OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

18179-E

Distr.
LIMITED

PPD.124(SPEC.)
10 July 1989

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

ORIGINAL: ENGLISH

PROGRAMME OF DIRECT SUPPORT TO INDUSTRY IN DEVELOPING COUNTRIES:
FACT-FINDING AND PROJECT IDENTIFICATION MISSIONS

TF/GLO/88/018

Technical report: The cement industry in Nicaragua*

Prepared for the Government of Nicaragua
by the United Nations Industrial Development Organization

Based on the work of B. Bülow Andersen, mechanical engineer
and A. Nørholm, process engineer

---

*This document has not been edited.

V.89-57610
5764T

CONTENTS

		Page
1.	Introduction	3
2.	Summary and Conclusions	4
3.	Historical Background	6
4.	Process of Production	8
5.	Mechanical Situation of Present Equipment	16
6.	Future Market Demands for Cement	27
7.	Enclosures	29

1. Introduction

The experts visited Nicaragua during the period 29 November to 17 December 1988. A Special Technical Adviser of UNIDO, who headed the mission, joined them during the period 8 to 17 December 1988.

The purpose of the UNIDO mission was to formulate a programme of development for the cement industry of Nicaragua and to define the scope of work required for improvements in capacity, quality and types of products. Specifically, the experts were to: (a) describe existing raw material reserves, including recommendations for necessary investigations to be carried out in order to determine proper exploration of new reserves; (b) recommend activities as well as equipment and parts needed for further modernization of the existing cement plant, including the pozzolana cement-grinding plant at Managua; (c) prepare a preliminary list of necessary main machinery for a new dry-process cement plant and a rough estimate of the total investment; (d) specify the necessary equipment for substituting pozzolana cement for normal cement; and (e) recommend equipment for the distribution of cement in bulk, with cost estimates.

2. Summary and Conclusions

The sole cement company in Nicaragua has a production capacity of 345.000 t Portland cement per year. The maximum sales over the recent years achieved in 1987 was 295.863 t corresponding to a utilization of the installation of 86%. Due to lack of spare parts and maintenance it is increasingly difficult to reach this output.

When peace comes to Nicaragua, a yearly increase of the cement consumption of 7% is expected. In order to satisfy the demand, manufacture of puzzolanic cement, which was tried in the years 1983-1987, should be resumed and expanded to the maximum possible at the Exmisa grinding plant in Managua.

In order to satisfy locally the demand for cement over the coming 6-7 years, the following recommendations can be made.

1. Limestone is available at different quarries near the cement plant in varying qualities with high amounts of overburden and in known quantities for only a few years' consumption. Geological investigations, which have been started should be resumed and intensified in order to locate sufficient amounts of useable limestone for at least 20 years, and in order to establish detailed and efficient quarrying plans and procedures for the near future.

2. The puzzolanic material pumice has been used for the production of puzzolanic cement at Exmisa grinding plant. These deposits are not available for the cement manufacture to-day. A thorough geological study should be carried out in order to locate new deposits of puzzolanic materials, establishing knowledge of quantities, grindability, puzzolanic activity, water contents and quarrying methods.

3. An effort should be made to obtain permission for temporarily quarrying pumice from the old deposits in order to start manufacturing and introduction on the market of puzzolanic cement.

4. Rehabilitation of the Exmisa grinding plant including the dryer for puzzolana and including new Symetro gear for cement mill No. 2 and high efficiency separator for cement mill No. 3 should be planned in detail and given high priority.

5. With the use of spare part deliveries under way to Nicaragua an efficient maintenance and production should be established in the cement plant at San Rafael del Sur.

6. Up-to-date laboratory facilities should be established in San Rafael and at Exmisa in order to make it possible to produce efficiently high quality products.

7. When details on limestone availability are at hand, studies should be made on the possibility of modernizing and expanding the plant at San Rafael or the construction of a completely new plant near new limestone deposits.

8. Training in mechanical and electrical maintenance and cement production should be given to personnel at all levels of operation at San Rafael and Exmisa.

9. For these efforts the following resources are deemed necessary as a supplement of the present organization:

   0.7 mio USD for assistance in geological studies of limestone and puzzolanic material

   3.2 mio USD for supplementary spare parts and equipment and for rehabilitation of the Exmisa plant.

   1.9 mio USD for management team for 2 years, consisting of

   1 manager
   1 maintenance engineer
   1 production engineer
   1 training officer

   0.1 mio USD for specialist visits, for filters, gears etc.

   5.9 mio USD in total estimate.

3. Historical background

In Nicaragua only one company is producing cement, Companhia Nacional Productora de Cemento, CNPC. The company started production in 1943 in San Rafael del Sur, 45 km southwest of the capital Managua.

From a clinker producing capacity of 60 t/24h the plant was expanded in 1955 with a new kiln. To-day a total of 5 kilns are installed, all operating after the wet process.

Kiln No.	Started Year	Nominal Capacity	Maximum Capacity
1	1943	60 t/24h	70 t/24h
2	1955	100 t/24h	120 t/24h
3	1961	150 t/24h	160 t/24h
4	1969	300 t/24h	360 t/24h
5	1978	300 t/24h	360 t/24h
Total		910 t/24h	1070 t/24h

Kiln 1 is out of production of clinker. Tests are being made for the manufacture of burned lime. The 4 remaining kilns correspond to a total maximum capacity of 1000 t of clinker per 24 h. With a run factor of 85% this corresponds to a total yearly output of 310.000 t clinker or, with addition of 5% of gypsum, 326.000 t of Portland cement.

Cement is also being ground at the grinding plant Exmisa in the west outskirts of Managua. The plant was constructed partly to supply cement to a nearby plant for concrete products, Mayco, partly for the manufacture of puzzolanic cement, using pumice from different deposits west of Managua.

From the very start of the first kiln in San Rafael del Sur in 1943 up to 1973 the production was supervised by engineers from F.L.Smidth working on long term contracts with the company. In addition technical services and spare parts were supplied by F.L.Smidth. The close contact between the company and F.L.Smidth was maintained up to 1980.

In 1980 the company was taken over by the government. Due to shortage of foreign currency, the purchase of spare parts from Denmark and the rendering of technical services from F.L.Smidth has been reduced considerably, resulting in a gradual deterioration of the mechanical and operational conditions of the equipment.

At the Exmisa grinding plant the difficulties were considerably worsed. The reason for this is the fact, that most of the equipment was bought second hand from different suppliers, mainly in the USA.

Recently funds from a DANIDA grant have been allocated to the purchase of some of the most needed spare parts. This shipment will ease, but in no way solve, the production problems of the plants at San Rafael del Sur and Exmisa.

The development of the total consumption of cement in Nicaragua during the recent 10 years is shown in enclosure No. 2. Rapid hardening cement, ASTM type 3, and puzzolanic cement form only an insignificant part of the total consumption of cement in Nicaragua. In 1988 nothing has been manufactured of either of these types.

The total consumption month by month during the years 1987 and 1988 is shown on the diagram in enclosure No. 3.

4. Process of production

4.a. San Rafael del Sur

4.a.1. General

As mentioned, the plant is operating as a wet plant. Limestone of different levels of content of $CaCO_3$ is after crushing in hammer mill stored in the limestone store and at the immediate vicinity of the plant. Limestone is mixed or fed to the raw mills, and slurry is mixed in a series of basins with ample capacity for securing a reasonably homogeneous kiln feed. The burning is carried out in the 4 kilns using fuel oil. Clinker are stored in a covered store and ground in open circuit cement mills, partly at the Exmisa grinding plant near Managua.

4.a.2. Raw materials

At the time of the start of the cement plant, the raw mix was composed of high grade limestone, clay and silica. The first quarry to be opened was at San Pablo, 2 km south-east of the plant, ref. maps enclosures No. 7 and 8.

When it became increasingly difficult to locate limestone sufficiently high in $CaCO_3$ contents for the above raw mix, the raw mix was changed into a mixture of high grade and low grade limestone from different quarries. Many different quarries have been operated in the area between Santa Rosa, 8 km south-east of the plant, and La California 18 km north-east of the plant.

At present limestone is quarried at San Pedro and K5. High grade limestone is taken from the quarry at La California and used in small quantities as sweetener.

The typical limestone from this area is a mixture of sea shells embedded in clay and silica sand. The limestone situation is rather confused, and quite an effort is needed for the continuous quarrying of sufficient limestone.

With great experience the titration can with reasonable accuracy be judged from the colour of the rock.

Useable rock form layers of a thickness of 2-4 meters, covered by layers of sandstone and clay of up to 25 m total thickness.

With assistance from a geologist from Cuba, a drilling programme has been carried through in areas north of the plant in order to have the basis for a better planned quarrying. Due to shortage of funds, the drilling is being discontinued.

A report on the drillings was not available. Preliminary reports indicate availability of limestone in quantities as follows:

	High Grade	Total
Overburden	15,0 m	13,3 m
Limestone	3,4 m	7,1 m
Titration	87,3 %	73,7 %
Quantity	1,4 mio t	3,5 mio t

The figures very clearly show how serious the raw material situation is. Before any projects for an expansion of the plant should be considered, a thorough raw materials investigation must be made in order to locate raw materials of sufficient quantity and quality, and in order to establish a quarrying programme permitting a reasonable planning of the excavation of raw materials.

Analises of limestone from different quarries operated in 1980 are shown in enclosure No. 9. Enclosure No. 10 gives daily analises of slurry made from limestone from the quarries San Pedro and La California.

Enclosures 11 - 19 show photos taken from various parts of the limestone deposits.

4.a.3. Slurry preparation

After crushing of the limestone in hammer mills with capacity 35 t/h and 120 t/h respectively, the limestone is fed to slurry mill No. 1, UM 20 x 8,8, 17 t/h, and 3 identical slurry mills UM 24 x 8,8, each able of producing 35 t/h. Slurry is passed through 3 slurry basins operated in series, capacity 800 m^3, 1700 m^3 and 3400 m^3 respectively, before being fed to the kilns.

Slurry quality is maintained through continuously keeping balance of titration wanted. Set point for titration is based on analises of kiln feed from the previous day, titration 73,5 - 74,0 %. Continuous slurry samplers and viscosity meters are installed, but all out of order. Consequently, the titrations are made on hourly spot samples. The samplers would allow easier and better slurry control and a lower moisture contents in the kiln feed.

Normally one or two mills are producing high titrating slurry and one or two low titrating slurry.

Average water contents in the kiln slurry is kept at 38-39% due to difficulties in maintaining the slurry pumps in good working order. With the pumps in optimum conditions, the water could be reduced to about 35%, corresponding to a saving in fuel consumption of the kilns of up to 100 kcal/kg clinker.

The slurry mills are all equipped with Folaphones, but none of these are in working order.

Sufficient grinding media, most of Spanish origin, are available for more than 6 months of operation.

The plant personnel is aware of the importance of keeping the slurry basins full of slurry, thus ensuring a homogeneous kiln feed and good possibilities of a uniform kiln performance.

4.a.4. Kiln operation

During our visit to Nicaragua only the newest kiln No. 5 was in operation. The operation appeared to be relatively smooth in spite of the lack of some of the most important instrumentation. Flame formation was lazy, and an increase in speed of primary air at the nozzle tip was suggested. Finer adjustments of the kiln operation are not possible due to uncertainty about O_2-contents and lack of Orsat instrument.

While the original production guaranty of this kiln was 300 t/24h, the production can be kept at a maximum of about 360 t/24h. Calorific consumption is too high, partly due to a too high water content in the kiln feed, partly due to the lack of the possibility of adjusting the kiln performance properly.

The fact, that the production is performed reasonably in spite of the above mentioned difficulties, can be explained through the long experience of a large part of the plant personnel. The production director Mr. Antonio Cruz, for instance, has been working at the cement plant continuously since 1956.

The performance of the kilns is reported as follows:

Kiln No.			
1	max. output	70 t/24h at	???? kcal/kg
2		120	1500
3		160	1550
4		360	1450
5		360	1450

A project is considered for kiln 1 for the production of burned lime. It will probably not be worth while to restart production of clinker from this kiln.

As mentioned kilns Nos. 2, 3, and 4 were all stopped during the whole of our stay in Nicaragua. The clinker stock thus has been reduced to about 8000 t, of which about 6000 t are stored in open air and therefore rather wet.

Analises of clinker produced are given in enclosure No. 20.

A study has been made by specialists from Czechoslovakia on the use of charcoal for firing the kilns. The conclusion is, that charcoal made from eucalyptus trees will be considerably cheaper than the presently used fuel oil. Furthermore, scarce foreign currency is needed for the purchase of fuel oil. Due to lack of funds for the investments, no progress has been made so far in this field.

4.a.5. Clinker storage

The rather hot clinker of 180°-200°C are transported directly to feed silos for the cement mills. Overflow from the silos are passed to the covered clinker store with storage capacity of about 16000 t.

4.a.6. Cement grinding

Cement is being ground in open circuit in 3 identical cement mills UM 24 x 8,8. Production from each mill about 15 t/h. Production control is very difficult, as Folaphones are completely out of order, and internal water cooling and measurements of cement temperatures are extremely erratic. Dedusting of the cement mills is out of control, and the electrostatic precipitators are not functioning satisfactorily.

Only ordinary Portland cement, ASTM type 1, is being produced, ref. enclosures No. 21 - 23, showing results of physical and chemical analises.

It should be noticed, that at times the cement produced does not comply with the specifications for ASTM type 1. It is imperative, that the cement mills are being equipped with instrumentation etc. allowing a uniform production process well supervised.

The gypsum added originates from deposits near Leon, about 100 km from the factory site. The raw gypsum contains about 50% $CaSO_4$, $2H_2O$ only, but the impurities hardly are to blame for the relatively low strength properties.

4.a.7. Packing plant

The cement is stored in cement silos and dispatched partly in bulk, partly bagged. The distribution between bulk and bagged cement from San Rafael is as follows:

	bulk	bagged	total
1986	27366 t	229685 t	257051 t
1987	61500 t	193700 t	255200 t
1988 x)	36346 t	128757 t	165103 t

x) January-October incl.

Bagged cement is bagged from 2 12 spout rotary Fluxo packers. Dedusting is very inefficient. Bulk loading equipment is primitive and worn, causing the filling of bulk transporters to be too time consuming.

2 types of bags are used, one made locally from paper imported from El Salvador, at a company economically independent from the cement company, the other imported from Costa Rica. The locally made bags are of a poor quality. Consequently imported bags are used, when currency situation permits.

4.a.8.Quality control

All quality control is carried out in a plant laboratory in dusty conditions in rooms without air conditioning and equipped with extremely little laboratory equipment.

Additional laboratory equipment is under way from Denmark on a DANIDA grant. It must be considered imperative that all this new equipment is going to be installed under far better conditions as far as dust and temperature is concerned. If not, the advantage of this investment may to a great extent be lost completely.

Analises of kiln slurry carried out at the F.L.Smidth laboratories in Copenhagen are shown in enclosure No. 24. The company laboratory tend to find a too low Al_2O_3 contents.

Photos from the plant at San Rafael del Sur are shown in enclosures Nos. 25 - 33.

4.b. Exmisa

4.b.1. General

Clinker are transported from San Rafael to the Exmisa grinding plant in the western outskirts of Managua. This plant was originally installed for the manufacture of Portland cement type 1 and type 3 for the Mayco plant for manufacture of concrete beams, blocks, etc. Most of the equipment was purchased second hand from USA.

Later the production of puzzolanic cement was started, using pumice from small deposits on the peninsula 20 km west of Managua.

4.b.2. Puzzolanic cement

Production of puzzolanic cement was started in 1983. The puzzolanic material volcanic pumice was drawn from the peninsula Chiltepe about 20 km west of the plant. So far a total of 10.987 t only have been manufactured since the start in 1983, enclosure No. 34.

The pumice, a very porous material, contains up to 35% of moisture. Drying takes place in a separate drying drum with a capacity of 3-6 t/h depending on moisture contents.

Clinker, gypsum and 35% of pumice is coground in open circuit. 2 mills bought second hand are in operation at the plant, and No. 3 is under erection. This mill was delivered as new from F.L.Smidth in 1978, but erection abandonned shortly after delivery. Erection is now close to completion, but some parts, particularly from the electrical supplies have been lost. Part of the supply has been used as spare parts at San Rafael plant.

Details and capacities of the mills are given in enclosure No. 34.

The drier as the whole plant is mechanically in a very poor state, ref. part 5. Puzzolanic cement has not been produced since 1987. Enclosure No. 35 gives data on the quality of puzzolanic cement produced during 1987. The quality barely complies with the specifications for Portland-puzzolanic cement, ASTM 595, type IP.

4.b.3. Portland cement

Also Portland cement type 1 and type 3 have been manufactured at Exmisa, ref. enclosure 34. Since 1983 a total of 24.117 t of type 3 have been ground. The manufacture of type 3 was discontinued in 1987 due to disagreements on the price difference between type 1 and type 3.

Both types of Portland cement are manufactured in open circuit. The grinding of type 3 thus will be inefficient, as noticed from a specific power consumption of about 60 kWh/t (nt). Quality is shown in enclosure No. 35. The strength properties do not comply with the specifications in ASTM 150.

4.b.4. Mill operation and quality control

The 2 cement mills in operation are in a very poor shape. Temperature control is made hourly by manual check. Mill ventilation is erratic and laboratory control can apart from sieve analises only be made at the plant laboratory in San Rafael del Sur.

4.b.5. Packing plant

The packing plant consists of 2 2-spout stationary Fluxopackers in a very bad shape. The environment is extremely dusty.

Problems with qualities of cement bags is identical to the situation at San Rafael del Sur.

4.b.6. Puzzolana

Puzzolanic pumice was during the manufacture of puzzolanic cement drawn from deposits of volcanic origin in the peninsula Chiltepe west of Managua. The cement company to-day has no access to these deposits, as they have been included in a government project for cattle breeding and milk production. The ownership is in dispute and an effort should be made to obtain a temperatury permission to exploit these deposits. Other investigations have been carried out of pumice by Instituto Nicaraguense de Mineria, but with the point of view of manufacturing light weight building blocks. A Colombian specialist G. Morales has included these investigations in a 6 month UNIDO study on building materials in Nicaragua. These deposits have not been checked for puzzolanic activity, which should be done for the possible use for manufacturing puzzolanic cement. For the future manufacture of puzzolanic cement, thorough investigations of location, quantities, grindability, humidity, puzzolanic activity etc. should be made.

No efforts seem to have been made in order to secure other supplies of pumice, due to, probably, the very poor state of the drying installation for pumice.

Photos from Exmisa are shown in enclosures 36 - 39.

5. Mechanical Situation of Present Equipment

Clinker plant in San Rafael

Raw material crushers (2 units)

The machines are in reasonable state of repair. No serious problems ascertained in the crushing plant.

Belt conveyors (4 units)

The conveyors show signs of wear, but they are still running without any noteworthy problems. Significant observations: material spill at chute boxes, missing belt scrapers, open chute boxes and missing inspection doors.

Raw material store

No problems.

Beltlines storage area/mills (4 conveyance systems)

The beltlines seem neglected, but so far no operational problems have been encountered.

The metal hoppers in the material extractors suffer from severe impacting or fractures at locations where clogging problems occur. Screws and packing material in flanged connections are missing; major material spill was ascertained at numerous points on beltlines. Many belt scrapers are missing.

Conclusion

Some degree of maintenance needed. No spare parts required except for idler bearings which can be purchased locally.

Raw mills

Mill No. 1 33 t/d
Mill No. 2 17 t/d
Mill No. 3 33 t/d
Mill No. 4 33 t/d

The standard of all mills is almost the same. General clean up of machines needed.

Extensive oil outflow was observed at the gear rims. No oil seals fitted at mill drive.

Electroacoustic Folaphone devices and sensors for monitoring of the main bearings temperature were supplied for three of the four mills.

Most of these features are missing to-day, and the units still fitted are inoperative. Presence of grinding media in the slurry was reported.

Conclusion

Overhaul of temperature and Folaphone system needed, and need for ordering of replacement parts.

Slurry pumps and compressors

No malfunction ascertained despite the age of these units. However, problems arising from wear occur; the capacity of some pumps is not satisfactory. However, the FLS shipment in transit includes components for this plant department, so that the units will be restored to full functionality following installation of replacement parts.

Conclusion

Mostly OK. In case need of additional components should arise, these must be ordered at later stage of time.

Slurry basins

The carriages for the agitating mechanism in the 3 basins show signs of wear. However, replacement parts will soon arrive at plant, and so there is no immediate need for any additional parts.

Kiln No. 1 (50 t/d)

Kiln in extremenly poor state of repair, and it is questionable whether the 50 t/d output of kiln can justify the costs incurred in terms of repair and maintenance. All the same, the client is planning to start up a lime production.

Conclusion

Spare parts supply essential in order to maintain the kiln in operation. The question is whether this is justifiable from an economic point of view.

Kiln No. 2 (120 t/d)

The kiln is in bad state of repair. The kiln has three supports, and especially on support 2 severe signs of wear occur on live ring and supporting rollers. In the next shipment FLS will supply spare parts representing value of about 1.7 mio DKK for this kiln; this is the reason why the necessary investments should be made to renovate this kiln.

Conclusion

Spare parts can be supplied in the future, involving f.i. live ring and supporting rollers for support 2.

Kiln No. 3 (160 t/d)

The kiln appears to be in fairly good condition, except for the supports 3 and 4 (enclosure No. 44), but given the fact that the next shipment from FLS includes live ring and supporting rollers for these two supports the standard of the kiln can be enhanced to a satisfactory level.

Conclusion

No further supplies required.

Kiln No. 4 (360 t/d)

Kiln is in fairly good condition except for support 1 which is affected by tearing problems on the supporting rollers and rolling-out on the live ring. The mentioned shipment includes 4 supporting rollers which can be used on the supports 1, 2, and 3, but no live ring is included in the supply.

It needs mentioning that kilns 4 and 5 are identical so that the parts can be employed for both kilns.

Conclusion

Future supply of 1 live ring for support 1 seems likely.

It must likewise be mentioned that the maintenance personnel at plant conducted an inspection and alignment of kiln 4 during our visit. The operation is finalized, but the kiln has not been aligned properly.

Kiln No. 5 (360 t/d)

The kiln appears to be in good state of repair.

Burner's platform

Much of the equipment is extensively worn and obsolete. Right now some electrical equipment is missing, causing numerous problems.

