FEASIBILITY STUDY REPORT ON ESTABLISHMENT OF CARBIDE AND PVC PLANTS IN THE REPUBLIC OF PERU

JANUARY, 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

FEASIBILITY STUDY REPORT ON ESTABLISHMENT OF CARBIDE AND PVC PLANTS IN THE REPUBLIC OF PERU JANUARY, 1984 JICA

FEASIBILITY STUDY REPORT

ON

ESTABLISHMENT OF CARBIDE AND PVC

PLANTS

IN THE REPUBLIC OF PERU

JAPAN INTERNATIONAL COOPERATION AGENCY

PREFACE

In response to the request of the Government of the Republic of Peru, the Government of Japan decided to conduct a feasibility study on the Establishment of Carbide and PVC Plants and entrusted the study to the Japan International Cooperation Agency (JICA). The JICA sent to Peru a survey team headed by Mr. Koji Tanaka from June 4 to July 14, 1983.

The team exchanged views with the officials concerned of the Government of Peru and conducted a field survey in the Project-related areas including Lima, Paramonga and Pariahuanca. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Peru for their close cooperation extended to the team.

Tokyo, January 1984

Keisuke Arita
President
Japan International Cooperation Agency

PARAMONGA (PLANT SITE)

PARIAHUANCA (LIMESTONE DEPOSIT)

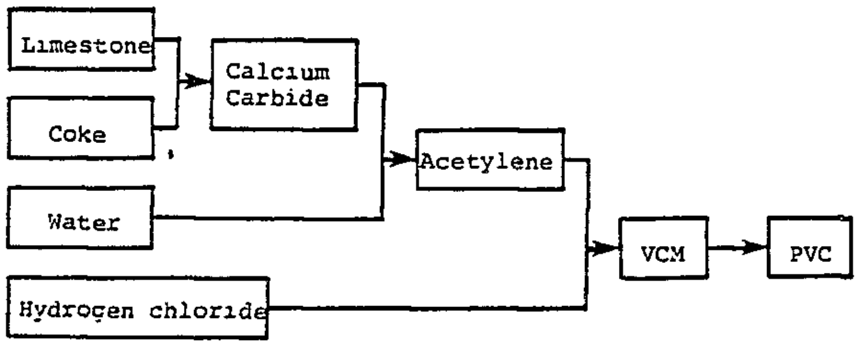
OVERVIEW, FEASIBILITY STUDY ON ESTABLISHMENT OF CARBIDE AND PVC PLANTS IN THE REPUBLIC OF PERU

1. Summary of Project

This project consists of establishing a series of process plants in Peru to manufacture PVC starting from limestone through calcium carbide and acetylene. The important feature is utilization of such domestic resources as limestone, hydroelectric power and hydrogen chloride that is now being disposed of in waste for lack of effective use.

(1) Manufacturing process

The manufacturing process may be schematically shown as:



(2) Material balance (tons/year)

Raw Material		Intermediate Products		Products	
Limestone	58,000	Calcium carbide	35,000	PVC	25,000
Coke	19,800	VCM	25,500		
Hydrogen chloride	15,300				

(3) Project promoter — Sociedad Paramonga Limitada (SPL)

(4) Plant location — The plant site next to the existing alkali and PVC plants in Paramonga.

(5) Market Domestic market

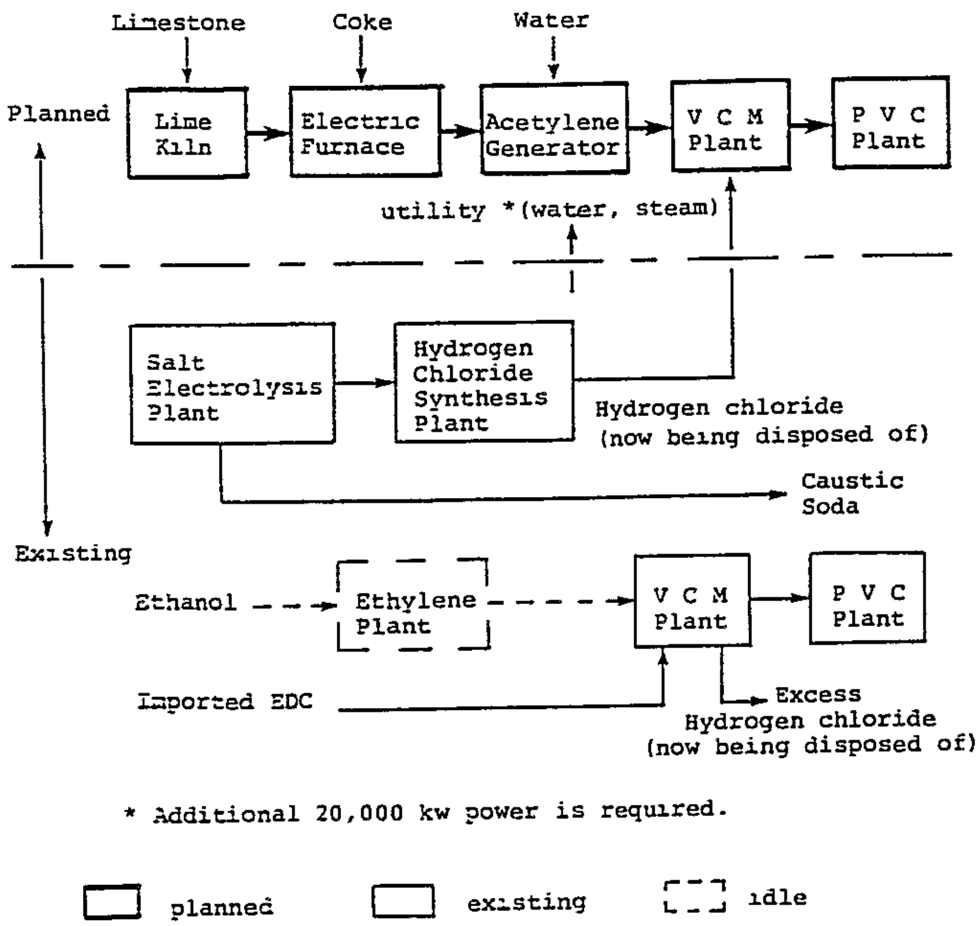
(6) Total capital requirement (1,000 US dollars)

