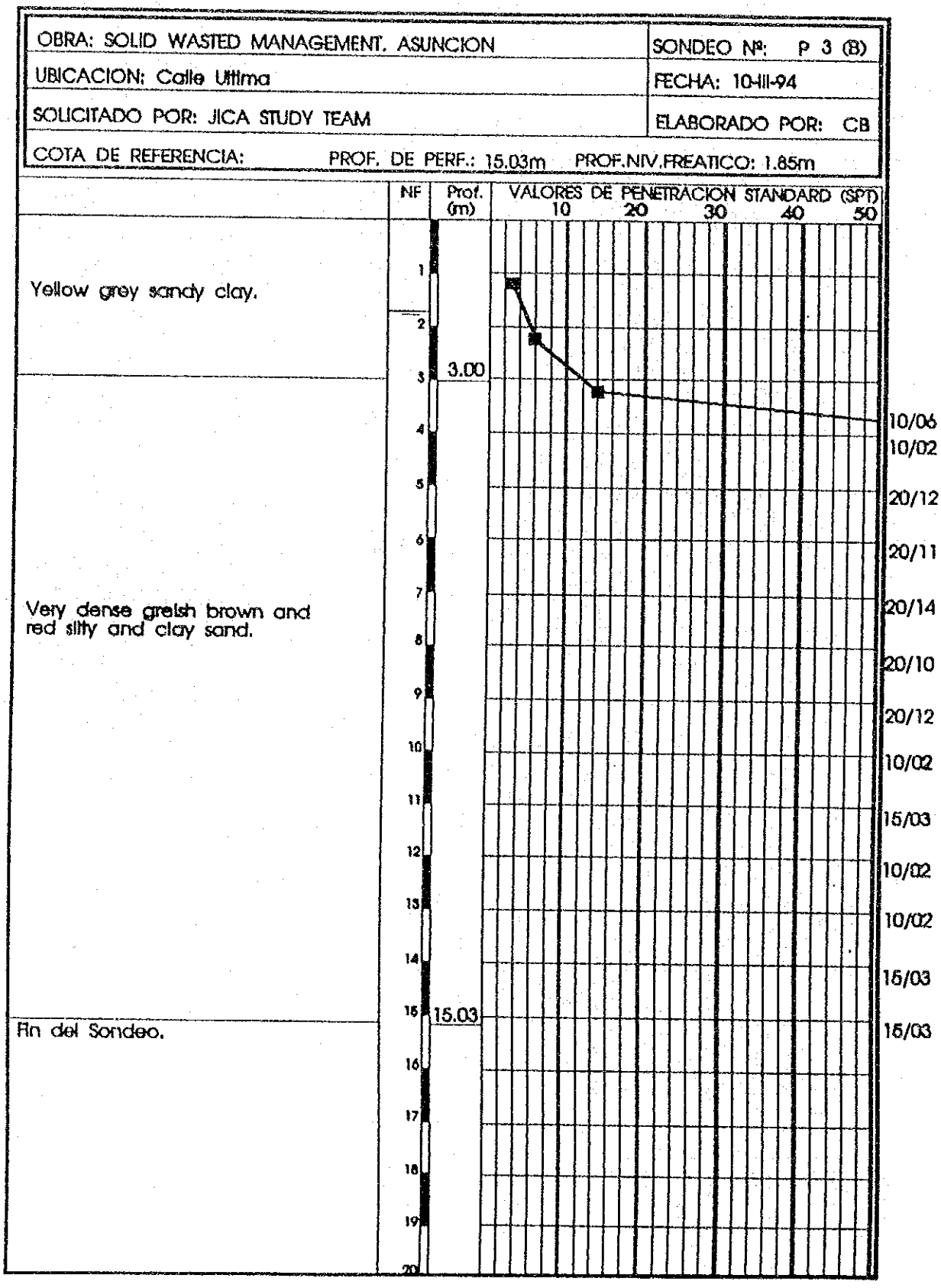


Figure D.4.2b Result of Penetration Test No.P3

