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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Report on a paper industry for TRINIDAD AND TOBAGO

September 1968

by Julius Grant

REPORT

ON

A PAPER INDUSTRY

FOR

TRINIDAD AND TOBAGO,

00707

Prepared

for

THE UNITED NATIONS

By

Dr. Julius Grant,

M.Sc., F.R.I.C.

107, Fenchurch Street,
London, E.C.3.
England.

September, 1968.
Ref: 28182X.

REPORT ON A

PAPER INDUSTRY

FOR

TRINIDAD AND TOBAGO

Contents

PART I

INTRODUCTION

In accordance with a Special Service Agreement dated 8th July, 1968, between the Author of this Report and The United Nations, a visit was made to Trinidad and Tobago during the period 29th July to 24th August, 1968, inclusive. The following were the terms of reference as set out in the above Agreement, and in the course of correspondence referring thereto. "To assist the Industrial Development Corporation of Trinidad and Tobago in evaluating proposals for the re-establishment, as a commercially viable operation, of a paper manufacturing plant in Trinidad to serve local and regional market requests (requirements) as far as possible making maximum use of indigenous raw materials."

Arising out of these general terms of reference the following more specific problems were to be investigated :

(a) To make a study of the extent to which a local paper industry could be established in Trinidad and Tobago at the present time, or in the future.

(b) To recommend to what extent, if any, the existing paper factory referred to above could be used for such a scheme.

(c) If the factory could not be so used, to recommend alternative means of utilising or disposing of it.

(d) To investigate the extent to which local raw materials, fibrous and otherwise, could be used in connection with any of the above alternatives.

It should be explained that in 1966, a local company named General Paper Products (Caribbean), Ltd. was established to manufacture paper from sugar cane bagasse; and it was granted "pioneer" concessions for this purpose. The intention was primarily to produce paper, mainly for toilet tissue and on jumbo rolls, to

serve the domestic market requirements; and a production of approximately 8 tons per day was envisaged. The mill ran from approximately December, 1966, to April, 1967, and has since been closed. During its running period it was unable to produce either the requisite quality or quantity of paper, nor was it able to use bagasse as was planned.

The Company is now in the hands of the Official Receiver and at least two other Companies, also in Trinidad, are interested in taking it over and putting it in working order again. A decision on this point has been deferred until the Report on the present study is completed.

The history of the Company and the general background of the project are described more fully in Part II, together with a full description of the present factory and its existing conditions; and recommendations as to its future are embodied in this Report. The future of the factory is obviously bound up with the whole question of the possibility of creating a papermaking industry in Trinidad and Tobago. The two important questions which arise in this connection are, therefore:

(a) What steps are necessary to put the factory on an efficient basis, and what is the approximate cost?

(b) Is it advisable to take this step?

(c) Whatever the answers to (a) and (b) above, what are their implications so far as a future papermaking industry for Trinidad and Tobago is concerned?

The desirability of using local raw materials (especially bagasse) in the above schemes has been stressed, but due consideration had to be given to alternative uses for bagasse for the manufacture of particle board and also for the production of furfural. The relative merits of all these possibilities are discussed

below (Part III (c)).

Travel Programme

This was as follows :-

Mon. 29th July	-	London to Port of Spain.
Tues. 30th July	-	United Nations Development Programme (UNDP) - Industrial Development Corporation (IDC) - Ministry of Industry and Commerce.
Wed. 31st July	-	General Paper Products (Caribbean), Ltd., Arima - UNDP - IDC.
Thurs. 1st August	-	Central Statistics Office - Customs House - Pannell, Fitzpatrick & Co. - Rolex Paper Co. (Trinidad), Ltd. - Sugar Manufacturers' Association of Trinidad, Ltd. - IDC.
Frid. 2nd August	-	Caroni, Ltd., Brechin Castle - IDC - Pannell, Fitzpatrick & Co. - Texaco Trinidad, Inc. - UNDP.
Sat. 3rd August	-	IDC - Forestry Division - Studying files, etc.
Sun. 4th August	-	Studying files, etc.
Mon. 5th August	-	Public Holiday.
Tues. 6th August	-	Caroni, Ltd., St. Madeleine - IDC.
Wed. 7th August	-	UNDP - IDC - Economy Products, Ltd. - Yuille's Printerie, Ltd. - Furness (Limestone Products), Ltd. - T. Lacheras.
Thurs. 8th August	-	Mr. V.K.R. Bedford - IDC - Government Printery - UNDP - Trinidad Paper Products, Ltd.
Frid. 9th August	-	IDC - Central Statistics Office - Laventille Sewerage Works - Geo. F. Huggins & Co., Ltd. - H.C. Arrindell.
Sat. 10th August	-	IDC - Reep, Fojo & Associates.
Mon. 12th August	-	IDC - Geo. F. Huggins & Co., Ltd. - Caribbean Knitting Mills, Ltd. - Caribbean Packaging Industries, Ltd. - Reed Trinidad, Ltd.
Tues. 13th August	-	IDC Board - Central Statistics Office - Customs House.

Wed. 14th August	-	Trinidad & Tobago Electricity Commission - British-American Printers & Box Manufacturers, Ltd. - IDC - UNDP - Ministry of Labour - Ramlogan Industries, Ltd.
Thurs. 15th August	-	IDC - Arima Factory - Ramlogan Industries, Ltd. - UNDP - H.E. Robinson & Co., Ltd.
Frid. 16th August	-	Caribbean Printers, Ltd. - Issa Nicholas (Trinidad), Ltd. - Arima Factory - IDC.
Sat. 17th August	-	Trinidad to Tobago.
Sun. 18th August	-	Tobago to Trinidad.
Mon. 19th August	-	IDC - Caribbean Envelope Manufacturing Co., Ltd. - Trinpad, Ltd., Marabella, San Fernando.
Tues. 20th August	-	IDC - UNDP.
Wed. 21st August	-	UNDP - IDC. To Caracas - Embassy of Trinidad and Tobago.
Thurs. - Frid. 22nd - 23rd August	-	C.A. Venezolana de Pulpa y Papel (Venepal) - to Moron, Edo Carabobo.
Sat. 24th August	-	Left Caracas for London.
Sun. 25th August	-	Stopover, New York.
Mon. 26th August	-	Arrived London.

Personal Contacts

In the course of my work I received the utmost co-operation and courtesy from everyone with whom I came into contact. I particularly wish to record my appreciation of assistance in one form or another from :

Rt. Hon. J.H. O'Halloran, Minister of Industry and Commerce.

Sir Alan Reece, C.M.G., Chairman, Industrial Development Corporation.

A. Syrdahl, Deputy Representative, United Nations Development Programme, (U.N.D.P.), Trinidad.

Valued assistance was also obtained from the following,

who are listed in the chronological order in which I met them :-

R.H. Milley, Assistant Deputy Representative, U.N.D.P.

V. Hill, Chief Accountant, U.N.D.P.

E. Warner, Manager, Industrial Development Corporation (I.D.C.).

H.V. Ford, Deputy Manager, I.D.C.

W. Shepherd, Senior Officer, I.D.C.

Mrs. Hanny, Librarian, I.D.C.

E. Braithwaite, Permanent Secretary, Ministry of Industry and Commerce.

- Fleming, formerly Foreman, General Paper Products (Caribbean), Ltd.

L. Assee, Statistician-in-Charge, Central Statistics Office.

D.A. Wright, Pannell, Fitzpatrick & Co.

A. Chou, Director, Rolex Paper Co. (Trinidad), Ltd.

H. Fleming, Controller of Customs.

M.Y. Khan, Secretary, Sugar Manufacturers' Association of Trinidad, Ltd.

G.L. Bovell, Board Member, I.D.C.

C. Mejias, Chemical Engineer, University of West Indies.

F.H. Blackburn, Managing Director, Caroni, Ltd.

A. Mitchell, Manager, Caroni, Ltd., Brechin Castle.

M.E. Easton, Factory Manager, Caroni, Ltd.

H. Le Fevre, Sales Manager, Texaco Trinidad, Inc.

H. Murray, Chief Conservator of Forests.

M. Pearse, Chief Development Engineer, Caroni, Ltd.

C.G. Vierra, Economy Products, Ltd.

Lt.-Col. H. Daw, Yuille's Printerie, Ltd.

J.B. Scott, Furness (Limestone Products), Ltd.

T. Lasheras, Customs Broker.

V.K.R. Bedford - formerly of General Paper Products (Caribbean), Ltd.

L.O. Weekes, Government Printer.

G.H. Stanley, Storekeeper, Government Printery.

S. Jeffers, Paper Agent.

L.A. Mendes, Works Manager, Trinidad Paper Products, Ltd.

H. Borde, Sales Manager, Trinidad Paper Products, Ltd.

J. Johnson - formerly of General Paper Products (Caribbean), Ltd.

Dr. M. Richards, Board Member, I.D.C.

R. Bates, Head of Technical Services, Water and Sewerage Authority.

P.R. Lawrence, Biochemist, Laventille Sewerage Works.

A.F. Castro, Castro Transport & Construction Co., Ltd.

M.O. Bayne, Manager, Agency Dept., Geo. F. Huggins & Co., Ltd.

A. Mitchell, Chemical Sales, Geo. F. Huggins & Co., Ltd.

H.C. Arrindell, Importer (salt).

F. Fojo, Reep, Fojo & Associates.

T. Richards, Chemical Sales, Geo. F. Huggins & Co., Ltd.

- Pouchet, Customs Clearance Dept., Geo. F. Huggins & Co., Ltd.

N. Maharaj, Caribbean Knitting Mills, Ltd.

B.S. Bayne, Caribbean Packaging Industries, Ltd.

G.J. Coleman, Director, Reed Trinidad, Ltd.

W. Doobay, General Manager, Reed Trinidad, Ltd.

E. Hales, Production Manager, Reed Trinidad, Ltd.

F.R. De Four, Superintendent, Planning and Development, Trinidad and Tobago Electricity Commission.

D. Abraham, Director, Ramlogan Industries, Ltd.

Sir Harold Robinson, H.E. Robinson & Co., Ltd.

L. Maynard, Director, Caribbean Printers, Ltd.

H. Roberts, Manager, Caribbean Printers, Ltd.

I. Nicholas, Issa Nicholas (Trinidad), Ltd.

R. Massey, Director, Caribbean Packaging Industries, Ltd.

A. Donawa, Johnson & Johnson (Trinidad), Ltd.

R. West, I.D.C., Tobago.

G. Haloute, Managing Director, Caribbean Envelope Manufacturing Co., Ltd.

R. Persad, Managing Director, Trinpad, Ltd.

A. Spence, Texaco Trinidad, Inc.

A. De Alth, World Food Programme, United Nations, Trinidad.

L. Williams, Consul, Embassy of Trinidad and Tobago, Caracas.

G. Meyer, Sales Manager, C.A. Venezolana de Pulpa y Papel (Venepal), Caracas.

B. Pellegrino, Works Superintendent, Venepal, Edo Carabobo, Moron.

Plan of this Report

The Report is compiled under the following headings :

Part I - Introduction.

Part II - General Paper Products (Caribbean), Ltd.

(a) Background and History.

(b) The Arima Factory.

(c) Future Considerations.

Part III - A Paper Industry for Trinidad and Tobago.

(a) General.

(b) Markets.

(c) Fibrous Raw Materials.

(d) Chemicals.

(e) Fuel and Electricity.

(f) Labour and Management.

(g) Site, including Water and Effluent.

(h) Process, Plant and Capital Cost.

(i) Profitability Considerations.

Part IV - Conclusions and Recommendations.

(a) Short term.

(b) Long term.

Part V - General Summary.

Notes :

The following points should be noted with regard to this Report.

1. Unless otherwise stated, all quantities are in long tons (2,240 lb.), and all values are in Trinidad and Tobago Dollars.

$TT.4.80	=	£1 (sterling)
$TT.2.00	=	$US.1.00
$TT.1.85	=	$Can.1.00

2. The term "per day", means 24 hours.

3. Part V is intended to be read independently of the remainder of the Report. It contains all the essential features of the latter, but without the supporting details.

4. The island of Tobago was visited. It is administratively and economically linked closely with Trinidad. However, apart from a few relatively small printer-users of paper and its general paper-consuming public (population, 1960, 33,000), it contributes

nothing material to the technical, economic or raw materials aspects of this Study.

References

The following Reports and other documents were studied in connection with this assignment :

"Feasibility and Project Report on the Manufacture of Hardboard and Medium Density Fibreboard". Prepared for Shell Trinidad, Ltd. by the International Design Corporation, Tacoma, Washington, October, 1965.

"Industrial Utilization of Sugar Cane Bagasse". W. Scott, Port of Spain, 1950.

"Bagasse Utilization". Prepared for Caroni, Ltd. by Sandwell & Co., Ltd., October, 1964.

Correspondence files referring to General Paper Products (Caribbean), Ltd. and Sterling International Development Corporation.

Report on General Paper Products (Caribbean), Ltd. by H.B. Herman, 1290, Bimini Lane, Riviera Beach, Florida, 1968.

Report on General Paper Products (Caribbean), Ltd. by Anderson & Sutherland, 63, Frederick Street, Edinburgh, 2.

"Pulping Characteristics of Pinus caribaea". Tropical Products Institute, August, 1968.

"Feasibility and Market Study for Production of Furfural". UNIDO/SIS Mission to Trinidad and Tobago, May, 1967.

Agreement Establishing the Caribbean Free Trade Association (Carifta), December, 1965, 1966.

Interim Report No. 2. Water Resources Survey. M.M. Dillon, February, 1968.

"Pulp and Paper from Coniferous Species grown in the Tropics". E.R. Palmer and C.B. Tabb, Tropical Science, 1968, 10, (2), 79.

PART II

GENERAL PAPER PRODUCTS (CARIBBEAN), LTD.

(a) Background and History

The background and history of this project have been pieced together, so far as it has been possible, from records in the files of the Industrial Development Corporation and such files as were available of the Company itself, which were seen by courtesy of Mr. D.A. Wright, Receiver, Pannell, Fitzpatrick & Co., Port of Spain.

The stages of the history can be set out chronologically as follows. This Company, referred to here as General Paper Products, is a Corporation organised under the laws of Trinidad and Tobago for the purpose of producing jumbo tissue rolls to serve domestic market requirements. The equity is owned or controlled by the following :

Manuel Capedeville, citizen of Venezuela.

Paper Operations Consultants, a United States Corporation of West Palm Beach, owned by L.B. Owen and Robert Davie.

Mr. and Mrs. G.M. Hauser and Mr. and Mrs. L.R. Williams, citizens of the United States.

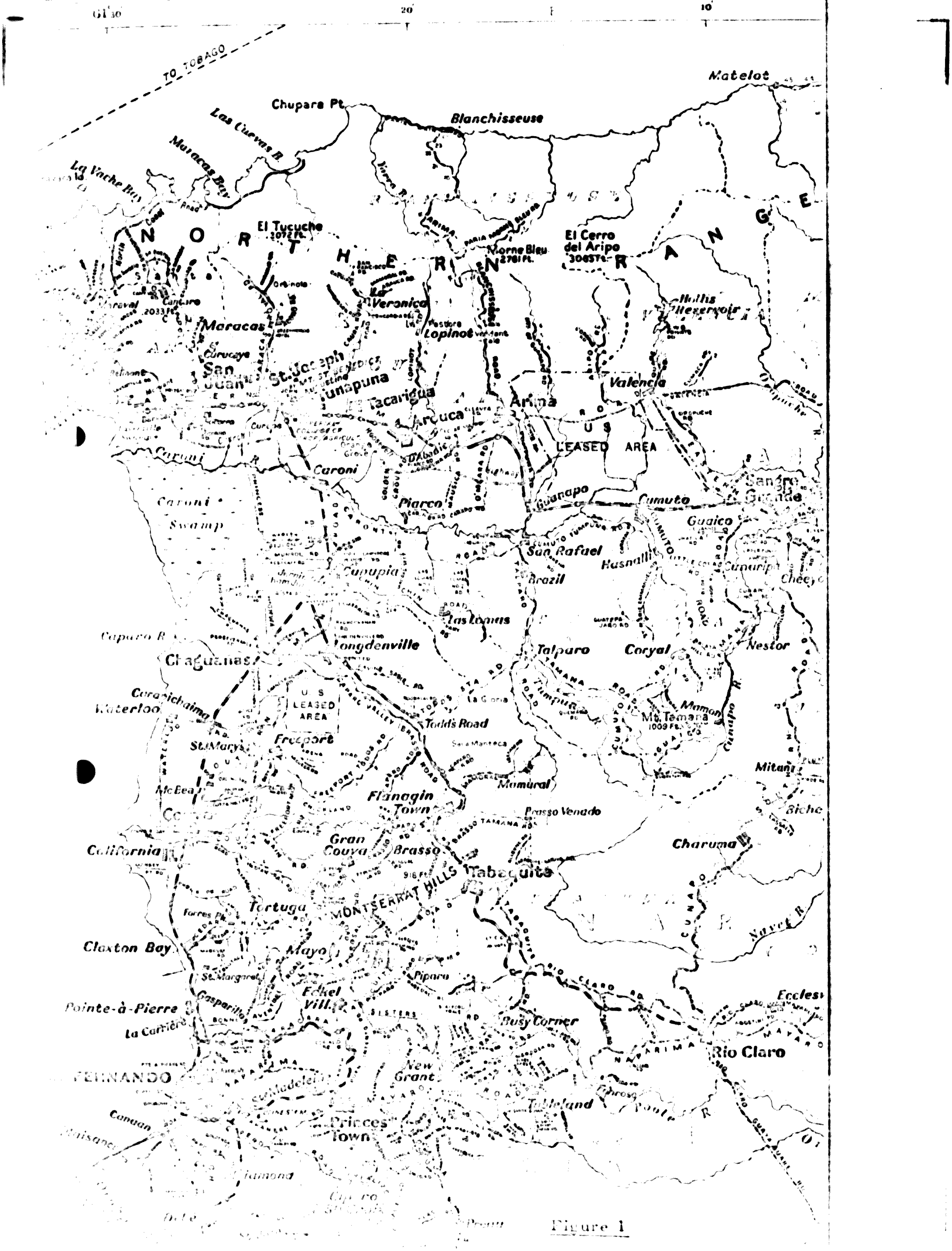
The only Director at present in Trinidad is Mr. A. Castro, Castro Transport & Construction Co., Ltd.

In July, 1965 the Company applied initially for "pioneer status" under the Aid to Industries Order, and this was granted in November, 1965. Pioneer industry status provides, inter alia, freedom from Trinidad income taxes for 10 years in the present instance; together with duty-free imports of plant and equipment and of raw materials and supplies. This applies for 5 years. Accelerated depreciation allowances may also be permitted under the provisions of the Income Tax (In Aid of Industry) Ordinance, Ch. 33, No. 2; these apply to all pioneer industries as from the end of the

tax holiday period. Pioneer industries are also granted certain other privileges in certain circumstances and, in general, qualify for Government support other than by direct financial investment. In the present instance it was proposed eventually to increase the amounts and types of papers made, in which case some form of protection against imports of similar grades would be requested from the Government. It was also proposed to train a local labour force in the operation of the machinery, under alien supervision.

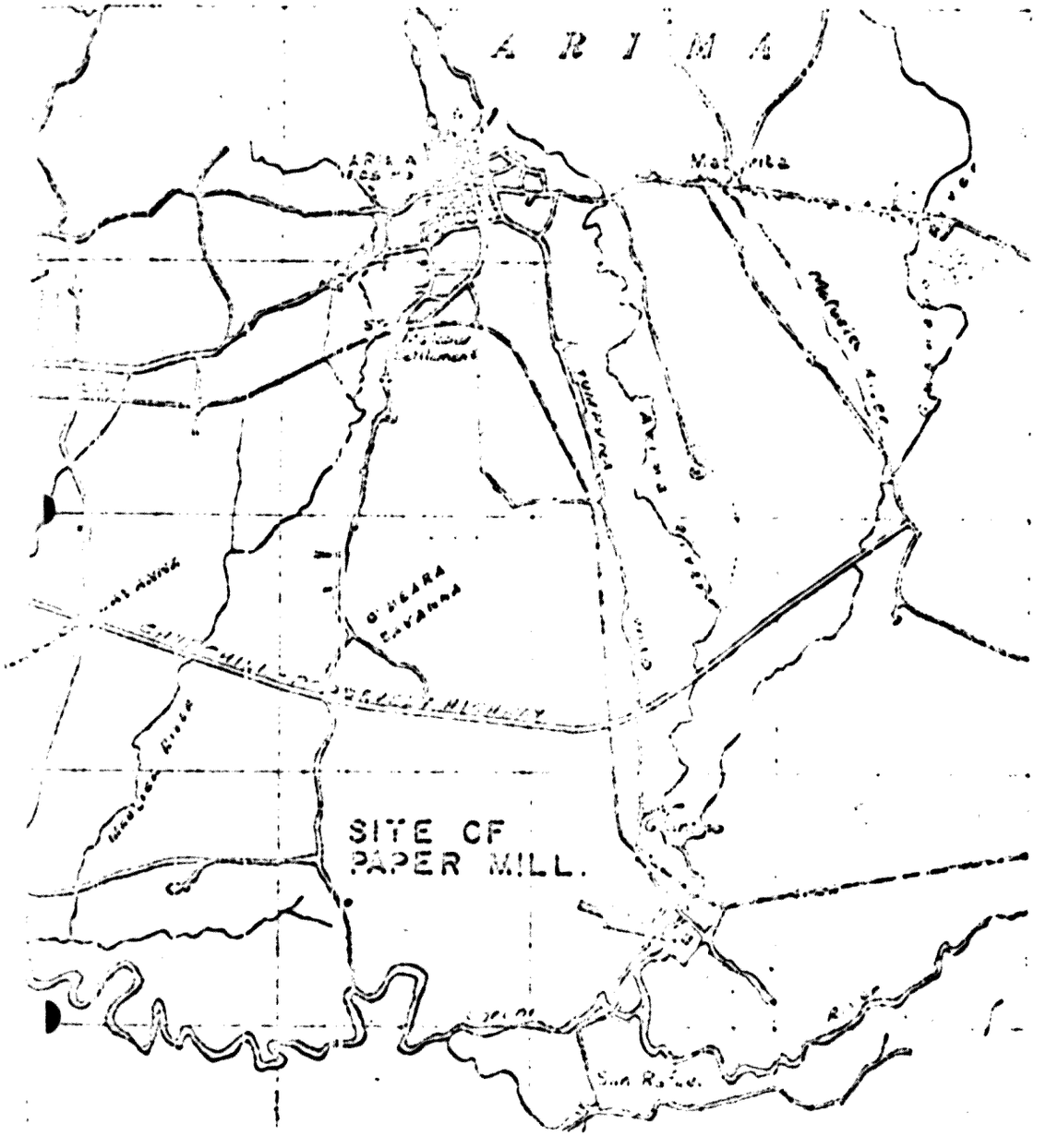
Location of the factory site is shown in Figs. 1, 2 and 3. It will be seen that it is just off the Manuel Congo Road, which leaves the Tumpuna Road at about 2 miles from the point at which the latter branches off southwards from the Churchill-Roosevelt Highway. It is thus approximately 4 miles from the town of Arima in an a most due southerly direction. The Guanapo River adjoins the site, and the factory is approached by a road bridge over this river.

The tangible assets of the Company include 10 acres of land acquired freehold, at $US.1,500 per acre, plus an option to purchase at the same price another adjoining 10 acres. Other tangible assets of the Company include a new and substantial steel-framed building, with a galvanised iron roof, and enclosed on three sides by concrete blocks; with office space, lavatories and adequate room for the installation of converting machinery for converting the jumbo rolls of tissue into toilet rolls and similar products. This building houses the paper machine and stock preparation equipment (see below). There is also an almost new Cleaver-Brooks steam boiler in a separate steel frame and cinderblock building, wells and pumps, an effluent treatment system, concrete tanks and chests, a fuel supply system, a heavy duty electrical system with switchgear, mill and yard lighting, piping, stock preparation equipment, a workmen's change room and office equipment. The bagasse pulp mill consists



TO TOBAGO
Chupara Pt.
Matelot
Blanchisseuse
Las Cuevas B.
Maracas Bay
La Vache Bay
N O R T H E R N R A N G E
El Tucuche 3072 Ft.
Morne Bleu 2761 Ft.
El Cerro del Aripo 3085 Ft.
Hollis Reservoir
Maracas
Veronica
Lopinot
San Juan
St. Joseph
Tunapuna
Tacarigua
Arouca
Arima
Valencia
U S LEASED AREA
Caroni R.
Caroni
Caroni Swamp
Piarco
Guanapo
Cumuto
Sangre Grande
Guaico
San Rafael
Brazil
Cunupia
Las Lomas
Caparo R.
Chaguanas
Longdenville
Talparo
Coryal
Nestor
Caranichaima
Waterloo
U S LEASED AREA
Freeport
St. Mary's
Todd's Road
Tumpuna
Mt. Tamana 1009 Ft.
Mamon
Mamural
Mitan
Flanagin Town
Brasso Venado
Charuma
California
Gran Couva
Brasso
Tabaquite
MONTSERRAT HILLS
Tortuga
Claxton Bay
Mayo
Piparo
St. Margaret
Pointe-à-Pierre
Gasparillo
Eckel Ville
Busy Corner
La Carrière
Rio Claro
New Grant
Tableland
Princes Town
Canaan

Figure 1



LOCATION PLAN

SCALE 1 50,000

Figure 2.

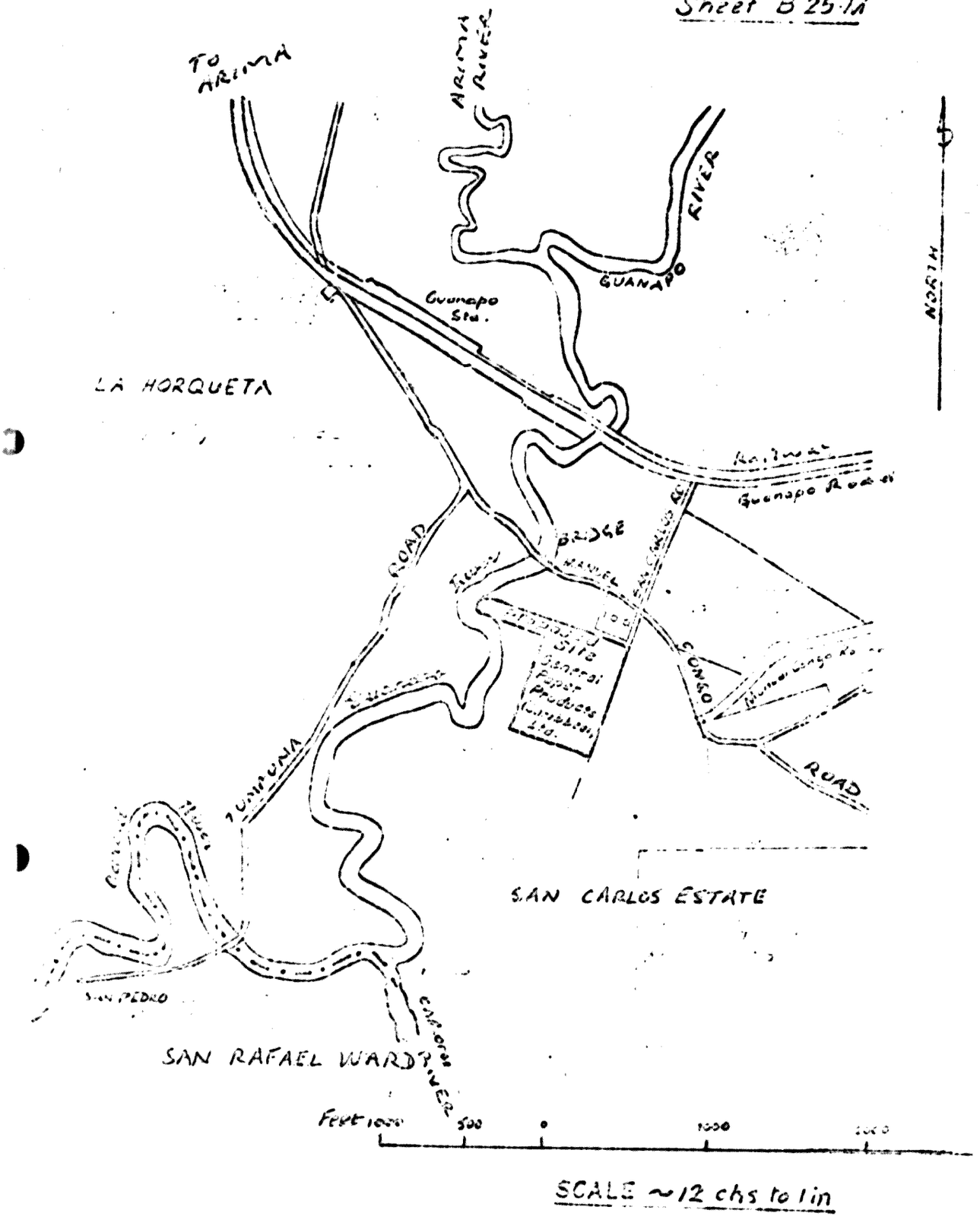

Wards of Arima
County of St George
Sheet B 25-14
TO ARIMA
ARIMA RIVER
GUANAPO RIVER
Guanapo Sta.
LA HORQUETA
NORTH
Railway
Guanapo Road
BRIDGE
ROAD
Tunapuna
SITE
General Export Products (Trinidad) Ltd.
CONGO
ROAD
SAN CARLOS ESTATE
SAN PEDRO
SAN RAFAEL WARD
FEET 1000 500 0 1000
SCALE ~12 chs to 1in

Figure 3.

of 2 rotary batch digesters.