Total Capital requirement including import duty	75,072
Total Capital requirement excluding import duty	59,845

(7) Project schedule

Start up, year	mid 1988
Operation rate, percent	
First Year	80
Second year	90
Third year and onward	100
Operation period, year	20

(8) Relation with the existing plants



2. Evaluation of Project

(1) Items for evaluation

Raw material
Market
Technology
Financial analysis
Socio-economic analysis
Natural conditions
Social conditions
Socio-political environment
Human resources, local technology
Promoter

(2) Raw material

A. Limestone

Pariahuanca deposits will be developed.

- Quality:	Satisfactory
- Reserve:	Sufficient
- Techinical difficutly:	None
- Transportation to Paramonga:	Easy
- Pollution problems:	None

B. Hydrogen chloride

Hydrogen chloride is supplied by the existing alkali plant.

- Quantity (tons/year)	Availability:	20,000 to 25,000
	Requirement:	15,300
- Technical problems:	None	
- Pollution problems:	Reduces present pollution problem	

C. Coke

Imported cokes will be used for the initial period of the project with possibility of replacement by domestic anthracite.

- Quantity: Easy to secure by import
- Quality: Satisfactory

D. Other inputs

Other inputs will be imported.

(3) Market

- Domestic market: Supports 25,000 tons per year capacity.
- Quality: Low residual monomer product desired.

(4) Technology

- Manuacturing technologies: All proven
- Plant Site: Good
- Pollution: Not expected

(5) Financial analysis

	FIRR on I		FIRR on E	
	Before Tax	After Tax	Before Tax	After Tax
Case 1	11.2	5.3	8.9	Minus
2	13.2	6.3	12.8	5.7
3	13.2	6.3	12.8	6.2
4	14.1	7.1	14.5	8.1
5	14.1	10.3	14.7	11.5
6	16.8	11.9	19.7	15.5

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Hydrogen chloride price (US$/Ton)	101	0	0	0	0	0
Loss carry over	No	No	Yes	Yes	Yes	Yes
Internal tax refund	No	No	No	Yes	Yes	No
Income tax reduction for reinvestment	No	No	No	No	Yes	Yes
Exemption of import duty	No	No	No	No	No	Yes

Case 6 falls in the viable range but FIRR on E after tax of 15 percent is not good enough as compared with 13.5 percent interest rate employed for evaluation. Therefore a finance of favorable condition is desired.

(6) Socio-economic analysis

- Contribution to balance of payments: 108 million US dollars
- Indirect benefits
  - Direct employment opportunities: 250
  - Abatement of pollution by hydrochloric acid
  - Employment of local engineering and construction companies

