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ENGLISH

EXPANSION OF A COMPOST PLANT AT CUENCA

SI/ECU/86/801

ECUADOR

Technical report: A feasibility study and design for the proposed composting plant at Cuenca - Ecuador*

Prepared for the Government of Ecuador
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of E.G. Hughes,
expert in composting of municipal solid wastes

Backstopping officer: R.O. Williams, Chemical Industries Branch

United Nations Industrial Development Organization
Vienna

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V.86-62782

EXPLANATORY NOTES

U.S.$ = 145 Ecuadorian Sucres
C.R.E.A.= Centro de Reconversion Economica Del Azuayn,Canar Y Morona Santiago.
MSW = Municipal Solid Waste
tpd = tons per day
tph = tons per hour
tpy = tons per year

This study was made 12.10.86 - 13.11.86

ABSTRACT

An economic and technical feasibility study of the composting of municipal solid wastes including the design of a proposed plant in Cuenca, Ecuador.

SI/ECU/86/801/II-01/32.I.I.

The objective was to carry out an economical and technical feasibility study for the establishment of a full scale municipal solid waste composting plant following on the operation of a pilot plant in Cuenca, Ecuador. After a great deal of discussion regarding the design of the proposed plant, it was decided to use the rotating drum type of pulveriser as this was the type in use in Quito and the type used for the pilot plant.

It appears to be both economically and technically feasible to build a municipal solid waste composting plant in Cuenca, Ecuador and it is recommended that the project proceed.

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ILLUSTRATIONS

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INTRODUCTION

The study,of which this report is the result,was undertaken during the period I2.I0.86 to I3.II.86.

The purpose of the study was to find out if it was economically and technicallly feasible to build a municipal solid waste composting plant in Cuenca,Ecuador, to handle the total collected municipal solid wastes.

A minor part of the study was to see if it was possible to alter or improve on the collection service to increase the success of the compost plant if it is built.At the time of the study,the collection service was about to undergo a major change,by more than doubling the size of the collection fleet so it was felt that the time for such recommendations was inoppartune.

The report is intended to give the relevant authorities the information necessary as to the advisability of constructing and operating such a plant and if an affirmative decision is taken,the technical and procedural inform-ation to enable the project to commence and when completed,for it to be operated in a way that will ensure its economic and technical success.

The report was undertaken after a pilot plant had been built and operated by CREA in Cuenca.

The Municipal Solid Waste Collection System In Cuenca.

From discussions with CREA and Dr.Pena, the Director of the Sanitation Dept. and his staff, it was established that currently Cuenca has a fleet of 7 refuse trucks and 3 skip containers that are used for market rubbish.

I or 2 trucks are normally undergoing maintenance and the others work from 8am to 2pm Monday to Friday and 8am to IIam on Saturdays.

Each truck has a driver and 5 collectors, i.e. 6men per vehicle and each truck makes 2 trips per day to the dump at Vallee.

There is a bonus system in operation whereby the truck operators get paid 2 hours per day to clean and maintain their vehicle.

It was stated that the population of Cuenca is I60,000 and that they produce a total of I35 tonnes per day of refuse of which 85 tonnes per day are collected and delivered to the Vallee dump. Private scavenging and river dumping appears to account for the difference.

The refuse collected is from households that put the refuse into plastic bags that they buy.

The position is complicated by the fact that the President of Ecuador is supplying Cuenca with a further II new collection vehicles which are due to be delivered in November I986.

I feel that any suggestions regarding the collection service will be pre-mature at this time.

Cuenca city landfill site.It is about 3600m above sea level

Scavengers surround an incoming refuse collection vehicle.

INFORMATION RECEIVED FROM THE MUNICIPALITY OF CUENCA

Resume of Samples

Number od domestic samples: 214
Number of population : 1195
Weight of rubbish : 951.22kg.
Average density of rubbish: $\frac{951.22}{4.2840} = 222.04 \frac{kg}{m3}$
= 222 kg/m3

GENERATION OF M.S.W. IN CUENCA kg/person/day:

ECONOMIC CLASS	AVERAGE GENERATION FRON THE SECTOR	POPULATION SECTOR	WEIGHT GENERATED PER DAY
V2C: Middle class plus commercial	0.64kg/inh/day	29104	18626.56kg
V1: High class	0.83kg/inh/day	23724	19690.92kg
V2: Middle class	0.75kg/inh/day	58796	44097.00kg
V3: Lower class	0.65kg/inh/day	45966	29877.90kg
	TOTAL	157590	112292.38kg

Average generation in Cuenca:

$$\frac{112292.38 \text{ kg}}{157590 \text{ inh.}} = 0.7125 \text{ kg/inh/day}$$

RUBBISH GENERATED IN THE MARKET

Average weight of the rubbish generated from the market:

$\frac{808\ 60.97\ kg}{7\ days}$ = 1 1552 kg/day = 12 ton/day

Average volume of the rubbish generated from the market:

$\frac{229.160\ m3}{7\ days}$ = 32.7¼ m3/day = 33 m3/day

TOTAL AMOUNT GENERATED DAILY IN THE CITY:

	WEIGHT	VOLUME
Domestic rubbish	117 ton/day	528 m3/day
Market rubbish	12 ton/day	33 m3/day
TOTAL	129 ton/day	561 m3/day

Collected Amount:

Domestic collected amount:

Data for the calculation:

Population in the central zone : 41025 inh.

Population in the Peripheral zone: 44458 inh.

Generation: 0.7125 kg/inh/day

Average density domestic rubbish : 222 kg/m3

Frecuency of collection : each 2 or 3 days

The amount collected in the central zone is about 95 % from the total generated and the 5% is taken by the steert cleaners, with garden waste.

In the peripheral zone the amount collected is approximatly 95% of that generated from which 75% is taken by collection vehicles, 20% is deposited in skip and it is emptied into vehicle and 5% it is thrown into the river or cultivated terrance.

The collected amount is:

MONDAY	:	41025 x 0.7125 x 3 x 0.95 =	83306 kg.
TUESDAY	:	44458 x 0.7125 x 3 x 0.95 =	90278 kg.
WENESDAY	:	41025 x 0.7125 x 2 x 0.95 =	55538 kg.
THRUSDAY	:	44458 x 0.7125 x 2 x 0.95 =	60185 kg.
Friday	:	41025 x 0.7125 x 2 x 0.95 =	55538 kg.
SATURDEY	:	44458 x 0.7125 x 2 x 0.95 =	30093 kg.
		TOTAL :	374938 kg/week

Average amount collected daily:

$$\frac{374938}{6} = 62490 \text{ kg/day} = 62.5 \text{ ton/day}$$

Volume: $\frac{62490}{222} = 281$ m3/day

Domestic amount collected with no regular service: the probable service for population is aproximatly 10114inh. And the percentage service is about 80%

Amount collected: 10114 x 0.7125 x 0.8 = 5765 kg/day
= 6 ton/day

Volume: $\frac{5765}{222} = 26$ m3/day

Amount collected from the tipping trucks: the two uncovered tipping trucks take an approximately amount of 7 m3 daily

Amount collected:

$$7 \times 2 \times 222 = 3108 \text{ kg/day} = 3 \text{ ton/day}$$

Volume: 14 m3/day

Amount collected from the market: the amount collected from the market is the same, in general as produced in the containers" they collected every day. From the - figure 12 is obtained:

Amount collected : 12 ton/day

Volume : 33 m3/day

Total Amount collected in the City:

Domestic rubbish :

62.5 ton + 6 ton + 3 ton = 71.5 ton/day

281 m3 + 26 m3 + 14 m3 = 321 m3/day

Market Rubbish:

12 ton/day or 33 m3/day

Total collected : 83 ton/day
354 m3/day

CHARACTERISTICS

Domestic Rubbish:

Economic Class	Average density of Domestic Waste (kg/m3)
V2C	211
V1	236
V2	219
V3	228

We see there is no great difference between the different sector. The density of the rubbish is estimated - in thewhole city, as 222 kg/m3.

Market Rubbish :

Density: the density from the market is:

MARKET	DENSITY (kg/m3)
9 de Octubre	376
12 de Abril	384
10 de Agosto	337
D Del Otorongo	273

Average density from the market is 344 kg/m3

The average density from the domestic is lower than the - market rubbish because of the organic material is higher, and also the rubbish supported a compactation in the containers.

CHARACTERISTICS PHYSICAL CHEMICAL: these values correspon ded to the organic material from the market refuse, and - is obtained from the teis "OPTIMATATION RUBBISH PROCESSING PLANT OF CREA".