Also missing is the replacement for the steam boiler for oil preheater station; however, this unit is in transit from FLS.

The heat treatment installation for desalination and decalcification is not performing well.

Conclusion

There are not control features for the electrical equipment in the burner system at plant. It would be advantageous to install a by-pass facility in the oil supply system so that the kilns are not necessarily fed from separate oil system.

Clinker transport

The drag chains behind the kilns seem to be in reasonable condition. Progressively as we approach the clinker store the standard continues to deteriorate, ending at the elevator and drag chain at the clinker store where the standard is extremely poor.

Conclusion

Spare parts needed for drag chains and elevator. Furthermore, a thorough clean up is required.

Clinker silos and surrounding conveyors

The condition of the drag chains, screw conveyors, bucket conveyors, elevators and belts is so critical as to necessitate thorough mechanical overhaul and reconditioning.

Cement mills

Mill No. 1 dismantled
Mill No. 2 15 t/d
Mill No. 3 15 t/d
Mill No. 4 out of operation

In visual terms, the mechanical condition of the three mills does not differ much. Again, the main impression is that the plant is neglected with respect to maintenance; thorough clean-up is recommended as a first measure. The most neglected plant departments seem to be the cement mill circuit and the packing plant.

Electroacoustic Folaphone devices and bearing temperature sensors inoperative.

The condition of the water injection system is so poor that a reconditioning of the system will hardly be worthwhile. Servo-operated dampers for regulation of the air flow through the mills are without connecting arms to motors, but are regulated by strokes applied by hammer. Extensive oil spill observed at gear rims.

The gear unit on mill 4 is dismantled on account of problems with the gear wheels. Further, the membranes of the torsion shaft are damaged. See enclosure No. 46.

Conclusion

Expert assistance strongly needed at plant to restore its functionality. Major spare parts supply expected for this plant department.

Dedusting of mills

The dedusting efficiency is extremely poor. The collecting efficiency of the two electrostatic precipitators is very poor, causing an extremely high degree of dust contamination in the area. (Enclosures No. 50 - 51).

Conclusion

It is recommended that, initially, a precipitator specialist is sent to plant; this specialist is to form the plant maintenance group in collaboration with the mechanical plant supervisor. As is apparent from above observations, a spare parts supply will be required.

Packing plant (2 machines)

As already mentioned, the packing plant is no doubt the worst affected installation at plant.

One bag filter for dedusting of packer unit No. 2 has been out of operation for almost 5 years. The compressor for the supply of air needed to generate the pneumatic vibrations was needed elsewhere at plant, and therefore it was dismantled but it was never returned.

As is the case with many other machines at plant, the filter is equipped with a roof structure; refer Enclosure No. 52. This method is applied everywhere where the roof structure of the buildings has cracked in order to prevent inflow of water.

For instance, most of the equipment in the emergency generator station is provided with similar roof structures.

The packer units suffer from leaks at some points due to wear exposure, but spare parts from FLS are in transit. There is no doubt that the two packers can be restored to an acceptable level of operation, but the severe dust nuisance in the area will continue because of major problems with low quality bags.

Imported bags are too expensive and the standard of those obtained from local sources is poor, both in terms of paper quality and manufacture.

The dust conveyance system is in need of maintenance. The dust spill from the packers is so substantial and the conveying capacity of the underlying screw conveyors so poor that the basement was covered by dust, stacked several metres high, preventing any access to basement.

Conclusion

Following the installation of the new replacement parts, a check is needed to evaluate whether additional parts will be required. Also need for call--in specialist to assist at plant must be expected. Many mechanical problems at plant require attention.

Bulk

Total reconditioning of system required.

Generator station

Generator 6: Stator broken down
Generator 7: Good condition
Generator 8: Good condition
Generator 9: Poor starter

The on-duty mechanic reported that problems with all generators are frequently encountered and complained about long delivery times.

Conclusion

No immediate action required.

Cement Mill plant EXMISA

Store for handling of clinker and aggregates

The condition of store and the underlying extracting devices must be said to be fairly good. If maintained properly, the plant can be operated without any supply of replacement parts.

Rotary drier (Pozzolana)

The condition of the oil preheater system for the boiler is critical. It will be almost impossible to recondition the system. The entire installation was purchased as a second hand facility and it comprises several different makes. It will be more than difficult to trace the makers and spare parts. Again, there is not any guarantee that the makers still exist.

The condition of the drier drum is also critical. However, intensified mechanical efforts will be required to restore the unit to full functionality. Reconditioning of the drive station (installed partially only) deemed necessary. The supporting rollers and live rings are extensively worn, and it will probably be necessary to turn off the supporting rollers and live rings.

In space between the furnace and the drier drum there is an air gap of approx. 50 - 100 mm; therefore, execution of seal is required. In view of the replacement cost of the unit, reconditioning would seem to be the proper solution.

Conclusion

Investments are made in a new oil preheater installation. Reconditioning of drier drum needed.

Elevators (2 units)

Still functioning, but the situation is critical. The mechanical performance level of the drive stations, dampers and associated screw conveyors is not satisfactory. On the silo roofs bits of screw sections were observed in dismantled state, which makes it impossible to fill all the compartments of the silos.

The screw conveyors are running without any bearing suspension, supported only by welded-on pieces of iron.

Conclusion

Spare parts needed for the conveyors in this plant department.

Extraction silos - mills (6 extractions)

The extractions are operative but their condition is critical. There are holes in the discharge channels, which are welded together with pieces of plate, with exposure to severe impacting in connection with material clogging, missing seals and, consequently, a drastic dust spill rate.

Conclusion

Lack of critical mechanical supervision, but serious efforts will be needed to rectify situation.

Mill No. 1

A visual disgrace and in extremely poor state of repair. (See enclosure No. 58).

Conclusion

Future spare parts supply for this mill anticipated.

Mill No. 2

Periodically inoperative because of defective Symetro gear unit. The mill appears to be in state of neglect, for instance the water injection system is in need of urgent attention, with substitution of defective valves, nipples and fittings.

Conclusion

If the mill is to meet the future production targets, it will be necessary to invest the necessary amount (DKK 3 mio) in the reconditioning of the Symetro gear unit.

Mill No. 3

The erection of the mill is not yet finalized. The erection was interrupted several years ago, but is now almost completed through deployment of the client's own personnel. The final stage of erection was completed without any supervision. In many places the types of bolts fitted are wrong, and elsewhere only every second bolt was inserted owing to the fact that the bolts originally supplied had disappeared during the intervening period.

The Dragpeb lining was improperly installed, but corrective action has been taken. The Dragpeb plates had not been grouted in place since no one seemed to know that this was essential.

No check has been made, but it is assumed that the drive station has been correctly aligned.

Conclusion

Assistance of mill specialist needed for overhaul of mills. In particular, an overhaul of mill 3 is recommended prior to start-up.

Electrostatic precipitator mill 3

The electrostatic precipitator for the mill has not been installed. The mill will go onstream without the precipitator installation. (Enclosure No. 59).

Some of the originally supplied parts for the precipitator are stored at the outdoor covered storage area. There are no electrical parts among the items since they have disappeared. The mechanical parts are scattered around or found in boxes half opened. The presence, through many years, of cattle wandering about at plant is evident.

Conclusion

The lack of respect for the parts now call for a thorough inspection of parts and renewed ordering of a major amount of high-cost equipment.

Screw conveyor mills - silos

The screw conveyors are working without problems, but it was ascertained that lids over the screw trough were missing; elsewhere the screw conveyors are covered by dust and dirt.

Conclusion

Lack of clean up and mechanical maintenance.

Extraction silos - packing plant

The location is very dirty and access is difficult due to missing lighting, high dust load and fear of the underlying open screw troughs.

Pipe system for silo aeration leaking with defective valves, pressure gauges etc.

Conclusion

Plant department in need of spare parts for the pneumatic equipment. Evaluation as to exact scope of supply to be made at later stage of time.

Packing plant (2 units)

Plant in miserable state of repair. At certain points the workplace involves occupational hazards. High dust concentration in the air due to absence of dedusting, open service silos and numerous leaks in the system.

Dedusting filter for packers exists but it is de--energized (Enclosure No. 60) given the absence of bags in the filter box.

Spill hopper under one packer is missing, with dust being dumped direct into the underlying storey.

Conclusion

It is quite apparent that the packer units are completely worn out and sustained in operation only thanks to the long standing experience of the operating personnel, acquainted with all the routines necessary to keep the packers operational. Spare parts and call-in of specialist required.

Bulk extraction

There are two bulk extractions at packing plant, but the system is partially destroyed and heavy dust spill occurs during operations.

Conclusion

Spare parts and mechanical supervision needed.

Main impression EXMISA

The plant is in state of disintegration. Lack of dynamic effort at plant. Assistance of a maintenance team dedicated to reconditioning of the installation is highly recommended.

6. Future Market Demands for Cement

6.a. Total Cement Consumption

The development of the cement consumption in Nicaragua during the recent 10 years is shown in enclosures Nos. 2 and 3. Since the revolution in 1979 the consumption has gradually increased to a maximum in 1987 of 295.863 t.

An estimate made by different government and international bodies shows an estimated increase of the consumption of 7% per year, when a solution has been found to the present war between Nicaragua and the Contras, ref. enclosure No. 62. Per capita consumption in the countries of Central America is shown in enclosure No. 63.

The present capacity of the San Rafael plant is at a run factor of 90%, which would be reasonable with proper management, maintenance and spares available, a total from kilns Nos. 2-5 of 328.000 t clinker per year. With the addition of 5% gypsum this amount of clinker correspond to a total of 345.000 t of cement per year.

According to the study mentioned, the cement consumption the first full year after peace would be about 300.000 t, with a yearly increase of about 21.000 t. This again means, that production of Portland cement from the present plant can only cover the demand for cement during the first 3 years after peace has been established in the country.

6.b. Puzzolanic cement

After erection of cement mill No. 3 at Exmisa, and after a rehabilitation of the total plant including Symetro drive of cement mill No. 2, a total production of puzzolanic cement from these 2 mills of 20 t/h would be reasonable. This corresponds to a yearly output of 140.000 t, at 7000 operating hours per year.

The puzzolanic cement made in the years 1983-1987 was produced with the addition of 35% of pumice. No investigations, however, were made on the optimum quantity of pumice and of the fineness of the product. These investigations should be carried out in the search for optimum efficiency.

With 35% pumice in the puzzolanic cement, full production of this type of cement from mills Nos. 2 and 3 will need 48.000 t of pumice. The maximum production of cement will be increased from 345.000 t to 393.000 t, covering the expected increase in consumption up to 5 years after peace.

The present drying capacity for pumice, however, is after a complete rehabilitation of the dryer installation only 5 t/h in average over the year, corresponding to 35.000 t of pumice or 100.000 t of puzzolanic cement. This again corresponds to 380.000 t of cement.

Installation of a high efficiency separator in connection with cement mill No. 3 would increase the output of puzzolanic cement to about 165.000 t, allowing the admixture of 57.000 t of pumice and a total yearly production of 402.000 t of cement. This equals the expected consumption in year 5-6 after peace in Nicaragua.

During the years 1983-1987 where puzzolanic cement was produced, only a total of 10.087 t was produced, and only for special purposes. Puzzolanic cement, however, will properly manufactured be a good product for general use. The market should already now be prepared for the acceptance of puzzolanic cement through product information, demonstrations, etc.

The production of puzzolanic cement should be resumed as soon as possible allowing a gradual introduction of this product on the market.

6.c. Bulk and bagged cement

In 1986 15,3% of the cement shipped was transported in bulk. In 1987 this percentage increased to 31.5%, an increase which has been maintained in 1988.

List of transport equipment available for bulk cement is shown in enclosure No. 64. Rehabilitation of the bulk loading facilities should be included in the next years' efforts.

7. Enclosures

1. Persons involved
2.-3. Cement Consumption in Nicaragua
4. Flow sheet of Cement Manufacture
5. Lay-out of Plant at San Rafael del Sur
6. Main Equipment at San Rafael del Sur
7. Map of San Rafael Region)
8. Map of Limestone Deposits) (at the end of the report after enclosure No. 64)
9. Analises of Limestone
10. Daily Data of Kiln Slurry
11.-19. Photos from Limestone Quarries, ref: Section 4a
20. Daily Analises of Clinker
21. Daily Analises of Cement
22. Physical Data on Mill Cement Type I
23. Physical Data on Cement Type I
24. Analises of Kiln Slurry
25.-33. Photos from San Rafael Plant, ref: Section 4a
34. Main Equipment and Data on Cement Deliveries, Exmisa Grinding Plant
35. Physical Data of Cement Type III and Puzzolanic Cement from Exmisa
36.-39. Photos from Exmisa Grinding Plant, ref: Section 4b
40.-55. Photos from San Rafael Plant, ref: Section 5
55.-61. Photos from Exmisa Grinding Plant, ref: Section 5
62. Estimated Future Cement Consumption in Nicaragua
63. Per Capita Cement Consumption in Central America
64. Cement Bulk Transporters in Nicaragua

Cement Industry of Nicaragua	Enclosure No. 1

Persons involved:

UNDP, Managua:	Orlando Olcese, UNDP resident Luis Correa, Programme officer
Ministry of Foreign Affairs:	Carmen Maria Lan, Director of Department Multilateral Cooperation Projects Rosaura Garcia, Vice director do do
Ministry of Industry, Trade and Economy:	Oscar Mendoza, Subgeneral director Planificacion Dien Garcia Fostre, Director de Inverciones Lazaro Cruz Jimenez, Presidente Junta Directiva Emp. Metalmecanica Fernando Velasques, President Matconsult and Cia Cementera. Mario Reye, Geologist, Empresa Servitec
Matconsult:	Sandra Salazar Sanches, General director Javier Mesa, Technical director Marco Cruz, Head of group of geologists Andres Rodrigues, Geologist (from Cuba) Gabriel Moraíes, Specialist building materials (UNIDO)
Companhia Nacional Productora de Cemento:	Rigoberto Ramos, Managing director Antonio Cruz, Director of production Mario Mandieta, Director of maintenance Ariel Dias, Director of mining Marcos Carballo, Head of laboratory Ramon Moncada, director Exmisa grinding plant Victor Manual Montoya, Head of erection team (Exmisa)

Cement Industry of Nicaragua	Enclosure No. 2

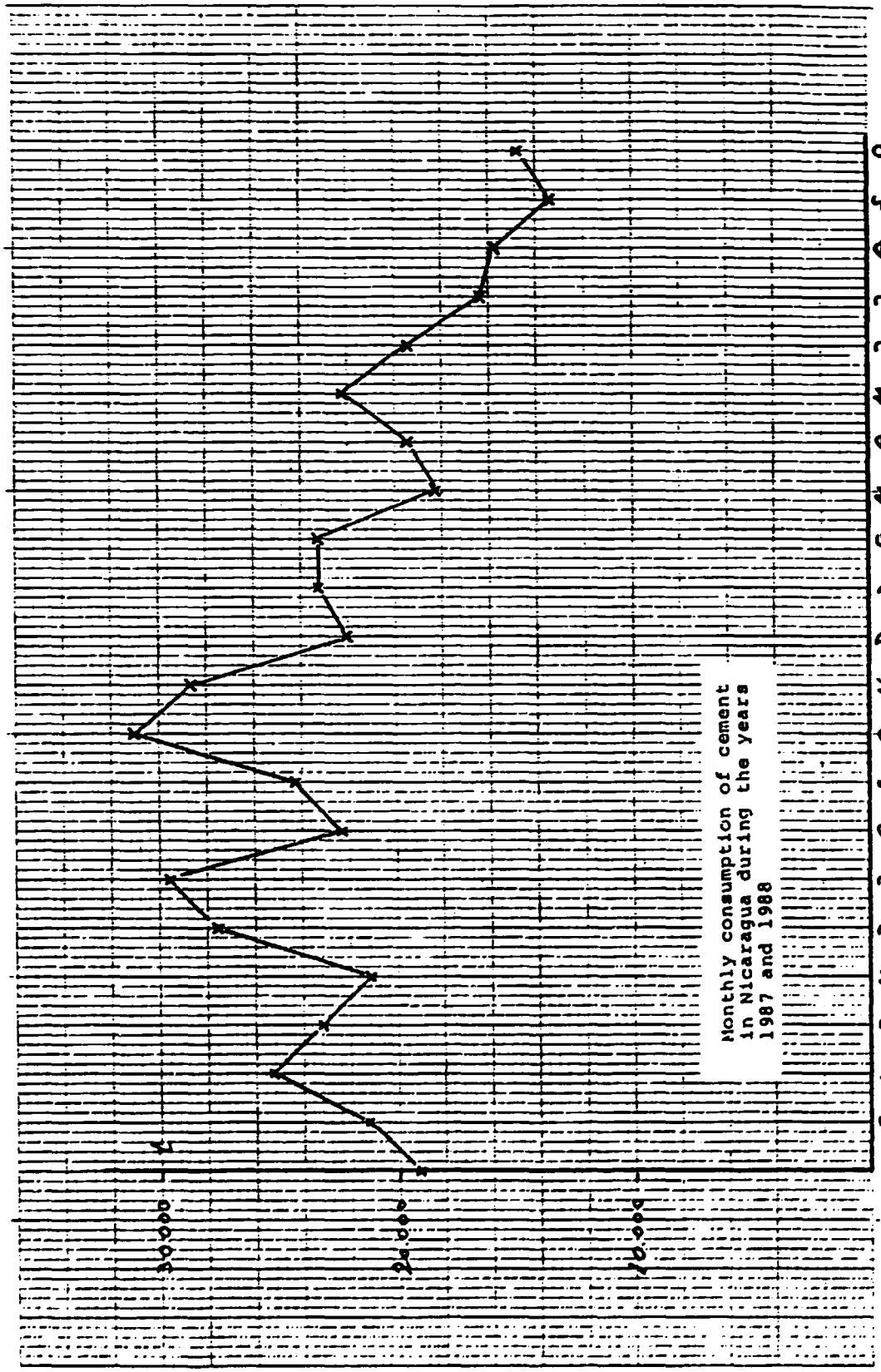
NICARAGUA

Cement Consumption

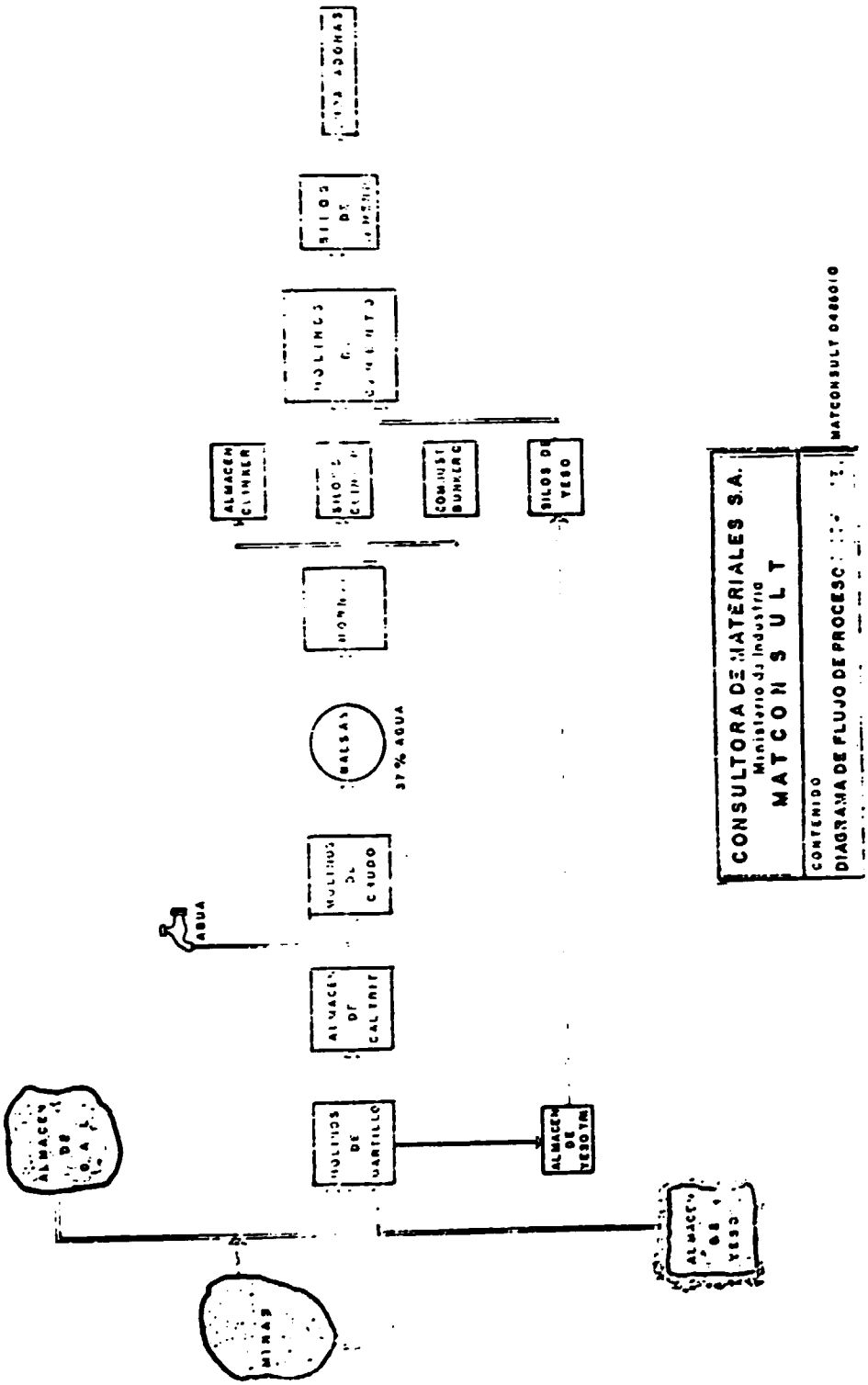
	Portland I	Portland III	Puzzolana	Total
1979				85.000
1980				154.700
1981				167.000
1982				165.200
1983	217.604	10.044	1.252	228.900
1984	273.012	2.755	2.233	278.000
1985	228.624	2.637	3.739	235.000
1986	277.221	7.355	1.355	285.931
1987	292.129	1.326	2.408	295.863
1988 x)	186.982	0	0	186.982