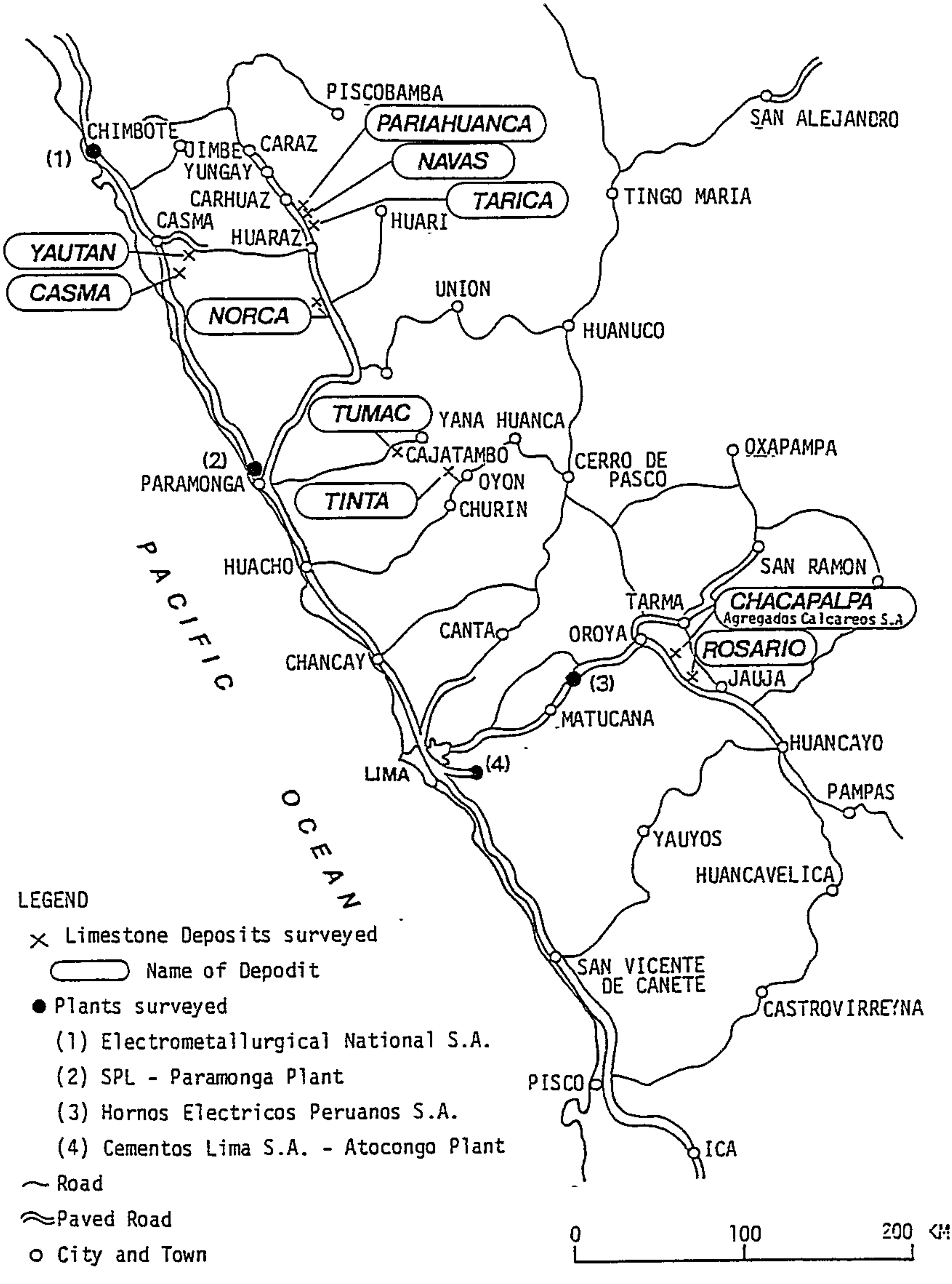
(7) Natural conditions Very gentle

(8) Social conditions and infrastructure: Adequate

(9) Socio political environment Reasonably good

(10) Human resources, loCal technology Good

(11) Promoter Very good



Location Map of the Surveyed Limestone Deposits and Plants

INTRODUCTION

This feasibility report concerns a project for establishment of carbide and PVC plants in the Republic of Peru which consists of quarrying limestone of required quality and transporting it to the plant site in Paramonga, a small city some 200 kilometers to the north of Lima, where the existing PVC and alkali plants and also sugar and paper factories are located, and installing a series of manufacturing facilities at the plant site to produce PVC from limestone and coke through calcium carbide and acetylene. Hydrogen chloride, another important raw material, is available in sufficient quantity as an excess product at the existing electrolysis plant at Paramonga. Pariahuanca, some 200 kilometers from Paramonga, has been chosen as quarry of limestone from a number of candidate limestone deposits.

What this project means to sociedad Paramonga Limitada (hereinafter referred to as SPL) and the nation can be very great. SPL has facilities to manufacture some 7,000 tons per year of PVC from fermentation alcohol from molasses but operation by this route has been suspended since November 1981 when fermentation alcohol became incompetitively expensive. Presently SPL produces about 7,000 tons per year of PVC from imported ethylene dichloride, or EDC. Besides this amount Peru now imports about 7,000 tons per year of product PVC. This means Peru pays valuable foreign currency to buy product PVC as well as the raw material for it. This project is expected to bring about various advantages. First and foremost, this project would realize savings of foreign currency by producing PVC domestically by using mainly domestic raw materials. Secondly, this project would promote utilization of domestic resources, particularly limestone and electricity. Thirdly, this project would absorb a great portion of excess hydrogen chloride now being discharged to the sea, thereby reduce environmental pollution of the sea, a very valuable resource to a large fishing country like Peru.

There would also be expected other advantages such as increased employment opportunities, increased tax incomes to the central and local governments, transfer of technology from abroad, stabilization of domestic market prices of PVC, stimulation of related domestic industries.

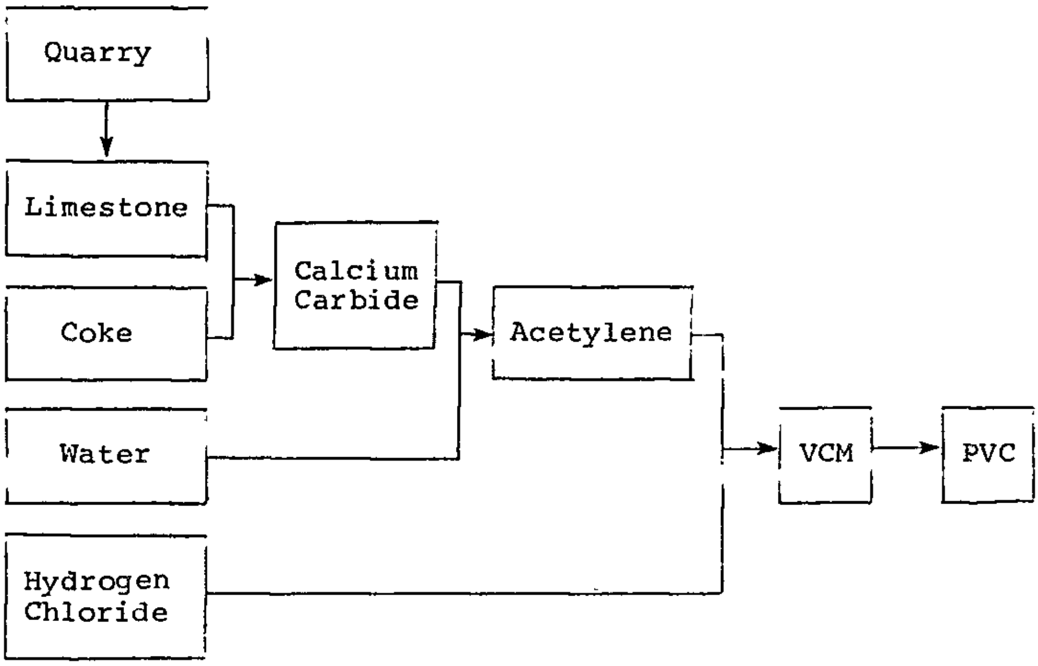
As the following pages show, the results of this feasibility study confirms such advantages. The results of the study indicate an area in which this project becomes financially viable specified by realistic ranges of investment cost, product PVC price and operation cost, notably cost of electricity under a certain set of conditions. This feasibility study report also presents recommendations on how this project should be implemented.