SAMPLE No.	1	2	3	4
DATE	13 Agos-84	31-Agos-84	1-July-85	15-July-85
Moisture	59.10%	59.82%	84.80%	89.43%
Ash	50.54%	51.51%	11.92%	9.81%
Valatile Solid	49.46%	48.49%	88.08%	90.19%
Carbon	54.54%	48.70%	45.11%	35.62%
Nitrogen	0.70 %	0.86%	1.78%	1.29%
Potash (k20)	2.69%	3.17%	2.92%	2.05%
Phosphate(P205)	0.40%	0.35%	0.40%	0.13%
C/N Ratio	77.91	56.63	25.34	27.61

RESUME :

1.-	Organic Material	61.9%
2.-	Inert Material	12.8%
3.-	Paper	6.3%
4.-	Plastic	4.6%
5.-	Toilet Paper	3.3%
6.-	Others	2.9%
7.-	Textiles	1.9%
8.-	Glass	1.6%
9.-	Metals	1.4%
10-	Carton	1.1%
11-	Wood	0.8%
12-	Bone	0.7%
13-	Leather	0.5%
14-	Tires	0.2%

From the resume we can observe the organic material in the domestic refuse including the products of domestic activity. The inert material mainly consists of construction and road cleaning materials.

The amount of paper and plastic found is mainly packaging.

The other components exist only in small amounts.

MARKET REFUSE:

1.- Organic Material	85.7%
2.- Inert Material	4.8%
3.- Paper	4.1%
4.- Others	2.3%
5.- Plastics	1.9%
6.- Carton	0.6%
7.- Metals	0.2%
8.- Glass	0.2%
9.- Wood	0.1%
10.- Textile	0.1%

The Higher contents of organic material in the market is justified because of the types of products.

The figure of inert material is due the refuse of - street cleaning, is deposited in the skip from the - market
The amount of the other component is lower.

UNIT COST FOR THE FINAL DISPOSAL

DESCRIPTION	NUMBER	UNIT COST S/. YEAR
Cost/inh/served	85.483 inh.	26,17
Cost/apart/served	17.097 apart.	130,83
cost/ton/collected	83 ton/day	73,83
cost/m3/collected	354 m3/day	17,31

RESUME OF COSTS:

- For street cleaning:	s/.	24'922.096
- For collection		37'571.499
- For final disposal		2'236.783
		64'730.378

REVENUE:

Local tax should produce		23'000.000
Actual tax collected		20'000.000
Deficit	S/.	44'000.000

THE PILOT PLANT

The pilot plant commenced operation in June I984 and consists of a feed hopper leading down to a rotary mill.The crushed material was fed onto a conveyor belt which loaded the material into the rotating drum.The feed hopper was manually loaded.

The drum is an exact copy of the Dano drum installed in Quito in I955 which is still operational. The Cuenca drum is I0 metres long,I.7 metres in diameter and is driven by an electric motor and Vee belts via an automobile gear box at 6rpm.

I was told by Dr Espinosa that the original residence time of the material in the drum was 8 days and the temperature within the drum used to reach 70°C when he was in charge of the operation.

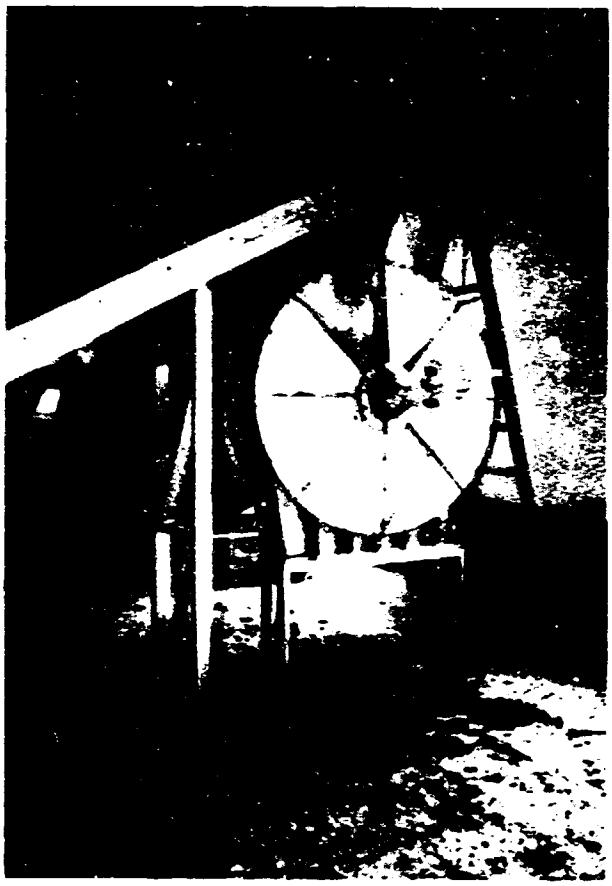
On the day that I saw the pilot plant,Tuesday,20 - I0 - I986,I was told it had been running the previous day.The drum was cold and the material (a bagasse based mix) bagged up for sale consisted of balls of material which were due to rotating a too wet mix. When the balls were broken apart they showed no signs of having been composted. Bagasse is a notoriously difficult material to compost because of its high content of cellulose and lignin. The balls contained a very high proportion of fibres of bagasse and these would not have been present if the organic materials had been broken down by the composting process.

During the retention time in the drum the atmosphere in the drum was supposed to be kept aerobic by blowing air into the drum by the fan mounted on the inlet end and allowing the air and the gaseous products of fermentation to exit at the discharge end of the drum.

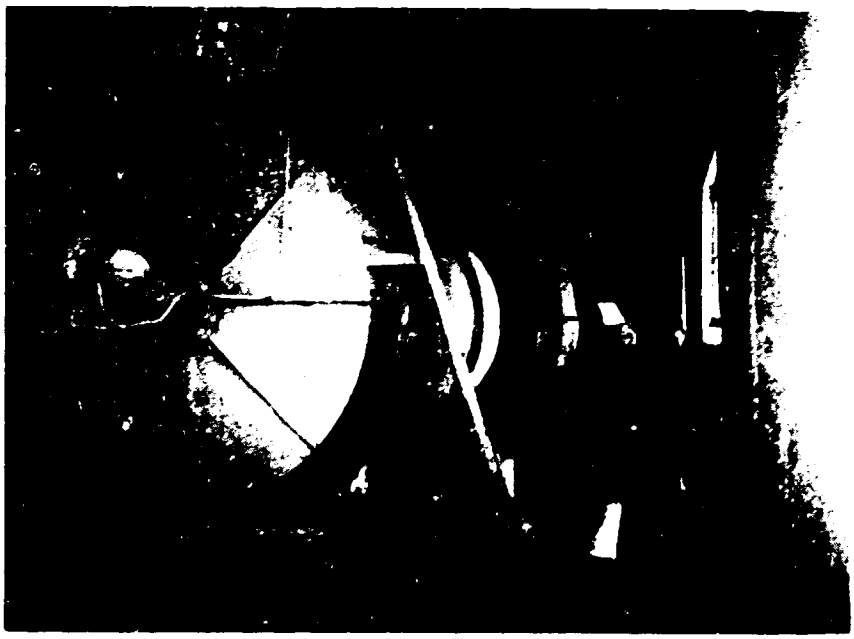
The plant had officially been shut down in December I985 due to objectionable odours causing neighbourhood opposition.

The feed hopper is manually loaded

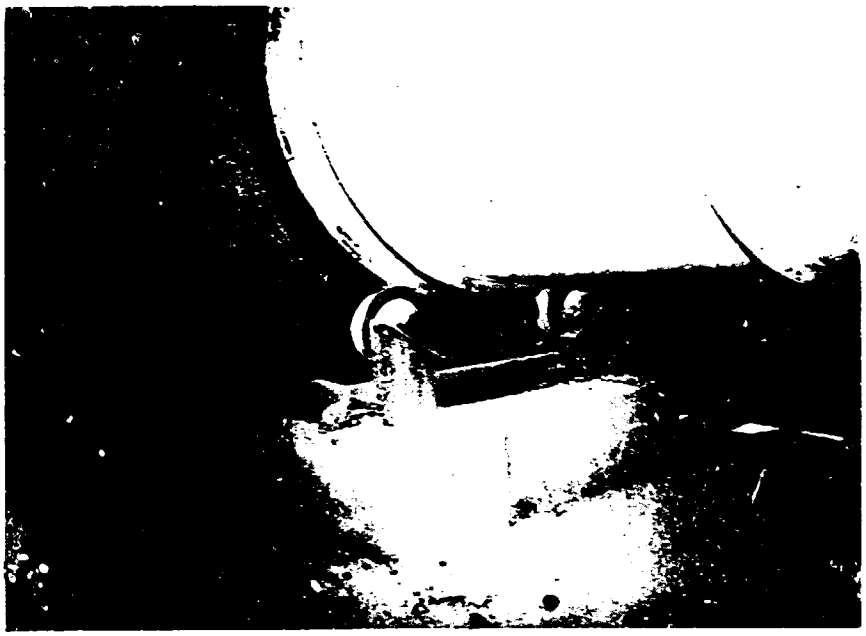
The material falls from the feed hopper into a rotary mill



The material is taken from the rotary mill, by conveyor belt to the drum.



The rotating drum is 10m long by 1.7m diameter and has a fan on the inlet end.