x) 01.01.88 - 31.10.88

Cement Industry of Nicaragua	Enclosure No. 3

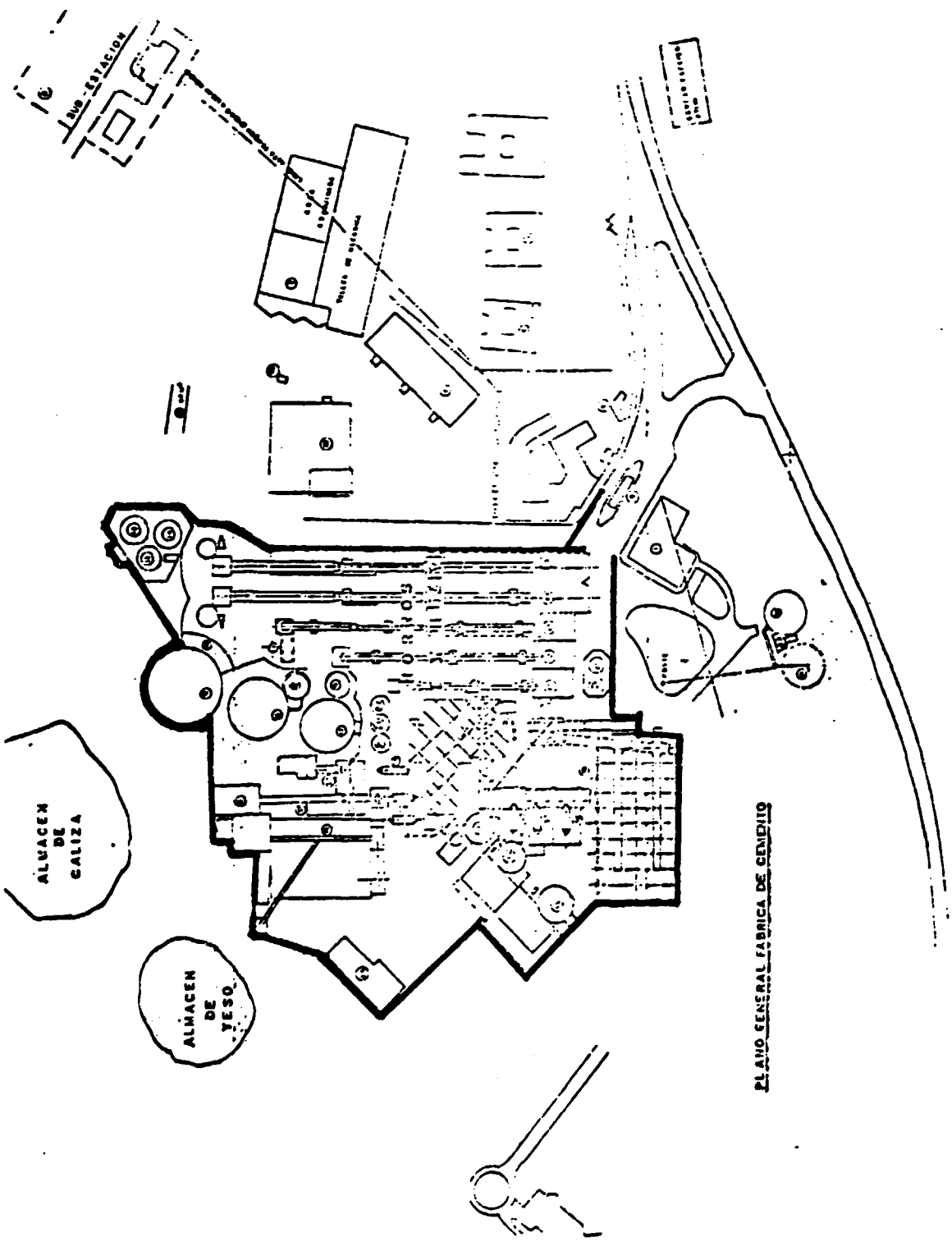


Cement Industry of Nicaragua	Enclosure No. 4



82.147

Cement Industry of Nicaragua	Enclosure No. 5



CAPACIDAD DE LA MAQUINARIA Y EQUIPO DE FABRICA DE CEMENTO

CUADRO No. 2

	DIMENSIONES METROS	POTENCIA H.P.	CAPACIDADES TON/DIA NOMINAL	TON/DIA PRACT.	TON/HORA PRACT.	TON/HORA TOTAL
A.- Molino de Martillo 2	1.200 x 800	2 x 40			30	
Molino de Martillo 3	1.600 x 1500	2 x 120			100	
						130
B.- Molino de Crudo 2	2.0 x 8.0	350			16	
Molino de Crudo 3	2.4 x 8.8	700			36	
Molino de Crudo 4	2.4 x 8.8	700			36	
Molino de Crudo 5	2.4 x 8.8	700			36	
						124
C.- Hornos 1	2.1 x 47		60	70		
Hornos 2	2.4 x 62		100	125		
Hornos 3	2.4 x 2.1 x 2.1 x 80		150	170		
Hornos 4	3.3 x 3.0 x 3.3 x 98		300	375		
Hornos 5	3.3 x 3.0 x 3.3 x 98		300	380		
						46.66
				Eliminando Horno 1 --		43.75
D.- Molino de Cemento 2	2.4 x 8.8	700			16	
Molino de Cemento 3	2.4 x 8.8	700			16	
Molino de Cemento 4	2.4 x 8.8	700			16	
						53.0
E.- Ensacadoras 2	12 Bocas	(1.800 Sacos/hora)			75	
Ensacadoras 3	12 Bocas	(1.800 Sacos/hora)			75	
						150.0

MATCONSULT

ANALISIS ZUIMICO A CALIZAS DE DIFERENTES CANTERAS EN EXPLOTACION (1980)

MINA	Sta. Rosa	K-2	Sn. Pedro	K-4	K-11	K-3	K-1	K-5
OXIDOS								
SiO_2	6.0	1.5	14.6	6.5	9.9	15.0	11.9	16.0
Al_2O_3	0.2	1.2	3.5	3.4	2.3	1.9	3.0	3.9
Fe_2O_3	1.2	0.4	3.2	1.0	0.9	1.3	1.7	2.1
CaO	49.0	52.6	13.8	49.0	47.7	43.0	44.2	42.2
P_2O_5	0.2	0.3	0.3	1.2	2.6	2.7	1.3	1.9
P.F.	12.8	12.7	34.0	38.9	35.6	33.0	34.2	23.5
$CaCO_3$	88.1	94.0	74.0	83.6	77.9	69.0	74.2	69.9

cc: Cro. Mario Mendieta
Archivo
Extra

Cement Industry of Nicaragua | Enclosure No. 10

COMPANIA NACIONAL PRODUCTORA DE CEMENTO

Mes de: Octubre 88 Pasta Balsa III

DIAS	SiO_2	Al_2O_3	Fe_2O_3	P_2O_5	CaO	SO_3	P. F.	R. I.	CaO Lib.	C_4AF	C_3A	C_2S	C_3S	FSC	M.H	M.S	M.A
1																	
2																	
3	13.7	2.9	1.4	1.2	45.2		34.6							104.1	2.4	2.9	1.5
4	14.1	2.7	2.1	1.3	43.9		34.4							99.9	2.3	2.9	1.3
5	14.0	2.4	2.0	1.3	44.4		34.2							103.2	2.4	3.2	1.2
6	13.7	2.2	1.9	1.4	44.[illegible]		34.8							104.3	2.5	3.3	1.2
7	13.6	2.6	1.9	1.3	43.7		34.7							103.6	2.4	3.0	1.4
8																	
9																	
10	14.3	2.8	1.7	1.3	44.3		34.2							96.6	2.4	3.2	1.7
11	14.4	2.5	1.9	1.3	44.6		34.3							[illegible]	2.[illegible]	3.3	1.3
12	14.5	2.9	1.9	1.2	43.6		34.3							91.5	2.3	3.1	1.5
13	14.6	2.9	1.9	1.3	44.4		34.1							97.9	2.3	3.0	1.6
14	14.4	2.6	1.9	1.3	44.2		33.8							99.4	2.3	3.2	1.4
15																	
16																	
17	14.1	2.6	1.9	1.3	43.2		34.5							98.4	2.3	3.1	1.4
18	14.1	2.4	2.0	1.3	43.6		34.5							99.9	2.4	3.3	1.2
19	13.9	2.5	2.0	1.3	45.1		34.0							104.3	2.5	3.1	1.3
20	14.1	3.1	1.9	1.3	43.6		34.6							98.5	2.3	2.9	1.6
21	14.0	2.1	1.9	1.2	44.2		34.6							101.6	2.4	3.5	1.1
22																	
23																	
24	14.2	2.6	1.9	1.2	43.9		34.4							99.9	2.4	3.2	1.4
25	13.8	2.4	1.9	1.2	44.3		34.3							104.1	2.5	3.3	1.3
26	13.7	3.0	2.0	1.1	43.7		34.7							103.4	2.4	3.2	1.5
27	13.4	2.1	1.9	1.2	44.5		34.9							108.9	2.6	3.3	1.1
28	13.8	2.2	1.9	1.2	43.5		34.7							102.4	2.4	3.3	1.2
29																	
30																	
31	14.3	2.4	2.0	1.2	43.5		34.4							95.4	2.3	3.2	1.2
MAX.																	
MIN.																	
PROM.	14.0	2.6	1.9	1.3	44.1		34.4							101.3	2.4	3.2	1.4
N																	
S																	

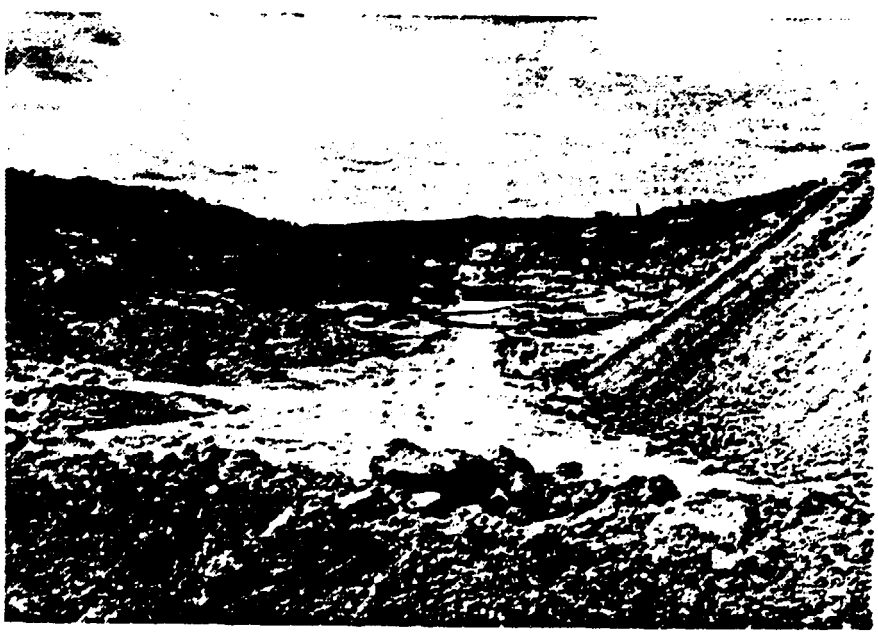
Cement Industry of Nicaragua	Enclosure No. 11

Limestone Quarry San Pedro

Limestone Quarry San Pedro - Removal of Overburden

Cement Industry of Nicaragua	Enclosure No. 12

Limestone Quarry K2



Limestone Quarry San Pedro

Cement Industry of Nicaragua	Enclosure No. 13

Limestone from Quarry San Pedro

Limestone from Quarry San Pedro

Cement Industry of Nicaragua	Enclosure No. 14

Limestone Quarry K2

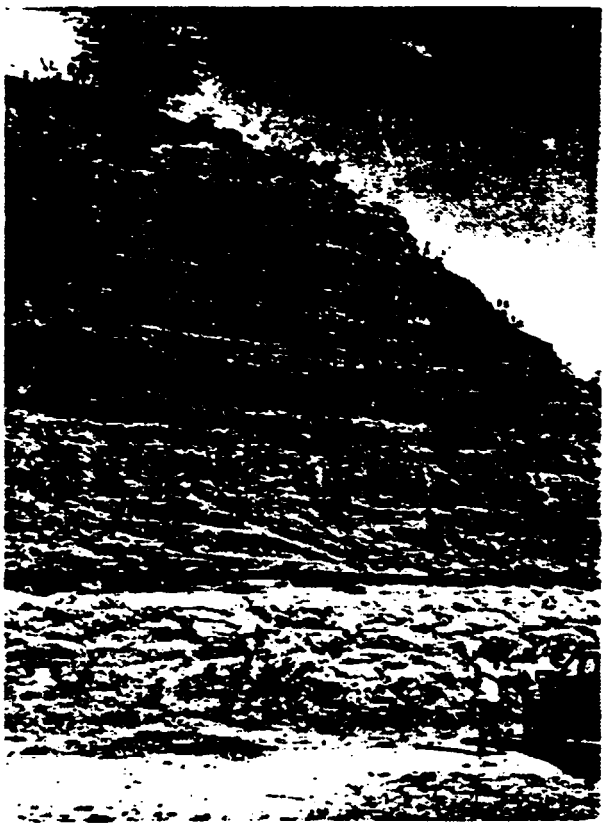
Limestone Quarry K1

Cement Industry of Nicaragua	Enclosure No. 15

Limestone Quarry K5

Limestone Quarry La California

Cement Industry of Nicaragua	Enclosure No. 16



Limestone Quarry La California
Limestone covered by silica rock and clayish overburden

Limestone Quarry La California

Cement Industry of Nicaragua	Enclosure No. 17

Limestone Quarry La California
Cuban geologist Andres Rodrigues

Limestone Quarry La California

Cement Industry of Nicaragua	Enclosure No. 18

Limestone Quarry La Campaña

Limestone Quarry Santa Rosa

Cement Industry of Nicaragua	Enclosure No. 19

Limestone Quarry K11

Limestone Quarry K11

Cement Industry of Nicaragua	Enclosure No. 20

COMPANIA NACIONAL PRODUCTORA DE CEMENTO

Mes de: Octubre 85 Clinker V

DIAS	SiO2	Al2O3	Fe2O3	P2O5	CaO	SO3	P.F.	R.I.	CaO Lib.	C4AF	C3A	C2S	C3S	FSC	M.H	M.S	M.A
1																	
2	21.3	4.7	2.9	1.7	66.1		0.6		1.5	8.8	7.5	12.4	64.5	98.3	2.3	2.9	1.6
3																	
4	20.6	4.4	3.0	1.8	64.1		0.8		1.4	9.2	6.1	4.3	72.9	100.9	2.4	2.8	1.5
5																	
6	21.7	4.4	3.1	1.6	66.1		1.5		1.3	9.4	6.3	14.5	63.4	97.3	2.3	2.9	1.4
7																	
8																	
9																	
10	20.8	4.6	2.8	1.9	65.4		0.4		1.0	8.6	7.3	6.3	72.2	100.5	2.3	2.8	1.6
11																	
12	21.4	4.9	2.8	1.9	65.1		0.2		1.5	8.6	8.1	11.3	57.7	96.6	2.2	2.8	1.7
13	22.0	5.3	2.8	1.9	64.7		1.0		1.5	8.6	9.4	25.6	56.0	92.6	2.1	2.7	1.9
14																	
15																	
16	22.1	5.3	2.8	1.7	65.4		0.4		1.4	8.6	9.3	24.1	52.3	93.3	2.2	2.7	1.9
17																	
18	21.2	4.5	3.0	1.8	65.4		0.2		1.5	9.2	6.6	10.3	66.4	99.1	2.3	2.8	1.5
19																	
20	21.6	4.5	3.0	1.7	65.7		0.4		1.5	9.2	6.9	10.0	66.8	99.3	2.3	2.8	1.5
21																	
22																	
23																	
24	20.7	4.3	2.8	1.7	65.5		0.6		1.3	8.6	6.5	7.7	71.4	101.8	2.4	2.9	1.5
25																	
26	20.8	4.2	3.0	1.7	65.7		0.9		1.9	9.1	6.1	7.5	69.0	101.5	2.4	2.9	1.4
27																	
28																	
29																	
30	21.0	5.0	3.9	1.6	64.9		0.8		1.5	8.9	8.3	14.8	60.4	97.3	2.2	2.7	1.7
31	22.2	5.0	2.9	1.7	65.4		0.4		1.3	8.9	8.2	22.6	54.5	93.5	2.1	2.8	1.7
MAX.																	
MIN.																	
PROM.	21.3	4.7	2.9	1.7	65.4		0.5		1.5	8.9	7.6	13.4	63.3	97.8	2.3	2.8	1.6
N																	
S																	

82.147

Cement Industry of Nicaragua	Enclosure No. 21

COMPANIA NACIONAL PRODUCTORA DE CEMENTO

Mes de: Octubre 88 Granel

DIAS	SiO_2	Al_2O_3	Fe_2O_3	P_2O_5	CaO	SO_3	P.F.	R.I.	CaO Lib.	C_4AF	C_3A	C_2S	C_3S	FSC	M.H	M.S	M.A
1																	
2																	
3	19.8	5.4	2.5	1.8	64.1	2.1	1.5	0.8	1.8	7.7	11.6	14.3	56.7	97.5	2.3	2.5	2.1
4																	
5	19.9	4.9	2.5	1.7	63.9	1.8	1.8	1.2	1.9	7.6	7.7	11.7	60.1	99.3	2.3	2.6	1.7
6																	
7																	
8																	
9	19.3	4.4	2.8	1.9	65.6	1.7	1.4	1.2	2.2	8.6	7.0	6.8	72.9	100.2	2.5	2.2	1.6
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17	20.4	4.7	3.0	1.7	64.0	1.8	1.2	0.4	1.9	9.1	7.5	15.4	51.6	92.1	2.3	2.7	1.6
18																	
19	20.7	4.6	2.8	1.7	64.9	2.1	1.4	0.6	1.9	8.6	7.5	16.2	52.5	97.0	2.3	2.9	1.6
20																	
21																	
22																	
23	20.1	5.1	2.7	1.7	64.2	2.2	1.0	0.6	1.9	8.2	9.0	14.5	57.1	98.0	2.3	2.6	1.9
24																	
25	19.8	3.9	2.9	1.6	63.5	1.9	1.6	0.4	2.2	8.7	5.5	22	65.2	100.4	2.4	2.9	1.4
26																	
27	19.8	4.9	2.5	1.6	64.9	2.1	1.0	0.4	2.0	7.6	7.9	9.3	63.0	100.9	2.4	2.7	2.0
28																	
29																	
30																	
31																	
MAX.																	
MIN.																	
PROM.	20.0	4.7	2.8	1.7	64.4	2.0	1.4	0.7	2.0	8.4	7.9	11.5	60.9	99.0	2.4	2.7	1.7
N																	
$																	

82.147

Cement Industry of Nicaragua | Enclosure No. 22

[illegible]
PRODUCTORA DE CEMENTO

REPORTE MENSUAL DE CEMENTO

MES DE: OCTUBRE _____ AÑO: 1,988

CEMENTO MOLINOS

DIA	FINURA		EXP.	F. FRAG.		CONSISTENCIA	COMPRESIONES				CEMENTO
	BLAINE	RESD 200	AUTO CLAVE	INICIAL	FINAL		1 DIA	3 DIAS	7 DIAS	28 DIAS	MOL. No.
1											
2	2,970	8.0	+0.11	240	3.45	23.6	950	2,250	3338	5650	Promecio 2 Dias
3	2,990	7.5	+0.02	235	3.35	23.6	860	2,350	3530	6380	Molino
4	No se hicieron ensayos muy poca melienca.										
5	2,970	9.0	+0.05	300	3.50	23.4		2200	3880	5920	Molinos
6	2,980	8.5	+0.13	225	3.20	23.4		2180	3190	5450	"
7											
8	3,090	7.0	+0.11	245	3.35	23.8	750	2350	3,810	5,520	Promedio M.
9	Molino parado Silos Llenos										
10	2,960	8.0	+0.12	225	3.15	23.4	730	2.060	3,020	5,820	Molino
11	3,020	8/5	+0.18	250	3.50	23.4	770	--	2,690	5,060	"
12	3,010	8.5	+0.19	300	4.10	23.4		1,930	2,790	5,910	"
13	2,980	8.0	+0.02	315	4.20	23.6		1,860	2,760	5,060	"
14											
15	2,970	7.5	+002	230	3.40	23.8	730	1,310	2,920	5,520	Promedio
16	Molino parado.										
17	3,150	6.5	+013	245	3.50	24.6	750	1,980	3,060	5,660	Molino
18	3,120	70	+015	250	3.45	24.8	770		2,880	5,910	"
19	3,190	60	+016	250	3.50	25.2		2,280	3,580	6,060	"
20	3,230	5.5	+009	235	340	25.0		2,310	3,390	5,990	"
21											
22											
23	2,900	8.5	+012	305	4.10	23.4	780	2,150	2,950	5,960	Promecio
24	3,480	6.0	+024	320	4.15	24.8	1,030	2,180	3,320	6,320	Molinos
25	2,800	8.0	+0.36	255	3.45	23.6	860		3,040	5,820	"
26	3,130	7.0	+014	235	3.40	24.8		2,480	3,770	6,830	"
27	3,060	7.5	+013	240	3.45	24.4		2,380	3,590	5,870	"
28											
29											
30	3,170	6.0	+ 002	240	3.30	24.6	730	1,980	2,810	5,770	M. Promecio
31											
MX.	3,230	9.0	0.036	3.20	4.20	25.2	10.30	2,480	3,810	6,530	
IN.	2,800	5.5	0.02	2.25	3.15	23.40	7.30	1,810	2,690	5,060	
ROM.											
N											
S											

Cement Industry of Nicaragua	Enclosure No. 23

NICARAGUA

San Rafael Plant

Average 1988

		ASTM 150 Type I
Blaine surface	3015 cm^2/g	(2800)
Residue + 90 my	8.2%	-
ASTM		
Compressive strength		
1 day	890 psi	-
3 days	2180 psi	(1800)
7 days	3250 psi	(2800)
28 days	5730 psi	-
Setting time		
Initial	2h25	(1h00)
Final	3h30	(10h00)
Analises		
SiO_2	20,3 %	
Al_2O_3	5,10%	
Fe_2O_3	2,85%	
CaO	64,2 %	
P_2O_5	1,52%	
SO_3	1,90%	
Free CaO	1,80%	
Loss on Ignition	1,67%	
Insoluble Residue	0,68%	
Autoclave expansion	0,15%	(0,80)

Cement Industry of Nicaragua	Enclosure No. 24

F.L. SMIDTH & CO. A/S
COPENHAGEN

CHEMICAL ANALYSES.