This feasibility study report consists of PREFACE, INTRODUCTION, SUMMARY AND MAJOR FINDINGS, 15 chapters and APPENDIX. Subsequent to INTRODUCTION is SUMMARY AND MAJOR FINDINGS which summarizes only major items of importance. SUMMARY AND MAJOR FINDINGS is so designed and arranged that the readers could have a fairly good idea of what this feasibility report contains without reading other parts of the report. CHAPTER 1, BACKGROUND, explains how this project or this feasibility study was conceived and has been developed. CHAPTER 2, PROFILE OF PERU AND ITS PVC INDUSTRY, describes the circumstances in Peru under which this project is contemplated. CHAPTER 3, RAW MATERIAL AND ELECTRICITY, examines availability of the raw materials and electricity. Electricity is dealt with here because of the vital effect its availability and price have on the viability of the project. CHAPTER 4, MARKET STUDY, examines the past and present situations of the market and forecasts the supply/ demand situations and prices of PVC and intermediate or byproducts. CHAPTER 5, PROJECT SCHEME, presents how the study team arrived at the project scheme among conceivable alternatives and provides rationale supporting the decision on the project scheme. CHAPTERS 6 to 9 concern technicalstudies. CHAPTER 6, LIMESTONE, explains the reason why Pariahuanca has been chosen, gives plans for quarrying and transportation and considers the environmental aspect as well. CHAPTER 7, PLANT SITE, investigates the conditions of the plant site and the surroundings. CHAPTER 8, MANUFACTURING FACILITY, presents conceptual designs of the manufacturing facilities together with related studies. CHAPTER 9, CONSTRUCTION WORK, focuses on the construction aspect of the project execution. CHAPTERS 10 to 13 deals with economic aspects of this project. CHAPTER 10, CAPITAL REQUIREMENT, estimates investment costs while CHAPTER 11, OPERATION COST, estimates operation costs. CHAPTER 12, FINANCIAL EVALUATION, evaluates the financial viability of the project based on the investment and operation costs of CHAPTERS 10 and 11 as basic inputs. CHAPTER 13, ECONOMIC

ANALYSIS, evaluates this project from the standpoint of benefits to the nation, or social benefits costs analysis. CHAPTER 14, OVERALL EVALUATION, passes the ultimate judgement to the project first by looking at the project from several different angles and then gives a comprehensive and coordinated examination to the project. Finally, CHAPTER 15, RECOMMENDATION, gives recommendation regarding how this project should be treated. In addition, computer outputs and various important pieces of information are attached as APPENDIX.

SUMMARY AND MAJOR FINDINGS

1. This project is to establish in Peru a series of facilities to manufacture PVC starting from domestic limestone. The simplified representation of the process is shown below:



2. At the request of the Government of the Republic of Peru, JICA has developed this feasibility study report on behalf of the Japanese Government as agreed between SPL and JICA on February 3, 1983 in Lima between Mr. Carlos Orams Basadre, General Manager SPL, Mr. Alvaro Vargas Guacucano, Engineering Manager SPL and Mr. Kenji Iwaguchi, Leader, Preliminary Survey Team, JICA. A field survey was conducted from June 4, 1983 to July 14, 1983 by a study team headed by Mr. Tanaka.

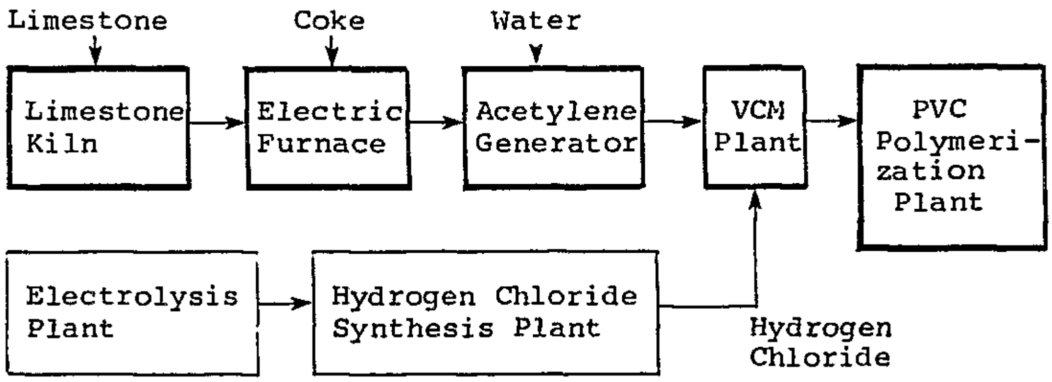
3. The capacity of this project is 25,000 metric tons per year as PVC product. (Hereinafter "ton" always means "metric ton", unless otherwise indicated.)

4. SPL is supposed to implement this project. SPL, or Sociedad Paramonga Limitada, is a Peruvian company owned essentially by Corporacion Financiera de

Desarrollo, a governmental financing organization. SPL ranks first in Peru in the field of chemical industry manufacturing such products as paper, cartons, salt, caustic soda, chlorine, hydrogen chloride, sodium hypochlorite, bleaching powder, acetic acid, alcohol, beverages, PVC. The head office is located in Lima. SPL has 12 plants in six different places in Peru. The major production center is in Paramonga where paper, alcohol, alcali and PVC plants are located.