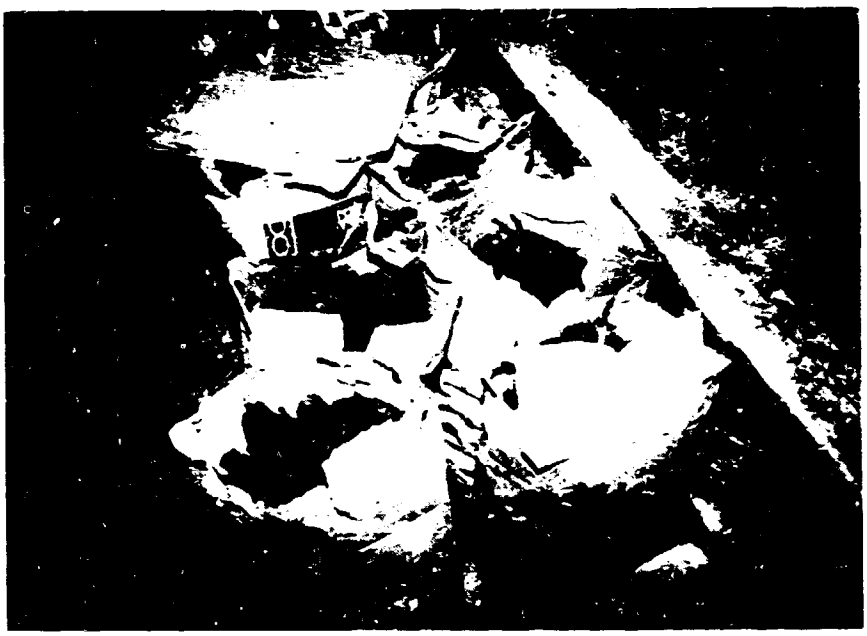


The drum support rollers are tractor wheels without the tyres

The drum drive is an electric motor with Vee belts via an automobile gear box

At the outlet end the too-wet material has clogged the screen and formed balls

The output from the drum



The material bagged and ready for sale. It is not composted and the Carbon Nitrogen ratio will be so high as to strip the existing nitrogen from the soil

DATA OBTAINED FROM CREA

Average Composition of Rubbish in the City of Cuenca.

		Salvage Rate
Organic Material	61 %	
Paper and Cardboard	15 %	13%
Metal and Drink containers	4 %	50%
Glass	3 %	6.7%
Textiles	2 %	25%
Plastic and Rubber	7 %	14%
Bone	1 %	
Inert Material	7 %	

Daily Production of Rubbish in Cuenca	135	150 Ton/day
Effective Collection	65%	95 %
Delivery to the Valle	85	142,5 Ton/day
Population		190.000
Daily Production per person	0,71	0,79 kg/day
20 collection vehicles		

Average Composition of Compost Produced en the Plant of Cuenca.

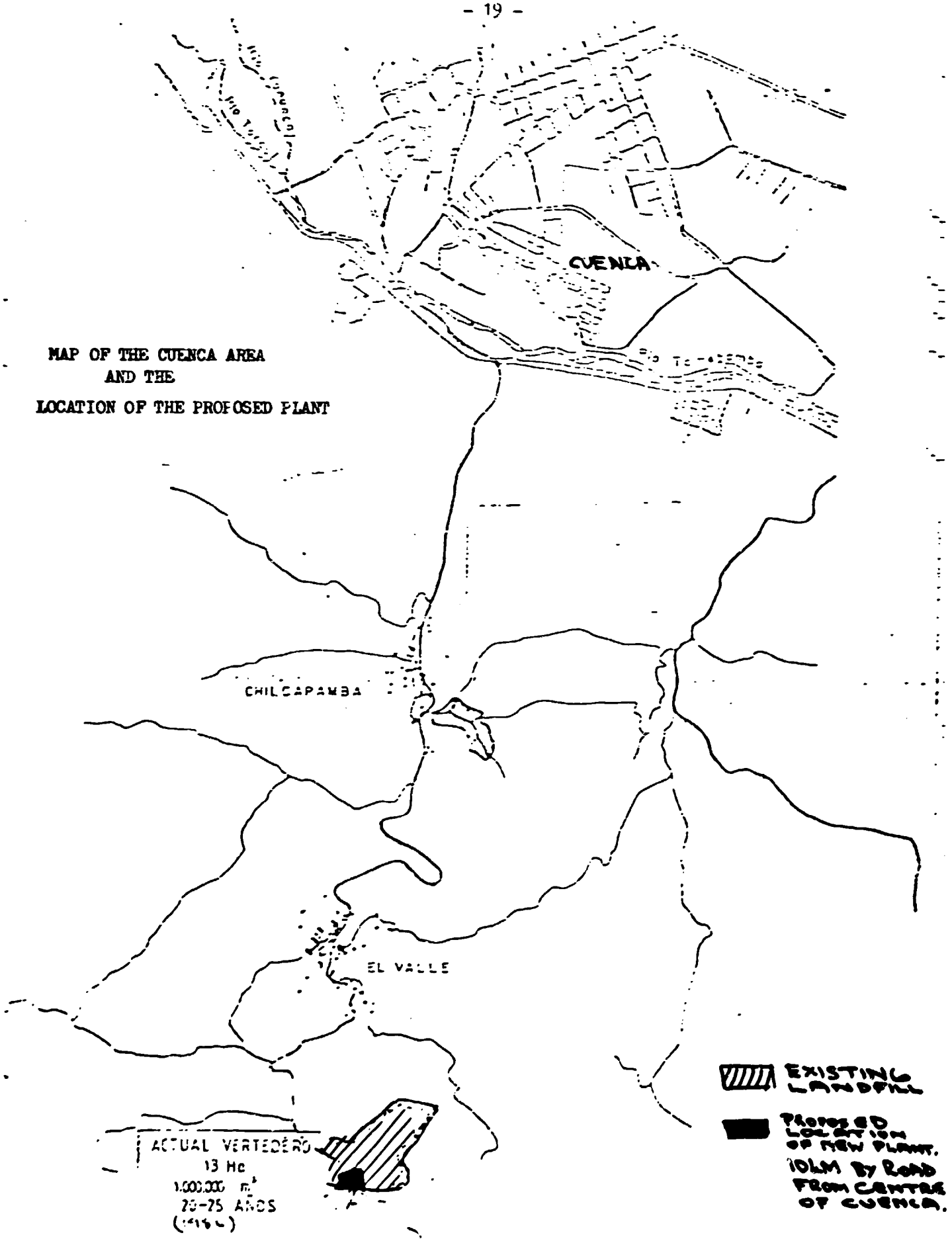
Organic Material	45 %
Phosphate	0,8 %
Nitrogen	1,0 %
Potash	1,1 %
Moisture	25-30 %

Density of MSW		260 kg/m3
Density of Compost		800 kg/m3
Moisture MSW	Winter 60-65%	
	Summer 50-55%	

DATOS METEOROLOGICOS DEL VALLE

ALTITUDE	2.600 m.s.n.m.
ANNUAL PRECIPITATION	850 m.m.
AVERAGE TEMPERATURE	12.5º
RELATIVE HUMIDITY	76%
HOURS OF SUN	1729.7 Hours
CLOUDY	6/8
EVAPORATION	1259.4 m.m.
POTENTIAL TRANSPIRATION	918. m.m.

NOTA: THIS DATA IS THE AVERAGE OF THE 4 YEARS.