DATE: 17/ 1-1989
NO. 890002
Encl 1

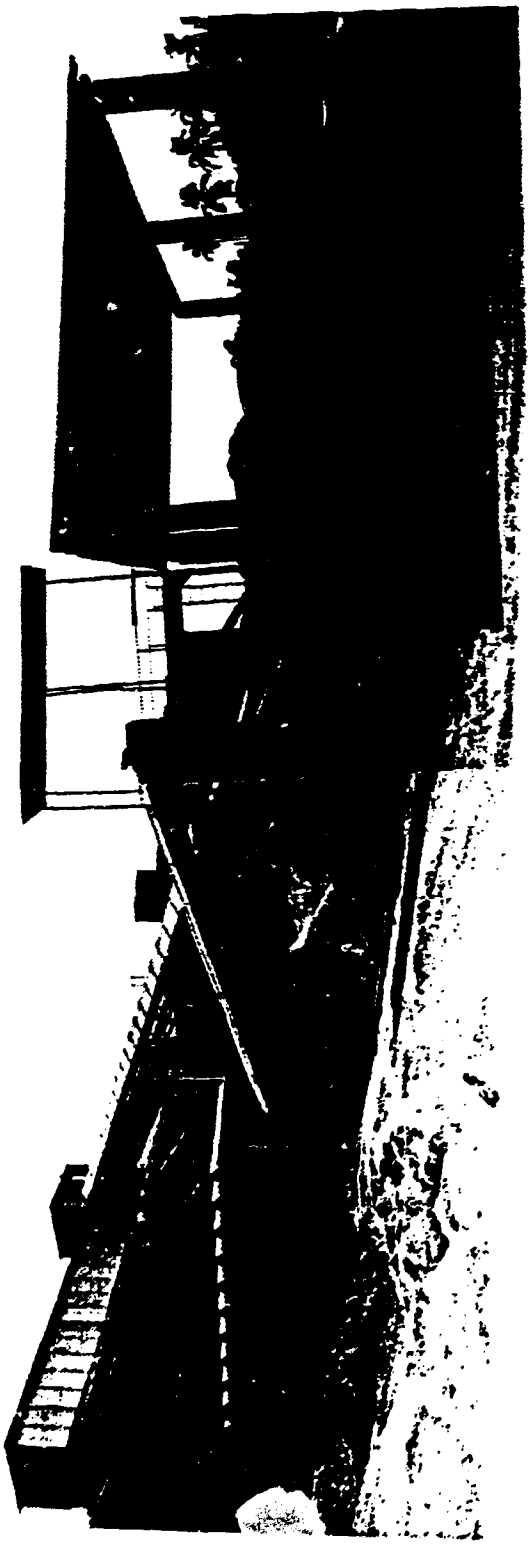
Plant: NAC. MANAGUA, NICARAGUA
Samples received: January 3, 1989
References:

	Sample	% H2O
M 1	Pasta seca Balsa nr. III	

ANALYSES		M 1
Titr.	%	
CaCO3	%	
MgCO3	%	
SiO2	%	13.6
Al2O3	%	3.85
Fe2O3	%	1.71
CaO	%	44.0
MgO	%	1.00
Mn2O3	%	.05
TiO2	%	
P2O5	%	1.15
K2O	%	.20
Na2O	%	.11
SrO	%	.06
SO3	%	
Loss on ign.	%	33.7
TOTAL	%	99.43
Free lime	%	
Inso. residue	%	
Cl-	%	.002
Stot	%	.0
F-	%	.11
Cr2O3	PPM	
	%	
	%	
	%	
	%	
Ms		2.5
Ma		2.3
LSF		101.
C3S	%	
C2S	%	
C3A	%	
C4AF	%	
C2F	%	
CaSO4	%	
Free lime	%	

PH

Cement Industry of Nicaragua	Enclosure No. 25



Limestone Store and Crushed Gypsum

Cement Industry of Nicaragua	Enclosure No. 26

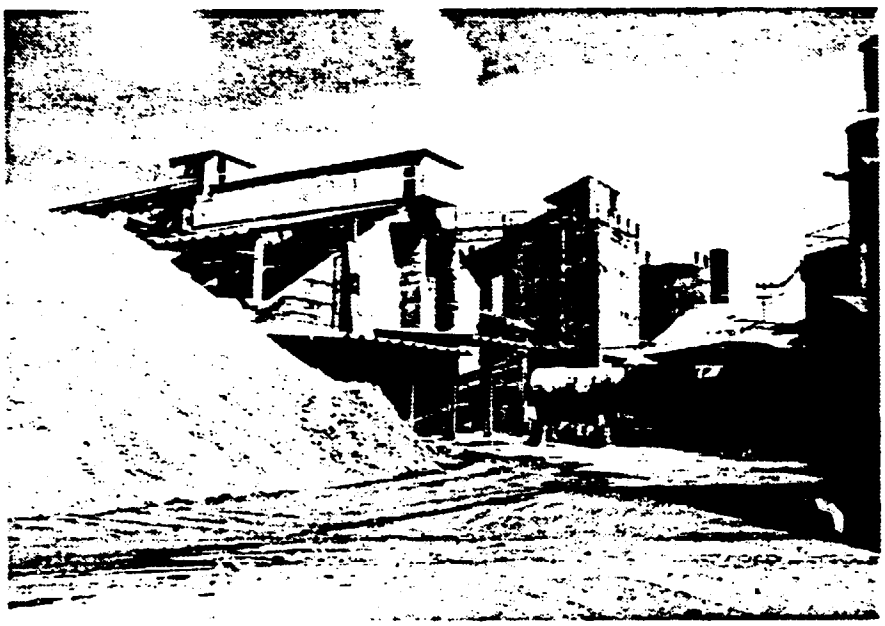
Limestone Store

Cement Industry of Nicaragua	Enclosure No. 27

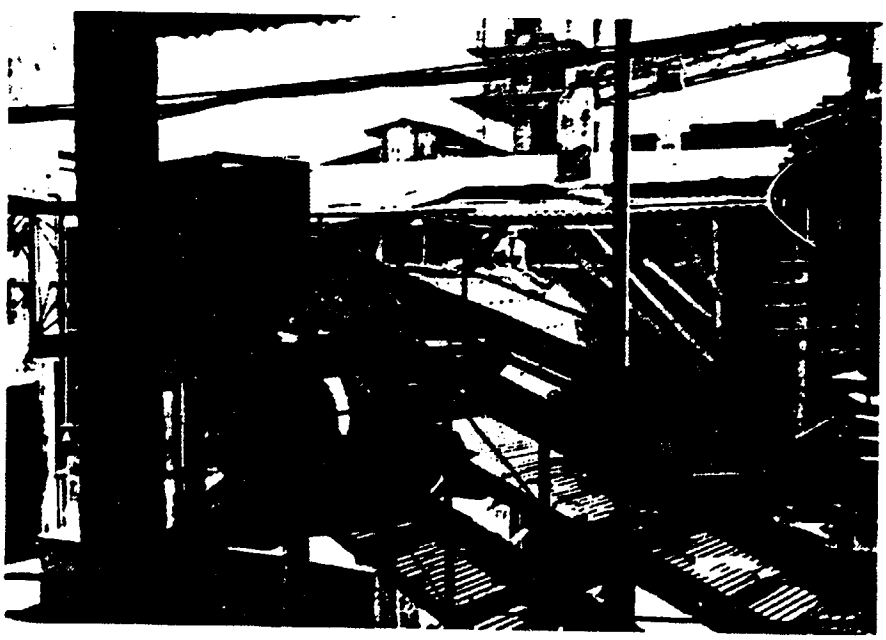
Clinker Stored Outdoors

Clinker Stored Outdoors

Cement Industry of Nicaragua	Enclosure No. 28

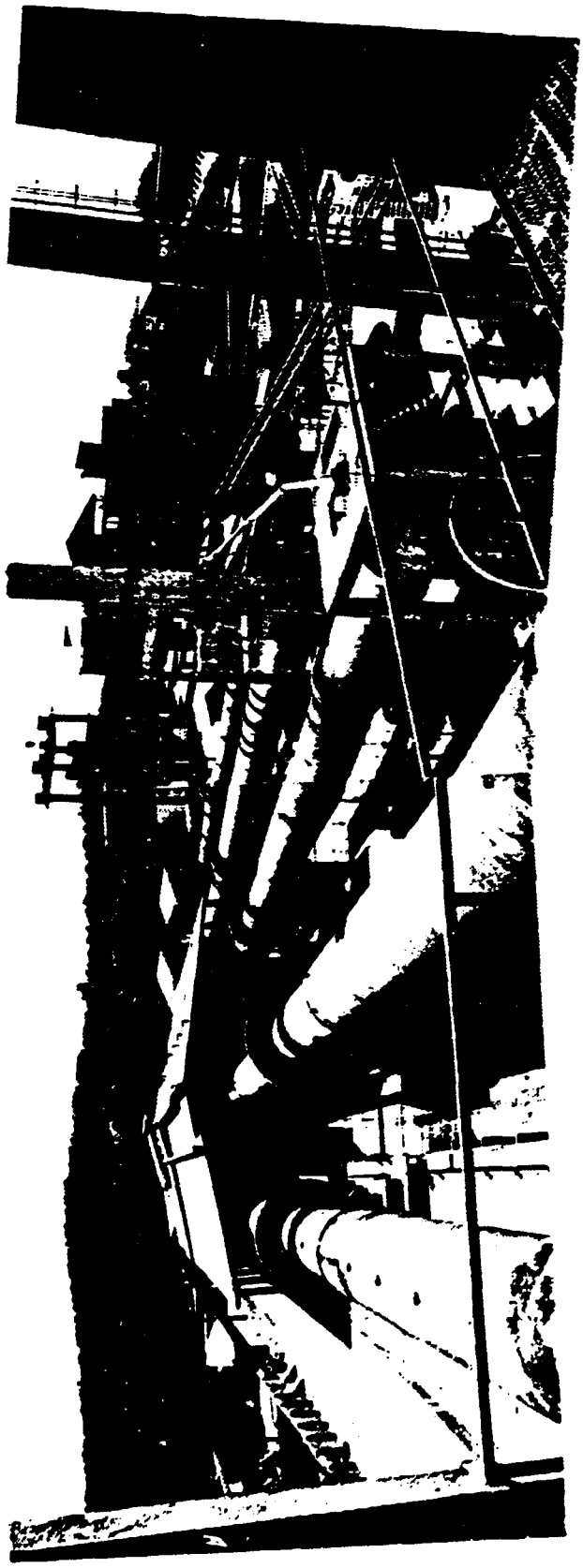


Limestone Store and Slurry Mills



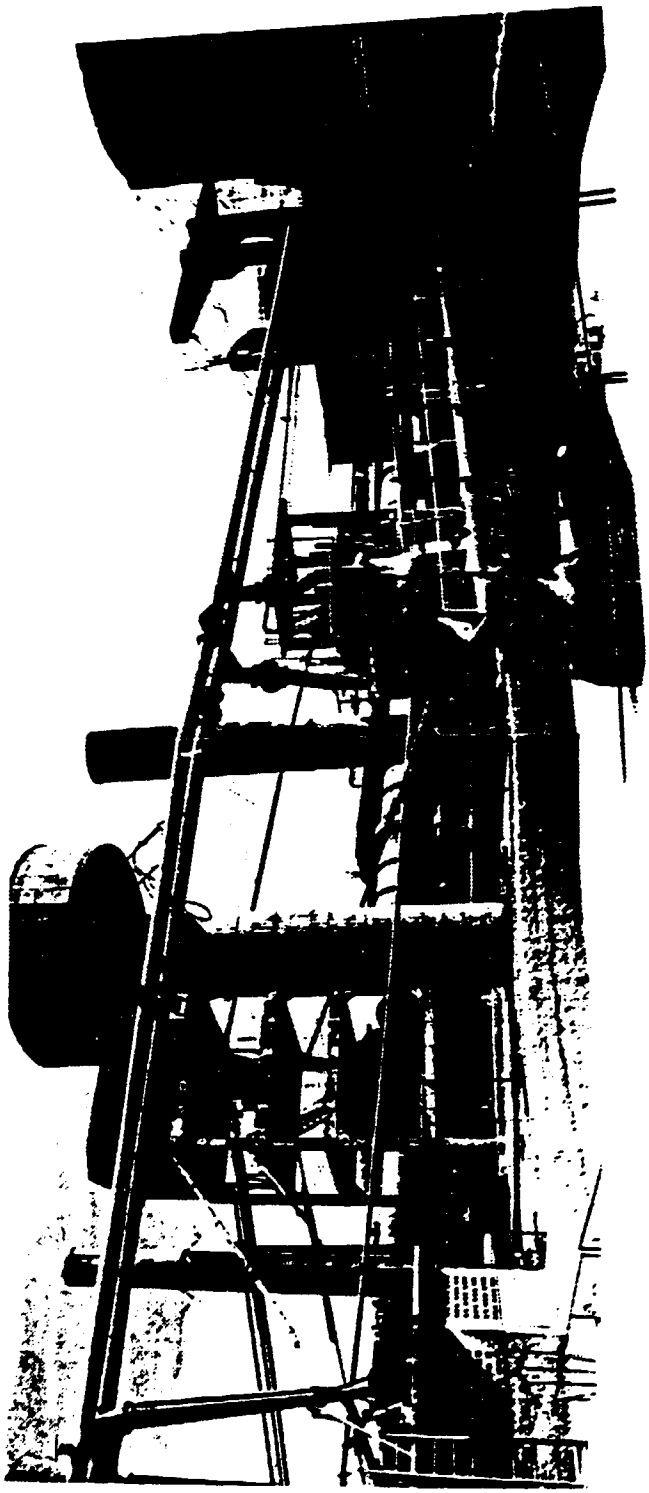
Limestone Feeder for Slurry Mill

Cement Industry of Nicaragua	Enclosure No. 29



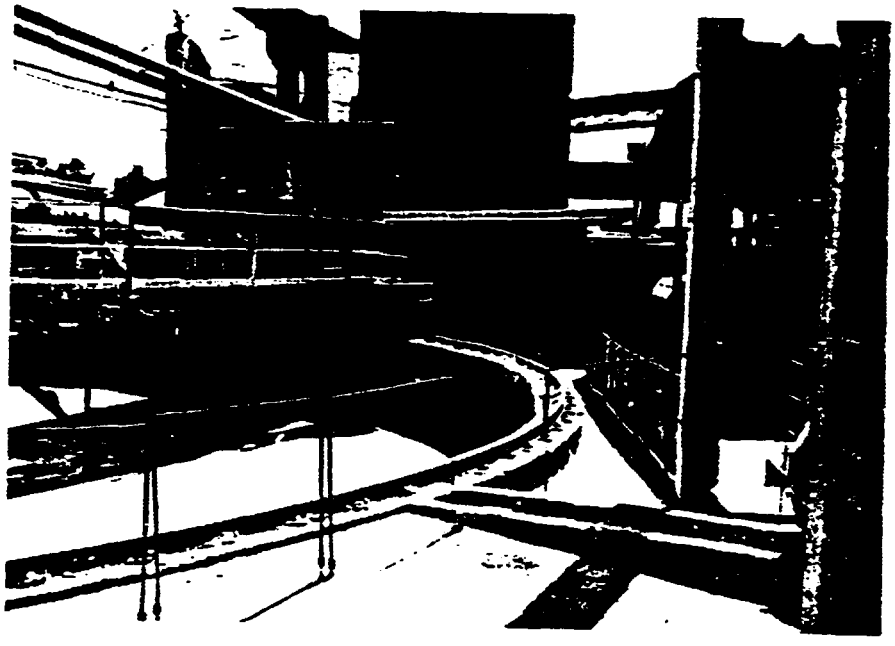
Cement Plant San Rafael del Sur

Cement Industry of Nicaragua	Enclosure No. 30



San Rafael del Sur Cement Plant

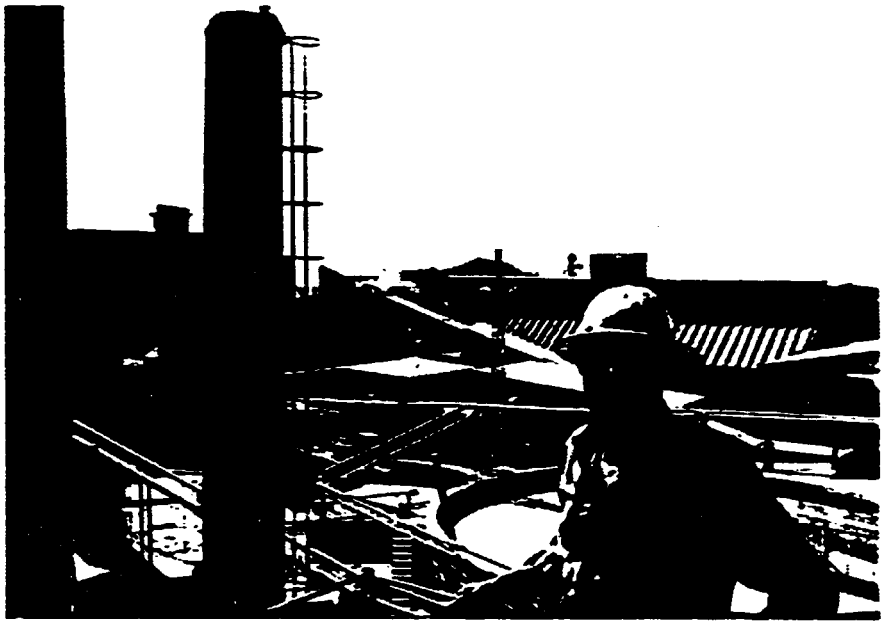
Cement Industry of Nicaragua	Enclosure No. 31



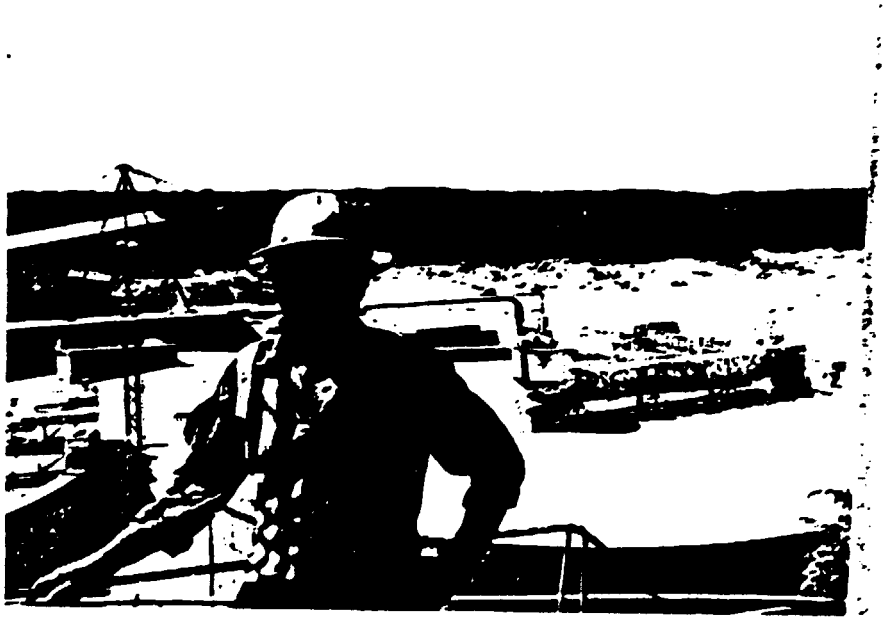
Slurry Basin, Raw Mills and Old Raw Materials Silos

Store of Uncrushed Limestone Sweetener

Cement Industry of Nicaragua	Enclosure No. 22

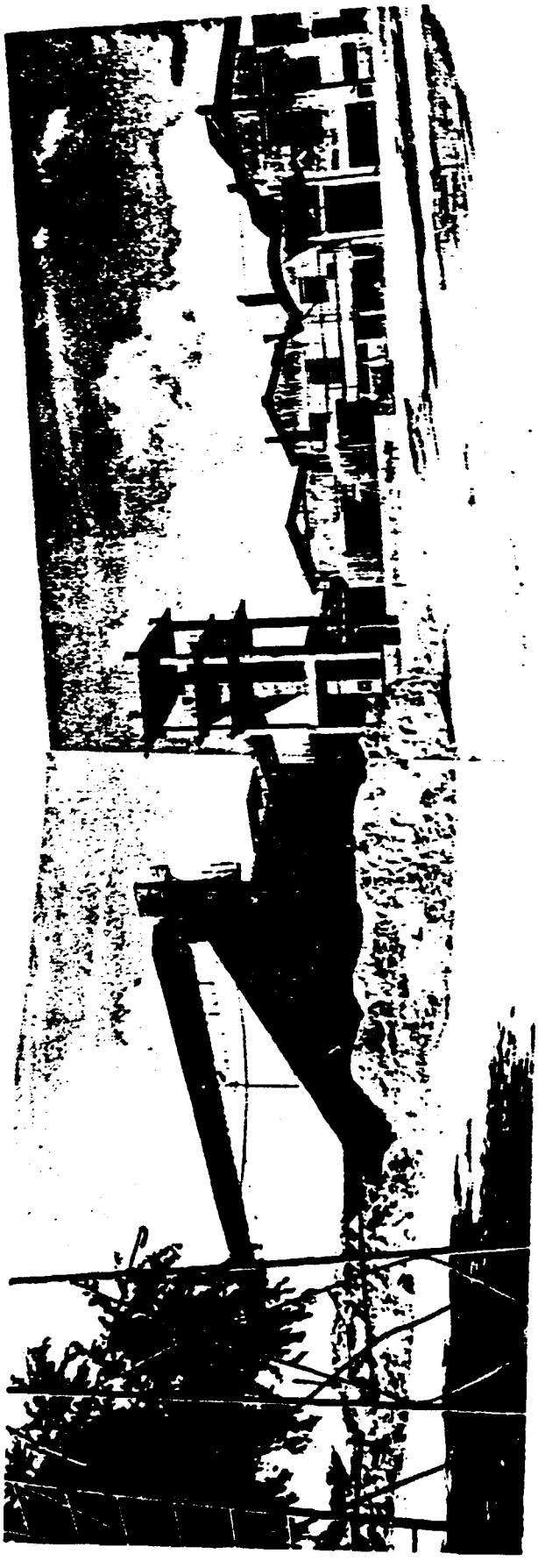


Limestone Store, Slurry Basin, Raw Mills
Production Director Antonio Cruz



Slurry Basin, Limestone Quarry #1

Cement Industry of Nicaragua	Enclosure No. 33



Clinker Store, Kiln House

Cement Industry of Nicaragua	Enclosure No. 34

EXMISA Grinding Plant

Mill No.	Dimension	Motor size
1	15 x 7,2	200 HP ~ 150 kW
2	21 x 11,2	690 HP ~ 515 kW
3	24 x 8,8	700 HP ~ 520 kW