5. The city of Paramonga is located some 200 kilometers north of Lima along Pan American Highway. The city is on the Pacific coast. Paramonga has a population of about 30,000 with adequate infrastructure and township.

6. All the manufacturing facilities; namely, a limestone kiln, electric furnace, acetylene generator, VCM plant and PVC plant, will be located at Paramonga plant site beside the existing alkali and PVC plants. JICA has pondered on the possibility of locating the limestone kiln and electric furnace at or near the quarry apart from other facilities in Paramonga plant site. JICA, however, has chosen to locate all the facilities in Paramonga. The manufacturing facilities to be constructed are shown below. Those in thick and fine lines represent new and existing facilities, respectively.



7. Of a number of candidate limestone deposits, Pariahuanca, some 200 kilometers from Paramonga, in the central region of Ancash has been chosen as quarry. The limestone deposit of Pariahuanca lies just along a very good highway which directly leads to Paramonga and transportation of about 200 tons per day of limestone would not present difficulty.

There is a small village nearby but it does not seem difficult to buy their land. It is also necessary to protect an electric cable and an agricultural canal that runs along the deposit from damages.

The owners of the quarry are identified as Comunidad Campesina de Shumay, a farmers' organization, and an individual, Eduardo Navas.

8. The forecast market situation justifies a capacity of 25,000 tons per year as PVC product. The annual production of intermediate products and major inputs are as follows:

	(Tons per year unless) otherwise stated)
Intermediate Products	
VCM	25,500
Acetylene*	9,945,000
Hydrogen chloride	15,300
Calcium carbide	35,000
Quick lime	32,200
Slaked lime	42,000
Major Inputs	
Limestone	58,000
Coke	19,800

*Cubic meters per year at normal temperature and pressure

9. Along with limestone, coke is also an important input. This could also be anthracite. There are deposits of anthracite around Oyon. However, anthracite is not produced in commercial scale; therefore, neither supply nor quality is dependable. JICA, therefore, chooses to use imported coke which is uniform in quality, shape, size and price competitive, with possibility of future replacement by domestic anthracite or coke.

10. There is a sufficient amount of hydrogen chloride available to this project at Paramonga Plant. This situation would not change in the future after development of possible utilization of excess chlorine.

11. There are other inputs like electrode, catalysts, dispersants for polymerization, silica gel. These could be obtained without difficulty perhaps by import from U.S.A. and others. The electrode paste may be imported from Brazil.

12. Since this project will be supplied by the exsisting plants with hydrogen chloride and utilities. In this connection, the conditions of the existing facilities are very important. The existing facilities at Paramonga are generally in good conditions. The electrolysis plant and hydrogen chloride synthesis plant are both mechanically healthy and could be used for the project life provided that they are properly maintained.

13. However, the existing hydrogen chloride strippers, the operation of which has been suspended since November 1981, have to be replaced by new units.

14. The planned plant site beside the existing alkali and PVC plants is adequate and large enough to accommodate all processing facilities, limestone/coke stockyards and product storage house, although the soil is a little too soft and piling is planned for foundations of heavy equipment.

15. SPL presently operates a 7,000 (7,230 to be exact) tons per year polymerization plant. JICA considered two possibilities to install 25,000 tons per year capacity; that is, (1) keep operating the existing 7,000 tons per year plant and istall an 18,000 tons pear year unit, the balance of the required capacity, or (2) suspend the operation of the existing unit and install a 25,000 tons per year unit. JICA has chosen the latter alternative. The incremental investment cost of a 25,000 tons per year unit over an 18,000 tons per year unit is marginal. Disadvantage of operating two plants with a double manpower requirement and various operating inefficiencies would far outweigh the savings in the investment cost.

16. The infrastructure around Paramonga is generally satisfactory although telephone communication is not as easy and quick as it should be.

17. Additional electricity required by the project is 20,000 kilowatts. This amount of electricity can be secured at the plant site by installing a cable of 2,000 meters going around the land owned by the farmers' cooperative.

18. Paramonga Plant as a whole will have more than enough industrial water with implementation of planned closing down of four steam turbines. However, a small cooling tower of 1,800 tons per hour capacity will be installed for the operation of the new facilities.

19. The consumption of steam by the project is small, about 10 tons per hour. Directly from the boiler plant runs a six inch line sufficiently capable of supplying this amount of steam.

20. Other minor utility facilities like an inert gas generator, instrument air system, pneumatic air system, fire-fighting system, etc. will be installed in the plant site.

21. As far as the JICA study team was able to survey, official written standards for environmental protection or pollution control do not exist in Paramonga Area. Irrespective of whether or not such standards exist or will be enforced in the future, with proper management this project is not expected to cause environmental problems in view of the circumstances in which this project is implemented.

Limestone quarrying will be done in a sparsely populated area. Limestone will be transported on the highway where traffic is not very busy. The processing facilities will be designed and operated to the modernest standards. Instead, this project will consume a great portion of excess hydrogen chloride, a very strong acid, being discharged to the sea and will, therefore, help reduce environmental pollution of the sea.

If so desired by SPL, instead of mercury catalyst normally employed for the reaction between acetylene and hydrogen chloride, a noble metal catalyst may be employed without necessity for modification of the facility.