MAP OF THE CUENCA AREA
AND THE
LOCATION OF THE PROPOSED PLANT

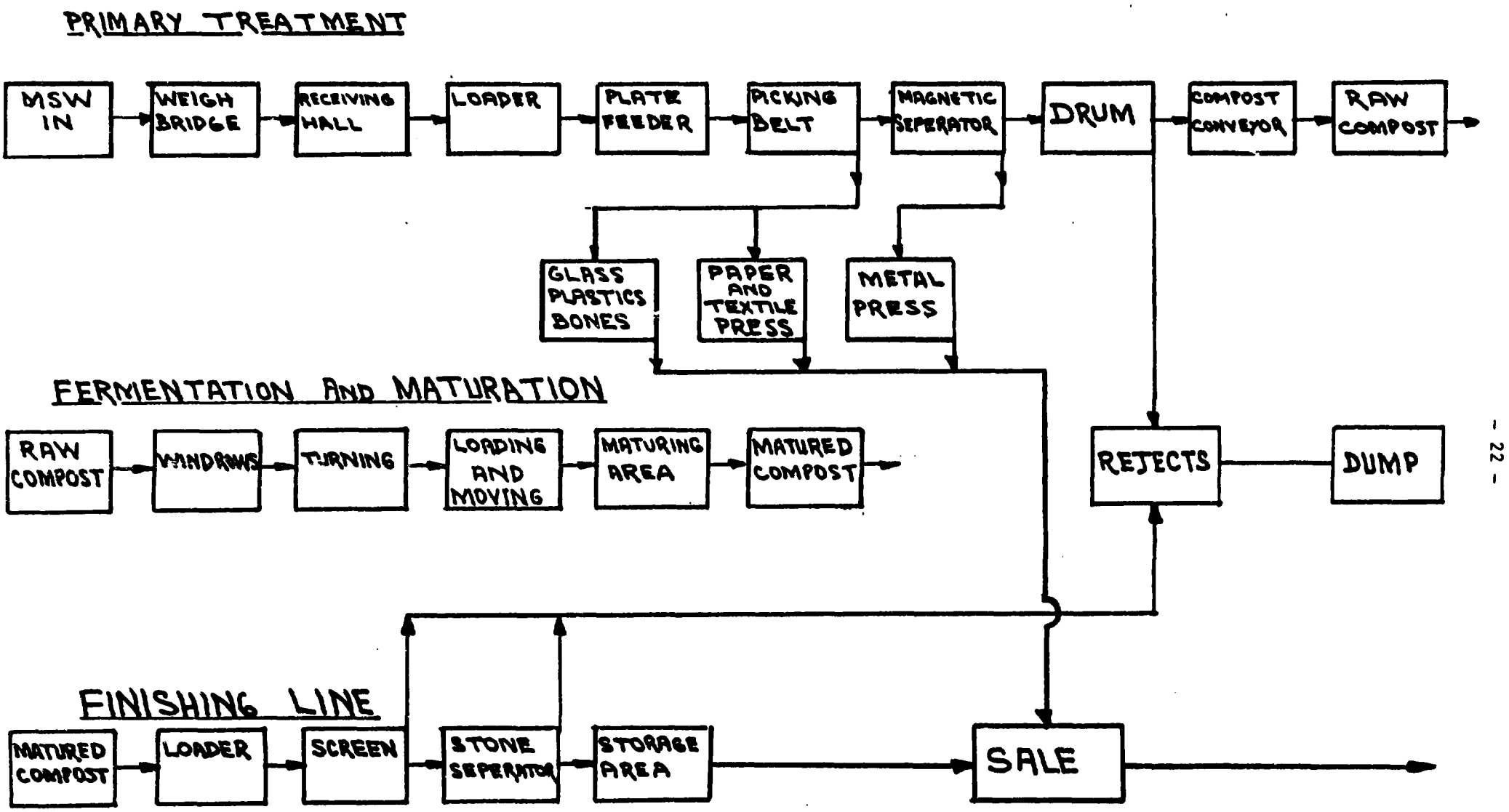
LOCALIZACION DEL ACTUAL VERTEDERO DE RESIDUOS SOLIDOS

The entrance road to the site is centre picture going off to the right

General view of the site

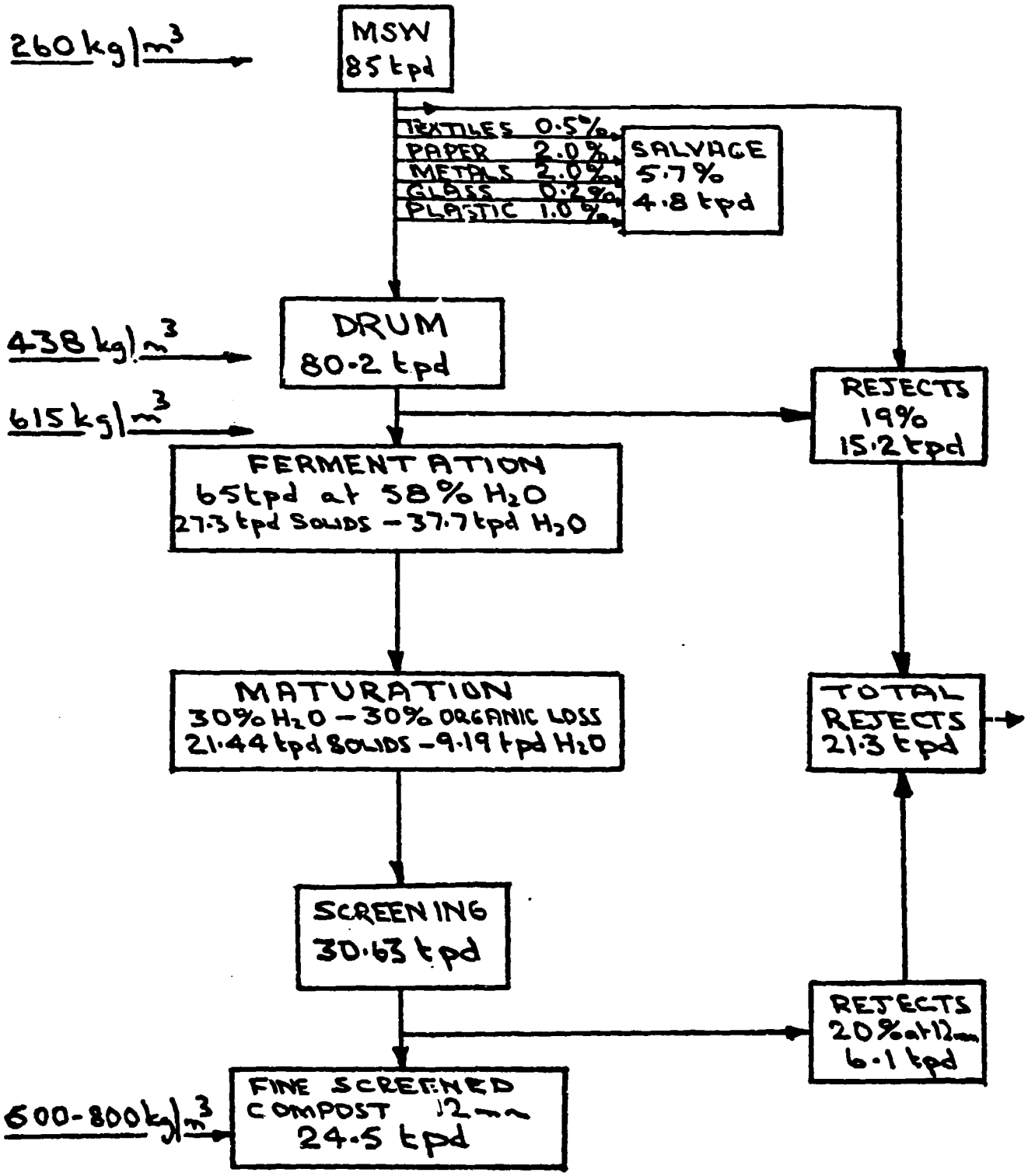
General View of the proposed site at 90° to the previous one. The city of Cuenca is visible in the centre

About I,660,000 m^3 remain for tipping the rejects from the proposed compost plant



PROPOSED PROCESS FLOW DIAGRAM

EGH. 23.10.86



E.G.H.
23.10.86

WEIGHT FLOW DIAGRAM
PROPOSED COMPOSTING PLANT
CUENCA ~ ECUADOR

DESIGN CALCULATIONS FOR THE PROPOSED COMPOST PLANT

DRUM

INPUT	= 80.2 tpd
INPUT/HOUR (8 hour day)	10 tph
Input density	= 260 kg/m3
Output density	= 615 kg/m3
Average density	= 438 kg/m3
Volumetric Input (10/0.438)	= 22,83 m3
2 Hour retention	45.66m3
Drum 2/3 full. Vol of drum	= 68.49 m3
Diameter of drum	3 m
CSA of drum	7.07 m2
Length of drum $\frac{68,49}{7,07}$	9,69 m

SAY 10 meters in length

FERMENTATION AREA

If there is a 28 day retention time, the compostable material will be produced by the drum in 24 - days. This is due to the six day working week.

Amount of compost to be fermented (65x24) = 1,560T

Volume at 615kg/m3 = 2,537m3

If windrows are 3m high x 7m wide

cross sectional Area = 10.5m2

Total windrow length = 242 m

Say we have 5 windrows 50m long plus additional - area for turning (2x7x50)

Area for windrows (7x242 + 2x7x50)
=1694 +700
=2,394m2

MATURATION AREA

Volume of compost to be matured 2,537m3

If stacked 3m high, area = 846m2

All the above areas are for the material only and- do not include any areas for roads or access.

SCREENING

30.63 tpd equals 3.83 tph on an 8 hour day or 7.65tph on a 4 hour operating day to save on machine time.

STORAGE AREA

24.5 tpd at 700 kg/m^3	= 35.0m^3
At 3m high area required per day	= II.7m^2
If a 30 day storage time is required, area	= 351 m^2

This is for compost only and does not include access or road area.

FERMENTATION AREA, MATURATION AREA AND STORAGE AREA.

The foregoing calculations are for the minimum areas to hold the compost. The areas need to be increased by 20% to allow for angles of residence and movement etc. That is :-

Fermentation area should be increased to	2873 m^2
Maturation area should be increased to	1015 m^2
Storage area should be increased to	421 m^2

TRANSPORT

Compostable material to fermentation area

Tonnes per day	65tpd
2m3 bucket holds at 615kg/m3)	1,230kg
No of trips= 65/1.230	53
Average distance and return	100m
Machine operates at 10km/hr	0,53hrs
Seven fold for loading, unloading and turning	-3-71hrs/day

Fermenting area to maturation area

Approx half the weight of the material to the fermentation area will be transferred to the maturation area - 2hrs/day

Maturation Area to Screen

Average distance and return	100 m
No of trips	24 per day
Time involved	1,68 hour
Screen to Storage Area 24.5 tpd say	2 hour

Compost turning

All compost to be turned 4 times in fermentation period and once per week = 1,560 tons/week

One 2m3 bucket will turn about 800 tonnes per day=16hour per week= 2.7 hour/day

Loading feeder Hopper and dealing with Rejects= 1 machine.