The paper machine is said to have a capacity of 8 to 10 tons of creped tissue paper per day, and is also said to have actually produced 6 to 7 tons per day. The mill started up in December, 1966, and production was suspended at about the end of May, 1967. The following is the balance sheet at that time (in $US.) :

Assets

Inventory	18,637
Plant and equipment	643,987
Start-up expenses	106,692
Organisation expenses	3,414
Total assets	772,730

Liabilities

Barclay's Bank D.C.O.	136,000
Due to suppliers	150,000
Stockholders' equity and advances	486,730
Total liabilities	772,730

The values of the principal individual items are as follows :

Freehold land	15,000
Buildings	36,950
Wells	12,000
Ponds, bagasse storage area, boiler house, subsidiary buildings and installations	16,500
Machinery	491,640
Supervision, labour and interest during construction	72,279

The debt to Barclays Bank is a fluctuating overdraft at 10% per annum interest, and is secured by a Debenture on all

the assets of the Company. The amount due to suppliers is for the supply of local services, for supplies used in construction, and for operating materials. Of the total, approximately $US.15,000 is owed to small local suppliers in amounts under $US.2,000; and the balance, including approximately $US.30,000 due to American pulp suppliers, is owing to about 10 suppliers. The equity of the promotors is $US.320,000, and advances made by stockholders total $US.166,730.

During the period of operation 224 tons of paper were produced at a total cost of $US.166,841, excluding interest charges of $US.3,000 and depreciation charges of $US.8,208. If these latter charges are taken into account, then the cost per ton was $US.795, against a selling price of about $US.320 per ton. This corresponds with a loss of $US.475 per ton, giving a stated total of $US.106,692 during the 5 months of operation. Actually, however, 224 tons at $US.475 per ton gives $US.106,401.

The loss has been attributed to :

(a) The high chemical cost in cooking the sugar cane bagasse.

(b) The production of a small tonnage of bagasse pulp is uneconomical.

(c) Wastage of the bagasse in storing and handling, due to uncompleted facilities.

(d) Intermittent production, due to long shut-downs for machinery modifications.

(e) Orders which did not utilise the full machine width.

(f) Lack of spare parts in stock, due to capital limitations and to delays in shipping from the United States.

(g) High cost and waste of materials and consumables involved in training an unsophisticated labour force.

(h) Bad general management.

The present position of the majority of the investors is that, being unable to provide capable technical and fiscal management and, in these circumstances being unwilling to provide additional capital, the Company is for sale. The promotors are prepared to concede that their total equity contribution of $US.486,730 must be reduced by :

(a) the operational loss of $US.107,000 shown on the balance sheet as start-up expenses;

(b) the cost of the mill, which represents approximately 33% of the $US.491,000 invested in machinery, i.e., about $US.164,000;

(c) the approximately $US.16,000 invested in non-productive wells, and interest during construction.

These items therefore, reduce the value of the stockholders' investment to about $US.200,000. If this is the base on which the investors are prepared to conclude some financial arrangement, this value could be represented by (a) common stock provided by investors who would assume voting and management control; or by (b) a non-cumulative Preferred Stock to bear interest at a rate to be determined, and to be retired over a period of years. The latter would be a percentage of future profit and cash flow, after due allowance for re-investment requirements and re-capture of newly-invested capital.

As stated the factory started production in December, 1966 and closed on 31st May, 1967. During this period it manufactured chiefly or wholly creped toilet tissue, using as raw materials imported wood pulp, waste paper and bagasse pulp. Attempts to use local bagasse to make this pulp were not successful, and a licence was obtained to purchase 200 tons of bleached bagasse pulp

from the Company Venepal, in Venezuela (see Part III, (c)). This pulp appears to have given much better results but the quality of the paper made, judged from the only samples I have been able to find, was poor. Table 1 gives the analytical results for these samples. They do not correspond with the statements made as to the composition of the papers; in particular, bagasse is not greatly in evidence. The 2 sole customers for the tissue were very critical of the quality. They were Rolex Paper Co. (Trinidad), Ltd. and Trinidad Paper Products, Ltd.; and they described it as dirty, weak and abrasive. This does not seem to be an overstatement, although it may be coloured by the difficulty in obtaining licences to purchase toilet tissue from abroad when it was available from General Paper Products, Ltd.

The selling prices of the product were :

Single ply	$699 per ton
Double ply	$784 per ton

It was also the intention of General Paper Products, Ltd. to produce bleached and unbleached general-purpose wrappings and exercise and other book papers, and similar school papers, and to sell them to local converters - but not to convert themselves. In actual fact these plans were never realised. During the period that the factory was in production the output averaged only about 1.5 tons per day and was frequently as low as 0.75 ton per day. However it has been stated that on isolated days the production ran from 7 - 8 tons of tissue in 24 hours.

Since the closing of the Arima factory several reports have been made on it. These are summarised as follows :

H.B. Herman (1290, Bimini Lane, Riviera Beach, Florida): 19th January, 1968. This report was made for

Table 1

HEHNER & COX, LTD.

DIRECTORS
DR. JULIUS GRANT, M.Sc., F.R.I.C.
C. W. AYLEN.
C. H. ROBINS, B.Sc., F.R.I.C.
PUBLIC ANALYST

ANALYTICAL & CONSULTING CHEMISTS
UNION INTERNATIONALE DES
LABORATOIRES INDEPENDANTS

Telephone Royal 3538.
Telegrams Hehner, Royal 3538.

The Laboratories,
107, Fenchurch Street,
London, E.C.3.

OUR REF. JG/MU/28182X
YOUR REF. U.N. Trinidad.

27th September, 1968.

ANALYSIS OF A SAMPLE OF 5 Toilet Tissues

RECEIVED ON .....

MARKED A, B, C, D, E.

SEALED -----

Fibre compositions are as follows:

A.	Arima manufacture.	
	Chemical wood (mainly deciduous)	85%
	Mechanical wood	15%
B.	Imported.	
	Chemical wood (mainly sulphite).	100%
C.	Arima manufacture, said to contain Venezuelan bagasse pulp.	
	Bleached kraft coniferous wood	90%
	Deciduous chemical wood	8%
	Mechanical wood	2%
D.	Arima manufacture.	
	Chemical wood	85%
	Mechanical wood	15%
E.	Arima manufacture.	
	Chemical wood (mainly deciduous).	75%
	Mechanical wood	15%
	Bagasse	10%

p.p. HEHNER & COX, LTD.,
J. Grant.

Barclays Bank D.C.O. The view is expressed that the project was basically sound and that the failure was due to bad management and equipment. It is estimated that the present imports of toilet paper are approximately 150 tons per month on jumbo reels, plus 30 tons per month of napkin paper, also on jumbo reels, giving a total of say 2,000 tons of thin papers per annum. The conclusions have been supported by others, notably by the Government Printery (letter of January, 1968). In addition to this, there is, it is stated, an approximately 6% per annum growth rate for such products in Trinidad and Tobago, plus the possibilities offered by export under the Carifta Agreement (see however, Part III, (b)). It is concluded that the market therefore exists, and it is suggested that the factory should convert its products into small reels as well as manufacturing the raw material paper, so as to be independent of its 2 sole customers and at the same time take advantage of the considerable profits involved in conversion. In this connection the following costings were produced (Tables 2 and 3).

Anderson and Sutherland, (63, Frederick Street, Edinburgh, 2.) This report is dated 1966, and it values the factory at $US.40,000. It was made for the Sterling International Development Corporation (see below).

A United Nations Report (date unknown). This report concludes that a maximum of $US.135,000 would be required to rehabilitate the mill so that it could produce 7.5 tons of toilet paper per day, at a production cost of $US.250 per ton (cf. Table 2).

As a result of the Anderson and Sutherland Report the following suggestions have been put forward by Sterling International Development Corporation, and have been the subject of an

Table 2

COSTING (HERMAN REPORT)

Production - 2,000 tons per annum

Imported pulp	1,500 lb. at $160 per ton -	$120.00 per ton
Waste paper	500 lb. at $ 60 per ton -	$ 15.00 per ton
Total		$135.00
Allow for yield loss		13.00
Total		148.00
Labour		40.00
Power		6.50
Steam		6.00
Maintenance		5.00
Wires and felts		4.50
Chemicals		1.00
Management and overheads		25.00
Total		236.00
Contingencies		9.00
Interest (at 7.75%)		5.00
Total		$250.00

Selling prices :

1-ply	312.00
2-ply	356.00

It is interesting to compare this costing with those given in Part III (i), bearing in mind that selling costs, packing, transport and depreciation are not taken into account. The interest figure corresponds with a total capital of $US,130,000.

Table 3 gives costings for the conversion of the paper into toilet rolls.

Table 3

CONVERSION OF PAPER TO TOILET ROLLS (HERMAN)

Item	1-ply (14 lb.)	2-ply (10 lb.)
Proportion	60	40 %
Paper	1,200	800 t.p.a.
Cases	78,000	32,000 p.a.
Size of sheet	4.25 x 4.5	4.25 x 4.5 in.
Roll count	350 singles	550 doubles
Paper per case	31	49 lb.
Retail price per roll ($)	0.10	0.12
Wholesale price per case ($)	8.75	10.75
Cases per ton of paper	65	40

application to the Trinidad and Tobago Industrial Development Corporation for fiscal assistance under the Aid to Pioneer Industries Ordinance, in March, 1968.

The objective of the project is to develop a modern, efficient paper mill manufacturing a range of papers now imported. It will be undertaken in three stages :

(1) The rehabilitation of the facilities previously owned by General Paper Products, Ltd.

(2) Erection of a new paper machine adjacent to the existing mill. Other paper processing equipment will also be installed.

(3) Installation of equipment to process bagasse as a raw material for the paper to be produced.

To implement the above a new company, Caribbean Paper Company, will be formed, which will be a joint venture of one company from the United States and two Trinidad companies. The former, Sterling International, is a pulp and paper company whose headquarters is in San Francisco, California, United States. Founded in 1953, Sterling International has subsidiaries in Europe, Asia and Latin America and conducts a world-wide business in the paper industry. It is now active in Trinidad as a result of Sterling's interest in SIDCO, Ltd. (Sterling International Development Corporation), which is the controlling stockholder of Trinidad Paper Products. Sterling International's affiliation with Trinidad Paper Products is one of a series of Sterling paper industry manufacturing investments outside of the United States. Others include interests in Hong Kong, Costa Rica, and Thailand. The 2 Trinidad companies are Alstons, Ltd. and T. Geddes Grant, Ltd. It is possible that a third Trinidad partner with interests in the paper field may be included. However, Sterling International

will hold 50% of the interest.

Stage 1. This will cost an estimated $200,000 for the rehabilitation of the present factory. Extensive redesign of the existing equipment is required, a substantial amount of new equipment will have to be provided from North America and Europe, and further improvements will have to be made at the site. Major repair items on the paper machine itself include the wet end, the Yankee drier, and the rewinder. Repairs to the drier, which involve grinding the face, will cost $15,000. The principal items of new equipment include pumps and electric motors, and a basic inventory of running spares. It will cost $25,000 to develop satisfactory water resources, and storage and effluent disposal plant.

The interim objective will be to produce a range of wrapping papers; 3.5 tons per day, about 1,000 tons per annum. The secondary objective during Stage 1 will be to attempt to produce second quality toilet tissue; it is believed that the present machine is inherently incapable of producing first quality lightweight tissues.

Stage 2 will be undertaken when the breakeven point is reached. A new paper machine will then be ordered. It will be of modern design and will produce best quality tissue grades. The tender specifications for the paper machine have already been issued (since Sterling expects to buy a similar machine for installation elsewhere), and therefore the engineering for the expansion of the Trinidad mill is substantially complete. The rehabilitation of the present factory will be completed during Stage 2, at an additional estimated cost of $200,000.

During Stage 2, the venture will also invest a further $100,000 in machinery to produce facial tissue in boxes. This

is presently not manufactured in Trinidad, although some 9,000 cases annually are imported. This is enough to justify the installation of domestic manufacturing facilities.

The cost of the paper machine will be approximately $1.2 million and the total investment required to complete Stage 2 will be $1.4-1.6 million.

Stage 3. This concerns the question of the utilisation of indigenous bagasse. One of two things has to happen before bagasse can be utilised effectively. The most likely development would be that technology and machinery improves, enabling bagasse to be processed economically at low throughputs. Sterling is optimistic about this, but it has not yet occurred. The other factor is the increase in total market requirement in Trinidad and Tobago so that 20 or more tons per day of pulp could be utilised. Probably both technology will improve and market demand will increase, so that the installation of bagasse equipment becomes economically justifiable. At this stage modern bagasse pulping facilities will be installed and will cost about $100,000. There may also be opportunities to instal a small machine to manufacture, for example, printing papers, as a fourth stage, or as part of Stage 3.

Each of the stages of the project will result in savings of foreign exchange, viz. :

Stage 1: The imported raw material component of the mill production during Stage 1 will represent less than 20% of the value of the mill's production of just over 1,000 tons. Foreign exchange saved, about $300,000 per annum.

Stage 2: Production of 1,500 tons of tissue, whose imported raw material production component will be of the order of one-third of the total raw material cost; additional foreign

currency savings of $500,000 per annum.

Stage 3: The use of locally produced bagasse pulp would obviate the need for virtually all of the imports mentioned above, and would result in a mill operating wholly on local raw materials. Foreign exchange savings would be a further $300,000 per annum.

Fiscal incentives requested for Stage 1 are the standard concessions granted under pioneer status, a five-year income tax free period from the start of commercial production; duty-free imports of plant and equipment; duty-free imports of raw materials and supplies; accelerated depreciation allowances; unlimited carry-over of losses; and guaranteed repatriation of capital and profits.

It is further requested that at Stage 2 the pioneer status period be extended so that a new commencement date shall be applicable to the entire project, such date to be the day on which commercial production is achieved on the new paper machine. The justification for this is that it is virtually impossible, from an accounting viewpoint, to separate the finances and accounts of the 2 stages.

Finally, a new five-year term is requested from the day commercial production is achieved on a bagasse processing facility, and, again, the new date would be applicable to the entire project.

The joint venture also requests the direct financial assistance of the Industrial Development Corporation in connection with the execution of Stages 2 and 3. If the joint venture undertakes Stage 2, the joint venture will apply for a $100,000 IDC loan, such loan to be disbursed by the IDC at the time when a new paper machine having a value of at least $1,000,000 shall arrive in Trinidad ready for installation. The purpose of this loan shall

be to help defray the cost of local currency expenses during the construction of the new facilities. Further financial assistance is requested in the event that the joint venture proceeds to execute Stage 3. Accordingly, a loan of $100,000 is requested when bagasse pulping equipment arrives for installation, the purpose of the loan again being to help defray local installation expenses.

Concurrently with this application, certain permissions are being sought by the joint venture from the Exchange Control, both in connection with the registration of the capital to be invested in all 3 stages of the project and also in connection with the borrowings which may be arranged with local Trinidad banks. The help of the IDC in obtaining the necessary approval from Exchange Control is requested. Repairs of the approach road to the mill are also requested (see Part III, (g)).

The right is reserved to request the IDC to restrict the export from Trinidad of waste paper. Since the new operating company would expect to pay at least the presently prevailing prices for waste paper, there should not be any necessity for export restrictions, but the IDC committment in this matter is requested.

Finally, the joint venture understands that, as a matter of course, restrictions are imposed on the imports of products which are produced (of comparable quality). While some of the products to be produced by the new company will be dependent for their commercial viability on artificially created economic conditions, the joint venture does expect the normal protection accorded to products produced in Trinidad and Tobago.

In Part III, (i), (Table 26) an attempt has been made to translate the implications of Stage 1 of this proposal into a costing. It indicates a profit of $94,000 per annum, equivalent

to 13.4% on the total capital employed.

There is reason to believe that the other Company manufacturing toilet rolls in Trinidad would be interested in a plan involving a rehabilitated Arima factory. Reference is made to this under the heading of Visits to Paper Users (Rolex Paper Co. Trinidad, Ltd.), below, though no details as to any proposals from this source are yet available.

(b) Description of the Mill

This description is pieced together from three personal visits; documentary evidence from the mill records and elsewhere; and information received from Mr. A.F. Castro, former Director of the Company, and 3 employees of the Company. It must be appreciated that the mill had been shut for some 14 months at the time of my visit, and for this reason my personal observations were to some extent limited in scope and value.

The description is divided into 4 parts dealing, respectively, with bagasse pulp preparation, stock preparation for the paper machine, the paper machine, and general. Following the description in each case are my views on the plant, so far as I was able to envisage it in its operating state. This description does not pretend to be exhaustive; it deals mainly with the features of the factory and installation which are relevant to the comments and recommendations made in this Report.

Bagasse Pulp Preparation Plant. This consists essentially of 2 lagged, horizontal, cylindrical rotating digesters, each with 2 emptying or filling holes, and said to hold 2 tons of 50% dry bagasse and to operate at 30 lb. per square inch pressure. Caustic soda was dissolved in tanks at ground level and pumped to the filling floor. The loose bales of bagasse travelled to the filling floor on a conveyor, but no duster was used. It is

understood that a depithing machine was to have been installed, but this was not done; it is said to be still on the site but was not apparent. The digesters had individual dropping chests where water was added, the resulting pulp slurry being pumped on to an inclined machine wire through which the black liquor drained continuously on to a land soakaway. This process could be repeated continuously to wash the pulp. I understand that only one of the digesters was in operation at the time that the factory was closed.

The partly washed pulp then passed through a launder to a stainless steel shaking screen of the Jönsson type, having holes 5/8th inch in diameter, at the time of my visit, to a sump; whence it was pumped over another sloping machine wire to an Edward Jones and Sons potcher. This had a fixed roll and washing drum. Here solid bleaching powder was added to bleach the bagasse pulp.

Flow sheet drawings of the plant and process were inspected and generally speaking, they show a more elaborate and preferable system to that which apparently was actually installed.

Comments on Pulp Preparation. The preparation of bleached bagasse pulp as customarily carried out is dealt with in Part III, (h). It is apparent from this that a satisfactory bleached bagasse pulp cannot possibly be made in the type of equipment installed in the present factory. Even assuming pith removal, a rotary digester is not the best method (although it is a possible one), but a pressure of 30 lb. per square inch is far too low and the method of washing out the black liquor is crude and inefficient; moreover, all the chemicals used are wasted. The method of screening of dirt

from the pulp is also unsuitable and inadequate. As for the bleaching operation, the direct addition of bleaching powder in this way is unknown and contributes lime to the pulp with any advantage. Even if a bleaching powder solution is used, a reasonable colour cannot be obtained with it alone; the use of a sophisticated multi-stage bleaching process, using chlorine or chlorine dioxide, is necessary to produce a pulp of really good colour and stability without degradation of strength.

An average - to low-grade unbleached bagasse pulp could however be made with the present system slightly modified, and such a pulp could be used in such products as corrugating medium i.e., for making the corrugated inside layer of cartons. The method would not be ideal for this purpose on economic grounds because of the high cost of chemicals and the absence of proper mechanical defibration and dirt removal. However, the Jönsson screen could probably be adapted to take care of the former (see Part III, (h)).

Stock Preparation Plant. The object of this plant is to prepare the virgin pulp or other fibrous raw material for assembly into a paper web on the paper machine. In the present instance, the materials used were imported wood pulp (bleached kraft coniferous pulp), waste paper and bagasse pulp.

Bagasse pulp from the potcher was dropped into a chest and pumped to a similar type of equipment, which in this case is fitted with an adjustable roll and has no washing drum. It thus served as a beater. This beater was also used to disintegrate the imported wood pulp and the waste paper. The partly-beaten pulp was then dropped into 2 chests (without agitators, however), and thence pumped through a Poirier consistency controller to 2

No. 2 size Emerson jordan refiners, designed to be used in series or in parallel. Then followed a 5-unit Bauer Centricleaner set (not 6 units as stated in the specification), which I understand was not used. After this the stuff was pumped from a sump to the head-box of the paper machine.

Comments on Stock Preparation. The original drawings show a much more elaborate system of stock preparation than that described above. Indeed, it offers little ground for criticism for the manufacture of toilet tissue alone. The system as installed however, provides inadequate capacity because of the small size of the jordans and the wholly inadequate cleaning facilities for screening the pulp. The latter is important even when imported wood pulp is used, but it is vital if bleached or unbleached bagasse or waste papers are used. It is also bad practice to process bleached pulp and waste papers in the same equipment, and such pulps should be mixed only after the waste paper pulp has been through the screening process. This is not possible with the present arrangement. The absence of agitators in the chest is an obvious disadvantage because of the tendency of the pulp and water to separate, so that different concentrations of pulp are present in the top and bottom of the chest when pulp is drawn from the base and more pulp added at the top. This could result in differences in basis weight, unless adequate consistency control is used. Once again stress should be laid on the importance of adequately cleaning the pulp before it goes to the paper machine, if clean paper and absence of breaks are to be ensured.

The Paper Machine. The head-box is of the simplest type, with an adjustable slice and a monkey roll. The wire is comparatively short (top surface, 210 inches), and there are only 2

suction boxes. There are no tube rolls or shake, and wooden wedges under the wire serve to assist such water removal as cannot take place by natural drainage. The backwater apparently, runs to the drain, except after the first part of the wire where it is taken back for diluting the incoming pulp. There is a plain felted couch with a rubber top roll; and one suction press with a rubber top roll, which is stated to have given trouble.

Drying is on a Sandy Hill machine-glazed (M.G. or Yankee) drying cylinder 8 ft. (8ft.4in. in drawing) in diameter, and operating at 55 lb. per square inch pressure. It is covered by a Ross Engineering hood,the outlet of which is inside the roof and is stated to give rise to condensation trouble. The cylinder is said to be flat over an area of 8 to 10 inches, and has been filled with plastic, but it is said to give drying trouble over this area. The wet web is carried to the drying cylinder from the wire between 2 felts, the top being 56 x 86 feet and the bottom 45 x 60 feet. They carry the web through the single press (not a double press as shown in the original drawing), and thus it is transferred to the glazing cylinder by means of a pickup arrangement.

At the time of my visit the surface of the cylinder was greased for protection and consequently, it was not possible for me to form my own conclusions as to its condition. The cylinder was fitted with a creping doctor of Monel metal; dimensions, 0.050 x 4 x 90 inches. There is a 3-roll calendar and a Pope reeler trimmer giving a trimmed width of 80 inches. Single - or double - ply tissue could be made.

The drive is operated by mains electricity using alternating current motors and a line shaft with gear reducers; it is said to be capable of running at 750 feet per minute. In

practice, so far as can be ascertained, the maximum speed hitherto has been around 250 or 350 feet per minute. It seems to be in fairly good condition, and this speed should be possible.

Comments on Paper Machine. This machine has been put together from very old, used parts. For example, the dryer is dated 1938 and is specified as being 96 inchest on the face and having a working pressure of 50 lb. per square inch. Most of the other parts, according to the drawings, are dated 1941. The hood is comparatively new.

Apart from the above, the defects in the paper machine arise mainly from the poor type of head-box with lack of proper adjustment, absence of adequate water removal facilities in the form of tube rolls, etc., the use of only 2 suction boxes, the absence of a shake (which however, is not entirely essential for making tissues although it would be necessary for the wrapping papers which were to be made). Only one of the 2 presses shown on the drawings is installed, and the backwater recovery system (or absence of it) means that there must have been considerable wastage of fibre during the running of the machine. It is difficult to give an opinion on the drive without seeing it in motion; however, although it cannot be described as an up-to-date drive, with rehabilitation and certain modifications it should be satisfactory for obtaining a speed of 350 feet per minute. Whether the alleged 750 feet per minute could be obtained with the existing equipment is very much open to doubt. There appear to be no facilities for conditioning the felts. The state of the drying cylinder merits serious consideration because reconditioning can be an extremely costly matter. If such repairs as are necessary can be carried out in situ the cost can be kept to a minimum; this

would apply to plugging and grinding. If however, there are any major defects to be repaired the cylinder would probably have to be taken away for the purpose, in which case the cost of the repairing could be more than its total value. Further reference to this is made below (Part III, (b)). It is understood that a quotation of $15,000 has been obtained for this repair from Beloit Corporation.

Miscellaneous. The site itself is approximately 10 acres is area, and the buildings occupy approximately 9,000 sq. feet. It is not an ideal site by any means, being open to the possibility of flooding and not too well placed from the point of view of communication with the larger towns of Trinidad. However it exists, and its location does not rule out the possibility of further development on the same site. As Figs. 2 and 3 show, the approach road to the mill from the main Tumpuna Road crosses the Guanapo River by means of a road bridge following the Manuel Congo Road. This bridge is unsafe in its present state, having no sides and being very narrow; moreover, in flood weather it is submerged by the waters of the Guanapo River. This arises from the damming of the river by logs, etc., which cannot pass underneath it. This matter should be attended to in any future development of the site (see also Part III, (g)).

The following auxiliary services are shown on the planned drawing :-

Boiler House.

Gasoline storage.

Depithing area (for bagasse).

Two lagoons, each 200 x 200 feet.

Septic tank, and leaching field (for black liquor).

Locker room and canteen.

Offices.

Notes on these are given below, insofar as they affect the present Study.

Boiler House. The boiler is a Cleaver-Brooks "6,000 lb." oil-fired package boiler having the following specification :

Model, Sentry.

Date, 1962.

Maximum working pressure, 300 lb. per square inch.

Operating pressure, 150 lb. per square inch.

Rating, 6,600 lb. steam per hour (9,000 lb. mentioned elsewhere).

Maximum tube temperature, 400°C.

The boiler and its building are in good condition, indeed almost new, and should prove serviceable for any future development.

Water Supply. In order to make approximately 8 tons per day of paper using imported wood pulp or waste papers, not less than 250,000 gallons per day of water would be required in a mill run with reasonable efficiency and having a fairly good backwater recovery system. The quantity of effluent would also be of this order. This water requirement would be approximately doubled for a mill producing its own pulp for the paper output, as was originally intended at the Arima factory.

The original plan was to obtain the water requirements from a deep well located near the machine house, but this was abandoned when a stratum of micro-sand was tapped at about 150 feet deep; however, plenty of water was obtainable at this

depth. At that time the water of the Guanapo River which flows quite close to the mill (see Fig. 3) was clear, and it was therefore used for mill purposes. However the clarity of the river water was short-lived, since it corresponded with a period of inactivity at the 3 gravel washing plants upstream of the mill, namely, Kerry's on the Guanapo River, Haddaway's on the Arima River just before its junction with the Guanapo River, and Harriman's higher up the Arima River (see Fig. 2). When these gravel pits started work again following a new government contract, sand washings discharged into the Guanapo River made it turbid and coffee-coloured and quite useless for paper manufacture without purification. A shallow well was therefore, sunk by the river bank on the mill site, approximately 6 feet below the level of the river bed. It was stated that the water percolating into this well was satisfactorily clear, although the quantity which could be collected is not known. As this work coincided with the closing of the mill, the well was never properly put to the test.

At the time of my 3 visits, all rainy periods, the river was running very fast and was very turbid and discoloured.

The whole question of water supply is dealt with fully in Part III, (g). At this stage it suffices to comment that an adequate supply of clean water suitable for paper manufacture could have been made available to the Arima factory during its period of operation by taking suitable steps. The chemical nature of the water is more controversial, as relevant chemical analyses are not available although some were obtained for boiler feed purposes, see Part III, (g).

Effluent Disposal. As stated above, the black liquor and strong washings from the bagasse digesters were disposed of

during the operation of the bagasse plant by means of a land soakaway, and this appears to have caused no problem. This no doubt, is due partly to the fact that the mill operated only during the dry season; but chiefly because the boiling of bagasse was partly or wholly abandoned. As a long-term solution to the problem, the above measures are not likely to be satisfactory. Effluent disposal methods must be based on the standard requirements set down by the authorities for the effluent concerned, and in this connection the sponsors of the project sought the views of the Water and Sewerage Authority in July, 1965. These were set out in the following letter, dated 23rd August, 1965, from the I.D.C. to General Paper Products.