Output Capacities

Mill No.	Portland type I	Portland type III	Puzzolanic
1	5 t/h	3 t/h	3 t/h
2	14 - 15 t/h	8 - 9 t/h	9 - 10 t/h
3	14 - 15 t/h	8 - 9 t/h	9 - 10 t/h

Shipments of Cement

	Portland I	Portland III	Puzzolanic	Total
1983	4.074	10.044	1.252	15.370 t
1984	12.487	2.755	2.233	17.475 t
1985	10.762	2.637	3.739	17.138 t
1986	19.151	7.355	1.355	27.861 t
1987	36.627	1.326	2.408	40.361 t
1988 x)	21.880	0	0	21.880 t

x) 01.01.88 - 31.10.88

Cement Industry of Nicaragua	Enclosure No. 35

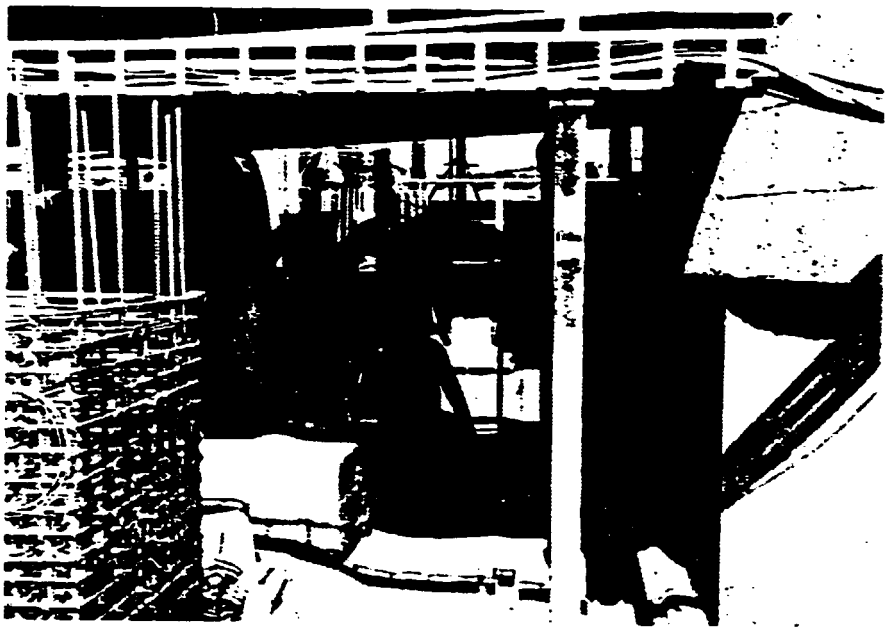
NICARAGUA

EXMISA Grinding Plant

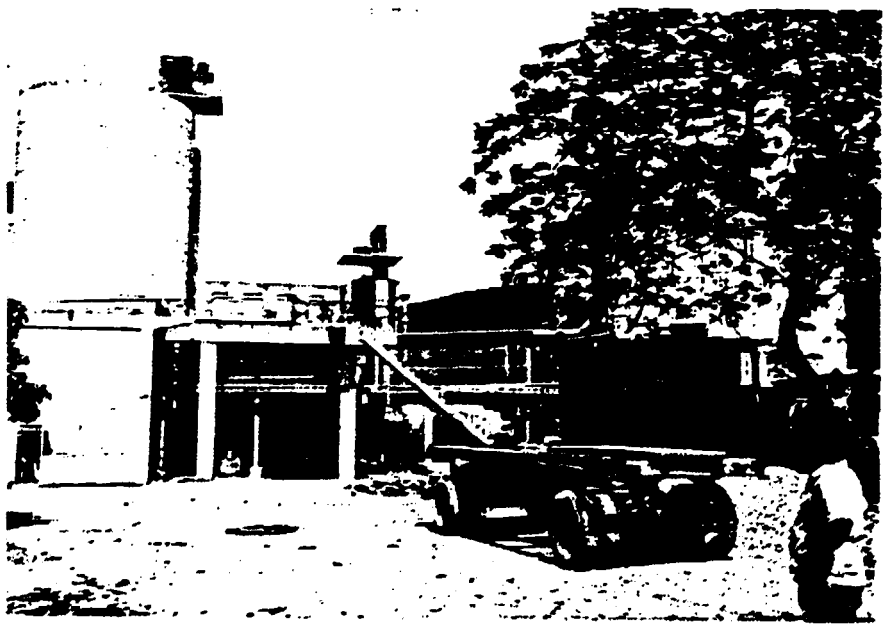
Puzzolanic cement 1987		ASTM 595 Type IP
Blaine surface	3780 cm^2/g	-
Residue + 90 my	1,9 %	-
ASTM Compressive strength		
1 day	725 psi	-
3 days	2030 psi	(1800)
7 days	2980 psi	(2800)
28 days	5520 psi	(3500)

Rapid hardening cement 1987		ASTM 150 Type III
Blaine surface	-	-
Residue + 90 my	2,3 %	-
ASTM Compressive strength		
1 day	1780 psi	(1800)
3 days	3170 psi	(3500)
7 days	4070 psi	-
28 days	6300 psi	-
Autoclave expansion	-	(0,80)
Setting time		
initial	1h 45m	
final	3h 00m	

Cement Industry of Nicaragua	Enclosure No. 36

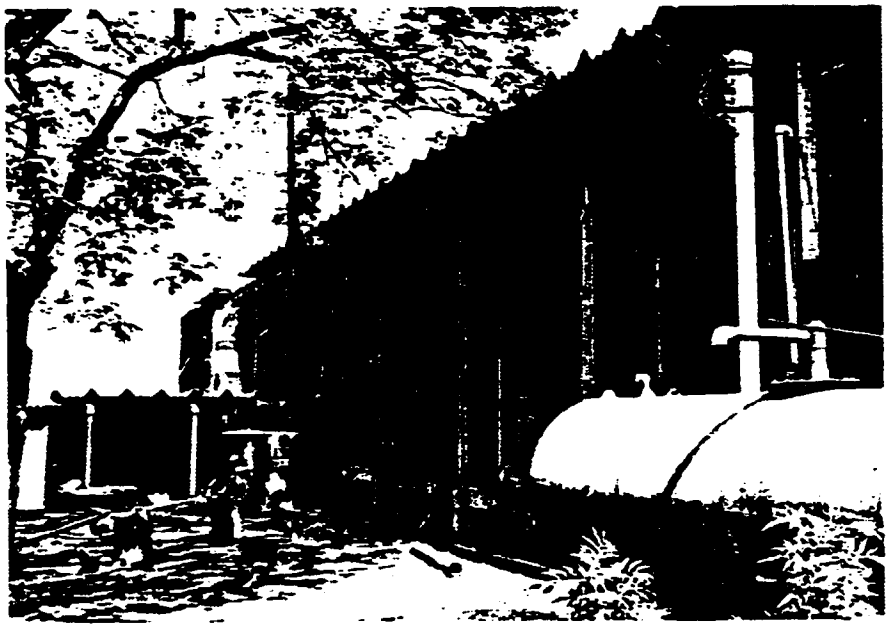


Exmisa. Feed Arrangement for Cement Mill No. 2



Exmisa. Cement Silos, Cement Mill No. 2.
and Silos for Clinker, Gypsum and Puzzolana

Cement Industry of Nicaragua	Enclosure No. 37



Exmisa. Drying Drum for Puzzolana

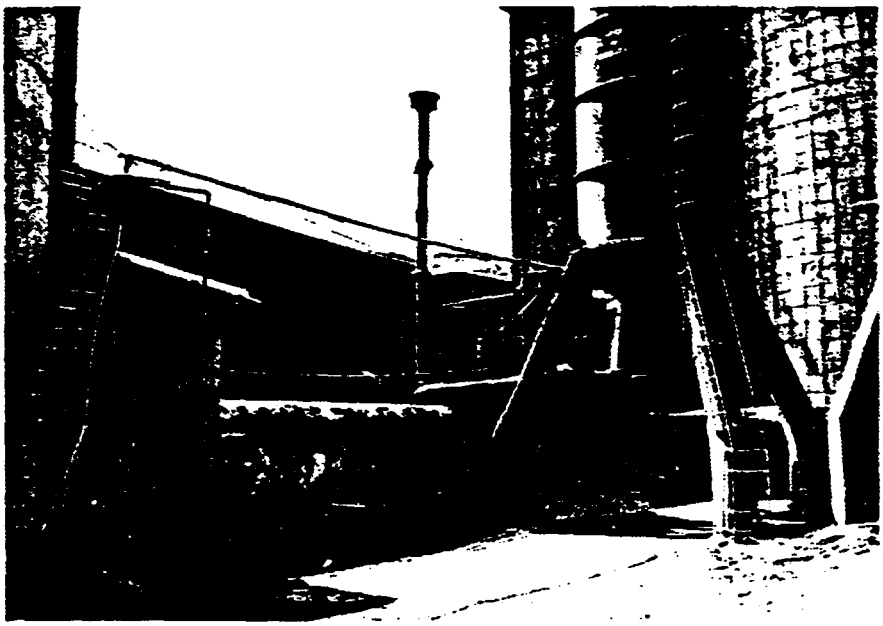
Exmisa from Road to Chiltepe

Cement Industry of Nicaragua	Enclosure No. 38

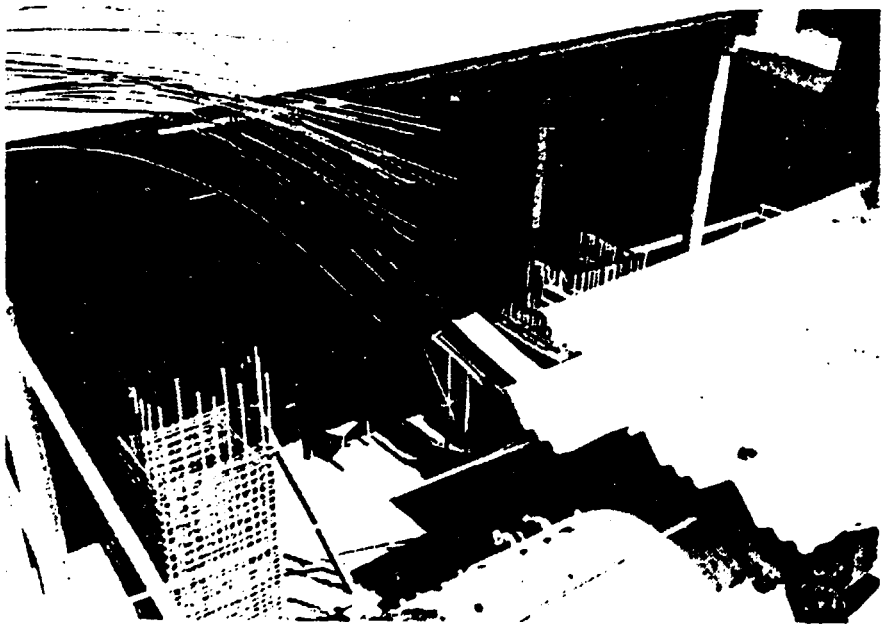
Pumice Deposit Chiltepe

Exmisa. Cement Mills No. 1 and No. 3.
Silos for Rapid Hardening Cement

Cement Industry of Nicaragua	Enclosure No. 39

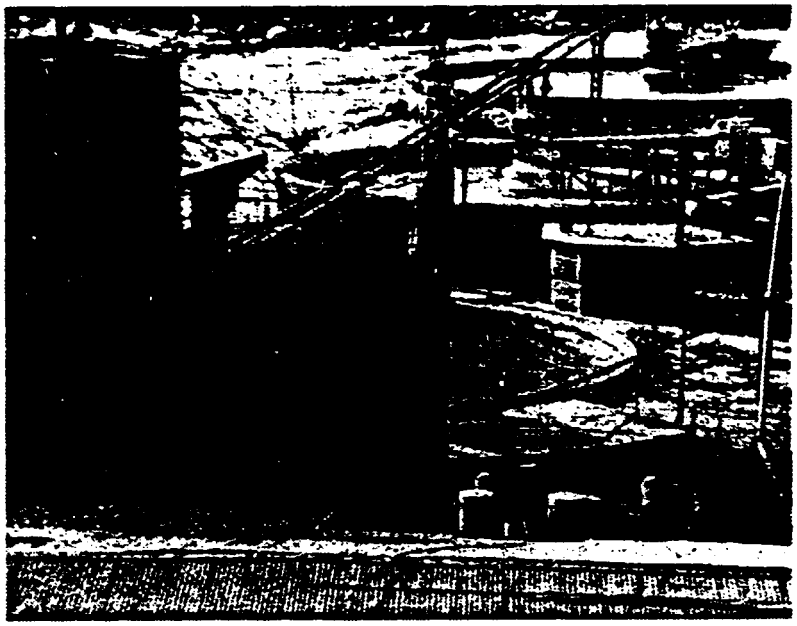


Exmisa. Cement Mill No. 1 and Silo
for Rapid Hardening Cement

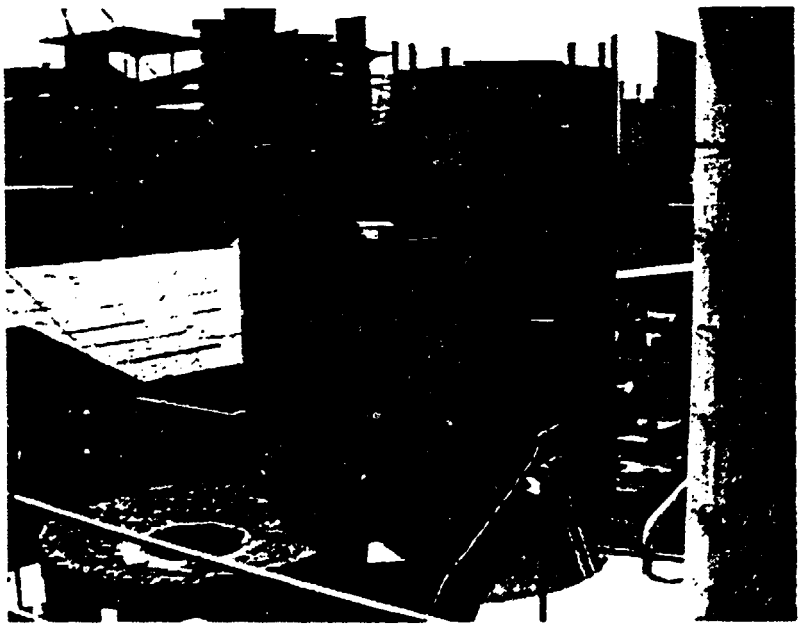


Exmisa. Cement Mill No. 3

Cement Industry of Nicaragua	Enclosure No. 4c

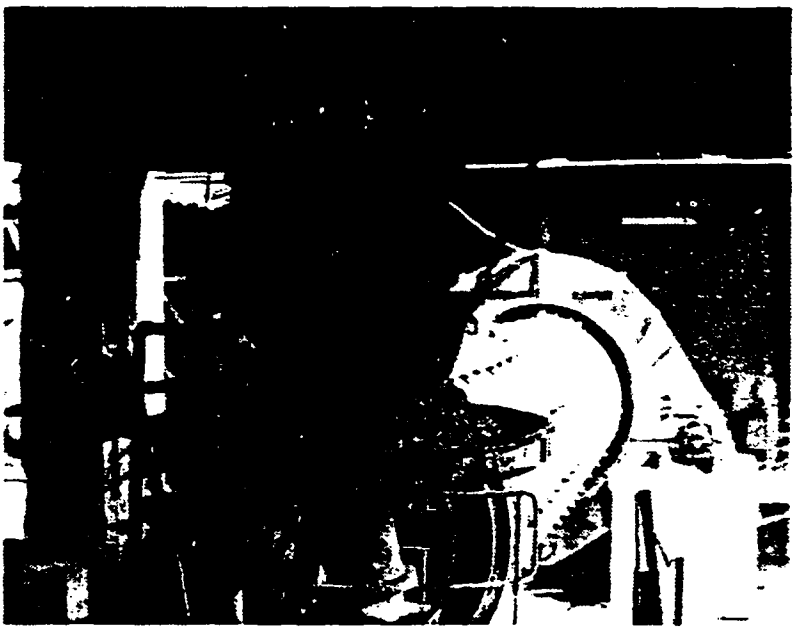


In the background, the three existing slurry basins
In the foreground, disused raw material siloes.



Disused silos. In the background, the cement mill department

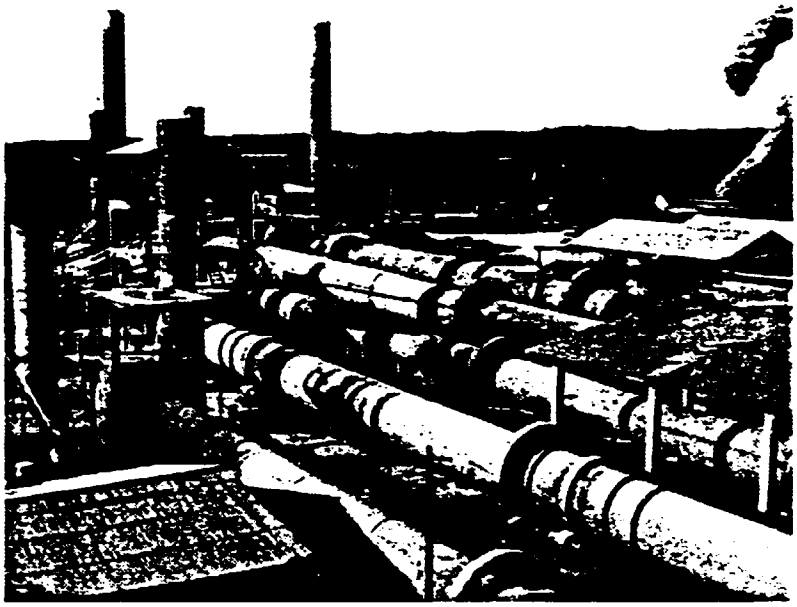
Cement Industry of Nicaragua	Enclosure No.41



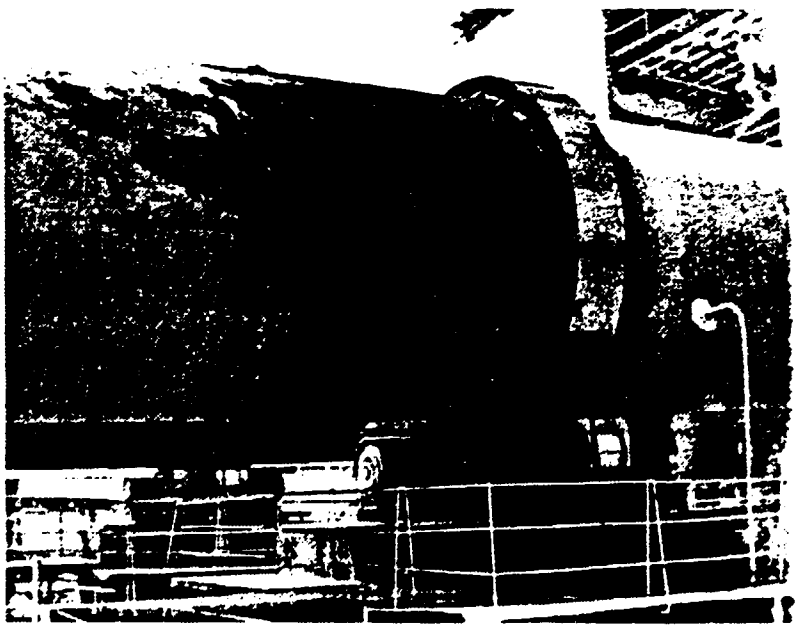
Raw mill.

Fan motor with cover.

Cement Industry of Nicaragua	Enclosure No. 42

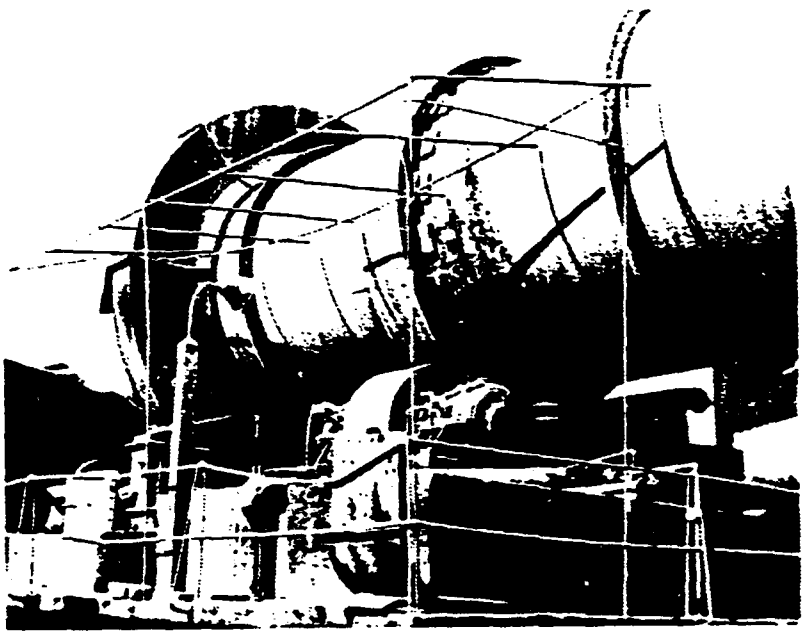


The five kilns of the plant - kiln no.1 in the foreground.



Kiln no. 5, support.