Total machine hour per day for transpor of material - to fermentation area, transport to maturation area, screening and screening to storage area = 12.09hpd=2 machines

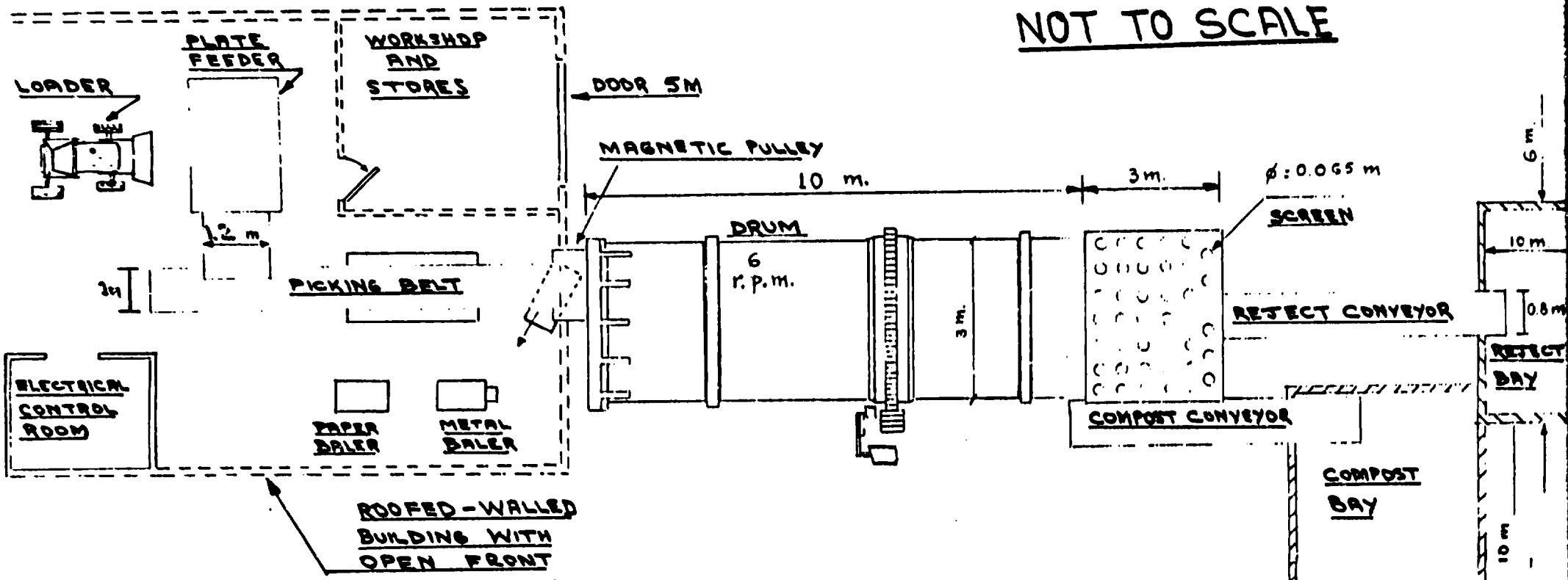
Feed hopper and rejects 1 machine

Therefore a total of 3, 2m3 front end loaders will be required.