"Dear Sir,

With reference to your letter of the 1st July, 1965, with specific regard to the conditions attached to the approval in principle for the grant of pioneer status granted to General Paper Products (Caribbean) Ltd., I am to inform you that the following are the conditions to be imposed as regards the disposal of effluent:-

A. No effluent (inclusive of that from the drying of sludge) to be discharged to the stream unless an emergency condition arises, in which case there shall be:-

(a) No direct discharge - (the proposal to provide two (2) lagoons each 200' x 6' - 0" deep while production is 5 tons/day is acceptable).

(b) The dissolved oxygen level at the 'critical' point down stream of the effluent discharge to be not less than 5 mg. per litre. If at any time stream dissolved oxygen above Paper-Mill is 5 mg. per litre or less, no effluent under any circumstances to be permitted to enter the river.

(c) No deleterious effects from floating or settleable solids.

(d) No toxic effects on fish and other acquatic life.

(e) No nuisance effects from colour or odours.

B. There should be a minimum depth of 4 feet between the bottom of the lagoons and the highest ground water table level.

C. (a) One (1) inspection chamber for sampling effluent to be provided between lagoon and river.

(b) Provision to be made for sampling ground water below lagoon.

I shall be grateful for your confirmation that the imposition of these conditions as regards your pioneer status approval would be agreeable to you, as the approval of your proposed site would depend on your observing these conditions."

Apparently these standards arose as a result of a misunderstanding, because it is obvious that condition (A) and condition (Ab) are impossibilities. For any subsequent project on this site, the effluent standards question would have to be reconsidered, and this is discussed further in Part III, (g).

The other features of the auxiliary services for the mill call for little comment. Absence of laboratory control and instrumentation on any appreciable scale are serious deficiencies.

(c) Future Considerations

As to the future of the Arima factory, the following 4 alternatives would appear to be available, namely :-

1. Abandon the present project completely and sell the mill and contents. This course is not recommended, because the machinery would have little more than scrap value once it is removed from the site; it is old, its condition is not good, and it is incomplete, and no one with any knowledge of papermaking economics would consider buying it for erection elsewhere. The boiler plant and all the buildings are however, in good condition, and if an industry could be attracted to the site and could make full use of both of these, then they should realise something approaching their full value. On this basis it seems that the whole mill and site, as it stands is unlikely to yield much more than about $180,000 say, $200,000 maximum. This assumes

that most of the papermaking machinery would be sold for scrap and that the land, buildings and boiler would be sold at approximately their original cost.

2. To establish a paper industry elsewhere in Trinidad, quite independently of the General Paper Products scheme in respect of both materials used, end-products made, and scale of manufacture. As is shown in Part III, (i), this would be premature at the present time.

3. Rehabilitate the Arima factory and use it to make toilet tissue much as originally intended. The scheme to do this put forward by Sterling International (Part II, (a)) appears to be a reasonably sound proposition along these lines.

4. Rehabilitate the Arima factory and operate it with a fresh approach as regards the fibrous raw materials used and the end-products made. This appears to offer the most promising future for the factory. It has the advantages of producing a greater annual tonnage at a fairly high average price (thereby saving more foreign currency); of flexibility, because it would manufacture more than one grade of paper; and the possibility of using a certain amount of local fibrous raw material in the immediate future.

As the cost of production calculations given in Part III, (i) demonstrate, alternative (4) offers the greatest measure of profitability, despite the additional capital cost required, as compared with alternative number (3). One advantage which might be put forward in favour of alternative (3), is that Sterling International and possibly also the other toilet roll manufacturer, Rolex Paper Co. (Trinidad), Ltd., would be interested in financing and implementing the venture. They may

be less willing to become involved in alternative (4), which would not assist them in providing material for their particular type of paper conversion. It may therefore, become a question of Government policy, whether to hand over the less attractive alternative wholly to private enterprise, or to embark on the problem of financing and running a larger but eventually more lucrative alternative.

Part III of this Study is therefore, concerned with a detailed study of the feasibility of a paper industry for Trinidad and Tobago, with a view to indicating just what is involved and the means of achieving it. Each factor concerned is considered on both a short-term and long-term basis, and the corresponding recommendations are set out in Part IV.

PART III

A PAPER INDUSTRY FOR TRINIDAD AND TOBAGO

(a) General

The main objectives of this part of the present Study have already been set out above. It therefore, examines in detail the merits of 2 alternative approaches, namely :-

1. Short-term, involving the reconditioning and rehabilitation of the Arima factory.
2. Long-term, involving a future paper and, possibly, a pulp industry for Trinidad and Tobago on a larger scale.

Any scheme of the first type should involve a minimum outlay of capital because, in addition to that already invested and lost in the General Paper Products, Ltd. project, a costly scheme is hardly likely to be attractive in view of the past history of the factory. It should be appreciated in a paper mill the paper machine is by far the biggest, most important and costliest single unit, and it offers few outlets for major economies in design and construction. This means that any immediate future scheme should be centred around the present paper machine at Arima, rather than around a new machine to replace it or to supplement it. The cost of the latter would be prohibitive, and the sale of the present machine would contribute relatively little to the cost of a new one.

It seems therefore, that the most logical approach would be alter and rehabilitate the present machine to enable to make not only a greater variety of grades of paper than at present, but also a larger quantity of products. This would give the mill greater flexibility, increased turnover (with saving a foreign

currency), and it would benefit a wider range of paper users in Trinidad. It would also avoid the likelihood of creating a monopoly as inherent in the sole production of toilet paper, for which at present there are only 2 customers. In any case, dependence on such a limited market and on one source of manufacture could be precarious both for the mill and for the users of the paper, respectively.

A market study of the paper consumption of Trinidad and Tobago has therefore been made, with the object of ascertaining the most promising grades of paper which the newly-constituted mill might make. It is important to realise that only a restricted number of grades of paper can be made on one particular paper machine, even if it is constructed so as to be as versatile as possible. Moreover both paper products and boards cannot be made on the same paper machine, so boards therefore are excluded from consideration except for the thin varieties used for folders and corrugating. The selection of the papers which, from the market point of view can be made to the best advantage, is therefore, a very important matter and was the purpose of this present part of the Study.

(b) Markets

In order to obtain the necessary information as to markets, it was necessary to rely partly on statistics as published by the Central Office of Statistics and the Customs Department; and partly on the views of the more important users of paper and paper products in Trinidad. With one exception, data as to quantities, future possible requirements and prices, were given very freely, and this information contributed in no small measure to the conclusions arrived at and set out below. The facilities

currency), and it would benefit a wider range of paper users in Trinidad. It would also avoid the likelihood of creating a monopoly as inherent in the sole production of toilet paper, for which at present there are only 2 customers. In any case, dependence on such a limited market and on one source of manufacture could be precarious both for the mill and for the users of the paper, respectively.

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afforded by the Central Statistics Office and Customs Department are also acknowledged with appreciation. However, difficulties were encountered owing to the use of "omnibus" headings and the methods of classification used, since these involved overlaps whereby the same type or grade of paper might be found in 2 different classifications. The problems involved and the method of solving them are indicated below.

Table 4 sets out the imports of paper and paper products into Trinidad and Tobago for the last complete year for which they are available (1967). They show the description, code number, tonnage, value, and average price in dollars per ton. The last-mentioned figure is of significance only where the papers imported were of a uniform type, i.e., involving one grade which perhaps differed only in basis weight. Unfortunately price values prior to December, 1967 are of limited value owing to the incidence of devaluation of the £. sterling at that time. Increases in price since that date would depend on the country of origin, i.e., according to whether it adopted devaluation - although there were some price increases even in countries which had done so. Other means therefore, were adopted of checking the prices of the papers, and these also are indicated below.

Table 4 lists 13 grades of paper or board under the Code number 641, which is intended to refer to these products in the unconverted state. Code number 642 lists 8 grades of paper which are, in effect, converted paper, i.e., in the form of paper articles. Average prices in Code 642 are, of course, of no significance at the present instance. At the bottom of the table are given the totals for Code 641 (paper and paper board), and

Table 4

IMPORTS OF PAPER AND PAPER PRODUCTS

INTO TRINIDAD AND TOBAGO, 1967

Description	Code	Tons	Value ($1,000 cif.)	Average Price ($ per ton)
Newspaper	641-01010	5,260	1,487	278
Other Newsprint	641-01020	105	38	365
Writings and Printings	641-02000	2,460	1,659	680
Wrappings	641-03010	1,245	749	632
Packing Paper	641-03020	220	65	296
Cardboard	641-04000	675	360	532
Building Board	641-05000	2,900	577	199
Bitumenized Paper	641-06000	208	48	232
Other Coated Paper	641-07000	1,570	1,529	980
Wallpaper	641-08000	5	8	1,600
Cigarette Paper	641-11000	43	86	2,000
Blotting Paper	641-12000	10	23	2,300
Paper and Paper Board N.E.S.	641-19000	6,800	2,949	440
Bags without Handles	642-01010	377	226	-
Bags with Handles	642-01020	94	73	-
Cardboard Boxes	642-01090	520	59	-
Envelopes	642-02000	26	66	-
Manufactured Writings	642-03000	104	274	-
Napkins	642-09010	123	165	-
Toilet Paper	642-09020	4	67	-
Manufactured Paper N.E.S.	642-09090	330	763	-
Totals:				
Paper and Paper Board	641	21,700	9,585	-

Code 642 (paper articles). It will be seen that in 1967, the former amounted to 21,700 tons, valued at $9,585,000. By comparison, the weight of paper articles imported was comparatively small, though disproportionally greater in value - as might be expected.

A further study of Table 4 demonstrates that the item "Paper and Paper Board not elsewhere specified" (Code 641-19000) accounts for 6,800 tons out of the total of 21,700 tons. It is in fact easily the largest in tonnage and also the greatest in value of all the grades of paper listed. Second in terms of tonnage is newspaper at 5,260 tons; it is assumed that this figure refers to newsprint rather than to finished newspapers. If the 6,800 tons of Code 641 and 5,260 tons of newsprint are deducted from the total of 21,700 tons, then the amounts remaining for all the other grades of imported paper (namely about 9,640 tons) are individually comparatively small.

These considerations must be borne in mind in selecting the grades of paper which the reconditioned machine at Arima might be able to make. Dealing with the grades listed, in series, newsprint and other newsprint papers are eliminated because of their low average price (as shown in the last column of Table 4). It would obviously be impossible for a mill such as that at Arima to compete, using imported wood pulp, with the high-production newsprint machines of North America and Northern Europe. Any advantage that might be derived from a saving in transport would be lost partly in the importation of the raw material, a very cheap product; and partly in the low production of the machine itself. On the other hand, writings and printings, which accounted for 2,460 tons, could probably have been made on the

reconditioned machine with the exception of some of the higher and specialised qualities. Much the same applies to wrappings and packing papers, although here again certain types would be excluded. Hardboard, building board, bituminised papers and other coated papers, wallpapers, cigarette paper, etc. blotting paper, would also be excluded, but these tonnages are in any case relatively small.

It therefore, appears evident that one of the most important categories of all is the 6,800 tons represented by paper and paper board "not elsewhere specified". It was therefore, necessary to find out just what was included under this particular heading, and this involved consulting the original documents for the year concerned, a very laborious but essential procedure. Actually only items exceeding or equal to 20 tons per consignment were taken into consideration, but during the course of the year there were nearly 100 of these. The results are summarised in Table 5. Of these, all or part of the following grades could be made on the proposed paper machine: Corrugating medium, certain bag papers, toilet paper, envelope paper. Genuine kraft papers could not be manufactured economically.

The balance of the 1967 tonnage in this class is made up of numerous small miscellaneous items of less than 20 tons per consignment, which were excluded from the analysis. Of course many of these belong to one of the above 4 grades of paper which might be made at Arima, but their quantities are small, though unknown.

Table 6, shows the imports of certain grades of paper into Trinidad and Tobago during the 6 months, January to June, 1968, inclusive; only those relevant to the present project are

listed. It will be seen that these total approximately 5,000 tons and, if it can be assumed that the figures for the second 6 months are similar, then a total for the year of approximately 10,000 tons of these grades of papers is reached. Actually this is rather less than the total for similar papers for 1967 (see Table 4), but it will be noted that during the relevant 1968 period virtually no packing paper was imported, whereas in 1967 some 220 tons of such papers came into the country. If one includes both the toilet paper rolls (844 lb.) and say, 300 tons of wrapping papers, then an estimated grand total for the year 1968 of approximately 10,300 tons is reached, as compared with a total of 10,725 tons for the same papers in 1967. The former figure is obviously only an estimate, because it is based on 6 months of imports, and it must be judged accordingly. A better indication of the rate of increase of consumption in Trinidad and Tobago is given below.

Table 5

PRINCIPAL GRADES OF PAPER "NOT ELSEWHERE SPECIFIED", 1967

Grade	Quantity (tons)
Semichemical corrugating medium.	990
Kraft liner and sack paper.	1,900
Tissue and toilet paper.	705
Envelope and similar papers.	108

Notes :

(1) Individual consignments of less than 20 tons are excluded.

(2) Boards and similar products are excluded.

(3) The tissue paper imports probably represent less than the normal annual consumption because some tissue was being supplied by the General Paper Products mill at Arima in early 1967.

Table 6

IMPORTS OF CERTAIN PAPERS INTO

TRINIDAD AND TOBAGO

January - June 1968 inclusive

Customs Code	Weight (tons)	Value $	Average Price per ton $
Printing and Writing Paper 641-02000	885	803,294	910
Wrapping Paper 641-03010	518	298,029	575
Packing Paper 641-03020	-	-	-
Paper & Paper Boards N.E.S. 641-19000	3,600	1,867,559	-
Totals	5,003	-	-
Toilet Paper in Rolls 642-09020	844 lb.	455	-

In view of the above data it seems that the output of the mill might best be made up along the following lines. It is first of all assumed that it could produce 12 tons per day for say, 340 days per annum (see Part III (i)), giving a total of approximately 4,000 tons per annum. This would best be made up approximately, as shown in Table 7 :

Table 7

SUGGESTED PRODUCTION FOR ARIMA FACTORY

Grade	Proportion of 1967 total (per cent)	Approx. Quantity (tons)
Writing and Printing Papers.	80	2,000
Wrappings and Bag Papers.	70	1,000
Corrugating Medium	100	1,000
Toilet tissue	as required	
Total (t.p.a.)	-	4,000

The above proportions could be varied according to the market conditions and prices. Costings of these grades are given in Part III, (i).

It will be noted that it is assumed that the Arima mill will not make all the local requirements (based on 1967 figures) of each grade of product. This is because a proportion may be of a speciality nature (see "Visits to Paper Users", below) which the mill could not make. In particular, some of the writings and printings will be of a quality which the mill could not attain. It will also be noted that it is assumed that all the corrugating medium requirements will be made. Actually, it is believed that the 1967 estimate of 990 tons is low (for reasons explained above), and that the consumption will be considerably greater in say, 1969-70. If it so happens that there is no market for the whole of the 1,000 tons to be made at Arima, then the balance of the production of this mill can be filled with toilet tissue, though less profitably as shown in Part III, (i).

Future Production.

The data of Tables 8 and 9 are plotted in the graph of Fig. 4. They show tonnages and values for the years 1963 to 1967, inclusive, for papers in the categories, printings and writings (641-02000), wrappings and packings (641-03010 and -03020), paper and boards not elsewhere specified (641-19000), and toilet paper in rolls (642-09020). These are the maximum total quantities that the reconditioned mill might possibly make. The quantities that the mill would actually make would be smaller, but it can reasonably be assumed that the same rate of annual increase would apply to the papers it can make as to the total papers in the above categories.

Table 8

IMPORT (TONS) OF CERTAIN GRADES OF PAPER AND PAPER PRODUCTS INTO TRINIDAD AND TOBAGO, 1963 TO 1967 INCLUSIVE

Description	Customs Code	1963	1964	1965	1966	1967
Writings and Printings	641-02000	1,575	1,240	1,290	1,900	2,460
Wrappings	641-03010	1,050	935	69	1,980	1,245
Common Packing Paper	641-03020	6	11	34	19	220
Paper and Paperboard N.E.S.	641-19000	1,520	3,780	5,050	5,880	6,800
Toilet Paper (Rolls)	642-09020	444	231	175	192	4
Totals	-	4,595	6,197	6,618	9,971	10,729

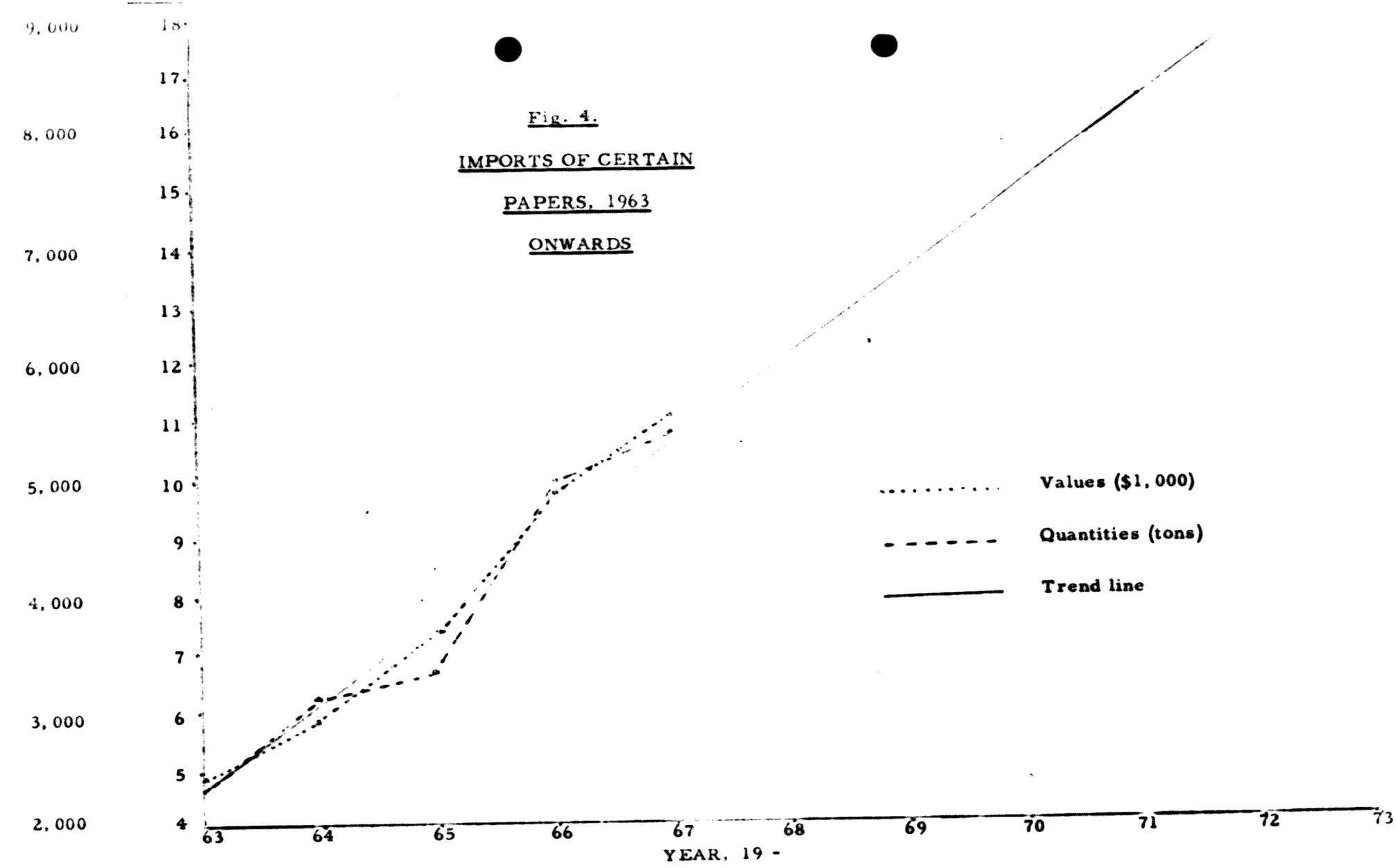
Table 9

VALUES OF IMPORTS OF CERTAIN GRADES OF PAPER AND PAPER PRODUCTS INTO TRINIDAD AND TOBAGO 1963 TO 1967, INCLUSIVE, IN $1,000 C.I.F.

Description	Customs Code	1963	1964	1965	1966	1967
Writings and Printings	641-02000	1,002	889	1,163	1,419	1,659
Wrappings	641-03010	526	461	515	959	749
Common Packing Paper	641-03020	5	7	18	6	65
Paper and Paperboard N.E.S.	641-19000	539	1,394	1,884	2,340	2,949
Toilet Paper (Rolls)	642-09020	307	153	107	121	6
Totals	-	2,379	2,904	3,687	4,845	5,428

Fig. 4.

IMPORTS OF CERTAIN PAPERS, 1963 ONWARDS



It will be seen that the graphs for both values and quantities rise at a surprisingly similar rate. It is also apparent from the slope of the trend line obtained, that if the mill could make a fresh start, say at the end of 1969, then an overall increase in demand of about 25% could be expected as compared with the last year for which statistics are available, namely 1967. This would mean that a market of some 6,500 tons per annum would be available of which the mill could make say, 4,500 tons. This would appear to place it in a conservatively safe position so far as markets are concerned. Moreover it could pick and choose the qualities of paper it makes so as to ensure that its operations are as profitable as possible. Thus for example, there is a bigger margin of profit on the writings and printings than on the wrappings; an increase in the market for the former could therefore be met by reducing production of the latter. Unfortunately it is not possible to take full advantage of the relatively high price of toilet paper, because production of such paper would fall well below the average of 12 tons per day (see Part III, (i)).

Finally, looking to the more distant future, it should be noted that the per capita consumption of paper and paperboard of all kinds has risen from 34 lb. per annum in 1959 to 53 lb. per annum in 1967, despite the increase in population from about 800,000 to about one million in that period. Some comparison figures are: United States 520, United Kingdom 250, France 73, Italy 32, U.S.S.R. 26, Algeria 11, India 1.5.

In spite of the relatively high figure for Trinidad and Tobago, there is obviously a very long way to go before local markets are saturated.

Prices.

A great deal of information on this subject was obtained. Some of it was deduced from the Customs statistics, and this was possible with categories of paper which were of one uniform quality, because it was then simply a matter of dividing the value by the tonnage. Where there were mixed grades in one category this was, of course, not possible. Unfortunately the 1967 data correspond with the price position before devaluation of Sterling in December, 1967, and this has introduced complications. Thus imports from countries which have not devalued usually show an increase in price, although seldom to the full extent of the devaluation; on the other hand, imports from countries which have devalued also often show an increase price due to natural rises in costs. With one exception all the paper users visited were very frank with information on quantities imported and prices paid. This information obtained from various users of paper, combined with the imports statistics, where authentic values could justifiably be derived (notably for 1968, Table 6) enabled certain average values to be obtained. By taking the averages of prices obtained from different sources, and erring on the low side, the figures shown in Table 10 were arrived at for the principal grades of paper which are relevant to the present Study.

Table 10

AVERAGE PRICES OF CERTAIN PAPERS,

JULY, 1968

Grade	Price ($ per ton cif.)
Writings and Printings	550
Wrapping and Bag Papers	415
Corrugating Medium	315
Toilet tissue:	

These data are used in the profitability costings of Part III, (i).

Exports.

It has been suggested that the markets for the mill's products might be extended by exports. There is at present a small but quite important export trade to the Caribbean area in converted paper products, especially toilet rolls. These go to trade distributors or retailers. The paper in sheets or on reels, from which these products are made, are of use only to convertors, and the number of these outside of Trinidad is much more limited. Apart from Jamaica, Guyana, and Barbados, they would be relatively few. On the other hand, a population of some 10 millions is involved as distinct from about one million in Trinidad and Tobago, and the possibilities of export now or in the future cannot be ignored in a Study of this nature.

Such possibilities have now to be considered in the light of the recently concluded Agreement Establishing the Caribbean Free Trade Association (Carifta); Principal Agreement, December, 1965, Supplementary Agreement, December, 1966. The countries involved are Antigua, Barbados, Dominica, Grenada, Guyana, Jamaica, Monteserrat, St. Kitts, St. Louis, St. Vincent, and Trinidad and Tobago.

It would appear that at the present time there is some doubt on the interpretation of the Carifta Agreement so far as it refers to paper. According to the Agreement, goods shall be accepted as eligible for Area tariff treatment if they are consigned from a Member Territory to a consignee in the importing following conditions :-

(a) that they have been wholly produced within the Area;

(b) that they fall within a description of goods listed in a Process List to be established by decision of the Council, and have been produced within the Area by the appropriate qualifying process described in that List;

(c) that they have been produced within the Area and that the value of any materials imported from outside the Area or of undetermined origin which have been used at any stage of the production of the goods does not exceed 50 per cent of the export price of the goods.

For the purposes of the above, materials listed in the Basic Materials List, which have been used in the state described in that List in a process of production within the Area, shall be deemed to contain no element imported from outside the Area. Nothing in the Agreement shall prevent a Member Territory from accepting as eligible for Area tariff treatment any imports consigned from another Member Territory, provided that the like imports consigned from any Member Territory are accorded the same treatment.

The terms "produced" and a "process of production" include the application of any operation or process, with the exception of any operation or process which consists only of one ore more of the following :-

(a) packing, wherever the packing materials may have been produced; (b) splitting and grading; (c) sorting and grading; (d) marking; (e) putting up into sets.

For the purpose of paragraph (a) above, the following are among the products which shall be regarded as wholly produced within the Area:- Vegetable products harvested within the Area; used articles fit only for the recovery of materials, provided that

they have been collected from users within the Area; scrap and waste resulting from manufacturing operations within the Area; goods produced within the Area exclusively from one or both of the products above, and, materials containing no element imported from outside the Area or of undetermined origin.

The export price of the goods shall be the price paid or payable for them to the exporter in the Member Territory where the goods were produced, that price being adjusted, where the necessary, to an f.o.b. or free at frontier basis in that Territory.

Waste paper and old papers were formerly classified as a basic material, even if they were imported by a Carifta country; however, they are now removed from the list of basic materials, and are subject to condition (c), above. On compliance with the conditions of (c) then the finished product can be exported from one Carifta country to another without duty.

Applying this argument to pulp imported and paper exported by the Arima factory, the imported materials would have cost less than 50% of the f.o.b. export price in order that the paper made from the pulp could be exported in the Carifta area without payment of duty. As the costings in Part III, (i) show, some but not all of the suggested products of the Arima factory are likely to qualify in this respect. Thus, for example, writing paper based on an imported wood pulp price of $310 per ton, and selling for an f.o.b. export price of say, $550 per ton, would not so qualify. The imported rosin, alum and china clay would also help to swing the balance in the wrong direction. It is understood that the Process Lists for Carifta are not yet completely compiled, and these may throw further

light on the above matter. However, it would seem to lessen the prospects of export from Trinidad to other countries in the Carifta area.

So far as the Caribbean islands themselves are concerned, the inter-island freight rates are comparactively low, when goods are carried by local schooners. These rates are set out in Table 11. It will be noted that the list does not include Jamaica, for which there is no schooner cargo service. Goods are carried to Jamaica by ocean-going steamers whose rates are much more expensive and comparable with those to the U.S. The rates shown in Table 11 include loading and unloading; approximately 1¼% should be added for insurance, but there are no wharf charges except for Jamaica.

There are of course other potential export markets outside the Carifta area, namely Surinam, the French islands (Martinique and Guadeloupe, etc.); Venezeula is hardly a possibility as it already has a flourishing paper industry (see Part III (c)).

Table 11

LIST OF INTER-ISLAND FREIGHT RATES ($)

Destination	Freight per ton	Per cu. ft.	Minimum Freight	L/ Chgs. Prepaid
Grenada	12.00	0.30	6.00	-
St. Lucia	12.00	0.30	6.00	-
St. Vincent	18.00	0.45	6.00	-
Barbados	15.00	0.375	6.00	-
Guyana	18.40	0.46	8.00	11.25
Martinique	15.00	0.375	8.00	8.40
Guadeloupe	17.60	0.375	8.00	8.40
Dominica	17.60	0.44	12.00	8.20
Antigua	17.60	0.44	12.00	13.45
Anguilla	17.60	0.44	12.00	11.40
St. Kitts	17.60	0.44	12.00	-
Nevis	17.60	0.44	12.00	-
Monteserrat	17.60	0.44	12.00	9.00

So far as Jamaica is concerned, it may be more logical for that country to import paper from the United States. Apart from this, it is understood that the Weyerhauser interests in the U.S. have a pulp and paper mill for Jamaica at the drawing office stage. This will make middles and corrugating medium from local bagasse and waste papers and U.S. wood pulp produced by the parent Company. The writer carried out a Study of a similar nature in Guyana some years ago, in which he was asked to consider the possibility of exporting to the Caribbean area, Trinidad in particular!