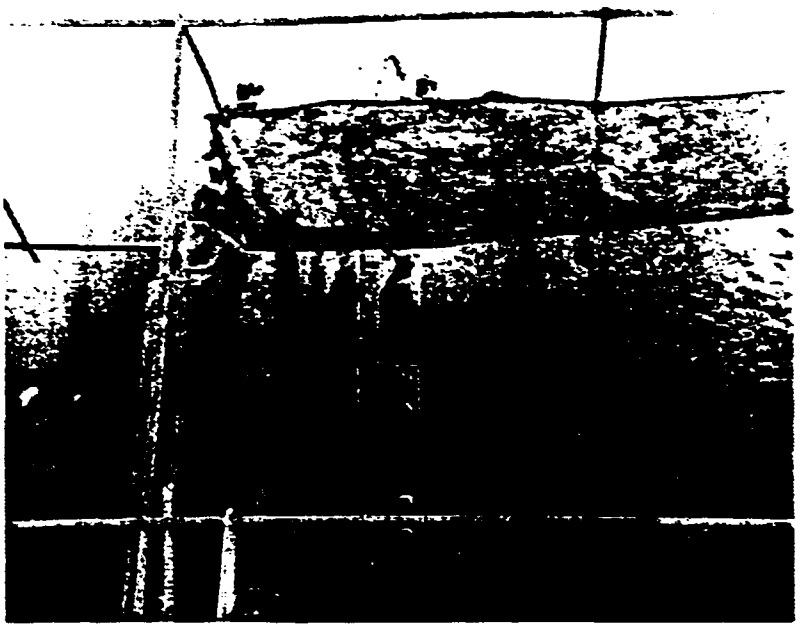
Cement Industry of Nicaragua	Enclosure No.43



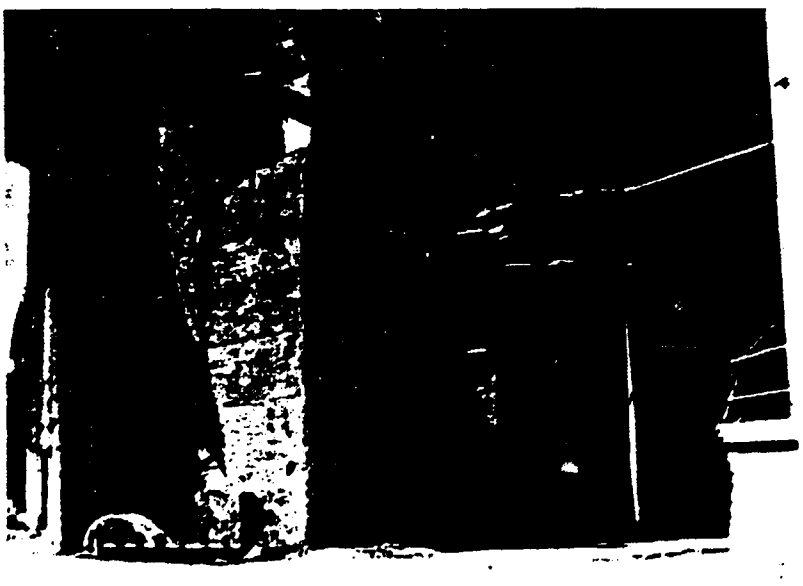
Kiln no. 2, support no. 2.

Kiln no. 2, support no. 2.

Cement Industry of Nicaragua	Enclosure No.44



Kiln no. 3, support no. 2.



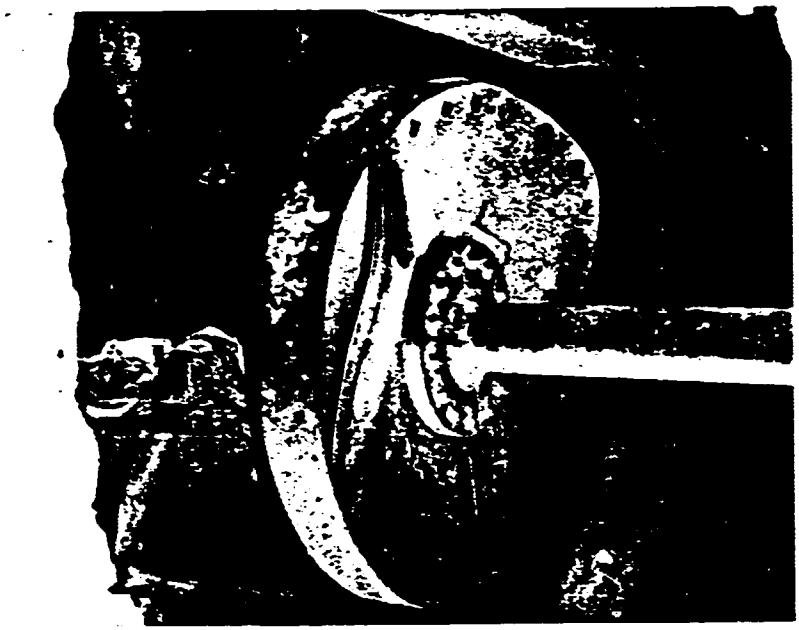
Disused clinker transport at cement mill department.

Cement Industry of Nicaragua	Enclosure No. 45

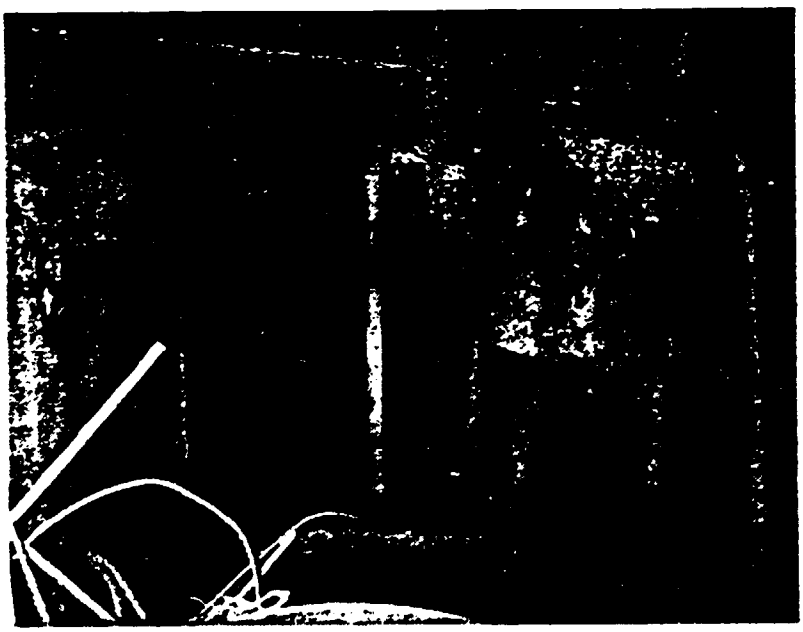
Disused clinker transport at cement mill department.

Disused clinker transport - to the right slate funnel.

Cement Industry of Nicaragua	Enclosure No.46

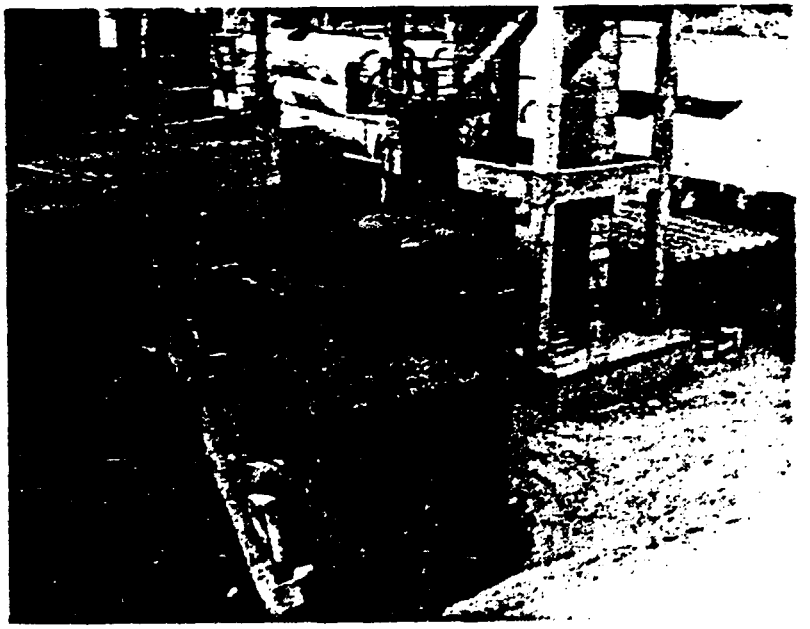


Cement mill department. Torsion shaft at gear unit dismantled.



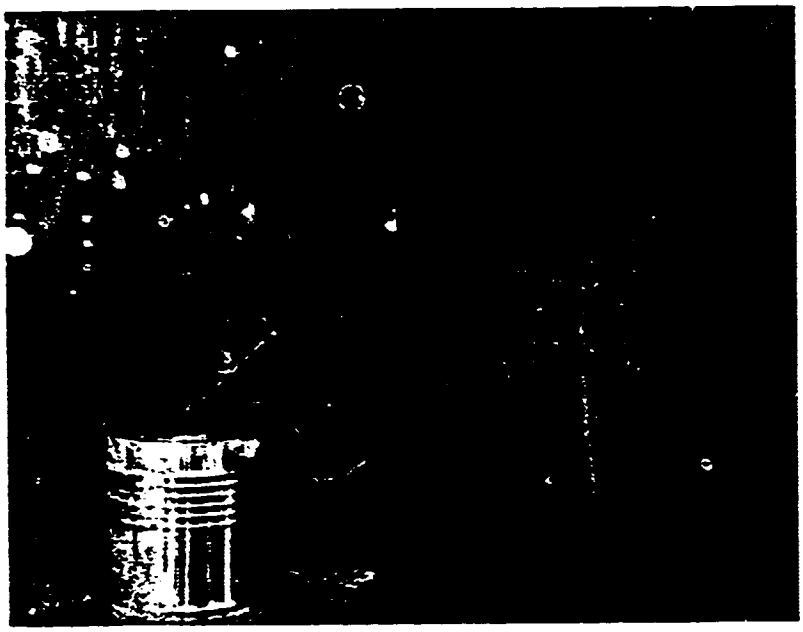
Cement mill department. Water tank for water injection.

Disused buildings at cement mill department.

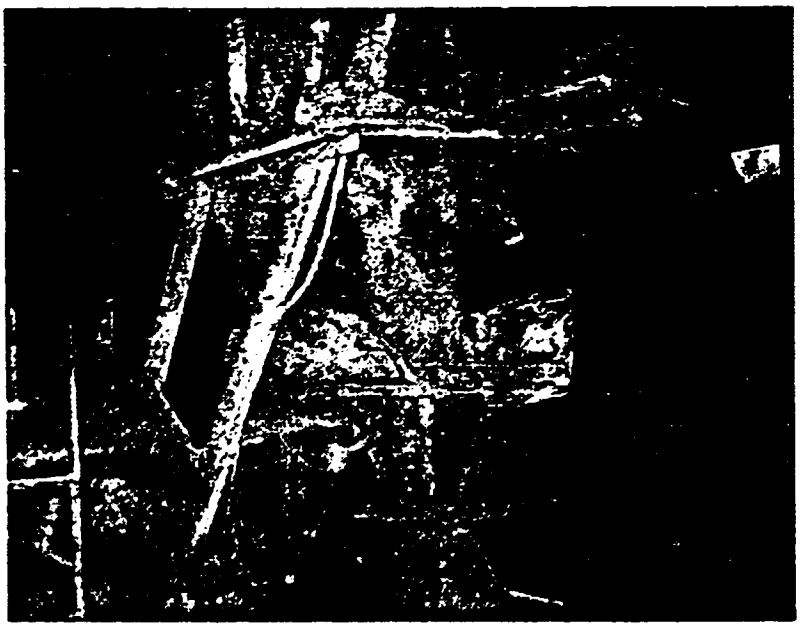


Clinker transport. Spillage and obstructionsproblems.

Cement Industry of Nicaragua	Enclosure No. 48

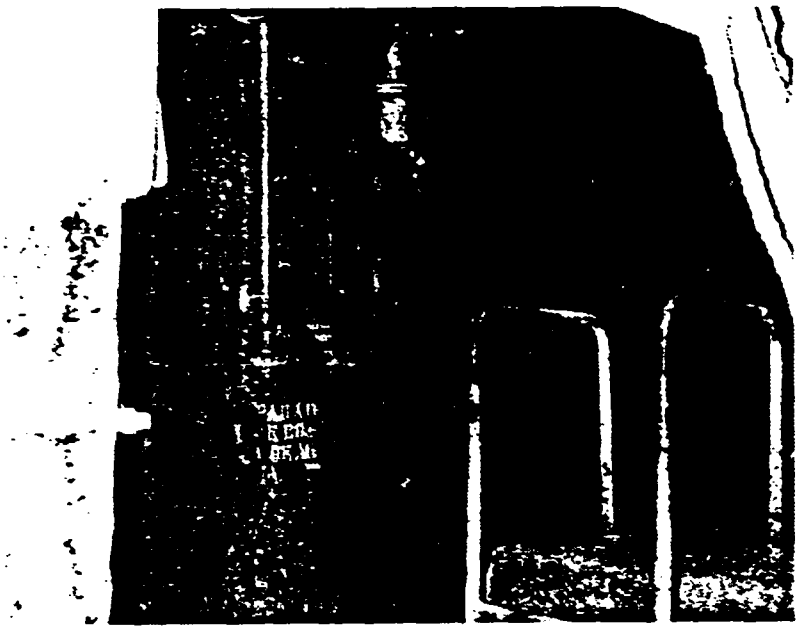


Cement mill with water injection equipment.



Outlet box, cement mill.

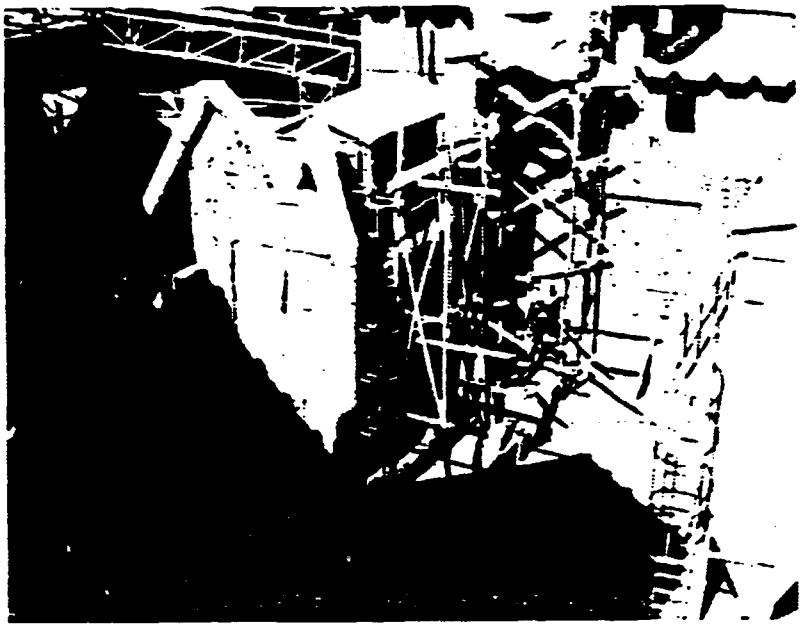
Cement Industry of Nicaragua	Enclosure No. 49



Damaged fittings for water injection. Cement mill.

Elevator shaft with bracing boards at the bottom.

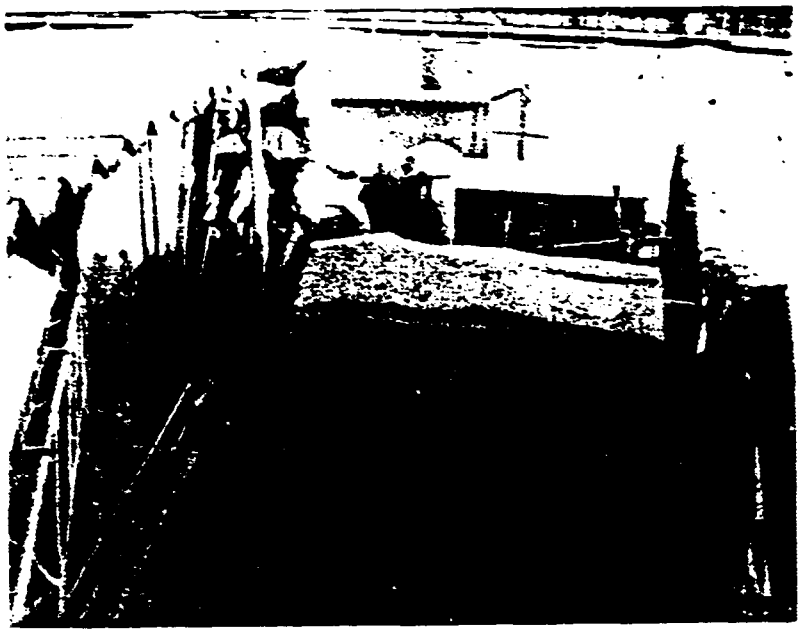
Cement Industry of Nicaragua	Enclosure No. 50



Cement mill department. Electrostatic precipitator.

Cement mill department. Electrostatic precipitator.

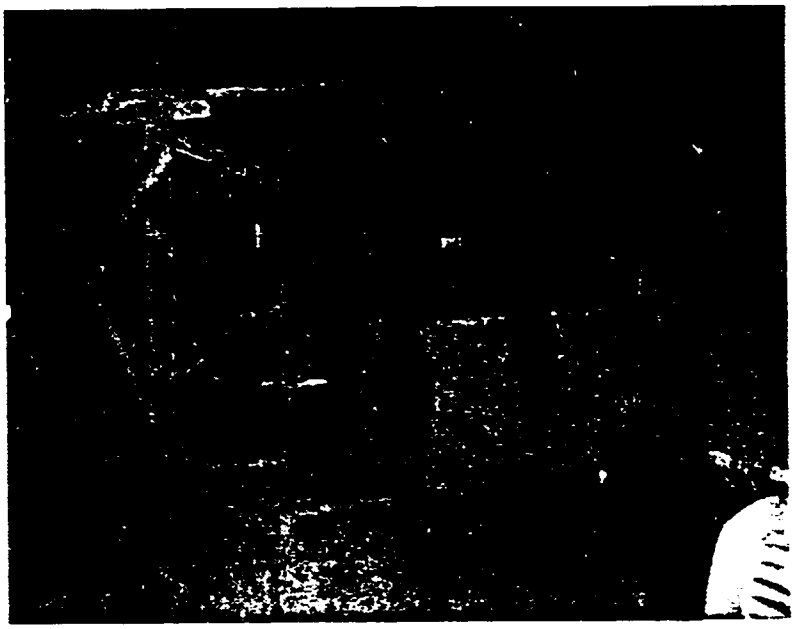
Cement Industry of Nicaragua	Enclosure No. 51



Cement mill department. Electrostatic precipitator.

Slate funnel.

Cement Industry of Nicaragua	Enclosure No. 52



Packing department. Bag filter.

Packing department. Bulk extraction. No longer operating.

Cement Industry of Nicaragua	Enclosure No.53

Garage area. Mainly scraped equipment owing to lack of spare parts.

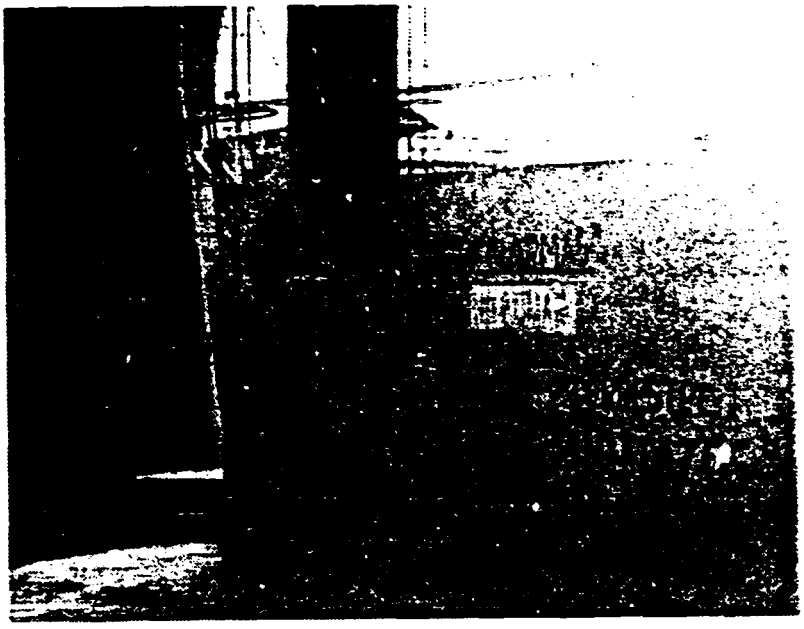
Garage area.

Cement Industry of Nicaragua	Enclosure No. 54

Workshop.

Workshop.

Cement Industry of Nicaragua	Enclosure No. 55

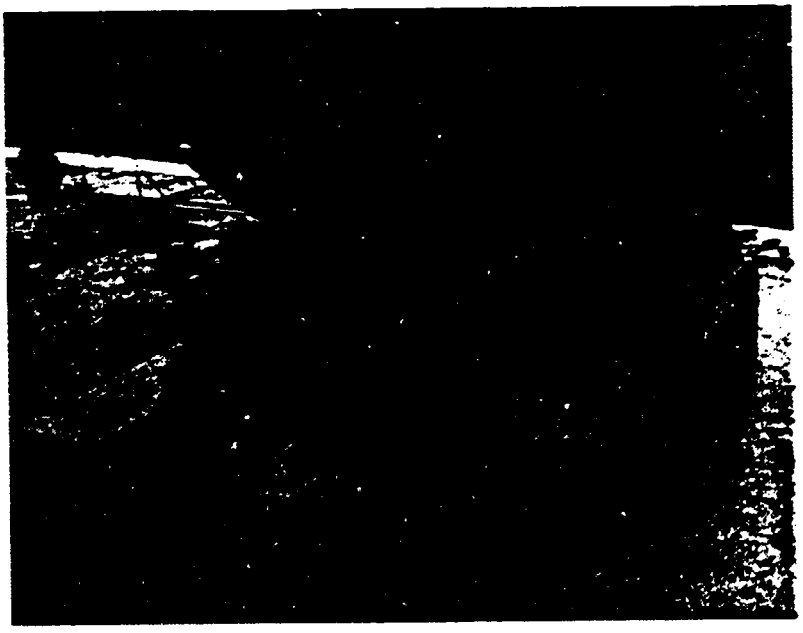


Information about alarm signalling in case of attack.