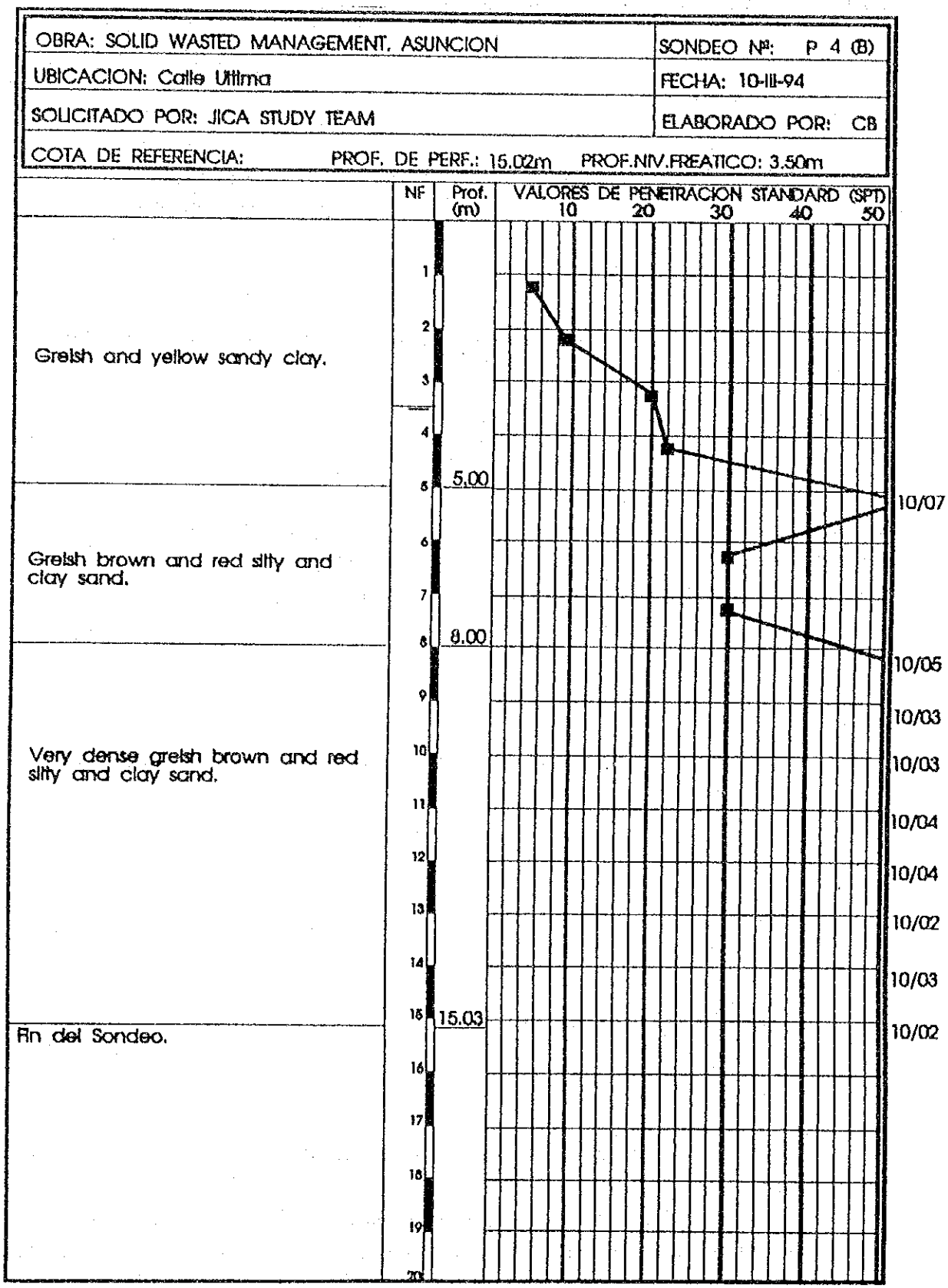


Figure D.4.2c Result of Penetration Test No.P4