Summing up the export potential of the proposed products of the Arima factory, it may be stated that these exist but that they are uncertain and under present conditions, unlikely to be considerable. In arriving at the conclusions expressed in Part IV therefore, the possibilities of export have been left out of consideration and home consumption only considered. If exports do materialise then these will provide additional support for the project; but it would be unwise to use possible exports as an argument in favour of the scheme.

Visits to Paper Users.

The visits made are listed below with brief details of the type and scope of manufacture. For obvious reasons exact tonnages and prices corresponding with each user are not recorded.

Rolex Paper Co. Trinidad, Ltd. This is one of the 2 companies making toilet rolls by slitting large ("jumbo") reels. They purchased creped jumbo reels from the Arima factory but did not like the colour or cleanliness, and they complain that the paper was hard and gritty, and much below the standard of the

imported paper. To them uniformity and softness are very important; the colour less so. The furnish of their imported paper is mainly bleached sulphite pulp, and the present principal supplies are from Canada. Both single-ply and double-ply grades are purchase.

As Mr. Chow, the local Manager, was about to leave Trinidad on a journey, there was little opportunity to discuss details with him. The gaps in the information from this particular source were therefore, filled as a result of personal contact in London with Mr. F.M. Freedman, Managing Director, Rolex Paper Co., Ltd. Mr. Freedman expressed the view that the rate of expansion of this type of business in the Caribbean was such that in 6 - 12 months the consumption of toilet tissue, other tissues and paper towels would amount to about 5 tons per day. This compares with the present consumption of toilet tissue in Trinidad of approximately 900 tons per annum (see Part II, (c)). Of this, some 60% is probably handled by the Rolex Co., and about 25% of this production is at present exported. Mr. Freedman stated that the Rolex Company (a member of the Bunzl Group), have the same interest in the rehabilitation of the Arima mill as Trinidad Paper Products, Ltd., and that their interest is not confined to the production of toilet tissue, but also would include other types of paper which the new mill might make.

Trinidad Paper Products, Ltd. This is the other Company making toilet paper, towels and tissues, similarly to the Rolex Company. Here again large reels are purchased, and slit and re-reeled on toilet roll-making machines. Their view is that the market is increasing rapidly. They also purchase some 15 tons per annum each of centres and wrappings for using with

the toilet rolls. Generally speaking, the position and the comments regarding the Arima paper are the same as those of the Rolex Company above. They are associated with the Sterling International Company whose proposals for the future of the Arima factory are set out and discussed in Part II, (c).

Yuille's Printerie, Ltd. Useful information as to the prices of printing and writing papers, and the qualities chiefly used, were obtained from this Company.

Government Printery. Here again valuable information as to qualities and prices, especially of writings and printings, were obtained, the United Kingdom being the chief source of supply. The tonnages used are not very large namely, approximately 140 tons in 1962 and 127 tons in 1966.

Caribbean Knitting Mills, Ltd. This is operated by Mr. Narrad Maharaj, and the qualities produced are chiefly paper napkins, towels, and adding-machine forms - the latter on a machine-finished, mechanical wood paper (65 g.s.m.); apparently present supplies are giving trouble and there is a desire to improve on the quality. Reels of gummed paper are also made, but only by slitting larger reels; and moulded plates are made from duplex board. This Company makes a wide variety of products, but only on a very small scale. However, the information obtained as to prices was very helpful.

Caribbean Packaging Industries, Ltd. This Company manufactures cartons from corrugated insides and pure kraft outside liners. The former are made from semi-chemical wood pulp (23 lb. per 1,000 sq. ft.) imported from Canada or Finland, and it is believed that approximately 1,000 tons per annum are used although this Company was very reticent as to their

outputs and prevailing prices (see Tables 5 and 10). The liner is pure kraft from the U.S. Paper bags are also made from pure and striped M.G. pure kraft paper. The Company have a similar factory in Kenya, which I have visited; and they also operate in Jamaica. Their imports therefore, are almost entirely pure kraft and corrugating medium, the former being used mainly for white or coloured liners. Delays have been experienced in obtaining deliveries of Finnish corrugating medium, but it is said to work well on their machines - better in fact than bagasse, of which they have had experience in their Jamaican factory where the bagasse has proved suitable. It is believed, that the liner paper imports amount to several thousand tons per annum, much of which is wet-strengthened. Table 5 showing imports for 1967, supports this view.

The operations of this firm are of special interest in the present connection, because one of the products which the Arima factory could make profitably would be corrugating medium. This would however, be made from semi-chemical bagasse pulp which the Company say that they do not greatly like. As they are the principal consumer of such material in Trinidad, and since it is known to give satisfactory results elsewhere, steps would have to be taken in due course, to deal with this situation. As shown in Part III, (i), the future of the Arima factory may well depend on this particular potential customer. It is believed that this Company are also interested in the Sterling International proposition for the future of the Arima factory - and, if this is the case, a useful measure of co-operation may result in the future.

Reed Trinidad, Ltd. This Company makes only multi-wall sacks for fertilisers, chemicals, sugar, and (chiefly)

cement. Some are lined with polythene, and many are wet-strengthened. The raw material is pure kraft, obtained from the Reed-owned Scandinavian mills and bought at local Scandinavian prices, which are very low judged by prevailing Trinidad paper prices; further economies are obtained by using unwrapped reels. The kraft used is in natural shade, white or orange, in various weights, sizes and reel widths; the last are not very suitable for the Arima machine, being $28\frac{3}{4}$ to $50\frac{3}{4}$ inches. Some 1,200 tons per annum of natural kraft are used, and this is expected to be doubled in the near future. However, at present concern seems to be centered around the position of paper in the Carifta Agreement, see Part III, (b).

British-American Printers & Box Manufacturers, Ltd. This is a small but vigorously developing Company. The chief manufactures are boxboards, lined, solid and polythene treated, and waxings; and it is unlikely that their requirements could be supplied by the Arima factory. The Company makes cable envelopes and coin envelopes by hand, mainly from kraft paper. Their policy is to concentrate on the solid board type of carton made from a very cheap Dutch strawboard, which they believe, will be able to compete with the corrugated type of carton; this means that no corrugating medium will be required. A requirement of more interest is Norwegian bond paper, which is used for stationery and labels, for which there is a big potential demand.

Ramlogan Industries, Ltd. This Company specialises in exercise books, and general ruling and printing work, and the covers that go with these products. It is expected that the present production (200 tons per annum) will be doubled shortly.

The papers used are wood free, of substances 60 to 75 g.s.m. and are obtained mostly from Czechoslovakia, instead of as formerly, from Austria, whose papers have become too expensive.

Caribbean Printers, Ltd. These are large printers associated with the "Trinidad Guardian", and consuming in all about 2,000 tons of material per annum, most of which however, is lined boxboard and machine-coated, and other coated papers. These could not be supplied by the Arima factory. However, there is a reasonable consumption of bonds and similar writing and printing papers, most of which have a high machine-finish or supercalender finish. Most of the paper is bought flat in sheets of basis weight 20 and 26 lb. (17 x 24 inches). Other papers used are mechanical printings and high machine-finished papers. An associated company in Guyana uses 40 tons per month of exercise book paper, which would be a useful order for the Arima factory if it could be obtained.

Issa Nicholas (Trinidad), Ltd. This Company specialises in bag making, mostly the small white, coloured or brown types, although some multi-ply sacks are also made; production, approximately 25 tons per month. It is all of machine-glazed finish, on reels 9 - 35 inches wide.

Caribbean Envelope Manufacturing Co., Ltd. This Company operates envelope machines and uses principally white wove and imitation manilla papers. They are comparatively new and small, but expect to increase production.

Trinpad, Ltd. As the name implies this Company specialises in writing pads, exercise books, notebooks, drawing books, duplicating books, memo books, etc., and ruled papers

of all kinds. Their total usage of paper approximates to 500 tons per annum, 90% of which is on reels 32.5 inches wide and 10% 27 inches wide. Strawboard backings and coloured wood-free covers are also required for the notebooks. They find that paper from France is the most suitable and cheapest for their purpose. Here again anxiety was expressed regarding the provisions of Carifta, and especially in view of competition from Jamaica and Guyana. They do not export greatly at present, but hope to do so in the future. Apart from this, they foresee good future prospects for their products and are contemplating expansion.

They also produce approximately 50 tons per annum of clean waste clippings from their exercise books, mostly white, but some with coloured covers and strawboard backs. The latter would be separated if worthwhile, and this waste paper could therefore be a useful raw material for the Arima factory.

(c) Fibrous Raw Materials

Criteria of Fibrous Raw Materials for Paper and Board

It is as well to consider at this stage what is required of fibrous raw material for the manufacture of paper and board. Theoretically, any material containing fibrous cellulose (i.e., any vegetable plant) can be used for the manufacture of pulp for paper and board. The value of any one particular plant species for the production of pulp depends however, on the following considerations.

Technical.

1. Ease with which the non-fibrous constituents (e.g., pith, wood, resins, etc., as the case may be) can be removed.

2. Colour-to-strength ratio. The strength is reduced

as colour is improved by processing, and vice versa; it is desirable to obtain the optimum balance between the 2 for each kind of pulp.

3. Suitability for the purpose in question.

4. Suitability for treatment at an economic figure.

5. Yield of cellulose.

6. General cleanliness.

Economic Considerations.

1. Quantities available; waste materials having no other use are preferable.

2. Ease of harvesting or collection.

3. Transport facilities and costs. Many suggested raw materials which satisfy the other considerations have proved uneconomical for this reason.

4. Regularity of supplies, both as regards quality and quantity.

5. Cost of processing, including chemicals, and steam and power; this is linked with the purpose for which the pulp is required. A pulp having exceptional properties can sometimes command an exceptional price, and the cost of production may then be a minor consideration.

6. Ease with which supplies may be replaced. Thus annuals are better than perennials from this point of view, and plants which take a long time to reproduce themselves, (such as trees) are at a disadvantage in this respect at any rate.

It is safe to say that, on the whole, coniferous wood fulfils these requirements, taken together, to a greater extent than any other plant material. Supplies are plentiful; they can be replaced when exhausted, although time is required; and a

variety of processes has been involved, enabling such wood to be converted into pulps suitable for most present-day requirements. Moreover these processes have been the subject of intensive scientific study and control over many years, so that regularity of output and quality are ensured. Other plant fibres fulfil many of these requirements to a less degree, and among these are certain possibilities which are worthy of exploration so far as the Arima factory is concerned.

Thus, the fibrous raw materials considered in the present instance are, sugar cane bagasse, bamboo, tropical pines, imported wood pulps, and waste papers. Of these, the first 3 concern primarily the long-term viewpoint of the Study, and the last 2 the short-term aspect. These materials will now be considered in greater detail.

Sugarcane Bagasse.

General. Sugarcane bagasse is the fibrous material residue after the sugar juice is pressed from the cane in the sugar mill. Although the physical properties of bagasse vary somewhat due to the variety of cane, the length of the growing season, and the method by which it is cut, shredded and crushed, it normally comes from the sugar mill with a moisture content of about 50%, residual sucrose content of 2.0 - 2.5 and a content of other water-solubles of 2.0 - 2.5%. The remainder amounts to 45 - 46% and is composed of true fibre, pith, dirt and fines. The true fibre is the only part of the bagasse of value for papermaking. On a moisture-free basis the average physical composition of the bagasse is approximately as follows :

Good quality fibre -	60%
Water solubles -	10%

Pith, dirt, fines, weeds, etc. 30%

Expressed chemically, Trinidad bagasse has an average composition as follows :

Lignin	-	17%
Cellulose	-	57%
Pentosans	-	22%
Mineral matter	-	4%

In this respect it is similar to bagasse from elsewhere in the world.

The fibre, which remains after the separation of the pith, dirt and fines, is of short to medium length. This length is decreased somewhat by high grinding pressures in the sugar mill but even so, under these conditions the depithed bagasse has good papermaking characteristics.

Bagasse has an advantage over other agricultural fibres, in that it involves no problem of collection. It has been found that properly baled and stored bagasse will keep in good condition for long periods of time. Storage is necessary because of the intermittent nature of the sugar grinding operations. However, if the pulp mill is located adjacent to the sugar factory, the bagasse requirements for the crushing period can be carried directly to the pulp mill without baling and storage.

Bleachable pulps from bagasse can be made by the soda, kraft or the neutral sulphite process . Soda or kraft pulping is particularly well suited for producing writing and printing papers. At the present time practically all types of pulps can be produced from bagasse, ranging from a mechanical-type pulp to high-brightness bleached pulp.

Bleached and unbleached bagasse pulps have many uses.

Although the bagasse fibres are not as long as coniferous wood pulp and thus do not contribute the same degree of strength, by proper refining and blending methods, bagasse fibres can give paper certain qualities which cannot be obtained from the longer fibre pulps.

There are at least 30 mills in the world producing bagasse pulps. Some of these are market pulp mills selling their production to other paper mills; there are thus, at least 40 to 50 mills using bagasse in some proportion.

As stated above, the bagasse from the sugar mill contains about 40% non-fibrous material, mostly pith. This pith, as well as the dirt and fines and other undesirable matter, must be removed from the fibre prior to processing into pulp. The pith consumes the chemicals used in the process, and it gives rise to difficulties in bleaching because it contains most of the dirt and silica in the bagasse; and further it also causes difficulties on the paper machine due to dirt spots and clogging wires and felts.

There are 2 depithing methods. In the moist process, the bagasse from the sugar mill is passed through rotary depithers in which about 50% of the pith content is removed. The separation is not as sharp as that obtained by the wet method but it has the advantage that the pith removed can be returned to the sugar mill for burning in the boilers, thus reducing the cost of the bagasse purchased by the pulp mill.

As bagasse is normally burned in the sugar mill boilers to raise steam, its value is determined primarily by the cost of its equivalent heating value in terms of a replacement fuel. In addition to this cost, there must be added the cost of primary

depithing and baling, the transport cost and a bonus payment to make the transaction attractive to the sugar mill. Bagasse with an average of 50% moisture burned with 100% excess air, has a calorific value of 2,624 B.Th.U. per pound. It is usual to replace this bagasse with fuel oil, which has a calorific value of 18,500 B.Th.U. per pound. Thus, the comparative heating values of bagasse and fuel oil are calculated as follows :

(1) One pound of fuel oil at 18,500 B.Th.U./lb. burned at 80% efficiency, yields a net heating value of 14,800 B.Th.U./lb.

(2) One pound of bagasse (50% moisture) burned in the sugar mill with 100% excess air, yields 2,624 B.Th.U./lb.

(3) 14,800/2,624 (= 5.64 lb.) bagasse (50% moisture) is equivalent in heating value to 1 lb. of fuel oil.

(4) One ton of bagasse (dry basis) burned wet = 0.4 ton fuel oil.

Bagasse in Trinidad. Sugar production in Trinidad (it is now negligible in Tobago) is in the hands of 2 large companies, namely the Tate and Lyle-Caroni, Ltd. interests who control 90% of the estates, and Trinidad Sugar Estates, which are managed by Caroni, Ltd. for the Government. Between them they grow two-thirds of the cane of the country, the remaining one-third being grown by numerous small farmers, who sell it to the large mills and in addition, receive a royalty on the sugar produced from the cane they sell. The Trinidad estates are associated in the Sugar Manufacturers' Association Trinidad, Ltd., and the other Caribbean islands have their own associations, there being collaboration between them.

The industry employs approximately 17,000 persons and occupies some 95,000 acres (according to the Sugar

Manufacturers' Association Trinidad, Ltd). The crushing season is from January to June, but 2-annual crop systems are at present being studied. The 2 principal estates are Brechin Castle, and Ste. Madeleine, which are both part of the Caroni, Ltd. interests. This Company made information on their files freely available for this Report.

The bagasse, as produced by the sugar mill, is normally approximately 50% dry, and in this state it comprises approximately 32% of the cane as cut; thus, dry bagasse is 15% of the cane. The production data for 1966 (which are the latest data available) are :

Brechin Castle	-	329,100 tons, of which 273,500 tons are used for fuel.
Ste. Madeleine	-	189,500 tons, of which 149,800 tons are used for fuel.
Reform	-	42,777 tons, of which 41,500 tons are used for fuel.
Total	-	561,377 tons, of which 464,800 tons are used for fuel.

At present (1968) the surpluses are more of the order of: Brechin Castle 80,000, Ste. Madeleine 70,000 tons per annum.

These figures correspond with yields of approximately 9 to 11 tons of cane per ton of sugar.

It will therefore, be seen that the total tonnage of surplus bagasse available under the conditions of 1966 was approximately 100,000 tons per annum. By making economies in fuelling the boilers with bagasse (which are inadvisable at present because the object of burning the bagasse is to get rid of it), this supply could probably be increased by at least 25% say, to 125,000 tons per annum. If in addition, the boilers were converted to use oil or natural gas fuel, then all the above bagasse could be

utilised other than for burning. It is understood that facilities for this already exist at Ste. Madeleine, although to convert at Brechin Castle would cost at least $200,000. However, the 100,000 tons corresponds with approximately 20,000 tons of paper (assuming a yield of approximately 30% on the dry bagasse and the inclusion of approximately 25% of long-fibred pulp on an average). As shown in Part III, (b), this corresponds approximately with the total paper and board consumption of Trinidad and Tobago at the present time.

Even assuming the most favourable conditions, nothing like the whole of these requirements could be made from the above fibre mixture. The large quantity of true kraft at present imported (see Part III, (b)), could not be made with a bagasse content of this magnitude, and indeed, it is doubtful whether more than 20% of bagasse could be used in such paper. It is safe to state therefore, that even under ideal conditions an existing mill could not use more than about 50% of the bagasse available.

Assuming the rate of increase of paper and board consumption shown in Figure 4 (although this applies only to certain grades of paper), it would seem that the present annual quantity of surplus bagasse available could not be used completely before approximately 1975.

Table 27 (Part III, (i)), shows a hypothetical costing calculation for a bagasse pulp and paper mill of this kind. It must be regarded solely as a rough guide, even if only because it is based on present day prices. Assuming these figures, however, and a profit of $2.00 per ton of wet bagasse for the bagasse producer, then it will be seen that such a mill is likely just to fail to break even. The major influencing factor is, of course, the high

capital cost of the factory, estimated at nearly $70 million.

Bleached bagasse pulp is also dealt with under "Imported Fibrous Raw Materials" (below).

So long ago as 1930 a Mr. McCrae made experimental paper from Trinidad bagasse. The question of utilisation of the surplus bagasse has, of course, been closely studied by the sugar estates, by Caroni, Ltd. in particular. However, the line of approach in the past has been principally that of the manufacture of bleached bagasse pulp for export mainly to Europe. This would seem to be a misconceived approach because :

(a) Bagasse pulp at its best is inferior to coniferous wood pulp for most paper and board manufacturers.

(b) Bagasse pulp would have to be sold on the world market at appreciably lower prices than wood pulp in order to compete with it; this despite the extra freight charges it would have to bear.

(c) Such competition is unlikely when comparison is made with the numerous wood pulp mills having very large productions and operating with a century of research behind them.

The following is an outline of the history of studies of bagasse utilisation in Trinidad, mostly sponsored by Caroni, Ltd. :

(a) In about 1951, bagasse (not pulp) was exported to England for wallboard manufacture (Celotex, Ltd.). This application has since ceased to exist.

(b) Approximately 20 tons of bagasse pulp were made experimentally and tested in several British mills. The matter was not pursued at the time because of the large capital outlay envisaged.

(c) In 1955, Messrs. Albert E. Reed & Co., Ltd. became

interested and a 30,000 ton per annum bleached bagasse pulp mill was envisaged. However, water and effluent disposal difficulties were anticipated, and the scheme did not proceed. It was stated that the provision of sufficient water would have meant a major damming operation on the Caroni River; and the absence of tide in the Gulf of Paria made dispersal of the effluent in the sea a difficulty. Consideration was even given to the disposal of the effluent in disused oil bore-holes.

(d) In 1964, a report was made by Sandwell & Co., Ltd. for Caroni, Ltd. This report assumed a water supply from the Oropuche River at Sangre Grande, involving a pipe-line approximately 40 miles long to Brechin Castle. Apart from this, Brechin Castle is regarded as the most favourable site for such a factory. The chemicals for the process would have to be imported, and no recovery of caustic soda was allowed for in the scheme. The actual figures given in the report must be regarded as confidential, but the general conclusions led to the fact that a fibreboard plant making 10,000 or 20,000 tons of product per annum, would be potentially more profitable and involve a much smaller capital expenditure than plants making either 30,000 tons per annum of bleached bagasse pulp for export, or unbleached bagasse pulp, paper and board for home use and export. Of the 4 alternatives, the 20,000 ton fibreboard mill would give by far the best return. It is interesting to compare the conclusions regarding the bagasse pulp mills with the costings of Part III, (i) of this Study.

(e) Bagasse Products Co., Ltd. of Watford, England, now make table mats by impregnating bagasse with resin. The scope of this particular outlet is obviously limited.

(f) Experiments are in hand on briquetting the bagasse in association with a Swiss firm, using mechanical methods. This is an improvement on the present system of utilising loose wet bagasse as a fuel, and it would enable the bagasse to be so used elsewhere than at the sugar factory. Export possibilities were envisaged, but transport costs would be a consideration, bearing in mind the low calorific power of bagasse as compared with that of coal. Unlike coal, the briquettes must be protected from the weather, as they disintegrate when wet.

(g) Cattle cake has been made from a mixture of 30% bagasse pith and 70% molasses. This however, does no more than utilise the pith, which in any case, must be removed before bagasse can be used for paper manufacture.

(h) The manufacture of particle board has been considered by Caroni, Ltd., but it was feared that State-subsidised competition from Eastern Europe would prevent it being exported at a profitable figure. The matter was further discussed with Sir Harold Robinson, who regards bagassosis (an ailment arising from the handling of bagasse) as a more serious consideration in the utilisation of bagasse for particle board. This disease is virtually unknown in bagasse pulp manufacture. However, recent experiments are said to have indicated that treatment of the bagasse with 2% propionic acid when fibre size grading, and removal of 10% of the pith, prevent bacterial growth; and that this should make particle board manufacture a possibility. In any case, assuming that the particle board project materialises, there should still be ample bagasse for both this and paper pulp manufacture when the time is ripe for the latter, assuming the present bagasse supply is unchanged. It should be remembered

that the transfer of even one of the Caroni factories to natural gas or oil fuel would release what, from the present point of view, is virtually an unlimited amount of bagasse for both pulp and particle board manufacture.

Cost of Bagasse. For the purpose of the costings of Part III, (i), the cost of bagasse delivered to the Arima factory site was estimated as follows. The costs are calculated in $ per ton of dry bagasse, but refer of course, to the handling, etc. of wet bagasse.

Baler operation and maintenance	-	2.70
Baling	-	3.83
Transport to stacks or truck	-	0.30
Stacking at sugar mill	-	0.25
Covering	-	0.70
Losses, wastage and contingencies	-	4.00
Profit for sugar mill	-	2.00
Transport cost to paper mill	-	9.00
Delivered cost	-	22.78

The profit of $2.00 per ton (dry basis), is regarded as reasonable by Caroni, Ltd. Bales averaging about 250 lb. (18 x 23 x 32 cu.in.) are envisaged. Transport costs are at the rate of $0.15 per ton (as carried - i.e., wet) per mile, for 30 miles from Brechin Castle to the Arima site.

A pulp mill using substantial quantities of bagasse is best situated near the source of supply, when this item would be substantially reduced. The transport and storage of large quantities of bagasse usually requires a special study so as to be organised to result in smooth running.

(i) Furfural production has been the subject of a

comprehensive report by the United Nations (UNIDO/T/TRTO-1) entitled "Feasibility and Market Study for Production of Furfural", February - March, 1967. Two alternative methods were studied namely, using the pith and using the whole bagasse; and 2 different techniques for obtaining furfural were considered in each case. The general conclusion reached was that even if the total bagasse produced from the Brechin Castle and Ste. Madeleine mills is used (and this would involve conversion of both mills to oil fuel), together with all the available coconut bass produced by the coconut industry (about 10,000 tons per annum), then the project is only marginal economically. Because of this, any future economic changes (for example, in the selling price of furfural) might sway the viability one way or the other. The project would however, give employment and other benefit to the economy of the island on a national basis; on the other hand considerable practical difficulties may arise, for example, in the transport of the large quantities of bagasse involved, and storage problems arising from the seasonal production of bagasse from sugar cane. There is also some doubt, apparently, regarding the actual pentosan content of the Trinidad bagasse and this determines the yield of furfural obtainable.

(j) Shell Trinidad, Ltd. made a study of the use of bagasse for the manufacture of fibreboard, but decided that this could not be economic if it had to be scaled-down to the size of the local market, even if the bagasse was obtainable for $6.60 per ton. Moreover, such a project could not conveniently be integrated with furfural production from the pith rejected by the process, because the scale of furfural production needs to be large to be economic, and the one process could not

subsidise the other.

Under the circumstances, it was decided in this Study to consider the use of bagasse, (a) to make unbleached pulp for the manufacture of corrugating medium in the rehabilitated Arima factory; (b) for a large future mill, making bleached pulp, and paper from it. As shown in Part III, (i), (a) is by far the most attractive possibility.

Bamboo.

Bamboo is a well-established papermaking fibre. It has been used in India for the last 50 years and is one of the mainstays of the paper industry of that country. The most suitable process is the kraft or sulphite process, and a modern bamboo pulp mill is similar in most respects to a kraft mill operating on pine wood. Bamboo is also being successfully pulped by the new rapid continuous methods.

The properties of bamboo pulp have in consequence been closely studied. The fibre averages 3 mm. in length, and is comparable in this respect with the coniferous woods. Bamboo pulp has a high tearing strength, but a relatively low tensile strength. When used in combination with the strongly-bonding pulps, such as those of sugar cane bagasse, it can be used to produce a full range of papers from bleached writing papers to high-strength multiwall sack papers. Thus, the need for long-fibred material by a pulp and paper industry can be met with bamboo.

The Indian bamboos used for paper manufacture are usually the Dendrocalamus, Bambusa, Melocanna and Ochlandra species. Members of the Oxytenanthera and Arundinaria species also occur in India, but less is known of their suitability

for paper pulp as compared with the Bambusa species. Paper making operations in other countries, e.g. Japan, Taiwan and the Philippine Islands, have also usually involved Bambusa species. Indeed, a number of bamboo species have been investigated for suitability for pulping and, so far as is known, none has been found unsuitable.

It will therefore, be seen that from the point of view of this particular Study, bamboo has important and unique properties, in that it is rapid-growing and yet it has a comparatively long fibre. The latter is not so long as the coniferous wood fibres, but it is considerably longer than those of the other fibrous materials available. In this sense therefore, bamboo can be regarded as a useful substitute for coniferous wood, if not a complete substitute from the quality point of view. Bamboo grows on an annual basis, but the roots are perennial. Normally full growth is obtained after about 7 years, but from the point of view of pulp production it is often convenient to cut after 3 or 4 years and then allow re-growth to take place. This occurs very rapidly, namely in some parts of Thailand to 25 feet in the first year, but in subsequent years the sticks may attain no greater height although the walls thicken. As pointed out above, there are many different varieties of bamboo, and these vary markedly in properties such as height, diameter and wall thickness. In consequence the yield per acre also varies; in India this can be as low as approximately 0.75 ton per acre per year.

In one very important respect different varieties of bamboo have a different habit; and indeed the same varieties may present different habits under different climatic conditions. This is in respect of the frequency of flowering. When a bamboo plant

flowers, it dies off, and several years must elapse before growth occurs again and the bamboo is ready for cutting for pulp manufacture. It is even possible for the roots to die off or be otherwise destroyed in the interval, and the plant so lost. The frequency with which flowering occurs varies considerably in different parts of the world and with different varieties, but with some African bamboos the flowering takes place regularly every 8 years or so and can be anticipated. Consequently if the bamboo is grown for pulping, allowance can be made for flowering in assessing the amount required for operation on a sustained yield basis.

In India however (and apparently in Trinidad also), the flowering intervals are much longer and less certain; they can be 30 to 50 years or even more. If the actual date at which flowering is to be expected is not known then its unanticipated onset can be a very serious matter for a pulp mill which relies entirely on a local bamboo forest. Unfortunately, when flowering takes place a whole forest, and not just individual clumps, can be affected simultaneously, so that the whole reserve supply can be lost. In the case of natural bamboo growing in forests, it is very difficult to foresee and to allow for this because the histories of the individual plants are not known. However, with cultivated bamboo it is possible to put down plantations at intervals which will allow for the ultimate flowering. If a species which flowers at long intervals (e.g., over 30 years) is chosen, then the problem becomes a long-range one, and can be dealt with accordingly.