22. As was agreed between SPL and JICA and recorded in Interim Report, the financial and economic evaluations are based on the value in US dollar as of June 1983 without escalation. The total capital requirement is estimated at 75,072 thousand US dollars. At this total capital requirement, the following indicators for profitability are obtained:

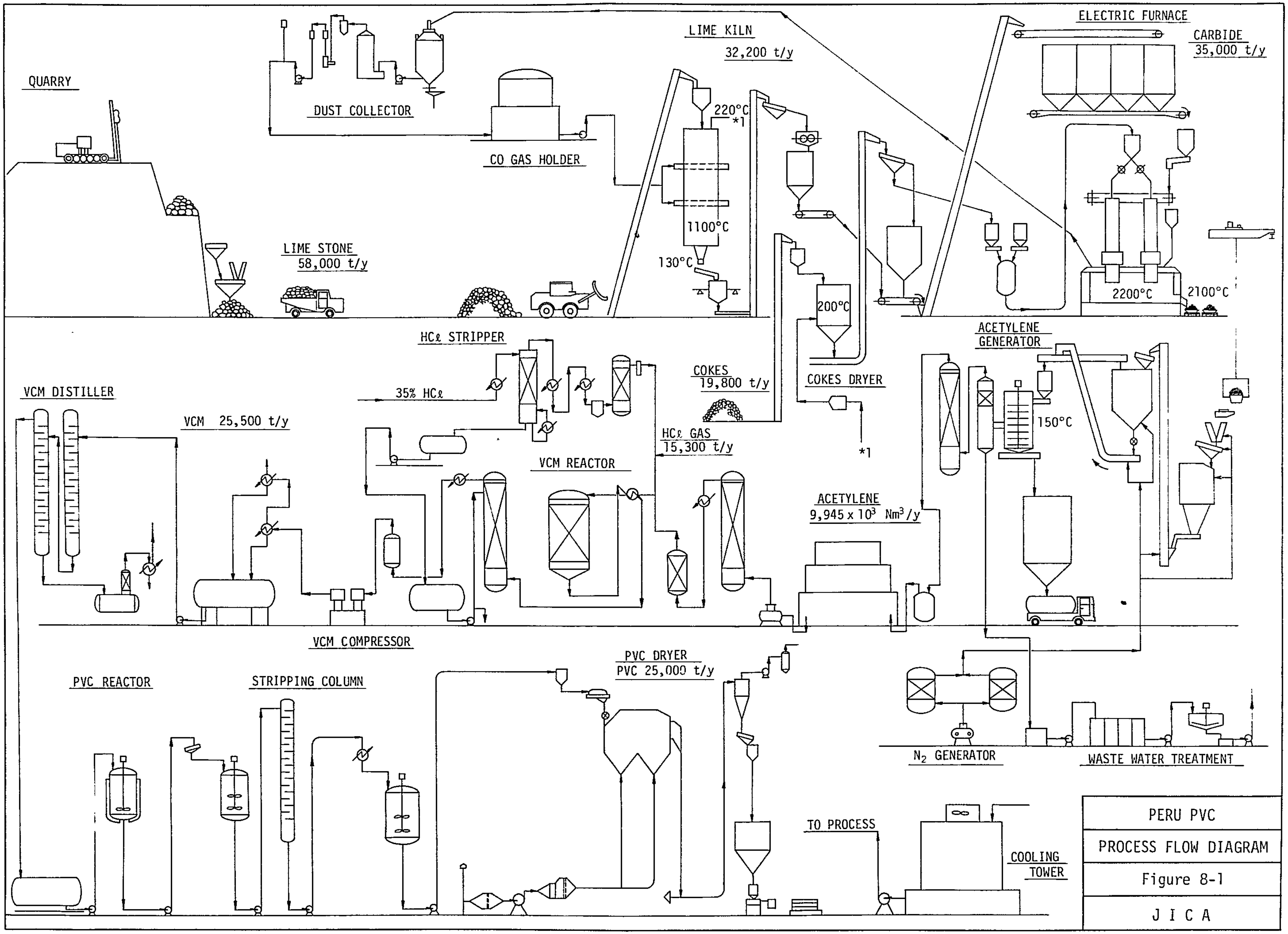
IRROI, % after tax	10.3
IRROI, % before tax	14.1

About 20 percent of this total capital requirement is attributable to import duty on equipment without which this figure could be reduced to 59,845 thousand US dollars. At this reduced total capital requirement the following indicators are obtained:

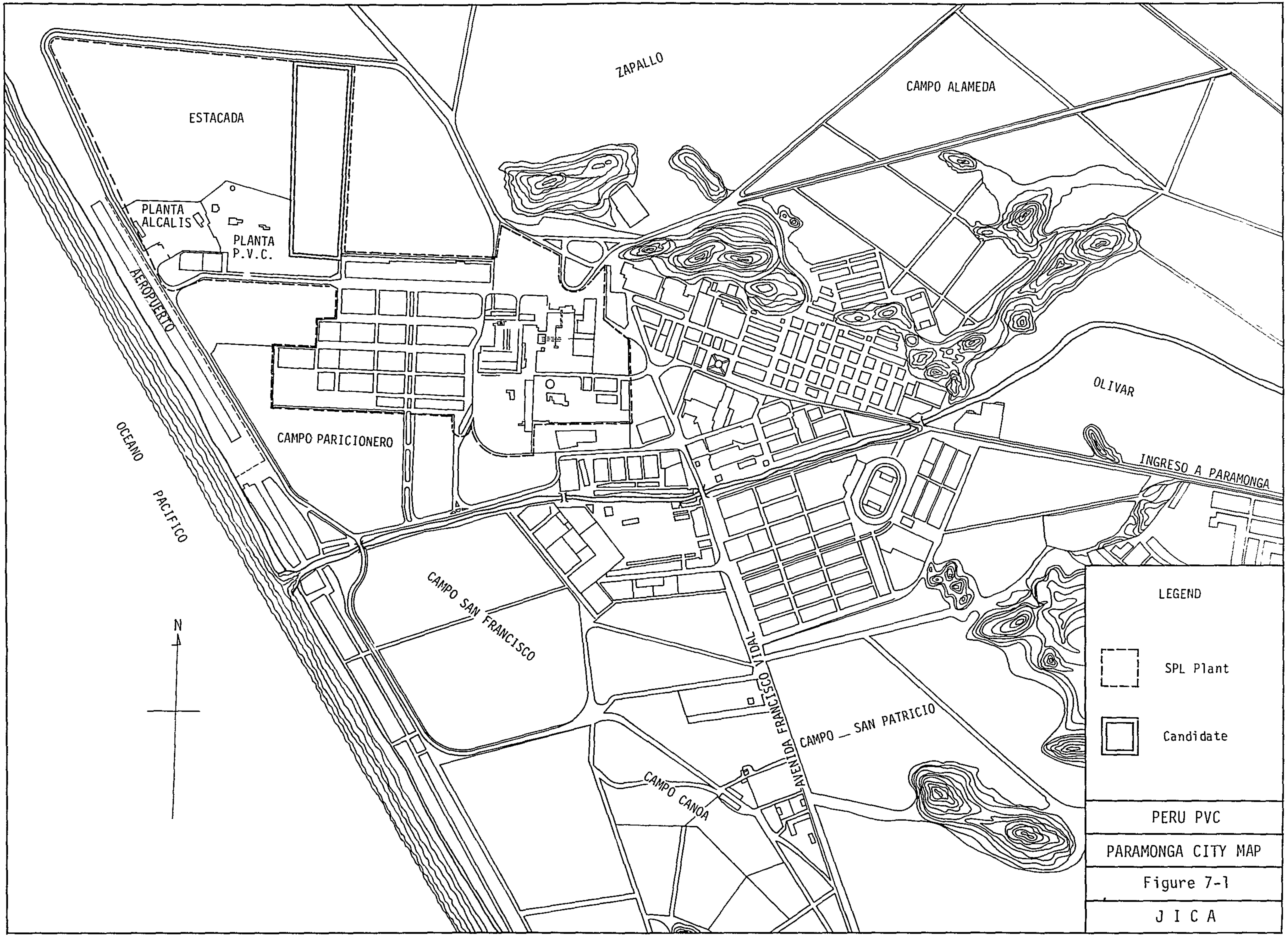
IROOI, % after tax	11.9
IRROI, % before tax	16.8

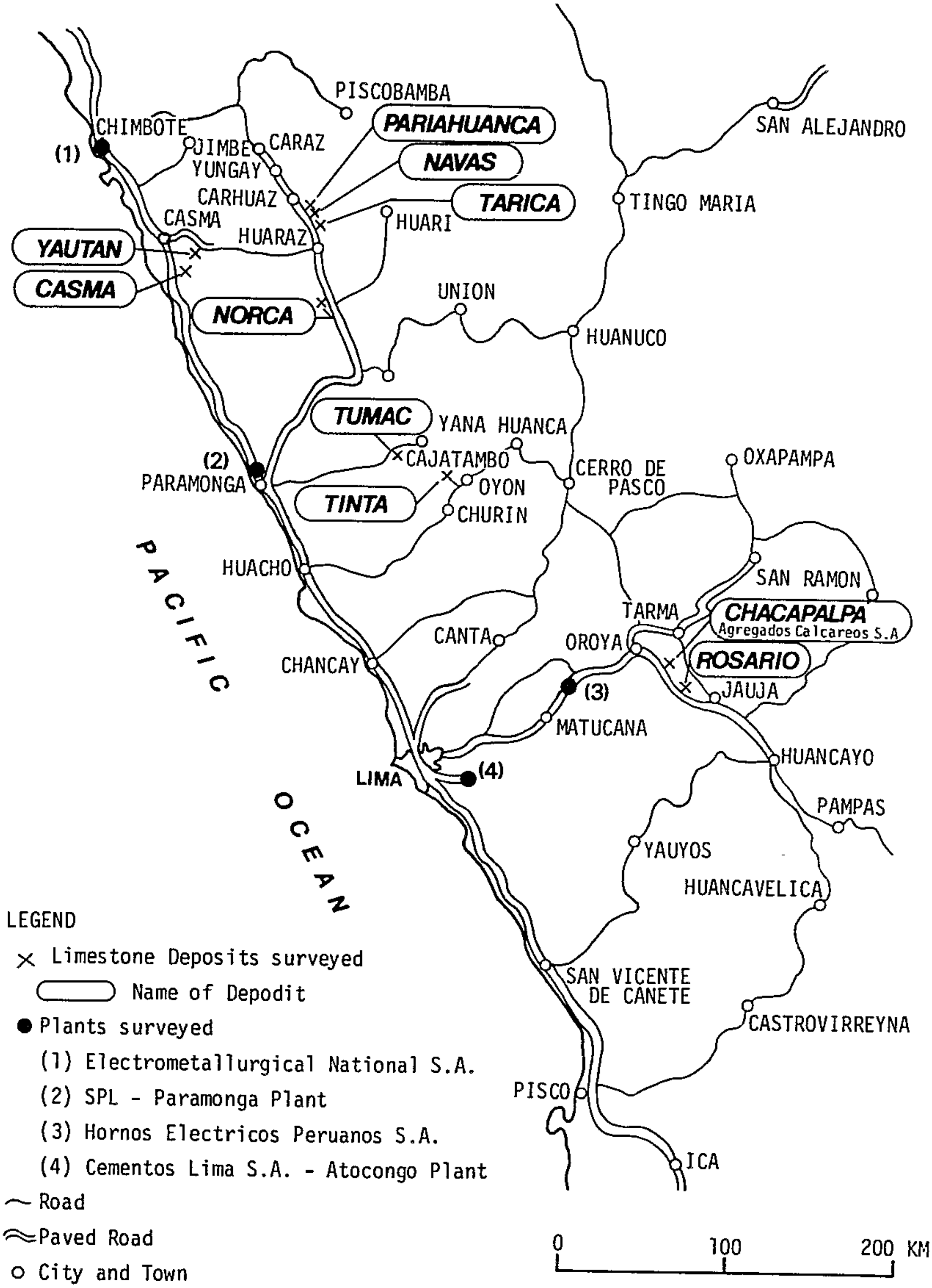
23. JICA therefore considers that exemption of import duty on imported equipment would be very beneficial to the project.