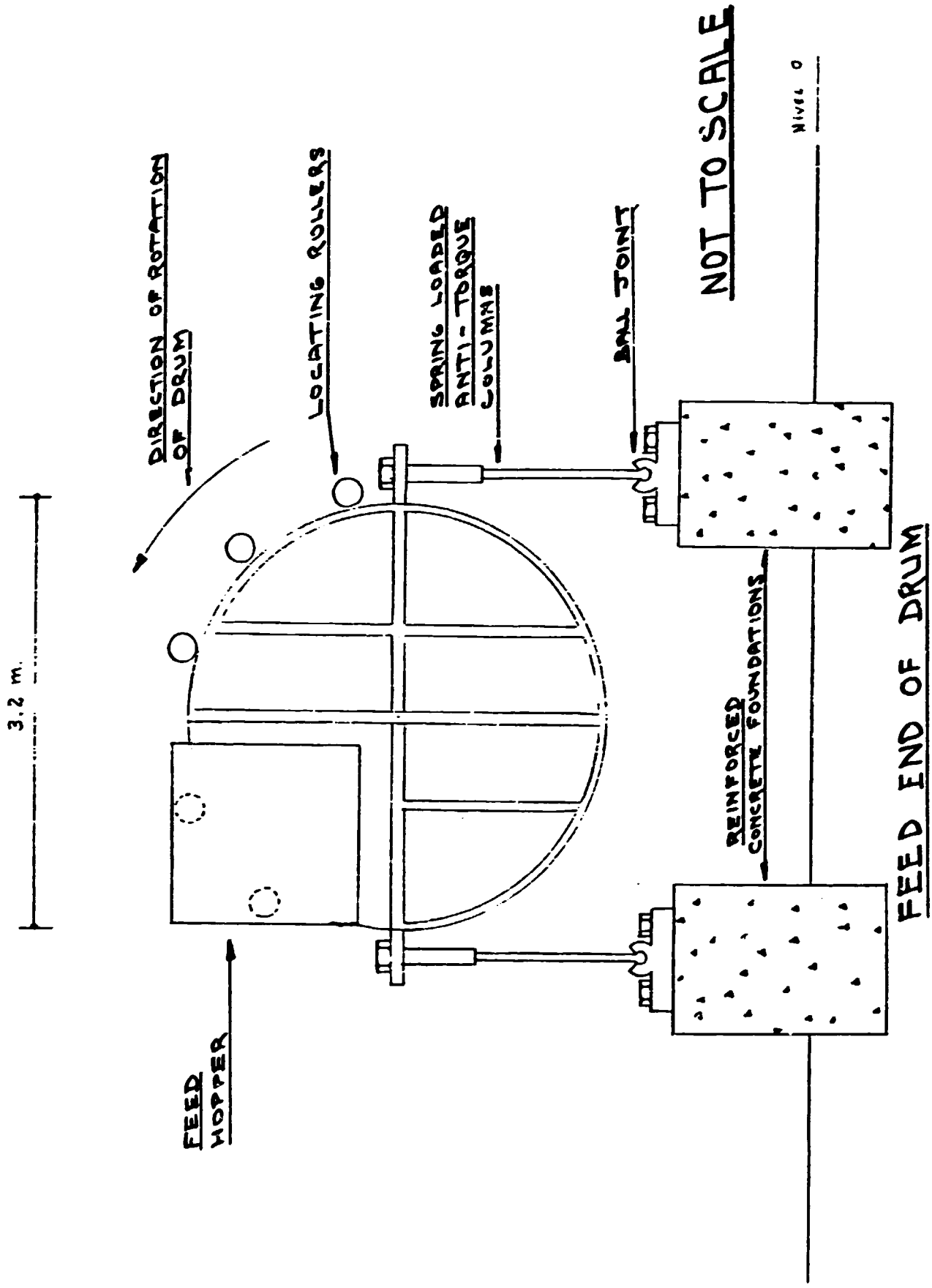
DESIGN DRAWINGS OF THE PROPOSED PLANT

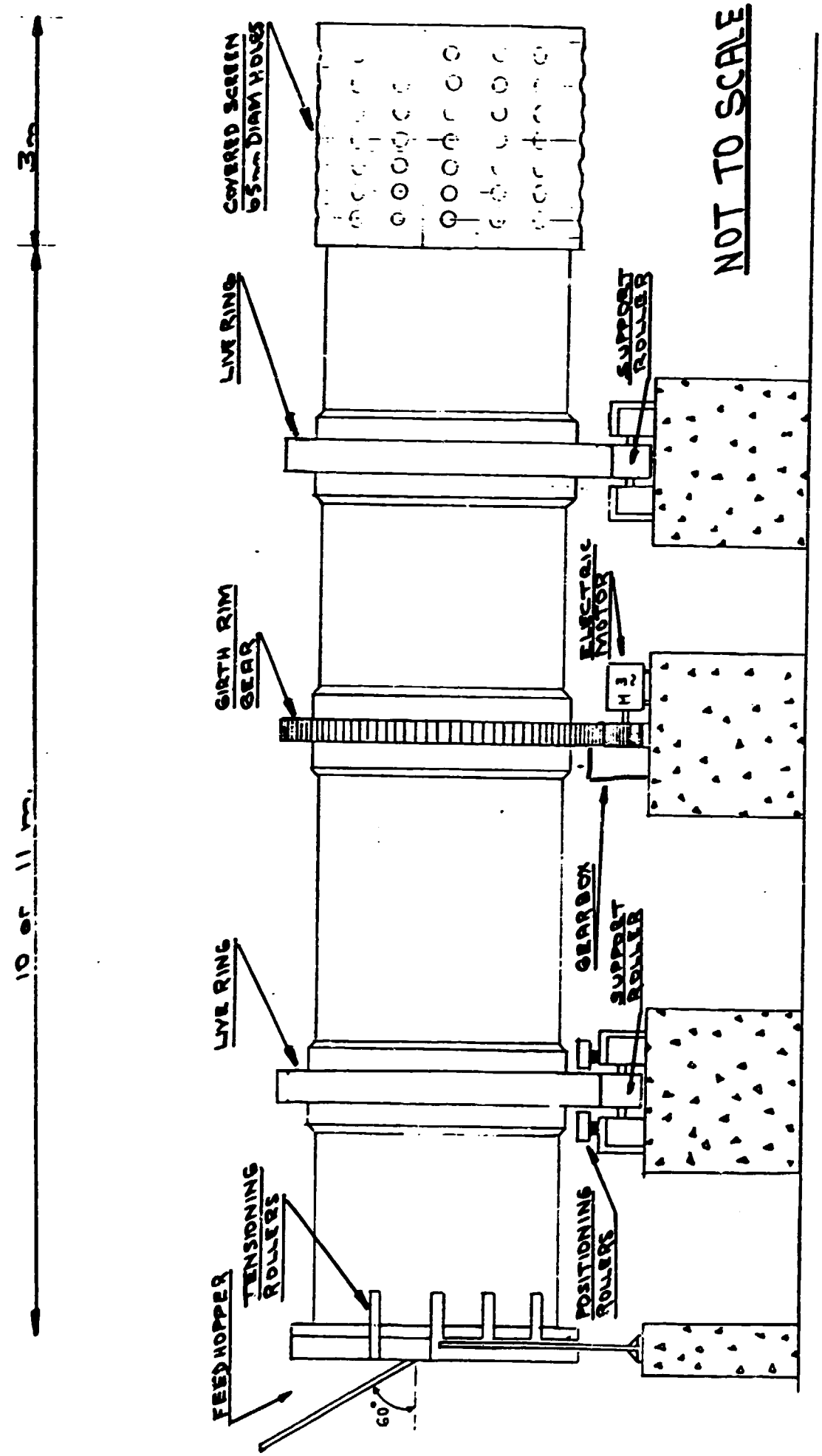
THIS LAYOUT IS INDICATIVE ONLY AND WILL HAVE TO BE ALTERED TO SUIT THE SITE AFTER SURVEYS HAVE BEEN COMPLETED

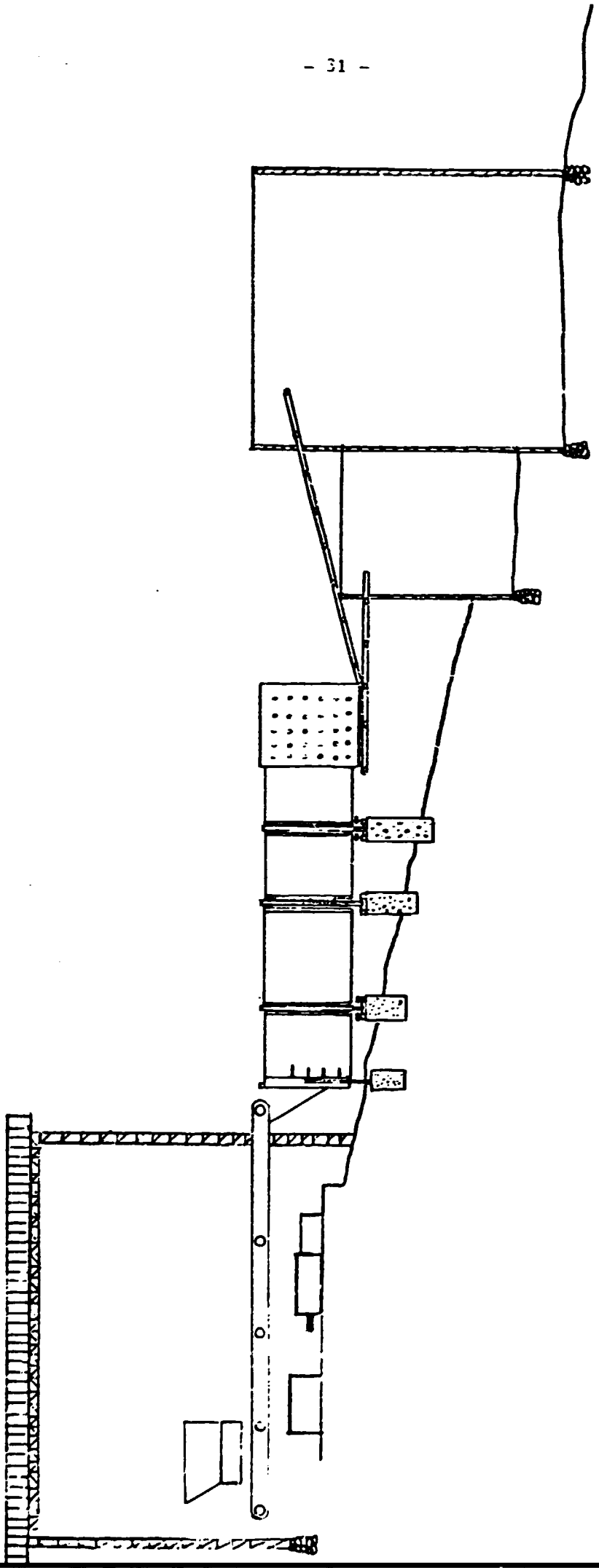
NOT TO SCALE



PLAN VIEW OF PLANT


NOT TO SCALE
Level
DIRECTION OF ROTATION OF DRUM
LOCATING ROLLERS
SPRING LOADED ANTI-TORQUE COLUMNS
BALL JOINT
3.2 m.
REINFORCED CONCRETE FOUNDATIONS
FEED END OF DRUM
FEED HOPPER


3m
10 or 11 m
COVERED SCREEN
65mm DIAM HOLES
LIVE RING
SUPPORT ROLLER
GIRTH RIM GEAR
ELECTRIC MOTOR
GEAR BOX
SUPPORT ROLLER
LIVE RING
TENSIONING ROLLERS
POSITIONING ROLLERS
FEED HOPPER
60°
NOT TO SCALE
SIDE VIEW OF DRUM



NOT TO SCALE

SIDE VIEW OF PLANT

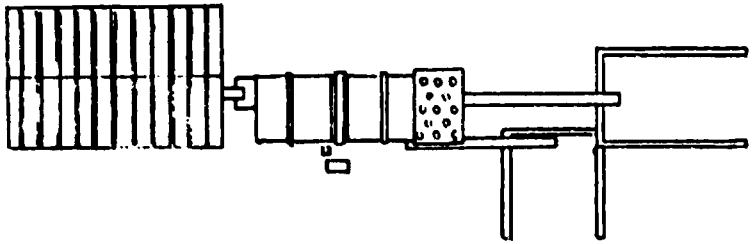
WEIGHBRIDGE

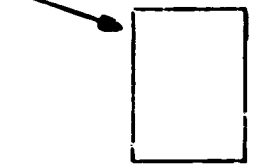
THE POSITION OF ALL THE COMPONENTS CAN BE CHANGED TO SUIT THE SITE

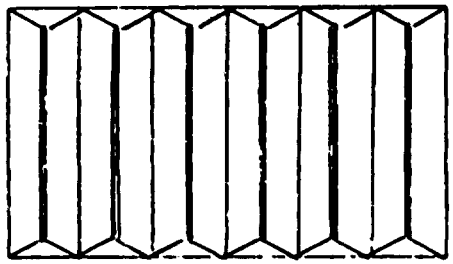
LANDFILL AREA

PROCESSING

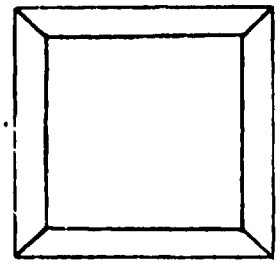
ADMINISTRATION BUILDING







2872 m^2
FERMENTATION AREA



1016 m^2
MATURATION AREA

FINAL SCREEN

421 m^2
STORAGE AREA

NOT TO SCALE

MAIN COMPONENTS OF PLANT

METHOD OF OPERATION

The MSW collection vehicle enters the plant and the contents are weighed. It proceeds to the reception area where the contents are emptied onto the floor. Any large or non - compostable items are removed and put on one side to be taken to the landfill site.

The front end loader loads the material onto the plate feeder which transfers it to the picking belt where recyclable materials are removed.It then passes over the magnetic drum which removes the ferrous metals.The paper,cardboard, and textiles go to the press for baling.The ferrous metal is baled in a seperate press.

The material is discharged from the picking belt into the feed hopper of the drum.It remains in the drum for approximately two hours where it is shredded by attrition and becomes a homogenous mixture.At the discharge end of the drum it passes onto the screen.The particles over 65mm pass over the screen and go by conveyor belt to the reject bay from where they are eventually taken to the landfill site by front end loader.The compostable materials that are less than 65mm pass through the screen onto the compost conveyor which transfers them to the compost bay.From there it is taken,by front end loader and formed into a 50m long windrow,of triangular cross section 3m high by 7m wide,in the fermentation area. It remains in this place for one week when the temperature will have risen to 70°C and the composting process will be very active. After one week it is taken and made into a new windrow,alongside its original position,by front end loader.This is repeated twice more at weekly intervals by which time the active fermentation will be much reduced.