Bamboo consists of a long woody stalk (or culm) with thickened denser areas at intervals known as nodes. Methods of processing the bamboo have to be so adapted as to contend with

these nodes, which resist penetration of the liquor. Consequently there is a tendency to overcook the remainder of the woody portion in order to resolve the nodes. In the early work on bamboo carried out in India some 35 years ago, this was achieved by digesting in 2 stages. In recent years however, more attention has been given to the preparation of the bamboo for the cooking process, i.e., by crushing the culms and then either chipping or shredding them. This has given good results in single-stage continuous processes, with yields of bleached pulp of around 40%. In this way culms ranging in diameter from 2 to 8 inches and cut to lengths of from 10 to 15 feet can be handled.

The culm part of the stem usually refers to the woody portion of a hollow tube, but there is also present in it some parenchyma tissue which contains no fibrous material suitable for papermaking, and is similar to pith. Consequently this is lost in the pulping process, and its presence only reduces the yield. The crushing of the bamboo stems breaks the nodes and renders the fibre bundles separable. This aids the penetration of the cooking liquor since, unlike wood, there are no means of conducting the liquor into the bamboo plant substance in a horizontal direction.

Bamboo grows prolifically in both Trinidad and Tobago especially in the valleys of northern Trinidad; but some of the best growths seen were along the Guanapo River.

In approximately 1943 the Nelson Publishing Company, of England, operated an unbleached bamboo pulp mill, based principally on plantations, at the western end of what is now the Churchill-Roosevelt Highway. The bamboo pulp was exported to Europe, but the project ceased operation in 1946. It was stated

that the bamboo, which was brought from India, was an unsuitable species for pulping because of the resistance of the nodes.

Further information on the subject of indigenous bamboo growth in Trinidad was sought from the Forestry Department, and also from the Department of Agriculture at the University of the West Indies, but without success. However, most of the bamboo seen appears to be Bambusa vulgaris, a type which is used for pulping in India, although 2 other species occur.

It is thus not known for certain whether bamboo would regenerate itself under the conditions in which it grows naturally in Trinidad; nor is it known whether cultivated bamboo would reproduce itself in the same way. It is known however, that when bamboo is cut at present it grows again and there is no record of flowering; however, this applies to individual sticks in a clump, and the complete cutting of whole clumps might involve different considerations. If the growth of bamboo is critical in any particular area, it might not regenerate itself after complete cutting.

It will be seen therefore, that so far as bamboo is concerned, a great deal more information on the subject is required before it can reliably be accepted as a potential source of paper making material. It would certainly be worth while carrying out experiments both on the cultivation of bamboo in this way, and also on the behavious of indigenous bamboo after cutting. A survey should also be made of the bamboo resources of the country both natural as at present existing, and cultivated for future use. The costs of extraction of the 2 types should be estimated. If these investigations are favourable, then bamboo might well prove to be an acceptable future raw material to

be used with the bagasse pulp in making paper in Trinidad.

The advantages of bamboo can therefore, be reiterated under the 2 headings namely; (a) it provides a long-fibred pulp which can be obtained in no other way at a reasonable cost; (b) as it reproduces itself fairly rapidly, the results of growth and cutting experiments can be obtained in a relatively short time and a reserve of bamboo suitable for use by a pulp mill, can be set up as a long-term project.

Tropical Pines.

It is known that certain tropical pines grow well in certain parts of the Caribbean area, notably Guyana, and this matter was therefore raised with the Chief Conservator of Forests. It was learned that experimental plantations of Pinus caribaea were planted in Trinidad about 13 years ago, a more ambitious scheme being initiated in 1958. There are now several plantations, mainly in the Valencia and Matura areas on the East-West Road, at Buenos Aires in the south-west, and at Cumoto and McNair in the north-central region; totalling in all approximately 6,000 acres. At present about 950 acres are being added per annum and this will be stepped up to 1,000 acres per annum when staff is available. Apparently there is adequate land for this work, but there is a tendency for farming to encroach on the forest reserves and this reduces the land available.

The Pinus is at present grown for timber, but the surplus thinnings are available because they are not used for poles in Trinidad, teak being more resistant. Tentative information, based however, on relatively few and young sample plots (less than 20 years old and closely planted) suggests a yield per acre of 4,000 to 5,000 H ft. at 25 years, with the first saleable

thinnings after 10 years (yield, 300-600 H ft. per acre). The mean diameter of the standing crop should reach 3 in. diameter at breast height after 5 years; thinnings will require about 6 years. Thinnings are sold for $0.50 per cubic foot (Hoppus) on the forest road. Their use for particle board has been suggested. Distorted crowns, which are useless for timber, could be used for the same purpose.

Details of the cost of extraction and likely selling price of this wood was sought but it was felt that as only one small thinning operation had as yet been made, it is premature to consider these. A figure of $10 per ton was suggested as a guide for extraction costs. This, plus a reasonable profit, could make this wood an attractive possibility as a source of pulp.

The following is a quotation from a letter from the Conservator of Forests, dated 7th September, 1968 :

"The information to be given here is tentative as it was derived from sample plots which we know to be too few and too young to provide completely reliable data. Moreover, the planting space in the oldest plots (20 yrs.) was rather closer than is current practice; this means that stems will attain 3" diameter sooner. Yield per acre will also depend on age and site fertility. Yield per acre by age 25 including thinnings is estimated at 4,000-5,000 H ft. The first saleable thinnings under present circumstances will probably be about 10 years of age yielding between 300 and 600 H ft./acre."

Although Pinus caribaea is not an ideal papermaking material, it is a long-fibred pulp comparable with the coniferous woods of the northern hemisphere, and its possibilities as a future source of raw material for papermaking should not be ignored. Such a development however, involves long-term planning and the earmarking of large areas of ground in order to accommodate forests as a source of raw material on a re-afforestation basis. For these reasons bamboo (if attractive in other respects) might be a better proposition than Pinus caribaea. Nevertheless it would appear that experimental pulping experiments on the thinnings of the Pinus caribaea would be worth carrying out in the near future. If these were unsuccessful then the whole long-term Pinus project could be rejected; if they were favourable then Pinus could be given further consideration. The present price of $0.50 per Hoppus cubic foot is of course quite unrealistic for a pulping wood, and the whole economics of the growth and sale of Pinus would require thorough investigation.

A report has recently been published on the pulping characteristics of Pinus caribaea carried out by the Tropical Products Institute. This refers to trees from Fiji, but the results obtained are nevertheless of interest in the present connection. It was found that in Fiji the growth rate is high namely, diameters at breast height of up to 9 inches being obtainable with a pulpwood harvesting cycle of not more than 10 years.

Parana pine (Araucaria angustifolia) is not grown at present in Trinidad, although it would probably do well as in Brazil; is not useful for timber but is an excellent pulping wood.

Local Indigenous Woods are highly dispersed hardwoods, there being some 27 major species. Many of these are of sawmill value, and their properties as sources of pulp are unknown. On a long-term basis there may be some value in investigations of these properties. However, experience has shown that tropical hardwoods are not good pulping species as a rule; that the cost of extraction from mixed stands is high by pulpwood standards; and that bagasse or bamboo, where available, is preferable.

Waste Paper.

It is stated that the waste papers available in Trinidad are handled solely by Economy Products,Ltd. (C.G. Vierra). It is estimated that the total of all grades is approximately 1,500 tons per annum. This does not include office waste, which is not at present collected owing to the difficulty of removing the many undesirable constituents present. The amounts available per month,and prices, are tabulated in Table 12.

Table 12

WASTE PAPER SUPPLIES, TRINIDAD AND TOBAGO

Grade	Estimated amount (tons per month)		Price ($ f.o.b.)
Old Corrugated Cartons	30		50
Newsprint	10		40
Unprinted Newspaper	5		80
New Cartons (Kraft)	30		85
Toilet Tissue Offcuts:			
White	1		100
Coloured	1		80
Envelopes and Copybooks	1		100
Envelope Kraft (brown)	2		80
Chipboard	30		50
Ledger (white and coloured)	5		60
Office waste	10		40
Computer cards	2		110
Total	127	Average	60

In addition to the above, a certain amount of waste paper is also obtainable directly from certain convertors (see Paper Users, Part III, (b)). These would all prove useful for the purpose of the rehabilitated Arima mill, and the total amount of usable material available is taken for the present purpose at 1,500 tons per annum having an average price of $60 per ton delivered, based on Table 12.

Rags.

There is a certain amount of trade with these in Trinidad at present, but most are imported and come under the heading of wipers for use in engineering works, and as such they command a higher price than could be paid for the manufacture of the type of papers to be made at Arima. Nevertheless, it seems possible that offcuts, (which are not suitable for wipers either because of their size or because of the dressing present) could be collected from textile factories. However, the amounts are small and the risk of synthetics is probably high. It is estimated that the price of such rags would be around $90 per ton, which is a very low figure. The imported hospital white fines, for example, cost $1,230 per ton; and the coloured hospital fines cost $830 per ton.

In view of the small amount of rags available in any case, and the rather doubtful question of their price, it was decided to leave these out of consideration in the present Study.

Imported Bleached Bagasse Pulp.

Information was obtained from the records of the Arima factory and from related sources of information, that General Paper Products, Ltd. obtained a licence for the import of 200 tons of bleached bagasse pulp from the C.A. Venezolano de Pulpa y Papel (Venepal) mill in Venezuela. Reports as to the price of this pulp

varied considerably from one informant to another, i.e., ranging between $185 and $290 per ton cif. No import duty was charged. At these prices it would be an attractive proposition to the new Arima factory, which would have to import bleached pulp in any case; their products would then consist of imported long-fibre wood pulp plus a certain amount of imported bleached bagasse pulp instead of 100% of the former. As shown below, the imported wood pulp would be more expensive than the bagasse pulp.

In view of the absence of definite information in Trinidad on this matter, it was decided to visit Caracas in order to ascertain the availability and price of bagasse pulp at the present time. As a result of this visit it was learned that the mill in question, which is a subsidiary of W.R. Grace & Co., is not now exporting bleached bagasse pulp because it does not have adequate quantities of bagasse pulp for its own use. A production of 50 tons per day is in fact regarded by them as the absolute minimum for the production of bleached bagasse pulp. The mill's bleached bagasse plant has not been working on any scale since April, 1967, because there is a greater demand for the unbleached bagasse pulp. The present bagasse production of the mill is 2,000 tons per annum of paper, and in 2 years this may be 3,000 to 4,000 tons per annum. The unbleached bagasse is used for linerboard and machine-glazed papers, and bleached hardwood pulps and bleached kraft are imported from the U.S. and Finland to supplement it. The total production of paper (brown paper and boards) amounts to 75,000 tons per annum and 20 to 40% of unbleached bagasse is used in many of these products. The mill may be interested in supplying Trinidad with bleached

bagasse paper at a competitive price at a later date, but nothing at present is certain. It is significant that the Company owning the mill made a market study of paper consumption in Trinidad in May, 1967. This is all interesting from the point of view of the present Study because it would appear that the Venezuela mill, which is large, modern and apparently well run, has an eye on the Trinidad market.

Imported Wood Pulp.

As already stated, whether the short-term or long-term basis scheme is in question, it will be necessary for the Arima factory to import a certain amount of long-fibred wood pulp and possibly in the initial stages also some short-fibred deciduous wood pulp. Difficulty was experienced in obtaining prices for such products, because it has not been customary to import such products into Trinidad in the past. In June, 1966 there is a record of a licence to import 200 tons of short-fibred bagasse pulp, (see above) and also 750 tons of coniferous bleached sulphate pulp, at $252 per ton, but it is not stated whether this is fob. or cif. In March, 1967 there is reference to a licence for 54 tons of "Bowater's bleached softwood sulphate pulp" at $278 cif. per ton. Another licence dated March, 1967, refers to wood pulp from the U.S. at $300 per ton cif.

In view of the importance of the price of imported wood pulps and the uncertainty of arriving at a reliable price in Trinidad, enquiries were made in New York and London with results as follows :

(a) Table 13 column (a), shows the prices of various grades of wood pulp at present exported from the U.S. to Venezuela, on a cif. basis. It can be assumed that the cost of

carriage would be approximately the same to Venezuela as to Trinidad and these therefore, provide a guide to prices in the latter country.

(b) The Norwegian Consulate in Trinidad stated that the cost of transporting from a Scandinavian port to Trinidad, would be $US.26.25 plus handling charges $US.7.20 per metric ton. This is equivalent to approximately $67 per long ton cif. Port of Spain. If this is added to the fob. prices of pulp in Scandinavian ports then the figures of column (b), Table 13, are obtained.

(c) Prices deduced from information obtained in London are given in column (c) of Table 13, for Scandinavian pulps.

Table 13

WOOD PULP PRICES

($ per ton cif., Port of Spain)

	(a)	(b)	(c)
Coniferous :			
Bleached kraft	317	330	325
Bleached sulphite	311	315	310
Unbleached sulphite	262	280	275
Unbleached kraft	249	265	260
Mechanical	190	200	195
Deciduous :			
Bleached sulphate	297	300	295
Semichemical	180	190	185

It is felt that, under the circumstances, the figures given in column (c) are the most reliable, and these therefore, are the ones used in the costing calculations of Part III, (i).

(d) Chemicals

The amounts and nature of the chemicals required by a pulp or paper mill depend on the types of product to be made, and on the process to be used. In this section of the Study,

supplies and prices of all the chemicals likely to be used in the near or more distant future, are considered; and the data deduced are used in the various production costings given in Part III, (i).

The chemicals used may conveniently be divided into the requirements for pulping and for papermaking, respectively, as follows :

Pulping Chemicals.

Caustic Soda (Sodium Hydroxide). In the case of bagasse or bamboo the preferred method of removing the non-cellulosic constituents from the plant material is by boiling under pressure with a solution of caustic soda, or caustic soda plus sulphur or a sulphide. The amount of chemicals used depends on the particular plant material, but it can be as high as 15% on the dry weight of the latter. For this quantity of chemical to be rejected to waste in the digester liquors ("black liquor") is obviously undesirable both because of the highly-polluting nature of the liquors and also because of the value of the chemical itself. It is therefore, usual to evaporate the black liquor and to burn the residue. The organic matter contained in the latter supplies heat to operate much of the pulping process, and the sodium compounds derived from the caustic soda are converted into sodium carbonate (soda ash). By heating with milk of lime this can be converted back again into caustic soda. This last operation involves the production of a sludge of calcium carbonate, which can be filtered off, washed, dried and burned to give lime again.

This recovery process varies in efficiency from about 35% with some cereal straws to 80% with coniferous woods, and

the resulting loss of caustic soda is usually made up by the addition of soda ash (which is usually cheaper than the caustic soda). This added soda ash is turned into caustic soda, along with the soda ash produced from the burned black liquor. Naturally, the removal of the caustic soda and organic matter in this way, overcomes the effluent problem.

In large mills it is common and convenient to make caustic soda by the electrolysis of common salt, since this operation also produces the chlorine required for bleaching the pulp. The economics of doing this in the present instance are discussed below under the heading of Salt.

Caustic soda is also used in a small amount (about 2% on the unbleached pulp) as a neutralising agent in the multistage bleaching of pulp.

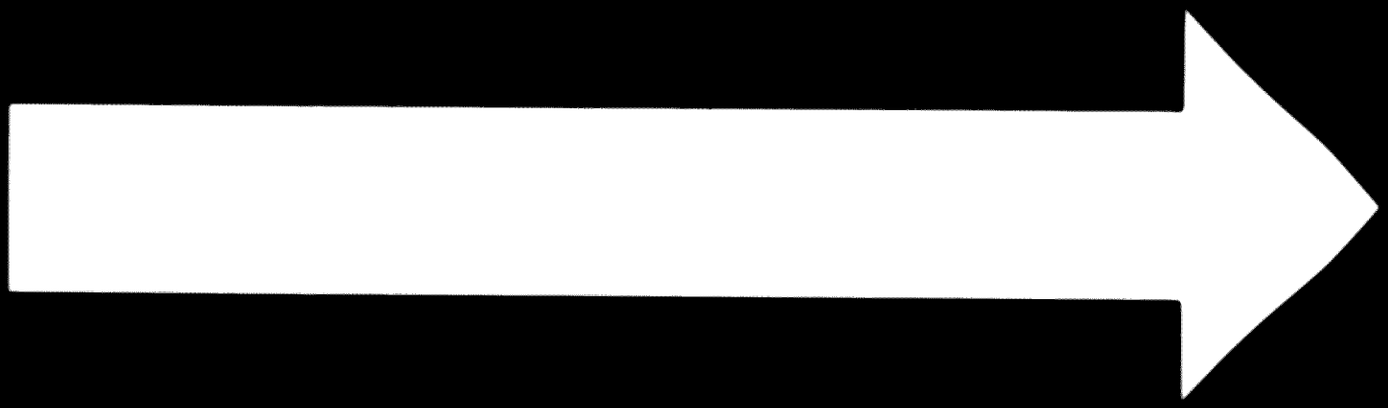
The current price for caustic soda imported in lump form, in non-returnable drums, 5 ton lots, is approximately $176 per ton cif. (source, Imperial Chemical Industries Ltd., U.K.).

The present estimated market for caustic soda in Trinidad and Tobago is approximately 3,500 tons per annum.

Lime (Cao). This chemical is used in the causticising process (see above), and also as an ingredient of bleaching liquor when this is prepared on the site from chlorine.

Lime is obtainable locally, notably from Furness (Limestone Products), Ltd. This Company operates near Port of Spain, and has 2 kilns, each of capacity 10 tons per day; however, they are installing a third kiln, and anticipate no difficulty in supplying lime as required. A typical analysis of a suitable lime produced by this Company is as follows

G-623



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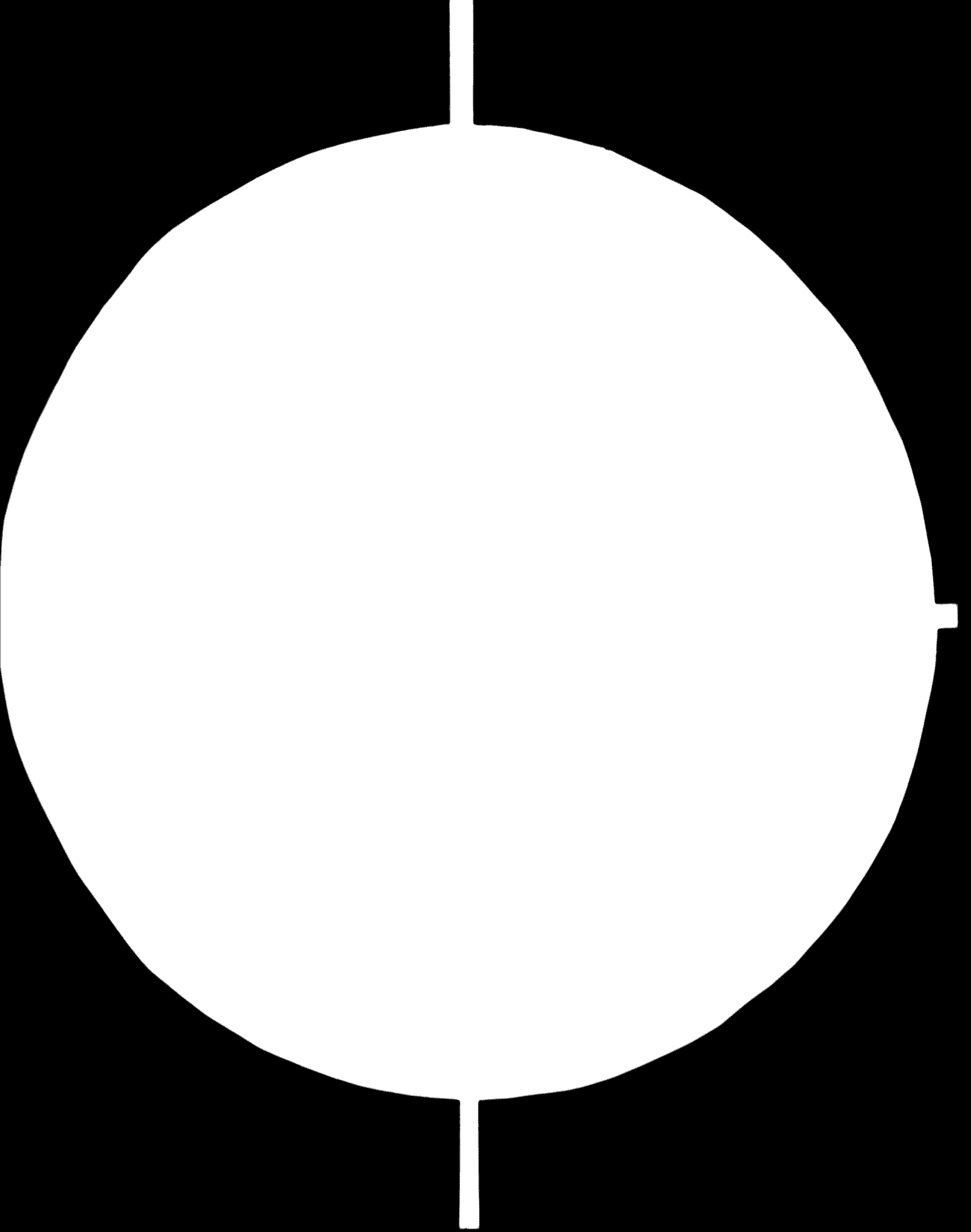

("temper" lime), in percentages :

Loss on ignition	2.19
Silica, sand, etc.	1.46
Iron and aluminium oxides	0.75
Calcium oxide	94.82
Magnesium oxide	0.78

This lime would be suitable for the purposes concerned.

The price of such lime normally, for one-ton lots, is $55.15, loaded in bulk at the works. Actually the Company are accustomed to transporting limestone (and not lime) in bulk; and the cost of this is $0.14 per ton per mile. However, lime in bulk must be protected from the weather during transport, so that it would probably be safer to assume a transport cost of approximately $0.20 per ton per mile. Assuming a site in the Arima area, about 20 miles from the works, this would give a delivered cost for the above item of approximately $60 per ton.

Chlorine. This is required for bleaching purposes. It is transported in liquefied form in specially-made, heavy-duty cylinders, which are difficult and costly to carry, and which must be returned for refilling. Whe, as in the present instance, the chlorine comes from abroad, this can be costly to an extent out of all proportion with the value of the actual chlorine. For factories situated on a continent the problem is solved by the use of 15- or 10-ton railway tank-wagons, and if 3 or 4 of these are in circulation for a particular mill, this usually suffices. However chlorine cylinders for transport by sea hold only 1,792 lb. of chlorine and therefore, many must always be in circulation in order to keep the mill supplied fully. The position is complicated by British regulations which prohibit the carrying

of more than 50 tons of chlorine in one vessel.

Imperial Chemical Industries, Ltd., quote $635 per ton in returnable drums cif. Port of Spain, but could supply only 200 tons per annum. This is an impossible price. The Jamaican Government is said to be starting a salt electrolysis plant in 1970, and this may offer a better source of supply, though expensive sea transport is again involved. Assuming sufficient demand however, production in Trinidad is the real answer, and this is considered under Salt, below.

Bleaching Powder (Calcium Hypochlorite). This is sometimes a possible alternative for bleaching purposes, but is not very effective for obtaining a good colour from bagasse; this is evident from the experience of General Paper Products, Ltd., see Part II. Moreover, it is an expensive way of purchasing chlorine.

The price quoted for tropical bleaching powder is $365 per ton cif., for a grade containing 34 - 36% available chlorine; less 8% discount. It will be seen that this is equivalent to buying chlorine at approximately $1,000 per ton and, in addition, the chlorine so obtained in a less reactive state.

Bleaching powder is itself used as a solution in the last stage of a multistage bleaching process, but it can more conveniently be made from lime and chlorine.

Salt (Sodium Chloride). Large mills making bleached pulp find it economical to electrolyse salt to produce caustic soda and chlorine. As a rule solar salt is used for this purpose, but it sometimes requires a slight measure of preliminary purification. It usually happens that in making the chlorine requirements of a pulping process, an excess of caustic soda is

produced over that required by the process itself. This applies particularly if a soda recovery process is used for the caustic soda (see above). In this event, it is often possible to find an outside local market for the surplus caustic soda, and a profitable sideline may then be developed.

The possibility of producing caustic soda by the electrolysis of salt has already been considered in Trinidad in other connections. A brochure issued by the National Development Corporation, states that the local market for caustic soda is 3,500 tons per annum and that the Caribbean region provides a market of 21,000 tons of caustic soda per annum. In the past, the difficulty has been in finding a market for the chlorine, which would be a by-product if caustic soda was produced as the main product. However, if the position is reversed, then there should be no difficulty in selling the surplus caustic soda.

Salt can be brought to Trinidad from Anguilla or Curaçao, and the current price quoted for a grade containing approximately 98% sodium chloride, in bags, is $60 per ton cif. This could probably be reduced if the salt is shipped in bulk, but a quotation on this basis was not available from the importers, Messrs. Arrindell.

It is interesting to note that on the 1st April, 1964, Mr. O.G. Rodriguez, made an application for pioneer status for processing coarse sea salt into refined table and cooking salt, the sea salt to be produced in lagoons. The operation was to be carried out in Trinidad and Tobago. The investment involved was $19,650, the machinery costing $6,650, and 5 acres of space would be required. The production was to be up to 800,000 lb.

per annum, equivalent to a turnover of approximately $30,000 per annum. The process involved was the addition of water to the salt, evaporation in a multiple effective evaporator, and fractional crystallisation of the salt to produce the desired product. The value of the raw salt was $14,000 per annum as imported from the Dominican Republic.

Finally, it is of special interest to consider the economics of salt electrolysis in Trinidad. Cheap electricity is of course, essential and generally speaking, it is found that pulp and paper mills can produce electricity at a lower price than electricity as purchased from authorities, because they make complete use of the steam produced at all pressures (see Part III, (e)). It would thus seem logical for electricity to be produced by the pulp mill thermoelectrically, using natural gas as fuel; and the cost should be about $0.03 per kilowatt-hour. In this event the approximate cost of producing caustic soda and chlorine would be as shown in Table 14.

It will be seen that under these conditions, chlorine can be produced at a much cheaper rate than the cost of the imported product. However, the cost is still high by world standards. Caustic soda costs rather more to make than to import, but if the surplus over the pulp mill's requirements (probably about 1,500 tons per annum) could be sold locally or in the Carifta area, this would help to redress these adverse factors. The fact that it is produced in solution would operate against its ready sale outside Trinidad.

Soda Ash (commercial Sodium Carbonate). As stated above, where the soda ash is cheaper than caustic soda, it is used for make-up purposes in the recovery process. Its use

Table 14

ELECTROLYTIC PRODUCTION

OF CAUSTIC SODA AND CHLORINE

FROM SALT

Cost Items	Amount	Unit Cost ($)	Cost per 2.1 ton of Products ($)
Salt	1.75 ton	62.5 per ton	108.4
Mercury	0.77 lb.	7.3 per lb.	5.6
Graphite	7.50 lb.	0.79 per lb.	5.9
Barium chloride	8.82 lb.	0.27 per lb.	2.4
Soda ash	17.64 lb.	0.07 per lb.	1.2
Electricity	4,700 kwh.	0.03 per kwh.	141.0
Labour	36 man-hr.	1.2 per hr.	43.2
Repairs and maintenance	-	-	15.0
Management and control	-	-	3.5
			326.2
Interest	2 million 7%)		
Depreciation	2 million 10%)		66.0
	Total		392.2

Cost of: caustic soda - $187 per ton

chlorine - $205 per ton

Notes :

(1) Total capital cost, $2 million.

(2) Production: 2,725 t.p.s. of caustic soda with 2,475 t.p.a. of chlorine.

(3) Graphite and mercury are electrode materials; barium chloride and soda ash are purification chemicals (average quantities used).

in this way is economic only if the cost of the lime and the processing offers some advantage over the direct use of caustic soda.

Current prices of soda ash, imported in 750-lb. bags, 99 to 100% grade, are approximately $175 per ton cif. (source, Imperial Chemical Industries, Ltd., U.K.). It is evident that under these circumstances it would be cheaper to use caustic soda for make-up purposes than soda ash.

Chemicals used in the Papermaking Process.

Rosin. This is used, with alum, for the sizing of paper, i.e., to prevent ink from "feathering" and to confer a certain amount of water resistance on the surface. It also assists in hardening the sheet during the papermaking process, when the sheet goes over the drying cylinders. Rosin is added to paper at the pulp preparation stage, and it can be added either in the form of an emulsion with water or alkali, in which case it is purchased in paste form; or the crude rosin can be dissolved in caustic soda or emulsified in the mill, and added in this form. The addition of the alum then precipitates the rosin on to the fibres and in intimate contact with them, so that when the web of paper is formed a sized effect is produced. For the present purpose, the use of rosin as such will be considered, because the alternatives in paste or emulsion form contain a fairly high percentage of water and this would add to the transport cost. The grade of rosin used depends on the class of paper made; for example, for white papers a relatively colourless grade is used whereas for packing papers, where in any case the sizing is not so important, a more coloured grade can be tolerated.