Part of oil treatment system on drier drum for pozzolana.

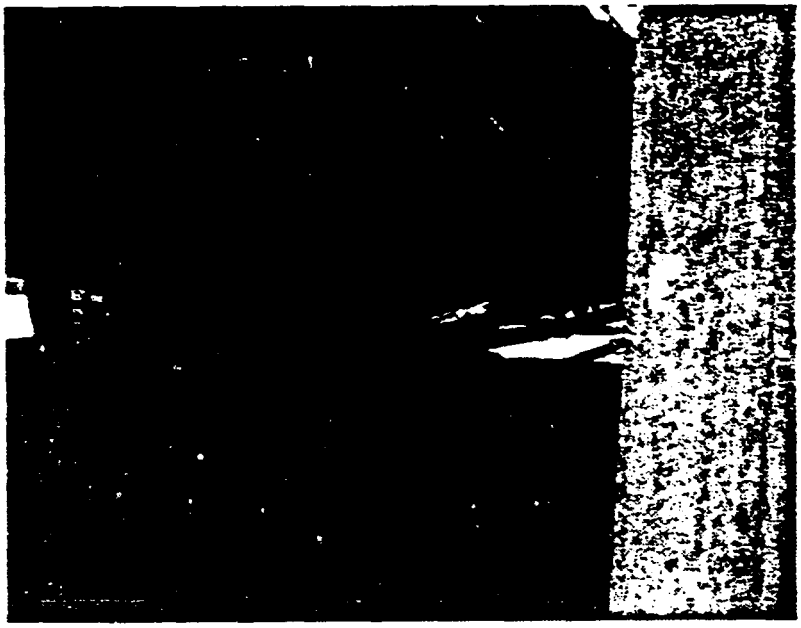
Cement Industry of Nicaragua	Enclosure No. 56

Drive station, drier drum for pozzolana.

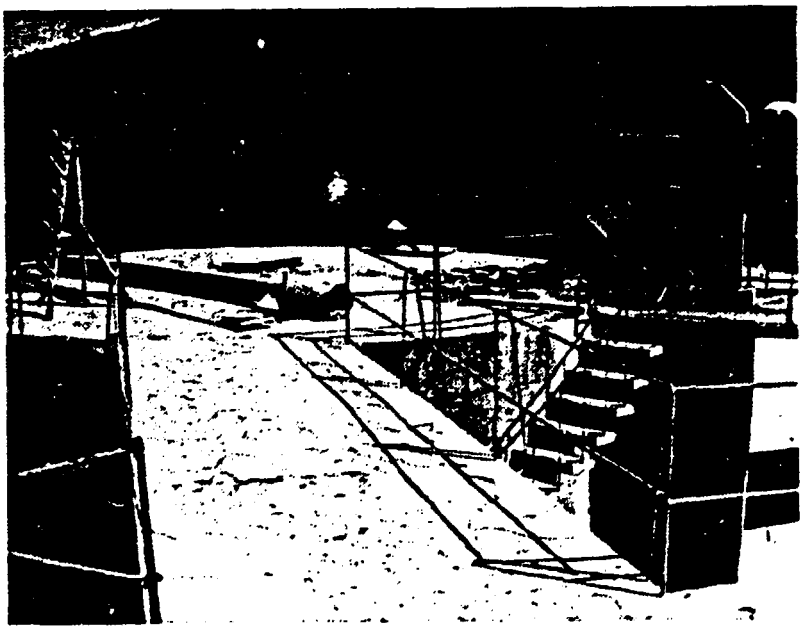


Support, drier drum for pozzolana.

Cement Industry of Nicaragua	Enclosure No. 57



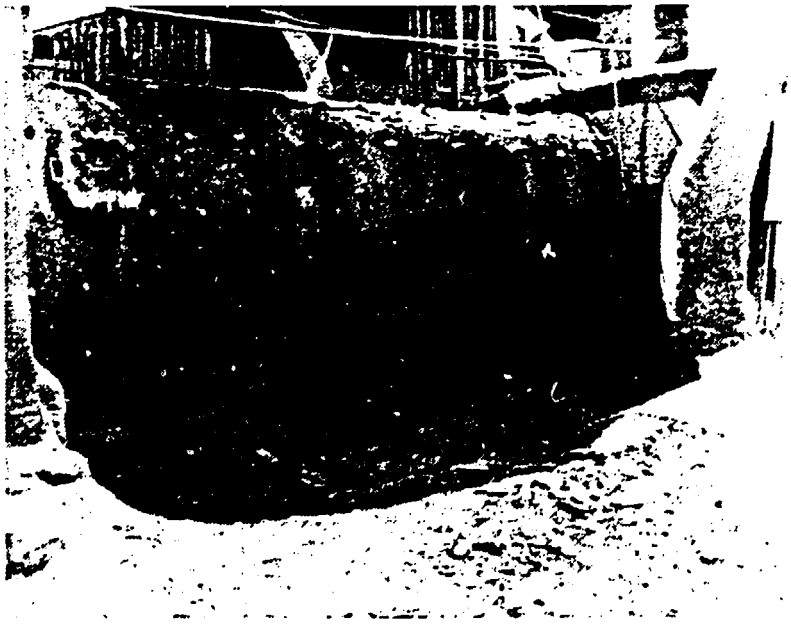
Area at cement mill inlet.



Roof of clinker silo. Note dismantled screw for distribution in silo compartments.

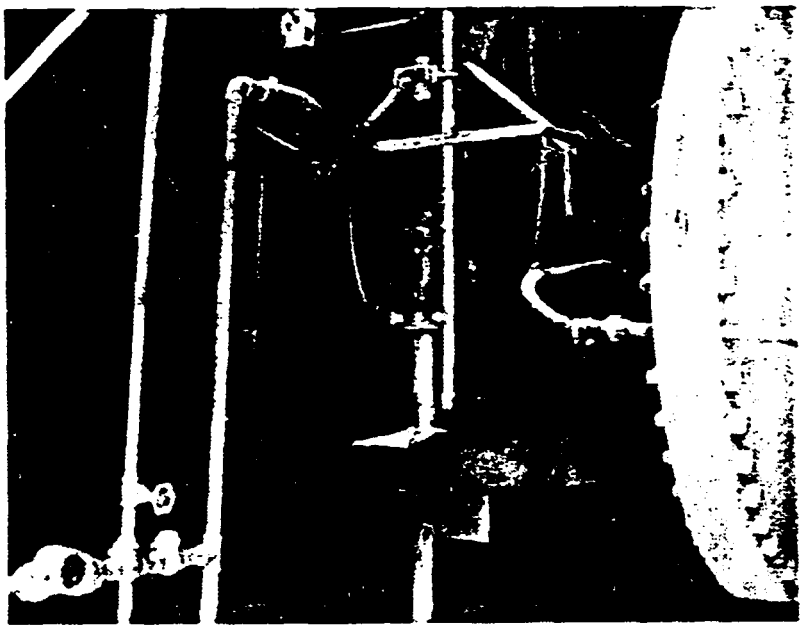
Cement Industry of Nicaragua	Enclosure No. 58

Clinker elevators on top of silo.

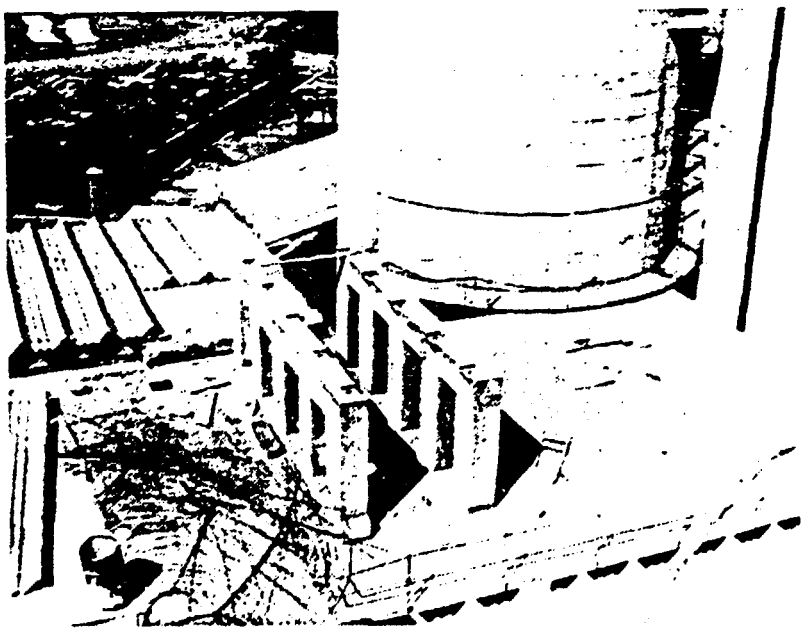


Cement mill no.1 with external water spraying.

Cement Industry of Nicaragua	Enclosure No. 59

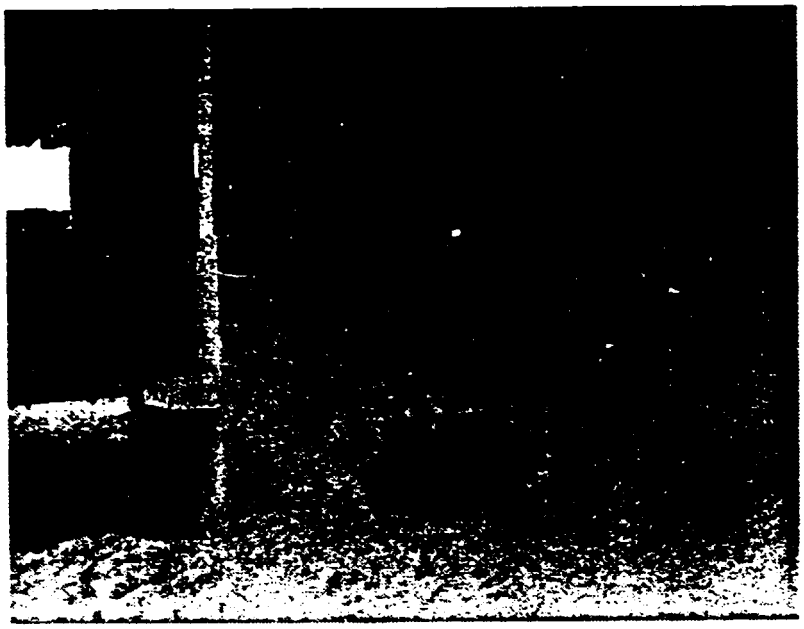


Water injection system, cement mill no.2.



Baseplate for missing electrostatic precipitator for cement mill no.3.

Cement Industry of Nicaragua	Enclosure No. 60

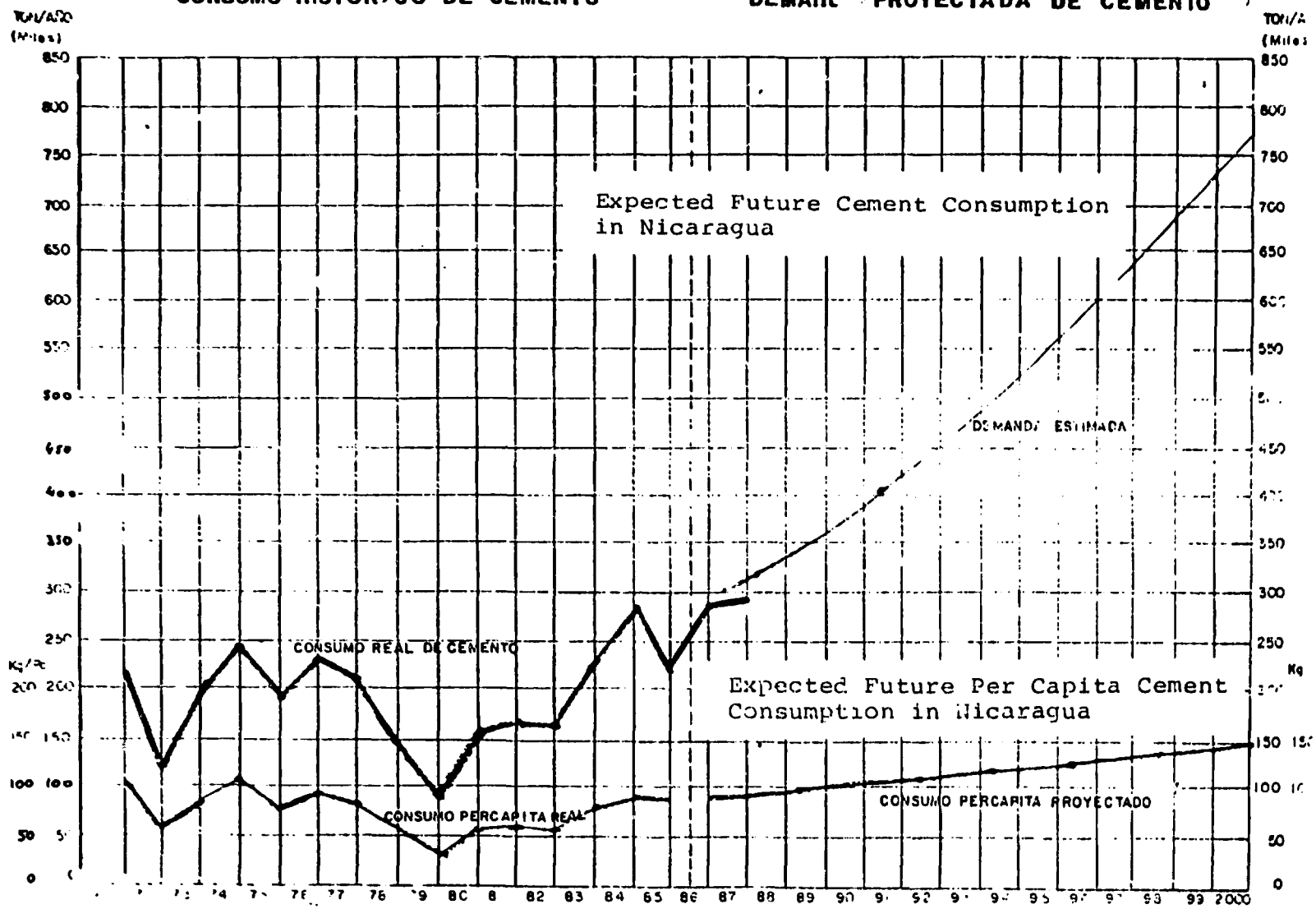


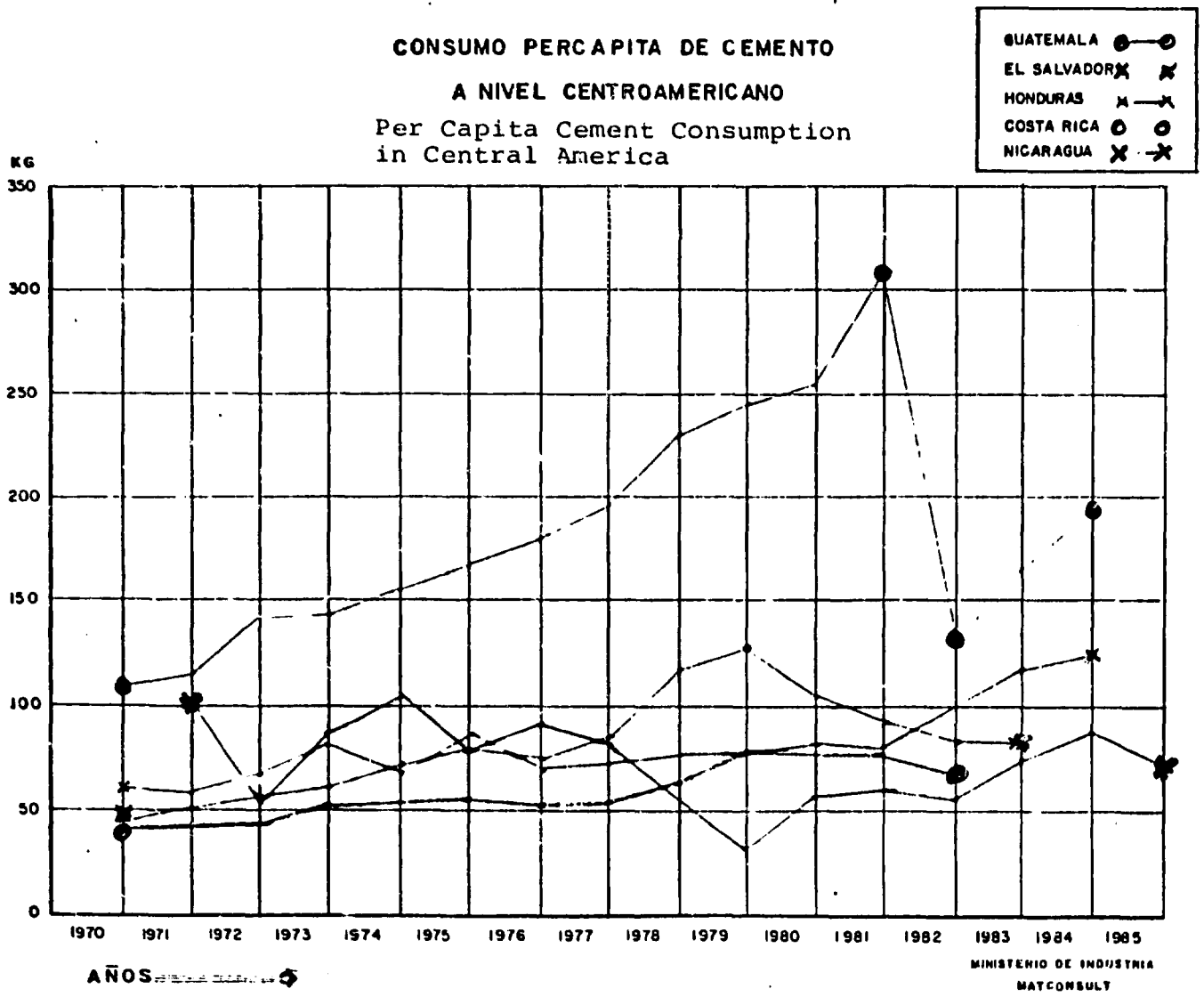
Area at packing plant.

Ledusting filter, packing plant.
Connection between filter box and screw is missing.

Cement Industry of Nicaragua	Enclosure No. 61

Cement delivery.


CONSUMO HISTORICO DE CEMENTO
DEMANDA PROYECTADA DE CEMENTO
TON/AÑO (Miles)
TON/A (Miles)
Expected Future Cement Consumption in Nicaragua
DEMANDA ESTIMADA
CONSUMO REAL DE CEMENTO
Expected Future Per Capita Cement Consumption in Nicaragua
CONSUMO PERCAPITA REAL
CONSUMO PERCAPITA PROYECTADO
Kg/Pc
Kg
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 2000


CONSUMO PERCAPITA DE CEMENTO
A NIVEL CENTROAMERICANO
Per Capita Cement Consumption
in Central America
GUATEMALA
EL SALVADOR
HONDURAS
COSTA RICA
NICARAGUA
KG
350
300
250
200
150
100
50
0
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
AÑOS
MINISTERIO DE INDUSTRIA
MATCONSULT

CONSULTORA DE MATERIALES, S.A.
(MATCONSULT)

INFORME SOBRE SILOS EXISTENTES

DESCRIPTION	ORIGEN	AND	CAPACIDAD	MARCA Y MODELO	ESTADO	QANT.	UBICACION
Silo para Cemento	URSS	1983	14 Ton.	TC GA-83	B	3	PROIMCO
Silo para Cemento	URSS	1985	14 Ton.	TC GA-85	B	5	MATRA
Silo para Cemento	URSS	1985	14 Ton.	TC GA-85	B	3	ENE
Silo para Cemento	URSS	1985	14 Ton.	TC GA-85	B	2	REGION I.
Silo para Cemento	-	-	20 Ton.		B	1	NICALIT
Silo para Cemento	-	-	20 Ton.		B	2	MAYO S.A.