The material is then taken by front end loader from the fermentation area and formed into a plateau 3m high in the maturation area. It remains here,under cover,for 4 weeks and matures as the self generated heat dries it out to about 30% moisture.

From this area it is taken to the final screen.The oversize rejects are taken to the landfill site and the compost can be put into the storage area ready for sale.

ECONOMICS

FINANCING

It is intended that the proposed project will be jointly financed by the Municipality of Cuenca, CREA and the Development Bank of Ecuador.

Construction COSTS

ITEM		Unit Cost US$	Total Cost US$
Reinforced Concrete		125/m^3	46,110
Asphalt		7/m^2	60,000
Buildings	Office	110/m^2	10,.00
	Factory	68/m^2	31,000
Drainage and septic tank			7,450
Weighbridge and office			13,000
Plate feeder			63,000
Conveyors		15,000	45,000
Magnetic seperator			4,500
Drum			349,000
Front end loaders		68,666	206,000
Metal baler			30,000
Paper baler			15,000
Stone seperator			1,500
Final screen			30.000
Switch gear			10,000
Roofed,wall-less building		48/m^2	49,000
Total			984,760

The above costs do not include the following:-

Electrical installation,

Transport,duties and taxes

Site work

Screen structure

Office furniture

Professional fees

Erection.

The non included costs are partly dependant on the site survey.

The overall costs could be in the region of US$ 1.5 - 1.8 million.

ANNUAL OPERATING FIGURES

BASED ON 300 DAYS PER YEAR

	TONNE
REFUSE INPUT	25,500
COMPOST (UNSCREENED)	9,189
COMPOST (SCREENED)	7,350
REJECTS (SCREENED COMPOST)	6,390
TEXTILES	128
PAPER AND CARDBOARD	510
METALS	510
GLASS	51
PLASTIC	255

ORIGINAL VOLUME OF REFUSE	
AT 260 kg/m3	98,077m3
VOLUME OF REJECTS	
AT 320 kg/m3	19,970m3
VOLUME OF COMPOST	
AT 650 kg/m3	11,308m3

ANNUAL INCOME

MATERIAL	TONNER	PRICE PER TONE US$	INCOME US$
COMPOST	6,426	35 22	226,300
TEXTILES	128		
PAPER AND CARD	510	50	25,500
METALS	510	35	I7,850
GLASS	51	I5	765
PLASTIC	255	25	6,375
TOTAL			276,790

ANNUAL COSTS

		US$
PERSONNEL		49,538
ADMINISTRATIVE COSTS	NIL	
OPERATING COSTS (Power,fuel,cleaning etc)		20,000
MAINTENANCE COSTS		I6000
TRANSPORT AND REJECTS	NIL	
CAPITAL AND INTEREST		
	TOTAL	

PROJECTED CASH FLOW

Total Income	276,790
Annual Costs	85,538
Income over Costs	+ I9I,252

This is the amount available to repay the Capital and Interest

STAFFING and COSTS

STAFFING (8 hour running)

			In Thousands
1	Manager	s/.	612
1	Maintenance Engineer		504
1	Secretary/Clerk		336
1	Weigh bridge Clerk		408
3	Drivers		972
4	Pickers		960
1	Press Operator (metal and paper)		276
1	Electrician		300
1	Mechanic		300
2	Labourer/Cleaner		480
1	Screen operator/cleaner		264
1	Receiving hall attendant		264
1	Plant Supervisor		444
	Plus whatever guards are required		360
		S/.	6.480

TOTAL US$ 44.689,00 Total plus taxes US$ 49,538
Plus Taxes 4,849. 8°

This is the minimum number required with no allowance for absenteeism, sickness or holidays.

Training Programme

In order to ensure the success of the project the manager,maintenance engineer,mechanic,electrician and the operations supervisor should be present at the plant from the start of the installation of the mechanical and electrical equipment.

During this period the personnel should spend three or four days at the Quito composting plant. It is realised that the operation of the Quito plant is quite different from that proposed at Quenca but as the machinery is so similar it will give the staff experience and confidence in the plant operation.

A U.N. expert or an expert appointed by the main contractor,who is fully experienced with rotating drum composting and the composting processshould be at the plant for a period of four months,commencing one month before production starts. This is to ensure that the commissioning is done correctly and also it will give sufficient time to train the staff in materials recycling,operation,planned maintenance and compost production.

Implementation Programme

Agree financing
Run pilot plant as a continuous feed,windrow plant to confirm design data.
Survey site
Draw plans
Order drum
Order conveyors,loaders and all electrical and mechanical parts
Prepare site
Start civil works including roads
Complete foundations
Install mechanical and electrical plant complete with controls and lighting etc;
Asphalt required areas
Establish stores and workshop
Commission mechanical and electrical plant
Commence production
Establish markets for all recyclable materials
Establish markets for compost which will be available approximately eight weeks after production starts.

Notes for the preparation of the tender documents

The City of Cuenca,in conjunction with CREA,has decided to build a solid waste composting plant.Tenderers are invited to submit full detailed tenders including engineering design,site preparation,construction,erection,operation and training of key personnel.
The capacity of the plant shall be 85 tonnes per 8 hour working day with the possibility of increasing the running hours to 16 per day.The plant will be operational for 6 working days per week.

The tenderer will take into account the nature of the refuse,the climate,the level of the site,the maintenance and manpower.

Tender Documents.
The tender documents must contain at least copies of the below mentioned documents:-
Flow diagram indicating full description of the proposed plant
General plant layout.
Project drawings showing layout and sectional views.
Project drawings showing layout and sectional views and the fronts of all buildings.
Specifications of all the proposed equipment including but not limited to:-
- Name of manufacturer,
- Place of origin and
- Technical specification.

A mass balance for the proposed plant including water and dry matter balances as well as the amount of compost and recyclable materials and rejects.
A list of spare parts together with information about the expected working life at full load.
Details of the personnel and their qualifications to run the plant for 8 hours per day and 16 hours per day.
Training programme for key personnel
Detailed time schedule for for the execution of the plant.
Daily consumption of electricity,water,fuel,oil and drainage as well as total consumption for the whole plant at full load.

Preventative maintenance schedules and estimated annual maintenance and operating costs.
Tenderers qualification and experience in the construction of similar intermediate technology windrow systems. A reference list of composting plants executed in the last five years shall be given.

General

This tender shall be in accordance with the laws and regulations governing adjudications in Ecuador and the following provisions:-
All quotations shall be based on the supply of all the equipment necessary for the project and executing all the civil and erection work needed for the correct functioning of the plant complete with all items stated in the technical specification.
Customs duties and any other expenses shall be paid by the contractor.
The contractor will be responsible for receiving all the imported equipment and transporting it to the site at his cost.
The contractor shall be responsible for supplying the site with power and water necessary for construction,erection and commissioning at his cost, including consumption.
The contractor shall be resposible for the safety of the equipment and the personnel during the construction,commissioning and testing.
The contractor shall provide an on-site office for the client during construction.
Bidders are requested to furnish a bid guarentee amounting to per cent of the total bid price which guarentee should be valid for at least three months from the date of the bid opening.
The bid guarentee of unsuccessful bidders will be released after the award is issued to the successful bidder.
The successful bidder will be released from the bid guarentee upon receipt of the performance bond amounting to per cent of the total price.
A copy of the specification,drawings and catalogues should be submitted with the offer.
Quotes shall include all shipping and insurance costs,customs duties and all other expenses for all imported equipment.

Bidders must state in their offers all the necessary catalogues stating the type and specification of the equipment and specifying clearly the procedures of production of the compost.

Bidders shall state the terms of payment for both the local and imported components

All the requirements for the provisional acceptance shall be taken by the contractor as the client will only be responsible to supply the plant with the necessary solid waste.

The contractor shall guarentee the whole plant for one year starting from the date of provisional acceptance.

Final acceptance shall be after one year from the date of the provisional acceptance providing the plant is performoing as required and no outstanding jobs remain.

The performace bond will be released after final acceptance.

Local Manufacturing.

The bidder shall have manufactured locally as much of the plant as is possible. All locally made equipment shall remain at the responsibility of the bidder.

Refuse Characteristics

Any information given in this tender regarding refuse characteristics are given merely as a guide and the client is not responsible for the accuracy or reliability of this information. Any plant or process failure resulting from different characteristics of the refuse will be the responsibilty of the contractor and any repair, alteration or remedial work shall be at the contractors cost.

The Technical Process

The plant is to be a moderate technology windrow composting plant provided with facilities for the hand sorting of recyclable materials.

The following stages are offered as a guide:-

Weighing the incoming trucks by using a mechanical beam scale

Unloading the vehicle in a receiving station where large non compostable materials can be removed.

Conveying the refuse to a picking belt for hand picking of recyclable and non compostable materials.