As an indication, prices were obtained for rosin W.W. grade. These were: minimum 1-ton lots, $060, minimum 5-ton

lots, $640 cif. Packing - galvanised drums containing 255 kgm.

Papermaker's Alum (Aluminium Sulphate). This is added in solution to the pulp during the pulp stock preparation stage, after the rosin. It precipitates the rosin on to the fibres, and so produces the desired sizing effect (see above).

Prices quoted for the grade 17 to 18% Al_2O_3, and assuming that the iron content and content of other impurities is satisfactory from a papermaking point of view, were $150 cif, in 50-kgm, or 100-kgm., gross, jute bags, with polythene liners. The alum is obtainable in granular or lump form, the latter being generally preferable.

China Clay (Kaolin). This also is added to the pulp at the pulp preparation stage. It is a fine, white pigment used as a loading to cheapen the paper, or as a filler to improve printing papers. The amounts which are likely to be used in the Arima factory are limited because the addition of china clay lowers the strength of the paper, and it can be suitably used only where the raw material fibre is itself strong. However, china clay is a definite advantage in printing papers, and in some cases so as much as 25% is added; its use therefore, has to be considered in the present connection. Most of the best china clays originate in Cornwall, and therefore have to be imported,and prices are of the order of $95 per ton cif., in paper bags. If the clay could be taken in bulk, the price would be about $85 per ton cif.

Other Chemicals used in the Papermkaing Process. These include colouring matters, wet strengthening agents, etc. The amounts used are relatively small, and are without significance on the conclusions of the present Study. The question of their availability and prices therefore, was not pursued.

(e) Fuel and Electricity.

Fuel.

Both natural gas and oil are plentiful and cheap in Trinidad and are the obvious fuels for all purposes.

Natural Gas. At present the main pipeline comes from the field at Penal, following the railway line to the Princess Margaret Highway and thence to spurs along the East-West main road. See map, Fig. 1. Sites that are more than one mile from the main pipeline are likely to be very difficult to supply with the gas, unless the consumption is high, when a specially-negotiated arrangement can be made. The present Arima factory site is in this category, and it therefore used fuel oil.

The gas has a calorific value of 1,100 B.Th.U. per cu.ft., and is free from sulphur. It costs $20,00 per 40,000 cu.ft. which are equivalent in the calorific value to one ton of fuel oil (see below).

Fuel Oil (Grade 6). This has a calorific value of 18,790 B.Th.U. per lb., density, 9 lb. per gallon; price $0.12 per gallon. Hence, the price is $30.00 per ton, which is equivalent in calorific value to 40,000 cu.ft. of gas. It is therefore, 50% dearer than natural gas on an equal heating basis.

The difference in costs between the above 2 fuels could have an important reaction on the long-term aspect of this Study. This situation will arise if at any time some or all of the bagasse at present burned in the Caroni mills is used for pulp manufacture. In this event, the price of the bagasse would be based on the cost of supplying an alternative fuel to the sugar mills. This would have to be fuel oil and not the much cheaper natural gas, because the use of the latter is eliminated by the seasonal operation of

sugar crushing; the natural gas would not be used for approximately 6 months of the year, which would mean that its price to the mill would be correspondingly increased.

Steam Raising. Details of the existing boiler house at the Arima factory are given in Part II, (b). It was made by Cleaver-Brooks in 1962, and has the following specifications :

Maximum working pressure	- 300 lb. per sq. in.
Operating pressure	- 150 lb. per sq. in.
Tube temperature	- 400°C.
Capacity	- 6,600 lb. per hour.

A mill making 12 - 15 tons per day of medium substance papers, at about 350 feet per minute machine speed, would require approximately 5,250 lb. of steam per hour.

If 3 pre-drying cylinders are installed before the existing large yankee (M.G.) cylinder, these being approximately 4 feet in diameter, and working at a pressure of 50 lb. per sq. in., then the drying requirements of this machine could be supplied by the existing boiler. The M.G. cylinder would have to be felted, and in addition there would have to be 2 presses. It will thus be seen that the existing boiler capacity is adequate for the scheme envisaged in the immediate future for the rehabilitation of the Arima factory.

Electricity.

The Trinidad and Tobago Electricity Commission is the exclusive power generating and selling authority in these islands, and alternative independent sources of supply are strongly discouraged. Table 15 shows how the rates would be calculated for the new Arima factory on applying the D.2 Schedule.

Table 15

ELECTRICITY CHARGES

Maximum demand - 750 kva.

(a)	Demand charge:	750 x $7.15 =	$5,350 (approx.)
(b)	Energy charge:		
	(750 x 0.80 x 0.85) x 24 x 30 =		370,000 kwh. per month.
	50,000 @ $0.015 per unit =		$ 750.00
	200,000 @ $0.012 " " =		$2,400.00
	120,000 @ $0.010 " " =		$1,200.00
			$4,350.00
Add (a)			$5,350.00
Total charge per month			$9,700.00

This calculation assumes a maximum demand of 750 kva., a diversity factor of 0.80, and a power factor of 0.85; operating period 24 hours per day, 30 days per month.

On the basis of 12 tons of paper per day, this is equivalent to a cost of about $29.00 per ton. In addition to the above, additional charges can become applicable under certain conditions namely, depending on the price of fuel and what are known as reserve charges. Thus, for every one cent increase above 21.5 cents in the average gross price per 975,000 B.Th.U. of fuel used in a month, the charge per kilowatthour for the following month will be increased by 0.014 cents. In cases where the Commission reserves at the Customer's request, transmission and distribution capacity exceeding 1.3 times the monthly Maximum Demand, the Commission will charge the sum of $3.30 per kVa of the difference between the reserved capacity and the Maximum Demand for the month.

The above charges are not applicable at the present time, and are ignored in the calculations of this Study.

Alternative charges are applicable for off-peak period use, i.e., avoiding the periods 11.00 to 12.00 and 18.30 to 19.30 hours (F2 Schedule). This method of calculation however, appears to offer only slight advantages over that given in Table 15, and these would be offset by any inadverdent consumption beyond a certain amount during the off-peak periods. The rate would then automatically revert to the D2 rate (above). It is therefore, felt that this is not a rate suitable for a paper mill which runs continuously.

Actually, many paper mills generate their own electricity. The most favourable conditions exist under these circumstances, since the low-pressure steam from the turbines can be used for drying the paper, and a very efficient system results. This applies with even greater force to a pulp mill, where high-pressure steam is required for the digestion process also. However, in a mill of the new Arima type, the total cost of fuel for steam-raising and electricity should not exceed the equivalent of approximately 0.7 ton of fuel oil per ton of paper made which, at $30.00 per ton for the fuel oil, is equivalent to $21.00 per ton of paper made. As will be seen above, the cost of electricity alone is $29.00 per ton, without the cost of fuel oil for steam-raising. Unfortunately, costs of this nature cannot be reduced by the use of natural gas, because the Arima factory is too far removed from the pipeline as at present planned.

The capital cost of a thermoelectric plant, operated by fuel oil, for the new Arima factory, cannot be justified for such

a small consumption, and the original procedure of purchasing electric power and raising steam by oil fuel will have to be continued. However, when taking the long-term view of a bamboo or bagasse or other pulp mill, integrated with a paper mill and having an output of about 80 tons per day, then the economic advantages of generating power on site are inescapable. It is estimated that with fuel oil at $30.00 per ton, electricity could be generated at approximately $0.015 per unit, and that the cost of steam and electricity together should not exceed $40.00 per ton of paper made from mill-produced pulp.

Interesting in this connection is the proposal now under consideration by the Trinidad and Tobago Electricity Commission to build a power station near the fertiliser factory at Claxton's Bay. This would sell both steam and electricity to local industry. If these are available at suitable prices at the site of the pulp mill, a large capital expenditure on steam and power plant at the mill could be eliminated.

(f) Labour and Management

Labour.

Table 16 shows the type and number of workers likely to be required to operate the new Arima factory according to departments, assuming a 5-day rota in a 120-hour week. The total number namely (59) compares with 46 to 50 at this mill on 31st December, 1966, according to the mill records. However, it is intended that the new mill shall normally work 7 days per week, 24 hours per day, in order to obtain the requisite production of 4,000 tons per annum. This will involve a 4-shift rota system for shift workers, and the numbers of such workers required will be increased by 7/5, i.e., from 44

Table 16

FACTORY PAYROLL

Department	Period	Foremen	Skilled Men	Semi-skilled Men	Labourers	Women	Tot
Raw materials Handling	Day	-	-	1	2	-	
	Shift	-	-	2	2	-	
Pulp Preparation	Shift	-	3	-	3	-	6
Paper Machine	Shift	-	3	3	3	-	
Finishing and Packing	Day	-	-	2	-	3	
	Shift	-	3	3	3	-	
General Supervision	Shift	3	-	-	-	-	
Maintenance	Day	1	1	1	1	-	
	Shift	-	2	-	2	-	
Boiler House	Shift	-	3	-	-	-	
Water and Effluent	Shift	-	-	3	-	-	
Watchmen	Shift	-	-	-	3	-	
Miscellaneous	Day	-	-	1	2	-	
Totals		4	15	16	21	3	5

to 62. This gives a total factory payroll of 77. It is believed that a number of the key employees previously working at the mill can be re-employed in the new Arima factory, so that the necessity for basic training may be to some extent eliminated.

Information was sought on the subject of wage rates, schedules, and agreements with the respective unions from Caroni, Ltd. and Texaco Trinidad, Inc. Actually the 2 schedules show considerable discrepancies for the rates paid for the same type of work. Thus, on an 8-hour day basis, for comparable skills, the Texaco rates were approximately twice those of the Caroni rates. There is no statutory basic weekly wage or working week in Trinidad and Tobago, and there is no standard ruling on fringe benefits. However, overtime is usually 1.5-times normal time. Wage rates are a matter of negotiation between the Company concerned and the Union.

In order to arrive at wage figures for use in the present Study, 2 alter atives appeared to be available :

(a) Add a shift bonus to the Caroni figures, say 4, 8 and 10 cents per hour for the morning, afternoon and night shifts, respectively.

(b) Take the average of the Caroni and Texaco figures. The latter course has been adopted, with the addition of 25% for fringe benefits and benefits in kind (such as housing, canteen facilities, social services, etc.).

As stated, there is no standard working week for Trinidad and Tobago, but as the trend is towards a 40-hour week in general, this was assumed in the present calculations. The usual shift hours are 00.70 to 15.00, 15.00 to 23.00 and 23.00 to 00.70 hours.

It is suggested that the new Arima factory works 24 hours

per day, and 7 days per week. The mill would normally run for 339 days per year, i.e., allowing 12 days for public holidays and 7 days for an annual shut-down for maintenance, etc.; the other 7 days would be accounted for by inadverdent losses of production. In this running period there would be 98 Saturday and Sunday holidays for day workers, who would thus work 241 days per annum . In order to achieve this system, a four-shift rota system is involved, and this can be worked out in such a way that no time-employee works more than five 8-hour periods per week. Shift workers should change shifts at suitable intervals. Day workers would of course, work the five 8-hour periods per week. The figures given in Tables 17 and 18 show the calculation of wages costs on the above assumptions.

Table 17

WAGES - ARIMA MILL

Grade	Number	Day Rate	Weekly Rate
		$	$
Day Workers :			
Foreman	1	12.0	60.0
Skilled	1	11.0	55.0
Semi-skilled	5	9.0	45.0
Labourers	5	7.5	37.5
Women	3	4.5	13.5
Total			211.0
Shift Workers :			
Foremen	3	12.0	36.0
Skilled	14	11.0	154.0
Semi-skilled	11	9.0	99.0
Labourers	16	7.5	120.0
Total			409.0

Table 18

ANNUAL WAGE BILL

ARIMA MILL

Day Workers (5 x 52 days)	$10,972
Shift Workers (7 x 52 days)	$29,777
Total	$40,749
Fringe benefits (25%)	$10,187
Grand total: per annum	$50,936
per ton (4,000 t.p.a.)	$12.73

Management.

Table 19 shows the estimated requirements and rates of remuneration for management and staff (monthly rates). The addition of fringe benefits is in line with local experience, and with the General Manager, this allows for annual leave in the case of an alien.

Table 19

MANAGEMENT AND STAFF

PAYROLL

Position	Monthly Salary	Fringe Benefits	Total
	$	%	$
General Manager	1,200	50	1,800
Works Manager	900	30	1,170
Chief Engineer	800	25	1,000
Chief Clerk	600	20	720
Laboratory Assistant	400	20	480
2 Typists	300	20	720
Total: per month			$5,890
per annum			$70,680
per ton (4,000 t.p.a.)			$17.67

The importance of employing a first-class General Manager cannot be over-stressed; so much will depend on him. He should have practical paper mill experience and be able, if necessary, to deal with ad hoc mill problems himself. Administrative experience is less necessary in such a mill, and provision has been made in the costings given in Part III, (i) for the handling of sales by an outside agent. It would be desirable for the General Manager to be engaged before the rehabilitation of the mill, so that his services and advice are available during this operation. The Works Manager can be a senior foreman type, and also may have to be an alien in the first instance.

(g) Site, including Water and Effluent

It is first desirable to state the criteria which go to make up the ideal site for a pulp and paper mill. These are as follows :

1. Availability of Water in adequate Quantity and Quality. This is by far the most important consideration and, if it cannot be satisfied completely, then a site must be rejected on these grounds alone. Although both quality and quantity of water are important, because of the availability of modern methods of water treatment the quantity is perhaps the more important. Nowadays natural waters can be purified both chemically and mechanically, to give a supply of any desired purity. However, water which is very impure to start with, especially in respect of finely-divided suspended matter, may require a great deal of treatment, and relatively large quantities of chemicals may be consumed. Consequently, the treatment cost of such water may become a significant factor in the

production cost of the product. A specification for a water suitable for the manufacture of the types of paper envisaged for the production of the proposed mill is given in Table 20.

Table 20

ANALYTICAL VALUES (MAXIMA) FOR WATER FOR PAPERMAKING

(in parts per million)

	White papers	Wrapping papers	
		bleached	unbleached
Turbidity	10	40	100
Colour	5	25	100
Total hardness ($CaCO_3$)	100	100	200
Calcium hardness ($CaCO_3$)	50	-	-
Methyl orange alkalinity ($CaCO_3$)	75	75	150
Iron	0.1	0.2	1.0
Manganese	0.05	0.1	0.5
Free chlorine	2	-	-
Soluble silica	20	50	100
Total dissolved solids	200	300	500
Free carbon dioxide	10	10	10
Chlorides (Cl)	75	200	200

As to quantity, the following approximate volumes are required by pulp and paper mills :

Manufacture of pulp and paper in an integrated mill - 50,000 to 70,000 gallons per ton of paper produced.

Manufacture of paper from purchased pulp - 11,000 to 25,000 gallons per ton of paper produced.

These quantities must be available day and night throughout the year, even in the driest season. The possibility of future increases in production must also be borne in mind.

Experience has shown that there is usually a tendency to underestimate the water requirements of a project of this nature. In general, it is advisable to consider only surface water,

i.e., rivers and lakes; and the salt content usually precludes the use of sea water or water near the coast. Water below ground can be a very uncertain factor in many countries, where such large quantities are concerned, although many large mills operate on well water, and conditions in Trinidad would appear to be favourable in this respect. The water table at the present site is said to be at about 4 feet below ground level. However, the cost of sinking the wells for large quantities must be borne in mind. In addition, there is the possibility of encroaching on underground supplies of existing wells; or alternatively, other wells may be sunk in the neighbourbood at a later date and draw water from existing wells.

2. Effluent Disposal. Most of the water taken from a river or other source for process work will ultimately be discharged from the mill. There will however, be certain losses, such as evaporation in a soda recovery plant and also during the drying of the paper on the paper machine. The water returned to the river will usually be less pure than in the form in which it was extracted, and the impurities will contaminate the river water to a corresponding extent.

It will be appreciated that, during the digestion process, approximately 50% of the substance of the plant is removed in order to produce a 50% yield, and that this must be disposed of in soluble form, with residual chemicals, in the black liquors from the digesters. Most of this organic matter is normally destroyed later by burning the evaporated digester liquors in the soda recovery process (see Part III, (d)), and the heat obtained thereby is usefully employed. However, in order to wash the pulp after it has been digested a certain amount of water is needed, and

although very efficient methods of washing are now used, small amounts of black liquor may be rejected to the mill effluent at this stage. These contain a very small amount of caustic soda, a certain amount of suspended fine fibrous matter, and some dissolved organic matter, usually in a colloidal state. These materials are very difficult to eliminate, but methods are available which enable a reasonably-pure effluent to be obtained. Much depends on the type of process and raw material used. It will be appreciated that considerations of this kind will only apply to pulp mills, i.e., of the nature of the long-term project outlined in Part III, (h).

One means of partial purification of such effluent involves passing it through sedimentation tanks, where most of the suspended matter is removed. The liquor can also be aerated in lagoons, artificially or otherwise, and a certain amount of organic matter can be removed by oxidation in this way. A further alternative is to segregate the worst portions of the effluent and to lagoon them separately, allowing only the least polluting portion to be discharged directly into the river. A method of this kind will be recommended in the present instance, when small amounts of bagasse are being used.

Pollution takes the form of what is known as Biological Oxygen Demand (B.O.D.); this is a measure of the extent to which the effluent will remove the oxygen present in a river water when the effluent and river water are mixed together. If the dissolved oxygen is decreased to a low level, this has adverse effects on the fauna and flora of the river. The natural plant life cannot grow, and so it cannot re-oxygenate the river, which thus becomes cumulatively worse in this oxygen content.

It is therefore apparent that, after water supply, effluent disposal facilities represent an extremely important factor in the selection of the site of a mill. If suitable facilities do not exist, then the site must be rejected. These considerations as stated, apply mainly to pulp mills. The purification of paper mill effluents is much less difficult. However, the selection of a site for a paper mill has often to be made with the possibility in mind of a pulp mill as a future development.

3. Proximity to Raw Materials and Markets. It is usually necessary, from an economic standpoint, to locate the mill in a central position with respect to its fibrous raw material requirements. This location is sometimes relative; thus many mills have to transport their fibrous raw materials from fairly distant points, but close proximity to the fibrous material is obviously a great advantage. The same considerations apply to other materials (such as fuel and chemicals), and to paper markets. In the present instance bagasse or bamboo is the only likely local fibrous raw material. Chemicals, etc. must be brought from Port of Spain. Since some 94% of the population of Trinidad is in the Port of Spain area this is the principal centre to be considered, although there are individual relatively large consumers in the Arima and San Fernando areas.

4. Transport. The above considerations indicate that transport facilities also are an important factor. It is a great advantage to locate a site so that it has both railway and road transportation. This obviously ensures convenience and flexibility. This particular point is of little importance in Trinidad, where road transport is rapidly excluding railway transport.

The Arima Site.

This site of course, already exists and has to be accepted.

Actually, although it is not an ideal site, or even the best site available at the time it was being selected, it is passable and the question of changing it can hardly arise. It was selected in the first instance mainly because of the availability of water, and this aspect is discussed further below. Applying the other criteria of the ideal site given above, it is neither particularly near to supplies of proposed raw material (bagasse), or to markets (Port of Spain); nor is it near the natural gas pipeline.

As seen from Figures 2 and 3 the mill occupies a site adjoining the Guanapo River, just off the Manuel Congo Road, which leaves the Tumpuna Road on the north side of the river. The site is approximately 4 miles due south of the town of Arima along the line of the Tumpuna road, and approximately 3 miles due south of the Churhill-Roosevelt Highway, which is crossed by the Tumpuna Road. The mill site is approached by a now unprotected road bridge which, as shown, crosses the Guanapo River; this is flooded in wet weather, when the debris forms a dam at the upstream side of the bridge. The land is low-lying, but there is no serious flood risk of the site as at present laid out. The railway from Arima runs quite near to the mill as shown on the map, but this will not be available in the future as it is to be discarded.

The only advantage to be gained by reconsidering the site of the proposed factory concerns the question of proximity to Port of Spain. The mill at present is approximately 20 miles by road from the town and this adds at least $3.00 per ton to all raw materials coming into the mill from Port of Spain and to all finished products going out to that destination, i.e., most of the production of the mill. This makes a total of about

$40,000 per annum for transport, assuming an average production of 12 tons per day.

Proximity to supplies of bagasse is no longer a major consideration, since the use of this material, except in relatively small quantities, is now excluded from the short-term project. If bamboo becomes a future raw material, then the present site may probably be as good as any. Certainly more bamboo was seen around the Guanapo River area than elsewhere. The only other factors of importance are the water supply and effluent disposal facilities, and these require serious consideration. Thus, to sum up, the present position is not ideal but it is unlikely to be improved materially by moving the site and moreover, it is unlikely that a much better site will be found near to Port of Spain.

Water. The overall water situation is outlined in Part II, (b). If the mill makes 12 tons of paper per day then it will require at least 360,000 gallons of water per day. This approaches a counsel of perfection, but it is attainable. One usually finds in practice however, that it is impossible to control the consumption of what is regarded by mill workers as a "free" commodity. A consumption of 500,000 gallons per day is more likely to be the actual consumption. A figure of this order makes no provision for future expansion, and in order to do so it should be at least doubled.

Full data on flows and chemical analyses of the Guanapo River and other neighbouring rivers are not available but the following is an extract from an earlier report on the subject received from the Water and Sewerage Authority, dated September, 1966 :

"As far as I can ascertain no licences have been granted by the now defunct Oil and Water Board for abstraction of water from the Guanapo River. However, the Guanapo is one of the important tributaries of the Caroni and several licences have been issued to various concerns for abstraction from this source. In addition, the Drainage Department is responsible for irrigating a large area of the Caroni Plain.

I regret that I am unable to forecast further rates of abstraction.

I have attempted to estimate the frequency of low flows of the Guanapo River at Eastern Mains Road and give below the results obtained :

Return Period (Years)	Run-off equal to or less than (million gal./month)	Average daily flow during period of 1 month equal to or less than (cu.ft./sec.)
25	10 to 20	0.6 to 1.2
10	15 to 25	0.9 to 1.5
2 (mean)	60 to 80	3.7 to 5.0

These values are only approximate, as the stream flow-records available are of unknown reliability and accuracy and were for a period of 7 years 1924-1927 and 1931-1933 (inclusive). These records were in the form of monthly run-off in millions of gallons so it is impossible to use any time period shorter than a month. The 7 years of stream flow-records were extrapolated by means of a correlation with large period monthly rainfall records at rainfall stations inside or adjacent to the drainage area. It appears that the required abstration of 380,000 g.p.d. (0.65 c.f.s.) would need storage."

Following this it was suggested that the official permission

(to abstract water) be given, with the proviso that within 5 years the Company drills a new borehole with a minimum of 9.5/8 o/d casing and gravel packed with at least 4" surround."

Table 21 gives an analysis of the Tumpuna River (a tributary of the Guanapo River, see Figs. 2 and 3), which is believed to have a similar composition to the latter.

Table 21

ANALYSIS OF TUMPUNA RIVER WATER

Date	13.9.66.
Received from :-	Trinidad Paper Products, Ltd. (Tumpuna Road, Arima).
pH value	8.5
Specific conductivity ($20^{o}C.$, micromhos)	231
Colour	Nil
Turbidity A.T.U.	140
Free carbon dioxide	nil
Alkalinity to phenolphthalein ($CaCO_3$)	2.5 parts per million
Alkalinity to methyl orange ($CaCO_3$)	115.5
Carbonates	3.0
Bicarbonates	134.81
Total Hardness ($CaCO_3$)	104.0
Calcium (Ca)	36.0
Magnesium (Mg)	3.40
Chlorides (NaCl)	16.48
Iron (Fe)	0.34
Sulphates (SO_4)	6.17
Silicates (SiO_2)	11.40
Total dissolved solids ($180^{o}C$)	126
Appearance :-	A discoloured water with a marked amount of suspended matter.

The analysis suggests that (apart from a rather high iron content), such a water should be suitable for the manufacture of the better qualities of paper (see Table 20). However, these tests should be repeated during the dry season when the water will be at its worst owing to the absence of the diluting effect of rainwater. This applies particularly to the chemical figures

of the river water, but is not applicable to the well water which does not change greatly in chemical composition according to season.

According to Interim Report No. 2 of the Water Resources Survey by M.M. Dillon, February, 1968, work on water gaugings started in 1966. There are no stream gauging stations on the rivers in question.

Iron cannot be removed economically from water to be used for paper manufacture, but suspended matter can be removed; although the large quantities seen at the time of my visit, due to the combined effects of the weather and sand washing, would be expensive to deal with, both in capital expenditure and running costs. Direct extraction of water from the Guanapo River should therefore, be avoided so far as possible, except in emergency circumstances - and such circumstances are more likely to arise in the dry weather when the river is less affected by flood water. The river water should be used only when sand washings are absent.

The following considerations apply to the water supply at Arima :

(a) It is understood that 60% of the water supply of Trinidad comes from relatively shallow wells, and that ample water is usually available at less than 200 feet below ground level. A well yielding 200,000 - 600,000 gallons per day costs $50,000 - $60,000. One such well would probably supply the requirements of the new mill at Arima. Actually a deep well of this nature has been sunk, but was abandoned because of the presence of micro-sand at 150 feet. The position of this well should be reinvestigated, and the well should be suitably packed

to eliminate the objectionable ingredient, any traces of which can be removed subsequently. If this can be done, the immediate water problem should be solved.

(b) The caisson type shallow well 6 inches in diameter and 18 feet deep, sunk 4 feet from the bank of the Guanapo River, is stated to have given good results as to the clarity of the water, although it came to late to be of any use (see Part II, (b)). This source of supply should also be further investigated.

(c) Provision should be made for using the Guanapo River supply if necessary by installation of settling tanks to remove the suspended matter. Means should be taken to stop the pollution of the water by the sand washing, and this matter is discussed further below under the heading Effluent Disposal.

(d) As Figs. 2 and 3 show, just over half a mile in a south-westerly direction from the mill, the Guanapo River joins the Caroni River, and the combined rivers (now known as the Caroni River) are crossed by the Tumpuna Road in the direction of San Pedro and San Rafael. At a point below the confluence of these 2 rivers, i.e., just downstream from the Tumpuna Road bridge, it should be possible to obtain a very plentiful supply of water - adequate for all the short-term requirements of the mill. Taking a direct line, this involves bringing the water only about one mile. The question of the quality of the water still remains however, and in particular, the removal of suspended matter in rainy weather or due to sand washing.

(e) The treated sewerage from the town of Arima, is discharged into the Mausica River, see Fig. 2. This river flows in a south-westerly direction from Arima, and joins the Caroni River about 2 miles west of the Tumpuna Road bridge.

Actually the straight line distance from the mill site to the Mausica River is approximately 3.8 miles. Effluent discharged into the Mausica River has a relatively high degree of purity, its B.O.D. being only 10 parts per million, and it could be used for most of the mill process work if necessary, especially if mixed with other supplies. The Arima sewerage effluent is approximately 200,000 gallons per day, to which must be added the natural flow of the Mausica River, although this is not high except in rainy weather. It has been stated that the flow of the Mausica River is about 1 million gal. per day including 200,000 gal. of effluent.

Incidentally the purified effluent from the town of Port of Spain as produced by the Levantille plant on the Churchill-Roosevelt Highway, was also considered as a source of mill process water, but it is much less pure than the Arima effluent, the chlorides being 200 - 300 parts per million, and the B.O.D. being 20 parts per million. It is also prone to algoid growths. However, the quantity is very large namely, 15 million gal. per day.

It will be seen from the above therefore, that excluding the Guanapo River water, there may well be a potential water supply at the Arima factory site as follows :

(a) Existing well when finished	-	300,000 gallons per day.
(b) Percolation well	-	100,000 " "
(c) Mausica River	-	200,000 " " (minimum).
Total	-	600,000 " "

This should certainly be sufficient for the foreseeable future, without having to draw on the Guanapo or Caroni Rivers.

If ever a large pulp mill using bagasse or bamboo, is

established in Trinidad, the question of water supply would loom large. The specimen calculations given in Part III, (i), assume a production of 80 tons per day of paper, mainly from bagasse, and this would require nearly 6 million gallons per day of water. Such water would have to be obtained from one of the larger rivers on the east coast of Trinidad, of which the Orbuche River, some 30 miles from Arima, is the most likely. This source of supply was envisaged for the mill at Brechin Castle described in the Sandwell Report referred to in Part III, (c).

Other alternatives might be the various dams under consideration in the north and north-eastern valleys, but the purpose of these is primarily to supply domestic water supplies for the island.