FUENTE: MINISTERIO DE LA CONSTRUCCIO:

Tiempo de Llenado : 20 minutos

Tiempo de descargue : 1 Hora

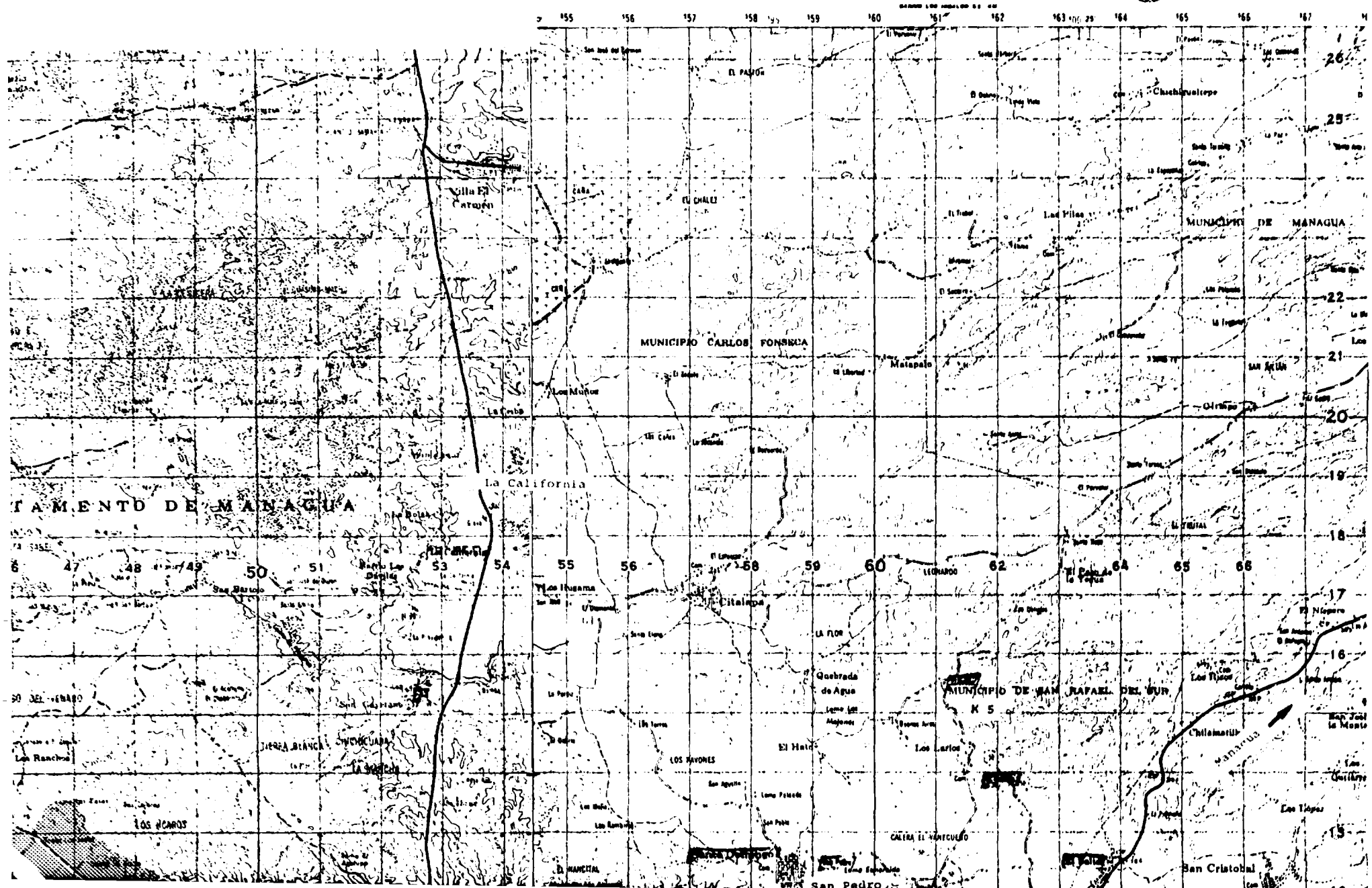
Tiempo de Transporte : 1 Hora Managua - San Rafael

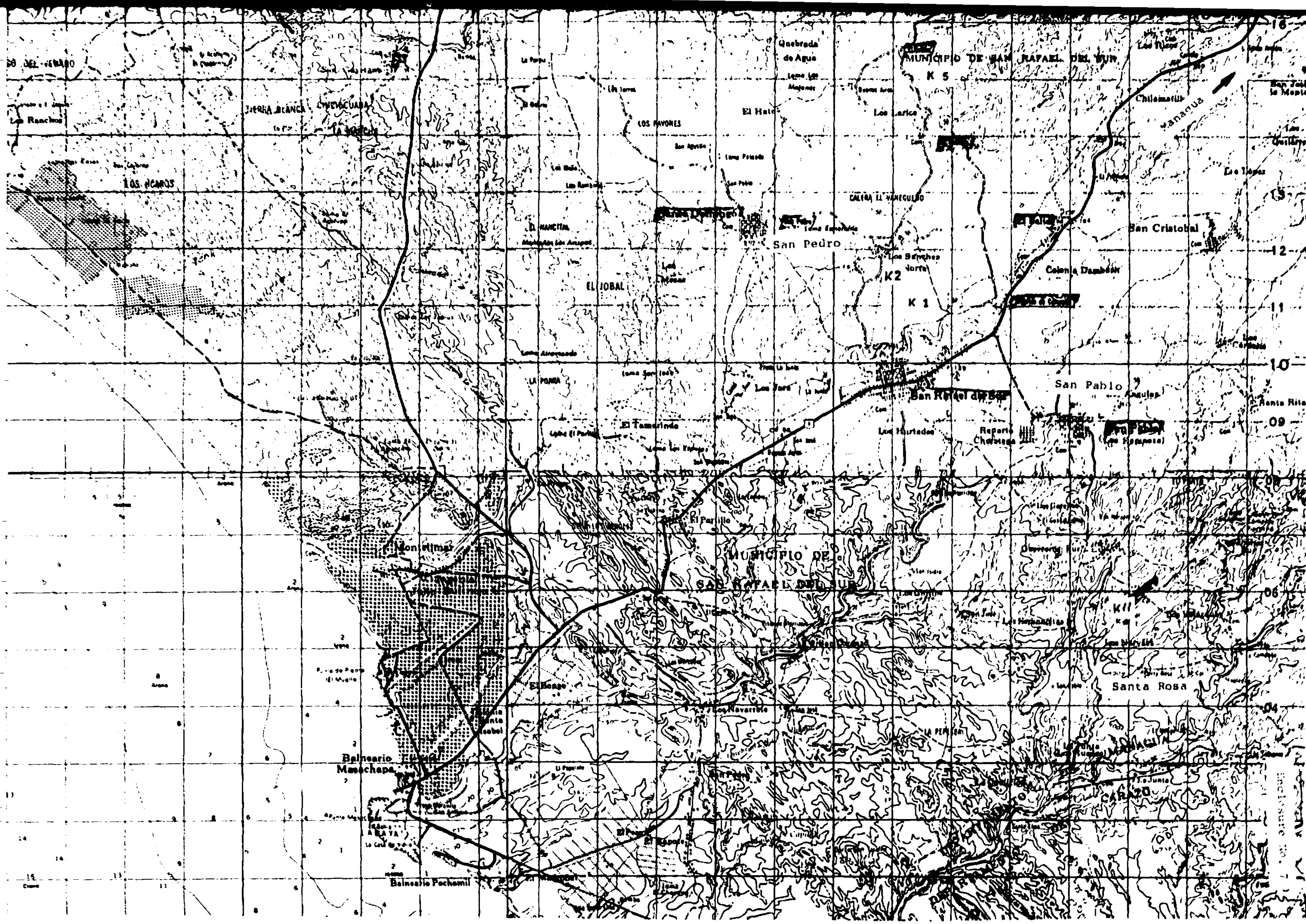
: 2 Horas San Rafael - Managua

SECTION 1

NICARAGUA 1:50,000

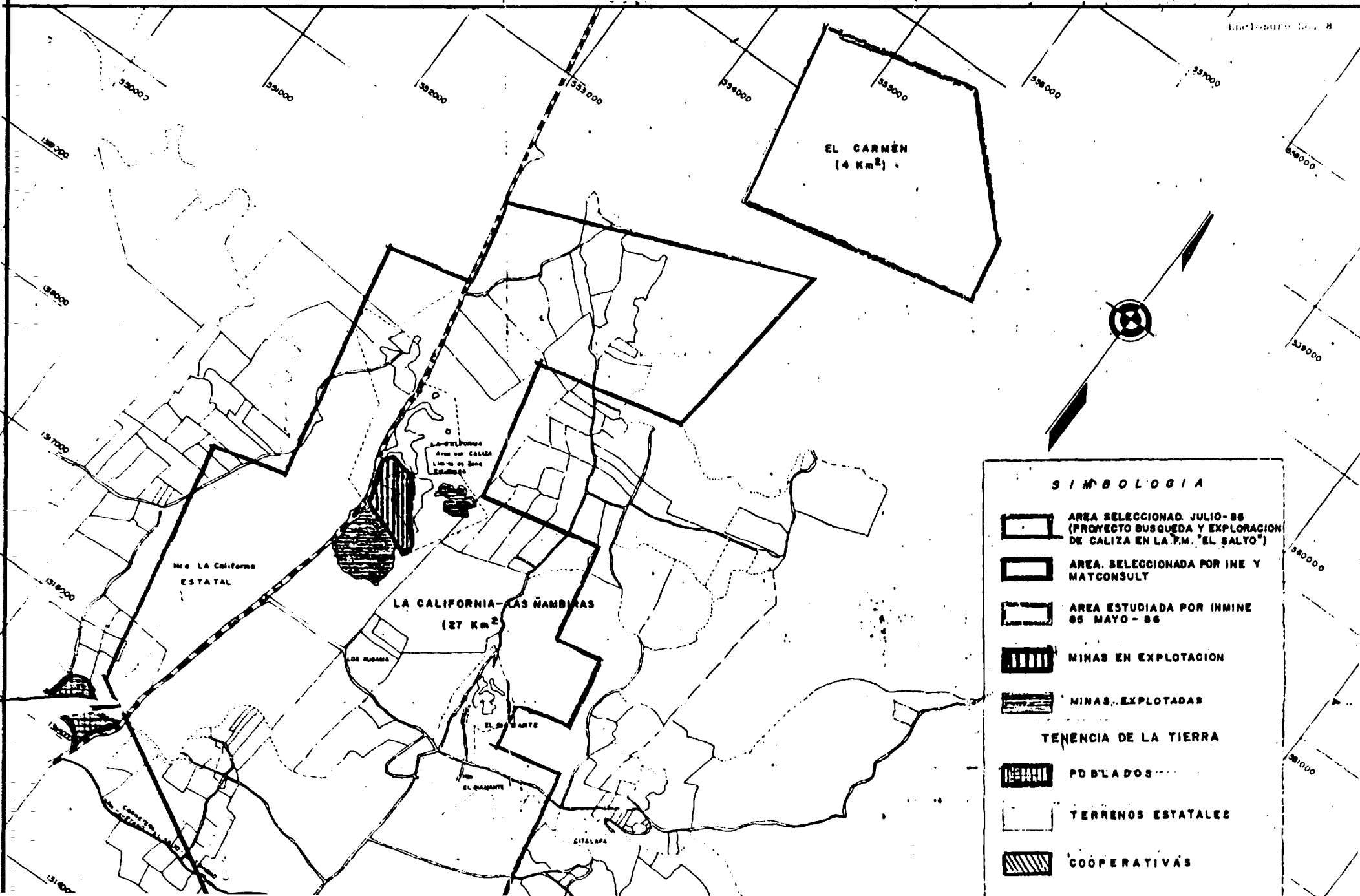
SAN RAFAE

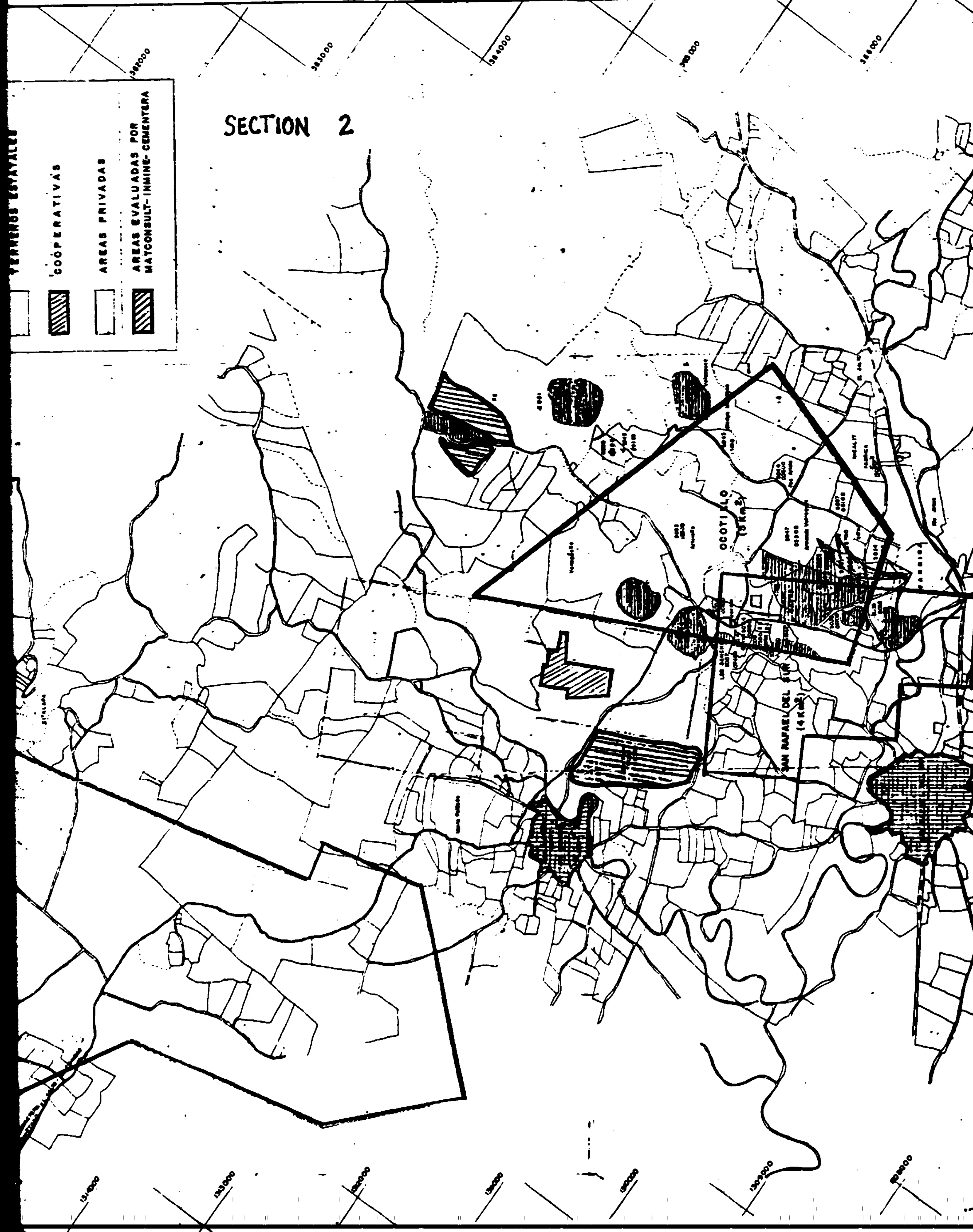


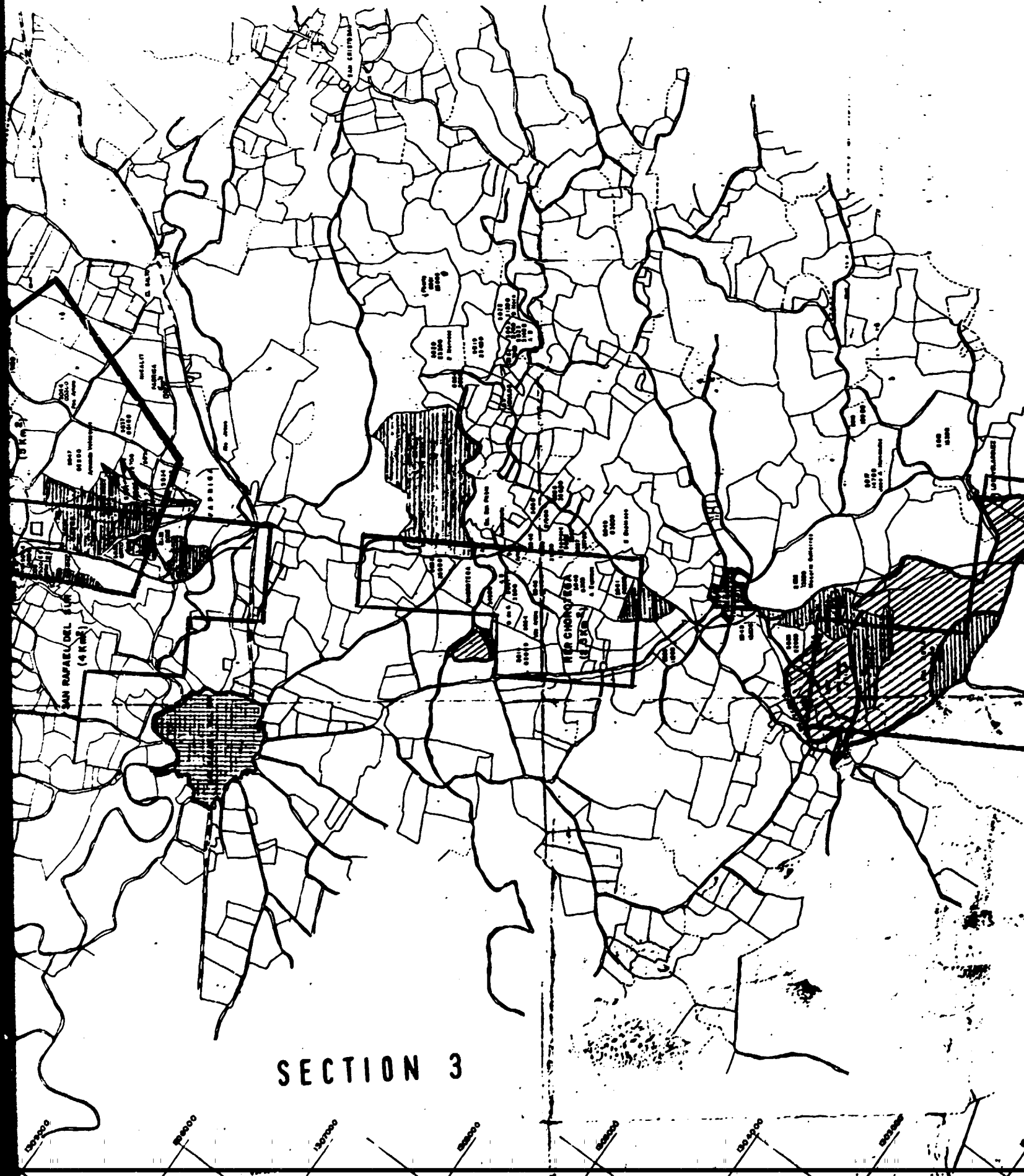

Enclosure No. 7
MUNICIPIO DE SAN RAFAEL DEL SUR
K 5
K 1
K2
San Pedro
San Pablo
San Cristobal
Colonia Dambert
San Rafael del Sur
El Tamarindo
El Parillo
MUNICIPIO DE SAN RAFAEL DEL SUR
Santa Rosa
CARAZO
Montelimar
Balneario Masachapa
Balneario Pochomil
Los Ranchos
LOS ICAROS
TIERRA BLANCA
LOS PAVONES
El Hato
EL JOBAL
Quebrada de Agua
Managua
Chiloimatillo
Reparto Chorotega
Los Hurtados
El Bonete
Los Navarrete

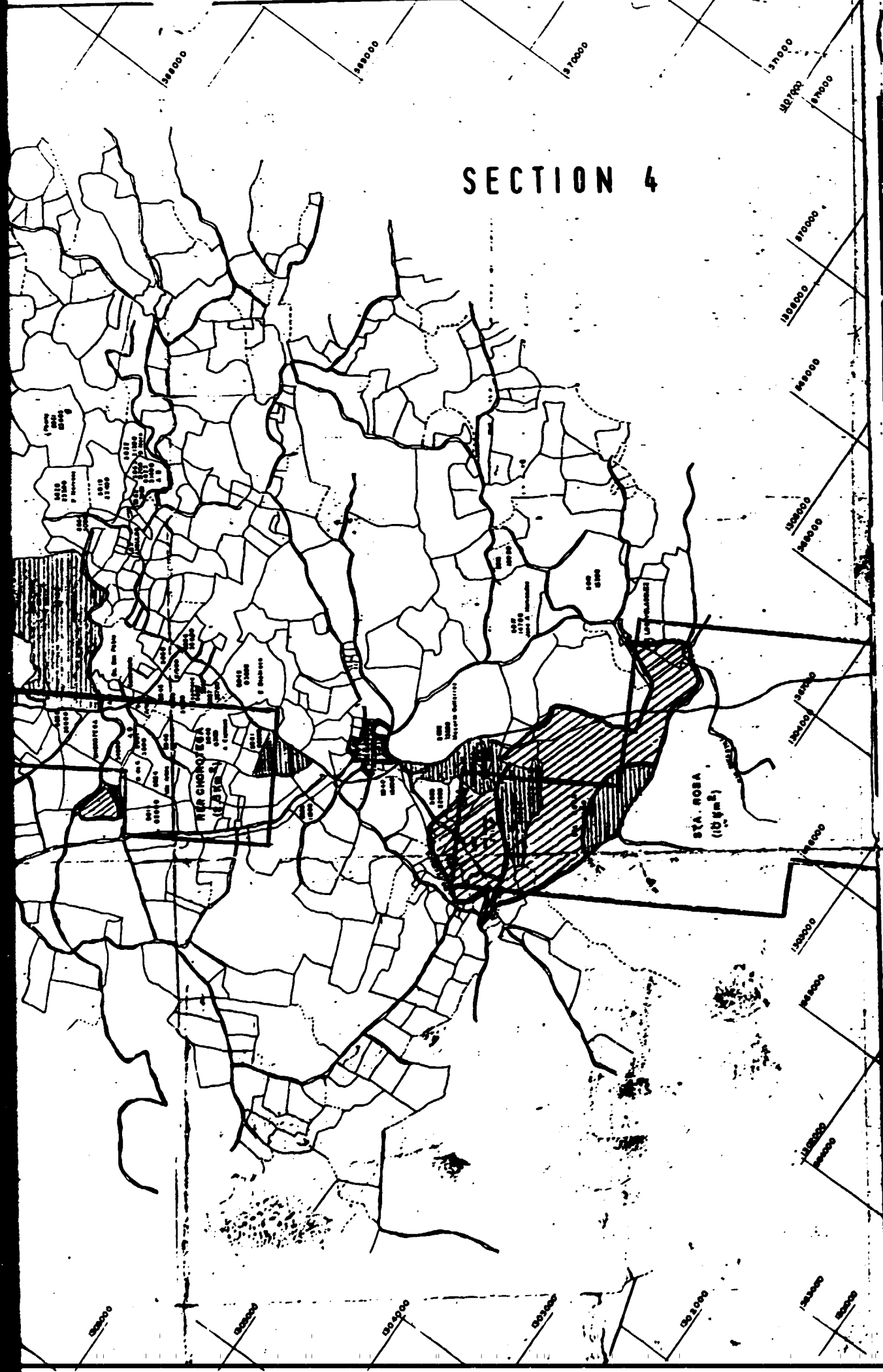
SECTION 2

SECTION 1


EL CARMEN
(4 Km²)
LA CALIFORNIA-LAS NAMBINAS
(27 Km²)
Mina LA California
ESTATAL
SIMBOLOGIA
AREA SELECCIONAD. JULIO-86 (PROYECTO BUSQUEDA Y EXPLORACION DE CALIZA EN LA T.M. "EL SALTO")
AREA SELECCIONADA POR INE Y MATCONSULT
AREA ESTUDIADA POR INMINE 85 MAYO - 86
MINAS EN EXPLOTACION
MINAS EXPLOTADAS
TENENCIA DE LA TIERRA
POBLADOS
TERRENOS ESTATALES
COOPERATIVAS


SECTION 2
382000
383000
384000
385000
TERRENOS ESTATALES
COOPERATIVAS
AREAS PRIVADAS
AREAS EVALUADAS POR MATCONSULT- INMINE- CEMENTERA


SAN RAFAEL DEL SUR
(4 KMS)
SECTION 3


SECTION 4
STA. ROSA
(10 km²)