Removing of ferrous metals by a magnetic pulley

Mixing,homogenizing,pulverising and screening through a rotating drum.
Transport of the compostable material to a compost bay from where it is transported by a front end loader to the fermentation area.
Transport of the oversize drum rejects to a reject bay from where they will be transported to the tipping site by front end loader.
Constructing the windrows for aerobic fermentation in adequate areas.
Periodic turning of the windrows by front end loaders.
Transporting the fermented compost to the maturation area by front end loader.
The fermentation and maturation period shall be at least sixty days.
The maturation area shall be an open,roofed structure.
The mature compost shall be fine screened on a flat bed oscillating screen and then passed over a stone seperator to remove particles of glass and stones.

Performance Specification For Mechanical Equipment.

All equipment shall be of good qualiy and made from new materials that are free from defects and rust.Surface treatment and painting shall be included.
The plant components shall require a minimum of adjustment and maintenance.
All bearings and driving mechanisms must be dust proof.
All lubricating oils and greases specified shall be easily obtainable in Cuenca.
Access must be provided for inspection and adjustment.

Truck Scale

The truck scale shall be a mechanical beam scale.It shall have a capacity of 30 tonnes and the bridge size shall be at least 8 X 3 mteres.
It shall be of pitless form and the foundations shall be reinforced concrete with approaching ramps.The equipment will indicate and print or stamp out the vehicle weight on scale tickets.The offer shall include tickets for one year operation.

Plate Feeder.

Incoming wastes shall be discharged from the refuse truck onto the floor of the receiving building. They shall be transferred by front end loader onto a plate feeder. The plate feeder shall be ... m wide and of variable speed. The mid point on the variable speed gear box shall be such that I0 tonnes per hour of refuse shall be delivered to the picking belt.

Picking Belt

The picking belt shall be constructed of fire resistant materials. It shall be placed horizontally at a suitable level for efficient and easy hand picking from both sides of the belt.The belt shall be of variable speed between

9 and 18 metres per minute. The effective length of the belt shall be approximately 20 metres long and I metre wide. The conveyor shall be equipped with a tensioning device,scrapers top and bottom and side seals to prevent spillage.The rollers and return idlers shall be of steel tube with sealed for life bearings.The pulleys shall be self cleaning.

Metal Baling Press

The metal baling press shall have sufficient capacity and pressure to bale the extracted metal to a size siutable for safe,easy handling without the need to use baling wire.The baling mechanism shall be hydraulic operated.

The Paper and Textile Baling Press

The paper and textile baling press shall be electrically operated and the bales may be tied with wire or ribbon.

Magnetis Seperator

The magnetic seperator shall be of the permanent magnet rotating pulley type installed at the discharge end of the picking belt. It will discharge into a suitable hopper close to the metal baling press. The pulley shall be of sufficient magnetic power to ensure efficent extraction of the ferrous metal.

The Mixing,Homogenising,Pulverising and Screening Drum.

The purpose of the drum is to reduce the size of the refuse by pulverising, tearng crushing and mixing the material to obtain a homogenous mixture that is suitable for fermentation in windrows.

The drum shall be of the closed rotating type that is driven by an electric motor and Vee belts via a gearbox that is capable of rotating in the reverse direction when the electric motor is stopped and the drum reverses its direction prior to coming to rest.

The drum should have a feed hopper at the stationary inlet end and the inlet end should be held in close contact with the drum by tensioning rollers to allow the minimum amount of spillage.

The drum should run on support rollers that can be adjusted to ensure the drum runs true.The support rollers should be of sufficient strength to take the weight of the drum and its contents through two live rings.

Positioning rollers should be fitted to the inlet plate to ensure rotational accuracy the inlet end plate should be supported on moveable spring loaded tensioning columns to protect the end plate and drum against any eccentricity that may have been built in or may occur due to temperature variations.

The longitudinal play shall be controlled to within stated limits by a locating roller situated on each side of the live ring nearest to the feed end.

The exit end of the drum shall incorporate an exit door with a variable opening.

Internally, the drum shall have wearplates at the inlet and exit end and a system of wear bars to prevent the refuse coming in contact with the metal of which the drum is constructed.

At the exit end of the drum the refuse should discharge through the exit door onto the rotating screen that is attached to and part of the drum. The screen should consist of screen plates with 65mm holes.

The inside of the drum should also have sharp spears for the opening of platic bags.

At the discharge end, the oversize material (rejects) should be dicharged onto a conveyor and the undersize material should be discharged onto a conveyor that transfers it to the compost bay. The design of both of these discharge points are of the utmost importance as blockages can occur here due to the high moisture content of the material.

Allowable eccentricity or vibrations shall be stated.

The driving unit shall be covered.

Compost Belt

The compostable material discharged from the drum shall be transferred to the compost bay by a conveyor belt. This belt shall be In wide. Scrapers shall be fitted top and bottom, the pulleys shall be self cleaning, the roller bearings shall be sealed for life and a tensioning device shall be fitted.

Reject Belt

The oversize rejects discharged from the screen shall be transferred to the rejects bay by a conveyor of the same specification as the Compost Belt.

Front End Loaders

Three front end loaders will be required.These should be standard production machines capable of operating at high altitudes.All spare parts should be available in Ecuador.They should be wheeled machines powered by normally aspirated,water cooled diesel engines.They should be two or four wheeled drive. The bucket capacity should be $2m^3$ and the dump height should be 3m.

Final Screen

A feed hopper should be provided to feed the matured compost via a conveyor belt to a flat bed,inclined,oscillating screen with a capacity of 8 tonnes per hour.The rejects shall be discharged into a bay and the compost shall be discharged onto an inclined belt stone seperator and then into a storage bay. The screen shall be supplied with easily interchangeable screen plates of 25,I2 and 8mm. hole size.

Spare and Wear Parts

The supply shall include necessary wear and spare parts for one years normal operation in two shifts.
The quantity and value of these parts must be submitted in the tender and the working life for these must be stated.

Compost Quality

The process offered shall be guarenteed to produce compost that:-
Is safe and free of pathogens
Does not contain material that is harmful to the soil or to plant or animal life.
Has bren through a temperature of 55° for three days and has received a minimum of three turnings during the windrowing period.
Has a Carbon / Nitrogen Ratio of 20:I or lower and in which the emergence of nitrates has commenced.

Performance Specification For Electrical Equipment

Material and works shall be in accordance with International Standards taking into consideration the elevation and climatic conditions of Cuenca.

The installations shall be well arranged to permit easy maintenance and operation.

All materials used shall be obtainable in Ecuador.

Transformers

Standard oil insulated transformers shall be supplied. The rated output shall include a suitable excess over the power requirements of the plant.

Main Switchboard

The main switchboard shall be placed in a seperate room. A circuit breaker with the necessary overloads and protection relays shall be provided. The switchboard shall be metal enclosed and shall include all the necessary protection for each item of equipment on the plant.

A system of intertripping shall be included to prevent material being passed on to a piece of equipment that has become non functional for any reason.

Cables

All cables shall be of copper conductors covered with plastic insulation. Underground cables shall be at a depth of 60cm. Other cables are to be placed on trays or in steel pipes and protected against mechanical-thermal effects. For motor and control components flexible pipes shall be used.

Power Factor Correction

Automatic power factor correction shall be supplied to compensate $\cos \phi$ to: $0.9 > \cos \phi < 0.95$

Earthing

A suitable earthing system is to be provided for all the electrical equipment.

Motors

Motors shall be according to international standards and suitable for use in the tropics.

Maintenance

Isolation switches shall be placed at all motors and emergency stop buttons shall be placed at all operating places.

Civil Engineering

To the normal Ecuadorian standards.

CONCLUSIONS

It is economically feasible to operate a composting plant in Cuenca.
It is possible to build the plant,with the exception of the drum,using local personnel.
The equipment to build the drum is not available in Ecuador.
The drum is of proprietary design.

RECOMMENDATIONS

It is recommended that:-

I) The financial arrangements be agreed upon by the involved parties.
2) Ecuadorian personnel and companies undertake the construction of the proposed plant,with the exception of the rotating drum.
30 The rotating drum should be purchased,complete,from one of the international companies specialising in the manufacture of these drums.
4) An engineer from the manufacturing company should be responsible for the erection,adjustment and commissioning of the drum so that the guarentees remain valid.
5) The Implementation Programme should be put into operation.

ANNEX

MEETINGS

Marcello Rovayo, Ministry of Industry
Beatrice Calvopina, CREA
Ing.Falconi, CEBCA Ecuadorian Capital Goods Corporation.
National Finance Organisation
Ing.Agr.Merino, Manager of the Quito Composting Plant.
Daniel Toral, Director of CREA
Dr Virgilio Espinosa, CREA
Dr Pena, Director of Cuenca Sanitation Department
Ing.Mejia,Manager,Industria Metalica Mejia

VISITS

Quito Composting Plant
Cuenca Pilot Composting Plant
El Vallee Landfill Site,Cuenca
Proposed Site for New Plant,El Vallee,Cuenca
Industrai Metalica Mejia

My thanks to Ms Helle Vadmand,UN JPO,for arranging and accompanying me on the Quito meetings and visits.