Effluent. This problem will be largely eliminated if little or no bagasse is processed. If the amount of bagasse is small, then the black liquors from the digesters can be allowed to soak away as originally planned. If the amount of bagasse is too large to enable this to be done, the black liquors can be evaporated by flue gases from the boiler plant and burned with fuel oil. The cost of doing this should not be high in view of the low price of the oil; and the equipment is not costly. The larger amounts of pulp mill effluent associated with the long-term scheme would have to undergo the usual soda recovery process, which destroys the organic matter, regenerates the caustic soda used and makes use of the heat involved. However, for such a scheme the whole question of the site location would have to be reconsidered.

As for the remaining effluent, this will consist almost wholly of fibre and some loading (china clay), and if passed through

a saveall or other effluent fibre recovery system, it should not only produce an acceptable effluent, but should also yield valuable recovered fibre. Money spent on such plant is therefore, doubly-well spent.

The effluent standards set out in the letter of 23rd August, 1965 (see Part II, (b)) should be drastically revised. Most standards for trade waste throughout the world are based on the first effluent standards, used in the United Kingdom, known as the Royal Commission Standards. Reasonable standards based on these are as follows :-

B.O.D.	-	20 parts per million
Suspended solids	-	30 " " "
pH value	-	6 to 11
Temperature	-	not exceeding 45°C.

Offensive and injurious matters should be absent.

The standards make no reference to the quantity to be discharged. This is a matter of arrangement, but normally it does not arise if the above standards are complied with. Compliance with these standards should safeguard the Guanapo River, and the mill should have no difficulty in meeting with them. A meat packing plant upstream of the Arima factory on the Arima River (see Fig. 2), has to comply with a B.O.D. of 20 parts per million.

If there is any difficulty with the mill water supply, consideration should be given to the pollution of the Guanapo River by the 3 sand-washing plants above it. If the Arima mill and other factories have to comply with a suspended solids limitation (see above), then surely this should also apply to the sand-washing plants. Otherwise the new Arima factory will, in

effect, be purifying the incoming water from pollution by the sand, and returning it to the Guanapo River purer than when removed. Installation of a sedimentation plant should not be an onerous condition for the sand-washing plant, but as these plants have been in existence for some time an element of hardship may be involved. The whole question need not be considered unless the raw Guanapo River water has to be used by the Arima factory and, as stated above, on a short-term basis, this does not appear to be likely.

(h) Process, Plant and Capital Cost

This section is considered under 2 headings namely, short-term and long-term. In each case information and data set out in the preceding pages is used in order to arrive at the conclusions reached.

Short-Term Project.

This involves the rehabilitation and improvement of the present Arima factory, referred to for convenience in this Report as the new Arima factory. There are 2 alternatives namely, the proposal put forward by Sterling International Company and that indicated as a result of this Study. The Sterling International proposals have already been dealt with in Part II, (c), from which it will be noted that the capital cost on plant and machinery is $200,000 to produce wrappings and second quality toilet tissue, totalling 2,000 tons per annum. Stage 2, which will cost another $1.5 million, involves a new tissue paper machine and converting plant.

Alternative Proposal Based on the Present Study. In some respects this follows the same lines as that put forward by the Sterling International, but the object is to manufacture

approximately 12 tons per day of several grades of paper instead of about 7 to 8 tons per day of wrapping and toilet papers. Imported wood pulp is the principal raw material with some waste paper, in each case; but the latter alternative envisages the use also of some home-produced unbleached bagasse pulp. These differences in objectives are reflected in the more drastic and costly alterations to the paper machine.

The proposed process, in outline, is as follows. The imported pulp will be fed into a Hydrapulper, and will thence pass through a modern recycling-refining system which prepares it for the paper machine. The pulp will then pass through an adequate screening system to the paper machine. The chests should be adequately provided with agitators. The wire part of the paper machine will require better facilities for water removal, such as tube rolls or hydrofoils and additional suction boxes, and provision should also be made for a shake, and a dandy roll for the better grades of paper.

Additional presses, preferably one reversing press, will also be required, and the machine-glazed (yankee) cylinder will have to be repaired and re-located in order to make room for the 3 new pre-drying cylinders which will be inserted before it. These will be 4 feet in diameter, and will operate at a pressure of 50 lb. per square inch. After the machine-glazed-finish cylinder, which will need to be felted, there will be a 5-bowl calender and a Pope reel. Provision should be made for missing the pre-dryers and taking the paper web direct to the M.G. cylinder, so that toilet tissues can be made if necessary. It is assumed that the information already available regarding the machine drive is correct, namely, that it is capable of running

at up to at least 350 feet per minute. Little attention therefore, should be required for the drive, except insofar as it has to be modified slightly to operate the additional cylinders, etc.

Waste paper and bagasse can also be handled in such a plant, the latter in the unbleached state, if necessary, in the Hydrapulper. However, this is not recommended in the present instance because of the desirability of keeping the white and brown pulp and papers in separate systems, so far as possible. One of the 2 existing breakers (i.e., that without a drum washer) can be used for the waste paper. The bagasse should be partly depithed, and this can be carried out in the depithing machine which already exists at the mill but has not yet been used. The partly-depithed bagassed will be boiled in one of the existing digesters, much as originally intended, and after draining off the black liquor to the land soak-away, the pulp will be diluted with water and pumped to the washer-breaker for washing and disintegration. It can then be used as required, either alone or with the waste paper or, in some instances, blended with the imported pulp. A single chest can serve for both waste paper and unbleached bagasse pulps.

The position regarding the output of the 2 digesters is uncertain, and their maximum combined capacity is unlikely to exceed about 5 tons of unbleached bagasse pulp per day. If this is inadequate, the balance of 7 tons per day required when the factory is making corrugating medium can be obtained by using the Hydrapulper as a pulper, the time cycle being on 1.5 hr. The caustic soda consumption is low and the waste liquors can be run to waste.

If bagasse is used on any scale, the questions of transport

and storage will require a separate and special study as to the best procedure to use. Thus, 12 tons per day of corrugating medium will require about 50 tons per day of wet bagasse, whether the sugar mill is crushing or not.

The separation, so far as possible, of the unbleached bagasse and the poorer grades of waste paper from the imported bleached wood pulp is important, and could give rise to difficulties. It means as long a run as possible on the white grades, followed by as long a run as possible on the brown grades. Then the system will have to be cleaned up by running on white wrappings comprising waste papers and unbleached imported pulp, before it is finally washed up in preparation for the white grades again. It such cases there is always the danger that traces of brown pulp will remain in the system and appear in and spoil the white papers. For this reason, frequent changes from white to brown and back again are undesirable, because the system will be dirtied each time. Normally this form of mixed manufacture is not regarded as good papermaking practice but in small mixed mills catering for local markets, it can be used successfully so long as care is taken.

The reels obtained at the end of the paper machine must be slit to smaller reels, and then cut into sheets as required by the customer. Improved equipment for this purpose will be needed. The better grades of paper will be sorted by women to eliminate defective sheets, such as dirty sheets, torn sheets, etc., and the paper will then be packed for despatch.

Auxiliary equipment will include a water filtration plant and backwater fibre recovery plant. A small tank with agitator will be required for mixing china clay to a slurry. The well

already started should be completed, with suitable means for excluding the micro sand; and the road bridge improvements should also be carried out to render this safe in all weathers. There should also be proper laboratory control facilities and instruments for the purpose of making the usual routine tests.

The details of all these purely mechanical improvements will need to be finalised with the manufacturers of the machinery, preferably in association with the future management of the mill or other experts.

The capital cost of these improvements has been estimated and is summarised in Table 22. These figures have been used in the profitability calculations given in Part III, (i).

Long-Term Project.

In order to obtain a picture of the future possibilities for an integrated pulp and paper industry in Trinidad, it has been assumed hypothetically, that the paper market of the country will be able to support a mill making 80 tons per day of various types of paper from bleached bagasse pulp with a proportion of imported wood pulp. The former would involve a complete pulping and bleaching plant, with soda recovery process, lime burning equipment and a plant for the preparation of chlorine and caustic soda by the electrolysis of brine, the excess of caustic soda being sold locally. The amount of imported wood pulp would average about 20 tons per day.

Present-day prices of plant and materials, and selling prices for paper have been used in the calculations. It is also assumed that the mill would not necessarily be at Arima, and that none of the buildings, equipment, etc., there, would be used, as indeed would be unlikely for a mill of the size envisaged.

Table 22

ESTIMATED CAPITAL COST OF NEW ARIMA FACTORY

(in $)

Stock preparation	35,000
Shake and wire improvements	40,000
Drying cylinders (3)	70,000
Re-location of drying cylinders and reel-up	8,000
Repair of M.G. cylinder	15,000
Calender	60,000
Water and purification and fibre recovery	50,000
Screens	50,000
Miscellaneous (pumps, agitators, etc.)	30,000
Total	363,000
Transport and erection	120,000
	483,000
Contingencies	50,000
	533,000
Purchase of existing assets	300,000
	833,000
Working capital (3 months' production at $427 per ton)	427,000
* Interest at 6.0% during reconstruction (say for 6 months on $833,000)	25,000
Engineering, etc.	30,000
Total	$1,315,000

* Assumes a reconstruction period of 1 year.

Notes :

(1) The major figures, including repair of the M.G. cylinder, are based on actual approximate estimates.

(2) Motors and switchgear are included in the above figures where appropriate.

(3) The price of the existing mill is arrived at as follows. Reduction of the owners' investments by costs

irrevocably written off gives a figure of $400,000 (see Part II, (a)). Estimation of the present break-up value of the factory, assuming the land, buildings and boiler house can be sold at a figure approaching cost price, and the paper machine is sold for its break-up value, is approximately $200,000. Since these represent 2 extremes, an average figure of $300,000 is used.

(4) The question may be asked whether it would not be preferable to instal completely new papermaking equipment. The answer is contained in the proposals of Sterling International (Part II), where the cost of a new paper machine (Stage 2) is estimated at about $1.2 million; and this assumes that the other parts of the mill (pulp preparation plant, water supply, etc.) have been put in good working order. A new mill on this site capable of making the types and amounts of papers now suggested would probably cost at least $2 million (including the purchase of existing assets); as against $833,000 above.

Both pulp and paper manufacture would be on conventional lines, and the total capital cost has been estimated at approximately $64 million. This figure is based partly on experience elsewhere in the world, and happens to be similar to the figure estimated in the Sandwell Report (Part III, (c)). To this must be added working capital ($1.5 million) and interest during construction ($3.8 million), making a total capital requirement of $70 million. Bagasse has been mentioned as the potential raw material for a scheme of this kind, but if further investigations show that bamboo is more likely to be favourable for the purpose then it equally, could be used. Experience has also shown that the general conclusions drawn from the data for bagasse are not likely to be greatly affected if indeed bamboo is used partly or wholly in its stead. However, this assumes that the bamboo costs the same on a yield basis, as the bagasse, and this is not yet established.

It must be emphasised that the project as now drawn up is purely hypothetical, because the possibility of utilising 80 tons per day (say 24,000 tons per annum) of papers of the types that can be made on one paper machine in Trinidad and Tobago in the near future is very unlikely (see Fig. 4, Part III, (c)). Moreover, such export markets as could take this type of paper are likely to be limited. The market study of Part III, (c) (Fig. 4), suggests that this might be feasible some 10 years hence, when such a local consumption may become available. The costing of the production of a hypothetical mill on these lines pinpoints the greater realism of the short-term suggestion made above, since it shows that under present conditions a mill of this size would just fail to break even.

With rising costs of plant and machinery, and a tendency for pulp and paper prices to fall (in the long-term) due to even larger manufacturing units in the traditional producing countries, it may well be that the mill as at present envisaged is too small to be profitable. On the other hand, the exploitation of bamboo or Pinus may result in a cheap fibrous raw material which, with cheap fuel, may make such a mill competitive by replacing imported wood pulp.

(i) Profitability Considerations

The purpose of this section is to compare the various proposals referred to in this Study in terms of costings, showing selling prices as against production costs in each case. Both the above short-term and long-term suggestions are dealt with, but the latter obviously is little more than of academic interest - except perhaps to emphasise the more immediate importance of the short-term view.

The following are dealt with under the latter heading, and so far as possible, the end-results are directly comparable.

Table 23. Production of 4,000 tons per annum of medium-grade writings and printings at the re-conditioned Arima factory, using imported wood pulp.

Table 24. The same, for 4,000 tons of wrappings, white and brown, using waste papers and imported wood pulp.

Table 25. The same, for 4,000 tons of corrugating medium, using unbleached bagasse pulp.

Table 26. Production of 2,000 tons per annum of second quality toilet tissue and wrappings from imported wood pulp (80%) and waste papers (20%). This, so far as one can tell from the information available, is the Sterling International

proposal (Stage 1) at present under consideration, although it is understood that some wrapping papers will also be made.

Table 27. Under the long-term heading is the production of 24,000 tons per annum of various white papers from bleached bagasse pulp (80%) and imported wood pulp (20%).

The items making up each costing are numbered, and explanatory notes are given numbered to correspond with each of these.

Table 23

COSTING FOR THE MANUFACTURE OF 4,000 TONS OF WRITING AND PRINTING PAPERS PER ANNUM AT THE NEW ARIMA MILL

Item	Quantity (tons)	Unit Price ($)	Cost per Annum ($1,000)
1. Wood pulp (dry basis)	4,863	310	1,508
2. China clay	400	100	40
3. Rosin	40	640	26
4. Alum	120	150	18
5. Miscellaneous	-	-	10
6. Wires, felts and maintenance materials	-	-	50
7. Fuel and power	-	-	120
8. Labour	-	-	51
9. Management	-	-	71
10. Overheads	-	-	30
11. Total (gross)	-	-	1,924
12. Added moisture	-	-	1,789
13. Sub-standard paper	400	200	80
14. Cost ex mill	-	-	1,709
15. Sales	4,000	2.5%	43
16. Packing	-	-	4
17. Transport	-	-	12
18. Cost delivered	-	-	1,768
19. Depreciation	833,000	6.5%	54
20. Interest	$1.32 m.	6.0%	79
21. Total delivered cost	-	-	1,901
22. Total per ton ($)	-	-	475
23. Sales ($1,000)	4,000	550	2,200
24. Profit: per annum ($1,000)		-	300
25. per ton ($)	-	-	75
26. on capital	-	-	22.7%

Notes:

1. Assumes an average of 93% in paper and average price of several grades :

Yield loss	-	5%
Sub-standard paper	-	10%
Moisture in materials	-	10%

2. Assumes an average of 7% in paper and a yield loss of 30%.

3. Assumes 1% on paper made of average grade rosin.

4. Assumes 3% on paper made.

5. Includes dyestuffs, wet strength additives, etc.

6. Based on experience.

7. Assumes a total of $30.00 per ton of paper (see Part III, (e)).

8. See Part III, (f).

9. See Part III, (f).

10. Includes insurance, social benefits, etc., see Part III, (f).

12. Correction for difference in moisture content between raw materials (bone-dry basis) and finished paper (7% moisture).

13. Assumes that the 10% of sub-standard paper is returned to the system at a value of $200 per ton.

14. Total (net) cost ex factory warehouse.

15. Allowance for selling costs.

16. Based on experience for short-distance transport.

17. Assumes 20 miles (to Port of Spain) at $0.15 per ton per mile.

19. Based on 5% depreciation for buildings and certain plant, and 7.5% for other plant, on $833,000 (Part III, (b)).

20. Based on total capital required (see Table 22, Part III, (h)).

22. Total delivered cost (21) divided by 4,000 tons.

23. Assumes an average price for the paper (white writings and printings) of $600 per ton (see Part III, (b)).

24. Difference between (23) and (22).

25. Is (26) divided by 4,000 tons.

26. Is (24) expressed as a percentage of $1.32 million.

Table 24

COSTING FOR THE MANUFACTURE OF 4,000 TONS OF WRAPPING AND BAG PAPERS PER ANNUM AT THE NEW ARIMA MILL

Item	Quantity (tons)	Unit Price ($)	Cost per Annum ($1,000)
1. Waste papers (dry basis)	1,400	60	84
Wood pulp			
Chemical	1,975	270	533
Mechanical	1,975	195	385
2. China clay	-	-	-
3. Rosin	40	640	26
4. Alum	120	150	18
5. Miscellaneous	-	-	10
6. Wires, felts and maintenance materials	-	-	50
7. Fuel and power	-	-	120
8. Labour	-	-	51
9. Management	-	-	71
10. Overheads	-	-	30
11. Total (gross)	-	-	1,378
12. Added moisture	-	-	1,282
13. Sub-standard paper	200	150	30
14. Cost ex mill	-	-	1,252
15. Sales	4,000	2.5%	35
16. Packing	-	-	3
17. Transport	-	-	12
18. Cost delivered	-	-	1,302
19. Depreciation	833,000	6.5%	54
20. Interest	$1.32 m.	6.0%	79
21. Total delivered cost			1,435
22. Total per ton ($)			359
23. Sales ($1,000)	4,000	415	1,660
24. Profit: per annum ($1,000)		-	225
25. per ton ($)	-	-	56
26. on capital	-	-	17.1%

Notes:

1. Assumes (average):

Waste papers - 20% in paper, yield loss 35%, sub-standard paper 5%, moisture 7%.

Wood pulps - 80% in paper of equal proportions of unbleached kraft ($270 per ton) and mechanical wood ($195 per ton), yields etc. as Table 23. Sub-standard paper, 5%.

3. to 12. inclusive. As Table 23.

13. Assumes sub-standard paper re-use value of $150 per ton.

14. to 22. inclusive. As Table 23.

23. Assumes an average selling price of $415 per ton (see Part III, (b)).

24. to 26. inclusive. As Table 23.

Table 25

COSTING FOR THE MANUFACTURE OF 4,000 TONS OF CORRUGATING MEDIUM PER ANNUM AT THE NEW ARIMA MILL

Item	Quantity (tons)	Unit Price ($)	Cost per Annum ($1,000)
1. Bagasse (dry basis)	8,700	23	201
2. Caustic soda	640	176	113
3. Rosin	40	640	26
4. Alum	120	150	18
5. Miscellaneous	-	-	10
6. Wires, felts and maintenance materials	-	-	50
7. Fuel and power	-	-	140
8. Labour	-	-	51
9. Management	-	-	71
10. Overheads	-	-	30
11. Total (gross)	-	-	710
12. Added moisture	-	-	660
13. Sub-standard paper	200	100	20
14. Cost ex mill	-	-	640
15. Sales	4,000	2.5%	16
16. Packing	-	-	3
17. Transport	-	-	12
18. Cost delivered	-	-	671
19. Depreciation	833,000	6.5%	54
20. Interest	$1.32 m.	6.0%	79
21. Total delivered cost	-	-	804
22. Total per ton ($)	-	-	201
23. Sales ($1,000)	4,000	315	1,260
24. Profit: per annum ($1,000)		-	456
25. per ton ($)	-	-	111
26. on capital	-	-	34.5%

Notes:

1. Assumes a 60% pulp yield from dry bagasse from which 15% pith has been removed, with yield loss on machine of 5% and sub-standard paper 5%. Actually, the yield is likely to be at least 65% when the Hydrapulpers are used.

2. Assumes 10% caustic soda on partly-depithed dry bagasse. Actually 10% would be used in the digesters, but only

5% in the Hydrapulper.

3. to 12. inclusive. As Table 23.

13. Assumes sub-standard paper re-use value of $150 per ton.

14. to 23. inclusive. As Table 23.

23. Assumes a selling price of $315 per ton (see Part III, (b)).

24. to 26. inclusive. As Table 23.

Table 26

COSTING FOR THE MANUFACTURE OF 1,000 TONS PER ANNUM, EACH, OF WRAPPING PAPER AND SECOND GRADE TOILET TISSUE

(STERLING INTERNATIONAL PROPOSAL)

Item	Quantity (tons)	Unit Price ($)	Cost per Annum ($1,000)
1. Waste papers and wood pulp	-	-	501
2. China clay	-	-	-
3. Rosin	40	640	13
4. Alum	120	150	9
5. Miscellaneous	-	-	5
6. Wires, felts and maintenance materials	-	-	35
7. Fuel and power	-	-	80
8. Labour	-	-	45
9. Management	-	-	65
10. Overheads	-	-	25
11. Total (gross)	-	-	778
12. Added moisture	-	-	724
13. Sub-standard paper	100	250	25
14. Cost ex mill	-	-	699
15. Sales	4,000	2.5%	18
16. Packing	-	-	3
17. Transport	-	-	12
18. Cost delivered	-	-	732
19. Depreciation	500,000	6.5%	33
20. Interest	690,000	6.0%	41
21. Total delivered cost	-	-	806
22. Total per ton ($)	-	-	403
23. Sales ($1,000)	2,000	450	900
24. Profit: per annum ($1,000)		-	94
25. per ton ($)	-	-	47
26. on capital	-	-	13.4%

Notes:

1. Based on 50% of this Item in Table 24.

3. to 12. inclusive. See Table 23.

13. Assumes sub-standard paper re-use value of $250.

14. to 18. inclusive. See Table 23.

19. Based on $300,000 for existing assets plus $200,000 for rehabilitation (see Part II, (i)).

20. Based on :

Capital (see 19.)	$500,000
Working capital (3 months, at $700,000 p.a.)	$175,000
Interest during construction (6 months, 6%, on $500,000)	$ 15,000
Total	$690,000

21. to 22. See Table 23.

23. Assumes an average selling price of $450 per ton; i.e., wrappings $415 and second-grade tissue $485 per ton.

24. to 26. inclusive. As Table 23.

Table 27

PRODUCTION COST FOR THE MANUFACTURE OF 24,000 TONS PER ANNUM OF PAPER MAINLY FROM BAGASSE

Item	Quantity (tons)	Unit Price ($)	Cost per Ton Paper
1. Bagasse (dry basis)	2.20	23	50.60
2. Wood pulp	0.22	310	68.20
3. Salt cake	0.096	100	9.60
4. Limestone	0.048	40	1.92
5. Lime	0.019	60	1.14
6. Chlorine	0.08	205	16.40
7. Caustic soda	0.02	187	3.74
8. Alum	0.045	150	6.75
9. Rosin	0.03	640	19.20
10. China clay	0.14	100	14.00
11. Miscellaneous	-	-	2.50
12. Fuel oil	1.20	20	24.00
13. Wires and felts	-	-	7.00
14. Maintenance	-	-	10.00
15. Miscellaneous	-	-	7.00
16. Labour	31 man-hr.	1.25	38.75
17. Management and overheads	-	-	9.00
18. Packing and despatching	-	-	4.00
19. Total			293.76
20. Added moisture	-	-	273.42
21. Sub-standard paper	-	300	30.00
			243.42
22. Sales expenses	-	2.5%	61.00
			304.42
23. Depreciation	$64m.	6.5%	173.00
24. Interest	$69.3m.	6.0%	173.00
25. Total delivered cost	-	-	650.42
26. Sales	1.00	600	600.00
27. Loss: per ton	-	-	50.42

Notes:

1. Assumes 80% bleached bagasse pulp (dry basis) in paper. For yield and price data, see Part III, (c).

2. Assumes 20% wood pulp (dry basis) in paper; for price, see Part III, (c).

3. Current quotation for imported product.

4. 5. Current quotations for local products.

6. 7. Assumes local manufacture from salt, see Part III, (d).

8. 9. 10. As (3); and see Part III, (d).

11. Includes dyestuffs, wet strength additives, etc.

12. Assumes steam and electricity are both generated at mill (see Part III, (e)).

13. 14. Based on experience.

15. Includes sundry materials and spares.

16. 17. See Part III, (f).

18. Assumes 20 miles (to Port of Spain) at $0.15 per ton per mile.

20. Correction for difference in moisture content between raw materials (bone-dry basis) and finished paper (7% moisture).

21. Re-use value of sub-standard paper assumed to be $300 per ton.

22. Allowance for selling costs.

23. Based on a capital cost of $64 million (see Part III, (h)).

24. Based on total capital requirement as follows :-

Plant, site, erection, etc.	$64.00 m.
Working capital (13 weeks' production at $243 per ton)	$ 1.46 m.
Interest on capital during erection (6% for 1 year)	$ 3.84 m.
	$69.30 m.

26. Assumes an average price of paper, delivered Port of Spain, of $600 per ton (see Part III, (b)).

27. Is (25) less (26). About one-third of this loss could be offset by the sale of approximately 2,000 tons of surplus caustic soda.

PART IV

CONCLUSIONS AND RECOMMENDATIONS

The conclusions reached and recommendations made as a result of this Study are set out in this Part under the headings of short-term and long-term projects, respectively They are as follows :

(a) Short-Term Recommendations.

1. The plant and equipment at the present Arima factory should not be dismantled and sold because of the small sum it would realise under these circumstances. It should be reconditioned and improved, and put to work to the best advantage to contribute to the economy of Trinidad and Tobago. It will be cheaper to do this than to build a new mill, even on the existing site and using such existing facilities as are suitable (Part III, (i)).

2. There appear to be 3 alternative methods of achieving the above objective, namely,

(a) Adopting the proposals put forward by Sterling International.

(b) Considering the proposals put forward by Rolex Paper Co., who have also expressed an interest in developing the factory.

(c) Adopting the proposals put forward as a result of the present Study.

3. Financially there is little to choose between alternatives (a) and (c), and since the details of (b) are not yet known. If (a) is chosen the Stage 1 capital expenditure will be less ($690,000) but the output of the mill will be small, and restricted to the manufacture of one particular class of paper for one particular user - i.e., toilet tissue. No doubt similar considerations will

apply to (b) when further details are known. Alternative (c) requires more capital ($1.32 million), but would appear to give a better profit; it is also more versatile and therefore, a better foundation for building a future national paper industry in Trinidad and Tobago. Having demonstrated the relative advantages of the 3 alternatives, it therefore becomes more a question of policy than of technical or even financial consideration as to which is chosen.

If alternative (c) is selected, then the following additional recommendations are put forward.

4. The paper machine should be reconditioned and improved so as to be capable of turning out approximately 12 tons per day of writings, printings and wrappings of average substance, as well as some thin boards and light weight papers. This would involve installing a shake on the wire with improved methods of water removal such as suction boxes, table rolls and presses. Additional drying capacity will also be required, and this can be provided by 3 additional drying cylinders. As a matter of course, the existing machine-glazing cylinder will have to be repaired, and its position moved. In order to accommodate these alterations the drive will have to be modified slightly, and it is assumed that when this is done it will be capable of running at least at 350 feet per minute. This will enable the desired production to be obtained. Improved facilities for calendering, reeling, slitting and cutting, and sorting will also be required.

5. In order to safeguard the water supply the unfinished well should be properly completed so as to exclude micro-sand; and the shallow well on the river bank also put into commission.

In times of shortage, the Guanapo River can be used, but the pollution by sand-washing must then be dealt with in this event, by either prevention or cure.

6. Facilities for water purification should be available, i.e., sand filters. Similarly, a fibre recovery saveall system should be installed, to ensure that there is a minimum loss of fibre from the system and that the water discharged into the river complies with the effluent standards.

7. The ruling as to effluent standards now applying should be subjected to drastic revision, with a view to bringing it into line with current practice elsewhere in the world and, in general, placing it on a more realistic footing. The provisions of the Royal Commission Standard are suggested as a basis in this connection.

8. The steam-raising boiler should be retained substantially as it is; if properly utilised it should be capable of providing the drying capacity necessary for the new mill.

9. This Study also contains recommendations (in Part III, (f)) as to the pay roll and management personnel of the factory. It is recommended that in the event of this short-term suggestion being adopted, a suitable General Manager is sought as soon as possible, and engaged at once so that he can assist in the rehabilitation process of the mill.

10. As many as possible of the former employees of the mill should be found with a view to their re-employment.

11. The mill working period should be 24 hours per day, 7 days per week, for 339 days per annum. Day workers should work 8 hours per day, 5 days per week. Shift workers should work 8 hours per day, 5 days per week, a 4-shift rota system being

introduced to enable the mill to run continuously and shift workers to change shifts at suitable intervals. Suggested wage rates are shown in Part III, (f).

12. The mill should be run in on imported wood pulp, chiefly bleached kraft or sulphite from coniferous wood for the better grades of papers, but to some extent deciduous wood for printing papers, and unbleached sulphite for strong papers where colour is not so important.

13. Waste paper should be incorporated into the furnish of the papers made where appropriate. It is hoped that it will be possible to segregate the better grades for use in the white papers, the remainder being used mixed in the wrappings.

14. A certain amount of bagasse should also be used. The purchased bagasse will be digested in the existing plant, and prepared as described in Part III, (h). It will then be blended with the imported pulp or waste paper or used alone in the case of corrugating medium. The waste black liquors from the digestion process should be treated on the land separately from the bulk of the effluent, which will be less contaminated and which will go to the river after treatment.

15. The selling of the product of the mill should be carried out through an agency in Port of Spain since that town is the principal market. An allowance of 2.5% commission on the production cost of the paper has been allowed for this purpose.

16. The question of the availability, price and reproduction of bamboo should be investigated with a view to using it as well as or instead of bagasse. It may also serve to replace some of the imported wood pulp. It is not however, suggested that bleached pulp should be made at this mill at this

stage.

17. Under the above circumstances the mill should be capable of making the following grades in the approximate quantities shown. At current prices of raw materials and finished paper the 4,000 tons per annum so produced should yield a profit of $317,000 per annum (Table 28).

Printings and Writings	2,000
Wrappings and Bag Papers	1,000
Corrugating Medium	850
Toilet Tissue	150
Total . . .	4,000 tons per annum

18. The average annual profit of the mill may therefore, be estimated as follows :

Table 28

Grade	Quantity (tons)	Profit ($ per ton)	Total Profit ($)
Writing and Printing Papers	2,000	75	150,000
Wrapping and Bag Papers	1,000	56	56,000
Corrugating Medium	1,000	111	111,000
Total	4,000	-	317,000

This total profit of $317,000 represents 24% on the total capital employed of $1,320,000. In practice this manufacturing schedule may have to be varied somewhat. Thus, at present the consumption of corrugating medium which the Arima factory could make is rather less than 1,000 tons per annum, and the production gap would have to be filled with toilet tissue (see Table 26). Similar considerations may also apply to the other papers for a year or two hence, and therefore these profit

figures should be assessed conservatively. However, the estimate of $317,000 per annum leaves room for some contingencies of this kind.

19. According to Table 26, alternative (a), the Sterling International proposal, should yield a profit of $94,000 per annum at Stage 1. This assumes that the calculations have correctly interpreted the proposer's intentions.

20. As a next step, the installation of converting machinery to deal with the above production should be considered. Examples are pad, envelope, bag, toilet roll, exercise book (ruling), carbon manufacture, etc.

(b) Long-Term Project.

1. The hypothetical long-term project set out in this Report (Part III, (h)) should be investigated on the following basis.

2. The production, extraction and selling costs and yields of Pinus caribaea should be studied with a view to its utilisation at some time in the future. The possibility of planting Pinus on a sufficient scale to provide the mill on a sustained yield basis, should also be considered; although this seems an unlikely possibility.

3. Similar considerations should be applied to bamboo in this connection, see above.

4. The long-term possibilities of bagasse should also be studied, although this has already been done fairly thoroughly. In view of the impending particle board industry, there may be some competition for the bagasse if a paper mill utilising it on a large scale is ever built. Such studies therefore, would have to be linked up with the likelihood of the use of fuel oil or natural

gas at the Caroni factories of Brechin Castle and Ste. Madeleine.

5. The hypothetical case for long-term study suggested in this Report, involves the manufacture of miscellaneous papers from a mixture of bleached bagasse pulp and imported long-fibred wood pulp. The bagasse could be substituted by bamboo if the Study showed this to be advantageous. Introduction of Pinus caribaea would, of course, replace some of the imported wood pulp; but if the amount available is sufficiently large it could also replace the bagasse assuming that the economics of such substitution were logical.

6. A study should be made of the site possibilities in various parts on the island, more particularly from the point of view of water availability, effluent disposal and availability of raw material. The nature of the raw material selected will to some extent determine the site.

7. To this end, data on the flow and analysis of the various watercourses should be collected especially under dry weather conditions; it is understood that steps are being taken to do this in any case.

8. The possibilities of the production of chlorine and caustic soda by the electrolysis of salt, should also be explored. It is understood that steps of this nature have already been considered, but could not be justified because of the low consumption by the local market. The utilisation of chlorine by a pulp mill would however, release caustic soda for sale locally (see Part III, (d)).

9. It is apparent from the costings for the long-term project shown in Part III, (i) (Table 27), that it is unlikely to be a viable proposition economically for some years. Of the

above recommendations therefore, only those which concern long-term raw materials such as Pinus caribaea, bamboo and bagasse, are worthy of investigation at an early stage.

PART V

GENERAL SUMMARY

This part of the Report is summarised in such a way that it can be read completely, independently of the more technical and detailed matter dealt with in Parts II to IV. It is therefore, intended primarily for those who desire to know of the general conclusions reached and the recommendations made without the necessity to study the technical and other arguments on which they are based. It can therefore, be read quite independently of the remainder of the Report.

The Report may be summarised as follows :-

1. In 1965, a company known as General Paper Products (Caribbean), Ltd. applied to the Industrial Development Corporation for "pioneer status". The objective was to build a paper mill on the Manuel Congo Road about 4 miles due south of Arima, which would make toilet tissue for local consumption from imported wood pulp and also from locally produced sugar cane bagasse. The output was to be 7 to 8 tons per day and this was to be sold to the 2 companies who at present convert large (jumbo) rolls of toilet tissue into small wrapped rolls of toilet paper as sold. These are the Rolex Paper Co. Trinidad, Ltd. and Trinidad Paper Products, Ltd. The 2 latter companies imported their paper from abroad at that time, and do so now. As a further development it was proposed to make paper napkins and paper towels, and possibly other paper products of a similar nature. It is stated that there was never any intention to make paper conversion products such as the small toilet rolls.

2. The pioneer status was granted, and in due course the mill was built and it started work in December, 1966. It ran

until the 31st May, 1967, when it was closed down. During this time it made 224 tons of paper at a cost of approximately $334,000. The paper was regarded by the users as bad in colour, dirty, harsh, and in other respects unsuitable for its purpose. Manufacturing difficulties were experienced in a number of respects, including water supply and bagasse pulp production. It was necessary to request permission to import bleached bagasse pulp from Venezuela and wood pulp from the U.S., and although this resulted in some improvement it did not resolve the situation, and eventually the mill had to close down because of the heavy losses being made.

3. At the time of its closure the financial position was as follows (in $US.) :-

Assets

Inventory	-	18,637
Plant and equipment	-	643,987
Start-up expenses	-	106,692
Organisation expenses	-	3,414
Total	-	772,730

Liabilities

Barclay's Bank D.C.O.	-	136,000
Due to suppliers	-	150,000
Stockholders' equity and advances	-	486,730
Total	-	772,730

4. The owners of the equity of the Company were :

Manuel Capedeville, Venezuela.

Paper Operations Consultants, U.S.A.

Mr. and Mrs. G.M. Hauser, U.S.A.

Mr. and Mrs. L.R. Williams, U.S.A.

5. Since May, 1967, several reports on the mill have been made namely, for Barclay's Bank D.C.O., for the United Nations and for an American Company interested in its purchase, see below. The general opinion reached was that the failure of the Company was due to poor and inadequate equipment, insufficient capital to complete the equipment, unsatisfactory raw materials (bagasse), and bad management. The value of the mill as it stands was estimated at various figures between $80,000 and $400,000. These assume that the necessary alterations and repairs would be made by the purchaser, and that the mill would run again as distinct from being broken up for scrap.

6. In March, 1968, Sterling International Corporation, who are the parent company of Trinidad Paper Products, Ltd. and have other papermaking interests throughout the world, applied for pioneer status on the basis of a new proposal for the future of the factory at Arima. In addition to pioneer status, various other concessions and aspects of governmental support were asked for by the proposers. The proposals would be put into effect in 3 stages, which may be briefly summarised as follows :-

(a) Rehabilitation of the present factory to enable it to make second-grade toilet tissue and wrappings from local waste paper and imported wood pulp. This would cost about $200,000 plus presumably, the cost of purchasing the present assets. The output would be approximately 1,000 tons per annum of wrapping papers and presumably, the same quantity of tissues

(although this is not stated).

(b) In the second stage a new paper machine would be installed (estimated cost, $1.2 million); and also a certain amount of converting machinery to make toilet rolls, facial tissues, etc. (estimated cost, $300,000).

(c) The third stage, which would be of a long-term nature, envisaged the use of local bagasse as one of the raw materials for use in the mill. It is however, stated that a good deal of work would have to be done on improving the process and reducing the cost of this operation when applied to a small mill of this nature.

The Industrial Development Corporation postponed their decision on this proposal, and applied to United Nations for the services of someone who would give an opinion on the situation under the following terms of reference :-

(a) To make a study of the extent to which a local paper industry could be established in Trinidad and Tobago at the present time, or in the future.

(b) To recommend to what extent, if any, the existing paper factory referred to above could be used for such a scheme.

(c) If the factory could not be so used, to recommend alternative means of utilising or disposing of it.

(d) To investigate the extent to which local raw materials, fibrous and otherwise, would be used in connection with any of the above alternatives.

7. The above work was entrusted to the writer of this Report, who visited Trinidad and Tobago during the period 29th July to 24th August, 1968, inclusive. This time was spent in making a number of visits to the factory and discussing various aspects of the situation with local sources of information.

8. The problem was studied from 2 aspects namely, what to do about the Arima factory; and a consideration of pulp and/or paper manufacture as a long-term project in Trinidad and Tobago. In both connections special consideration was given to the use of local raw materials and, in particular, bagasse.

9. So far as the short-term objective was concerned, i.e., the future of the Arima factory, the conclusion reached is that this should not be dismantled and sold for the best price obtainable because the papermaking machinery is such that, once removed, it would be of little more than scrap value. The buildings and boiler plant are probably worth what they cost, but a purchaser would have to be found whose requirements they suit precisely.

10. If therefore, one accepts the decision to consider what can be done with the existing facilities to produce paper in the future, 2 alternatives offer themselves namely, whether the Sterling International proposal should be adopted or whether an entirely different manufacturing programme is preferable. The relative merits of these 2 alternatives are discussed in the Report, and below, in this Summary.

11. The proposals and intentions put forward by Sterling International are fairly clear. In effect, they involve (as Stage 1) making 2,000 tons per annum of paper for a proportion of the (lower-grade) toilet tissue and wrapping paper requirements of the islands. The object is to ensure that the mill breaks even financially before commencing on Stage 2, which would involve the installation of a new, modern paper machine to make high-grade tissues, and also toilet roll and other paper converting machinery. The raw materials for these 2 stages

would be imported wood pulp and local waste papers, but the use of bagasse would follow in Stage 3, as a long-term consideration.

12. In order to explore all possible alternatives, a market research was made into the paper consumption of Trinidad and Tobago, and the directions in which it is at present being used. Statistics were extracted in summary form and in detail of all imports of paper and paper products between 1963 and 1968, inclusive, and visits were made to some 14 users of paper representing the principal consumers in the islands. The conclusions drawn from this work may be summarised as follows :-

(a) Of all the various types of paper and board imported into Trinidad only a relatively small number could be made economically by a small mill located in the country. Boards are eliminated because they cannot be made on the same machine as paper and, in any case, the machine at Arima is not suitable; newsprint is also eliminated because it is a very low-priced, mass-production material, and the Arima mill could not possibly compete using imported wood pulp. A number of specialty papers could not be made because the facilities and technique do not exist in the country. After due consideration is given to all the products which cannot be made, it appears that the following could be made on the present machine after it has been appropriately rehabilitated and repaired.

Writing papers, except the highest grades.

Printing papers, except those coated or otherwise specially treated.

Wrapping papers, except those made from genuine kraft pulp.

Bag papers, except those made from genuine kraft pulp.

Corrugating medium, for the inside layer of cartons.

Toilet tissue, as originally intended.

(b) Owing to the methods of classification used for Customs purposes it was difficult to segregate the amounts of each of the above which the mill could make and sell. However, by using methods described in Part III, (a) of the Report, it was possible to arrive at estimates, which appear near the truth and possibly, on the conservative side. An influencing factor was the annual rate of increase of consumption of certain papers: the curve illustrating this (Fig. 4) was remarkably uniform and suggested that between 1967 (the last full year for which statistics are available) and say, 1969/70 (when the mill would be rehabilitated) there would be an increase of about 25% in the consumption of these papers in the islands.

(c) On this basis the following approximate manufacturing programme was drawn up :-

Writings and printings	-	2,000 tons per annum
Wrapping and bag papers	-	1,000 tons per annum
Corrugating medium	-	1,000 tons per annum.

This might have to be varied somewhat. For example, in the early stages of mill production the demand for corrugating medium might not attain 1,000 tons per annum, and it would be necessary to fill-up the production capacity of the mill by some other product for example, second-grade toilet tissue. The same might equally apply to the 2 other types of papers mentioned above.

Also, most of the corrugating medium is used by one Company (Caribbean Packaging Industries, Ltd.) and this Company would have to be willing to take the whole of the output of the Arima factory. It is of course, understood that the suggestions put forward in this Report do not envisage any reduction of the present quality standards of papers used in Trinidad.

(d) In order to produce the above output the mill would have to work 24 hours per day, 7 days per week, for 339 days per annum allowing 12 days for public holidays, 7 days for inadverdent shuts, and 7 days for maintenance shuts. This should enable a total production of 4,000 tons per annum to be obtained.

13. It is estimated that the cost of rehabilitating the present Arima factory to enable it to make the above output, is approximately, as follows :-

Plant, machinery, equipment and engineering	-	$563,000
Purchase of existing assets	-	$300,000
Total	-	$863,000
Working capital (13 weeks' production)	-	$427,000
Interest (6%) during building, say, 6 months	-	$25,000
Grand total of capital required	-	$1,315,000

14. In order to arrive at the above figures and conclusions, the various factors influencing production were studied in detail. These were as follows :-

(a) It was apparent, that for this short-term project the mill would have to depend very largely on imported wood pulps of various grades. There is however, the possibility of supplementing them by means of locally-produced waste paper,

and it was ascertained that some 1,500 tons per annum of this are available. This would mean that approximately 3,500 tons of wood pulp would have to be used to make up the 4,000 tons, in addition to a certain amount of china clay used for loading purposes.

The question of bagasse was also considered, in great detail. It was concluded that, insofar as the immediate future is concerned, the manufacture of bleached pulp from bagasse is quite out of the question; the long-term aspects of this possibility are discussed further below. It was however, felt possible that an unbleached bagasse pulp could be made economically in the existing mill, with certain additions which in themselves are not costly. Unbleached bagasse made in this way is a recognised excellent material for the manufacture of corrugating medium, and this pulp would be so used in the above production programme. The above products would therefore, contain the following :

Writings and printings	-	mainly imported bleached wood pulps and china clay.
Wrapping papers and bag papers	-	imported wood pulp of a lower category, and waste papers.
Corrugating medium	-	unbleached bagasse pulp.

(b) Various chemicals and other additives are added to the pulp to give the papers their necessary qualities; such as rosin and alum for sizing, dyestuffs for colouring, wet-strengthening agents for wrapping papers, etc. These would all have to be imported, and quotations were obtained in appropriate cases.

(c) Steam would be raised in the existing Cleaver-Brooks boiler, which is almost new and in good condition. It has been ascertained that the amount of steam it can produce or is

scheduled to produce namely, 6,600 lbs. per hour, would be sufficient to dry 12 tons of the above papers per 24-hour day.

(d) Electricity would be purchased from the Trinidad and Tobago Electricity Commission, and rates were obtained locally. This was the procedure used when the mill was previously running.

(e) As to labour, in view of the operating hours of the mill, i.e., 24 hours a day, 7 days a week, etc. it will be necessary to have a 4-shift rota system so arranged that workers change shifts at suitable intervals, and work 5 8-hour days each week. The 40-hour week is adopted as the basis, in anticipation of future trends. In this way it was calculated that the mill would employ approximately 77 factory workers of which 62 would be shift workers and 15 day workers and women. The wage bill was also calculated, taking the average of existing payrates in the country and adding 25% for fringe benefits, etc.

The cost of management and staff salaries was also assessed. The Report emphasises the importance of securing a Manager of the highest capability, preferably having practical rather than administrative experience. If possible he should be engaged immediately, so that he is available when the mill is being rehabilitated. A staff and management roll of 7 persons is envisaged, with a total annual salary bill of $70,680.

(f) The present site at Arima has to be accepted in the circumstances, and although not ideal, it is usable. The principal difficulties arise from water supply and effluent disposal. Investigations into the former indicated that if the wells already started are properly finished, then adequate supplies could be obtained for the manufacture of 12 tons of paper

per day. They could, if necessary, be supplemented either by other wells or by water taken from the Guanapo River in times of emergency, but in any case, steps would have to be taken to purify the water and such a plant is allowed for in the rehabilitation programme and costs. One difficulty that arises in this connection is the fact the 3 sand washing plants upstream of the factory pollute the river. The removal of this fine sand would be an expensive matter though not an impossibility, and the situation might be remedied by some form of control so that no pollution takes place. Other alternative supplies of water are from the Caroni River, after the Guanapo River has joined it; or from the Mausica River which contains a high proportion of good quality, treated effluent from the Arima sewerage works. It would appear, that properly organised, no water supply difficulty is likely to arise at the mill as envisaged and that if an increase in production is contemplated at a further date, the new water requirements could also be met.

As for effluent disposal, it is proposed that the relatively small amount of digester liquors obtained from the pulping of the bagasse should be disposed of on a land soakaway, leaving only the backwater from the paper machine to be rejected to the river. In the interests of the economics of the mill, this backwater should in any case be treated to remove valuable fibre and loading for re-use, so that the residual water would be discharged to the river in a relatively pure form. This presents no difficulty with a normal paper mill. If bagasse production becomes particularly high, and the soakaway proves inadequate, then the digester liquors could be concentrated by means of the boiler house flue gases and burned mixed with oil.

An acceptable effluent could be produced in this way, and with the low cost of fuel oil, this should not be a prohibitively expensive matter.

(g) Numerous suggestions for the rehabilitation of the mill are set out in the Report. Basically however, they involve principally the paper machine which should be provided with a shake, better means of water-removal from the wire, and 3 additional drying cylinders to dry the greater amount of paper being made. For the same reason, the drive should be speeded up and,if reports are accurate, this should be capable of running at least at 350 feet per minute, which should be adequate for the proposed production of 12 tons per day. Better facilities for calendering and reeling would be required, and the various other shortcomings in the auxiliary services (such as backwater recovery, lack of agitators, pumps, piping, etc.), would all have to be remedied. Quite a big item would be the regrinding of the face of the present large drying cylinder for which a quotation of $15,000 has already been obtained by Sterling International.

On the preparation side, improved methods of disintegrating the pulp should be installed, and the bagasse should be prepared as unbleached pulp either in the existing digesters (if the amount required is not too large); or, for larger quantities, by using the Hydrapulper method. Either method is known to give satisfactory results.

The only criticism which might be levelled against the suggestion now made is the fact that running white papers and brown papers in the same mill can give rise to difficulties owing to the contamination of the former by traces of the latter

held up in the system. It is difficult to see how this risk can be avoided in the present instance. It could however, be reduced considerably by having as long a run of waste papers as possible, and then changing to corrugating medium for as long as possible. By then making wrappings from waste papers of an intermediate grade of cleanliness, the system could be cleaned up in preparation for white papers again. A system of this nature should not be impossible, but it would certainly mean adjusting the mill programme so as to make as much as possible of each kind of the 3 papers at one time. If the orders obtainable did not fit in with this programme it might be necessary to carry stocks in anticipation of future requirements when the mill could not conveniently make a particular quality. It is felt that the project should not be rejected because of this particular difficulty, and that it could be met by resolute planning.

The estimated cost of making these alterations to the mill and installing the new equipment, is given under (13), above.

(h) Specimen costings indicating profitability are given in the Report, with full explanatory notes. The results are summarised in the Table below. For comparison, corresponding figures for the Sterling International proposal are also given. Some assumptions have had to be made in the latter instance, because the precise intentions of the Company involved have not been fully disclosed.

Grade	Quantity (tons)	Average price ($ per ton)	Annual Profit ($)
Writing and Printing Papers	2,000	550	150,000
Wrapping and Bag Papers	1,000	415	56,000
Corrugating Medium	1,000	315	111,000
Totals	4,000		317,000
Second-grade Toilet and Wrapping Papers (Sterling proposal)	2,000	450	94,000

15. It would thus seem that so far as the short-term rehabilitation of the Arima factory is concerned, the choice is between the relatively low capital requirement of $690,000, which would enable 2,000 tons per annum of low-grade toilet paper and wrappings to be made from waste paper and imported raw materials, and give a profitability of $94,000 per annum; or a total capital requirement of $1.32 million, which would enable 12 tons per day of writings, printings, bag papers, wrapping papers, and corrugating medium to be made, giving a profitability of $317,000 per annum.

In support of the former, is the fact that the financial responsibility for the operation would presumably, be that a commercial company and not the Government. Against this however, is the fact that for some time at any rate, the mill would manufacture a limited type and small quantity of paper – and this principally for one company. On the other hand, the larger project would make twice the tonnage of a wide variety of papers for sale to all customers in the islands, and would thus save more imported finished paper products and of course,

more foreign currency. In addition, it could be the nucleus of a national paper industry for the country which could be expanded as thought fit at a later date; most important of all perhaps, it would utilise a large proportion of local material (sugar cane bagasse and waste papers).

The choice therefore, becomes mainly one of policy, i.e., a low expenditure on a commercial venture with a restricted objective; or a rather more costly scheme, offering greater economic benefits to the country as a whole, including more employment.

16. Some attention was also given to the longer-term aspect of the whole problem. In particular, the use of local raw materials was studied under the following headings :-

(a) Sugar Cane Bagasse. A great deal of work has already been carried out, notably by Caroni, Ltd., who are the principal and indeed, almost the only producers of this material. Earlier work has however, been directed mainly to producing bleached bagasse pulp on the large scale for export abroad. The possibility of making small amounts for local uses has not been studied in any depth. It was not surprising to learn that the former approach had given doubtful or negative results owing to a number of difficulties envisaged, including those of handling the bagasse, water supply, effluent disposal, not to mention the sheer economics of exporting a bleached pulp to Europe and North America in competition with the high-grade wood pulps produced there in very large and efficient mills. For many purposes, bagasse pulp is inferior to long-fibre (coniferous) wood pulps, and would have to be sold at an appreciably lower price; it would then be in competition with

hardwood pulps, of which there now are many of high quality, and with other short-fibred material from other parts of the world. In addition chemicals would have to be imported and these would be a very expensive item.

In this connection consideration was given to the manufacture in Trinidad of chlorine and caustic soda by the electrolysis of salt, but an estimated costing showed that even with a production of about 2,500 tons of each per annum, the cost would be approximately the same as that of the imported product for the caustic soda, although very much less for the chlorine. Such an electrolytic plant would therefore, be economic only if a use could be found for the chlorine, and this would be available in the event of a bleached pulp mill being erected. Such a mill would however, not use the equivalent amount of caustic soda produced, and this would be available for sale in Trinidad where there appears to be a market for $3,500 tons per annum at present.

As a matter of interest, a costing was made for the manufacture of white papers (writings and printings) from 80% of bleached bagasse pulp made in Trinidad mixed with 20% of imported long-fibred wood pulp. This showed that a mill making 24,000 tons per annum of such material might just approach the break-even stage. Since the total consumption of such papers in Trinidad and Tobago is at present less than 5,000 tons per annum, such a project seems to be extremely remote.

(b) Bamboo, another local raw material has been used very successfully in India, and its great advantage is that it can to a great degree replace the long-fibred coniferous wood pulp which has to be imported for any of the schemes outlined above.

Indeed, a mixture of bagasse and bamboo pulps has given good results in the manufacture of white papers. Unfortunately, it was not possible to obtain any local information as to the availability, rate of reproduction and costs of extraction and purchase of bamboo, either on the plantation scale or the natural scale although, it is understood that at one time a bamboo pulp plant existed in the country. This line therefore, can not be pursued very far in this Study, but it is certainly worth investigating in the future, since bamboo grows so prolifically on the island.

(c) Tropical pine (Pinus caribaea), as a long-term project, would of course have the advantage that it would replace the long-fibred coniferous wood imported from abroad. It is not as good a raw material for pulp but it could render the country almost completely independent of pulp imports. This of course, is a very long-range project, since it would take some 7 years from planting before even thinnings are available. However, existing trial plantations of this species appear to have reacted well to the local climate and it would be a simple matter at this stage to carry out laboratory pulping tests on the thinnings. By any standards, long-term investments in mature pine forests are usually worth while, and if the thinnings could be used profitably after a few years this might prove to be an additional incentive. However, as stated above, this requires long-term planning, especially as the quantities involved have to be large in order to ensure replacement of supplies during usage.

17. Consideration was also given to the possibility of extending the market for the mill's products by export possibilities. The Carifta Agreement was considered in this

respect. It was felt however, that these possibilities were not very strong, for the following reasons :-

(a) Cost of transport of the paper is always involved and, although this is not high for most of the Carifta islands where schooner traffic is available, it would be fairly considerable elsewhere (for example, to Jamaica) where ocean-going vessels are required.

(b) It is known that a mill is planned for Jamaica, and another may be projected for Guyana; these would not only be competitors for export markets, but might even be able to export to Trinidad and Tobago.

(c) The provisions of Carifta impose tariff restrictions on manufactured products containing a valuable imported product. This might apply to certain of the papers made in Trinidad, where an expensive imported wood pulp is used and the selling price of the finished product is not high enough to cover the difference required by the Carifta Agreement for duty exemption.

On the whole therefore, it was felt that the possibilities of export should not be used as a primary argument in favour of the scheme suggested. This must be justifiable in terms of local consumption and the national interest, and any profits from export be regarded only as a welcome extra.

Julius Grant.

London,
October, 1968.

Julius Grant.

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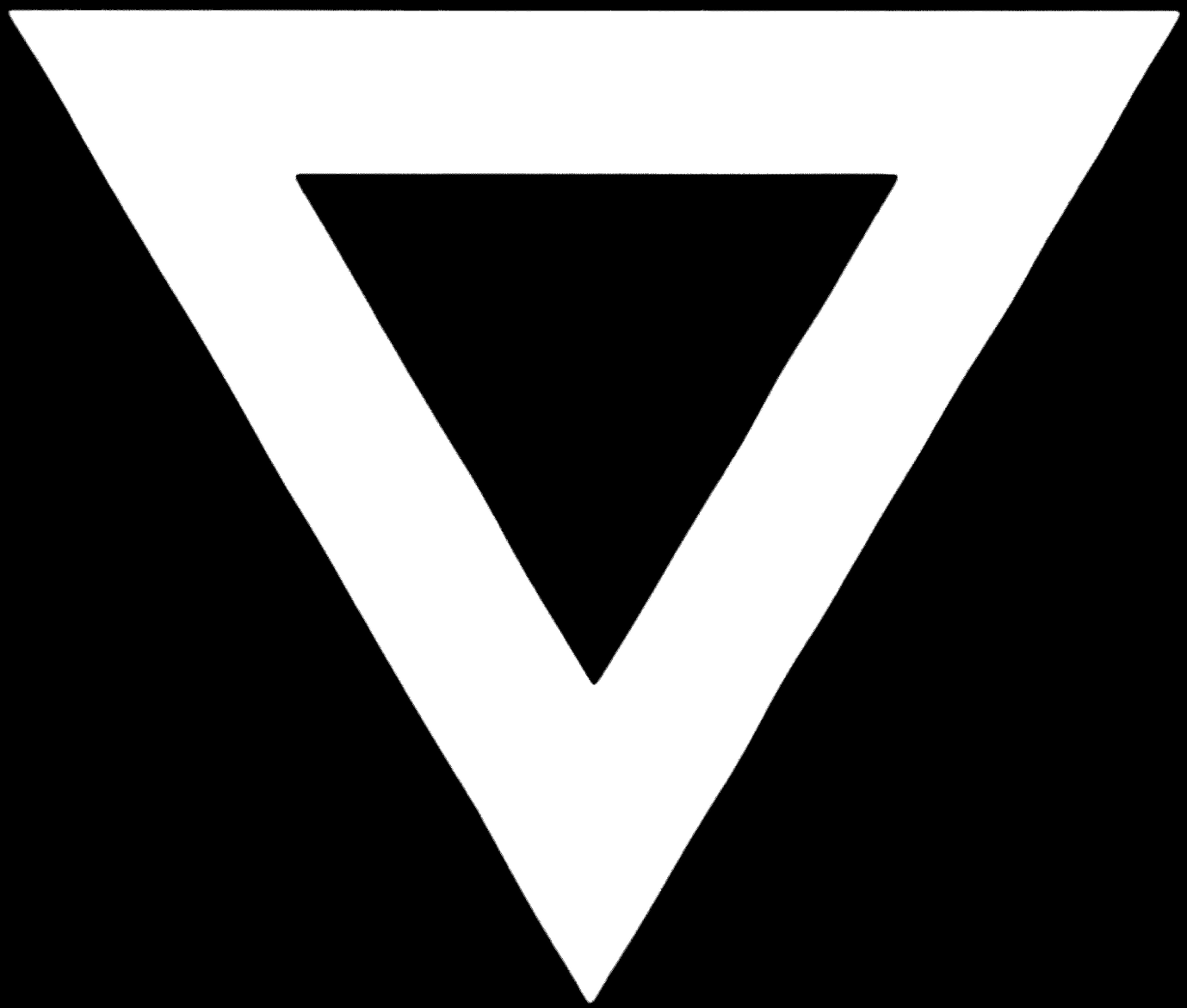

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