24. This project also have very favorable socio-economic effects as are explained in CHAPTER 13, ECONOMIC ANALYSIS. Also as stated in CHAPTER 14, OVERALL EVALUATION, JICA regards this project as recommendable for implementation.



PERU PVC
PROCESS FLOW DIAGRAM
Figure 8-1
J I C A


ZAPALLO
CAMPO ALAMEDA
ESTACADA
PLANTA ALCALIS
PLANTA P.V.C.
AEROPUERTO
OLIVAR
CAMPO PARICIONERO
OCEANO
PACIFICO
INGRESO A PARAMONGA
CAMPO SAN FRANCISCO
N
AVENIDA FRANCISCO VIDAL
CAMPO — SAN PATRICIO
CAMPO CANOA
LEGEND
SPL Plant
Candidate
PERU PVC
PARAMONGA CITY MAP
Figure 7-1
J I C A



Location Map of the Surveyed Limestone Deposits and Plants

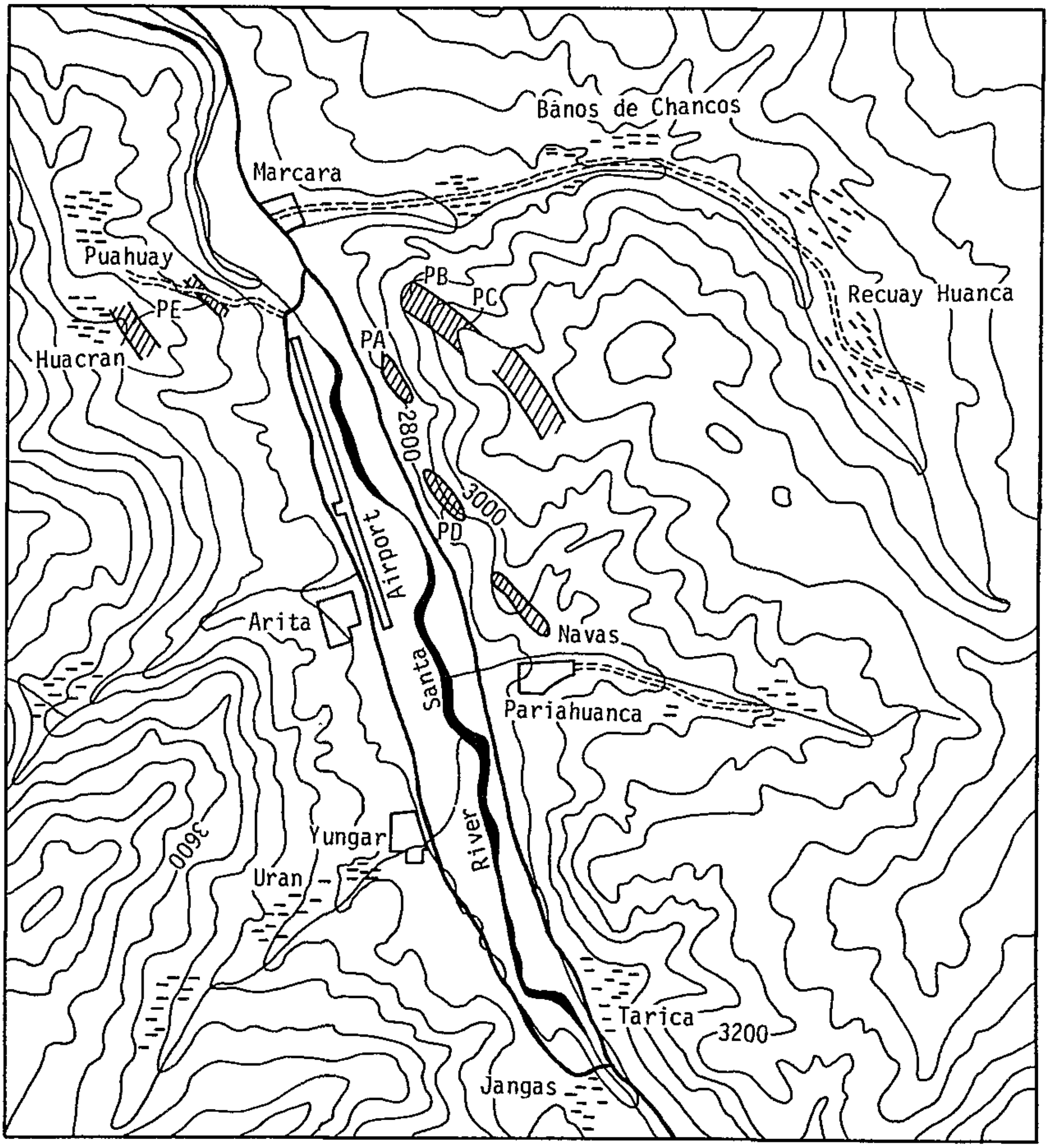
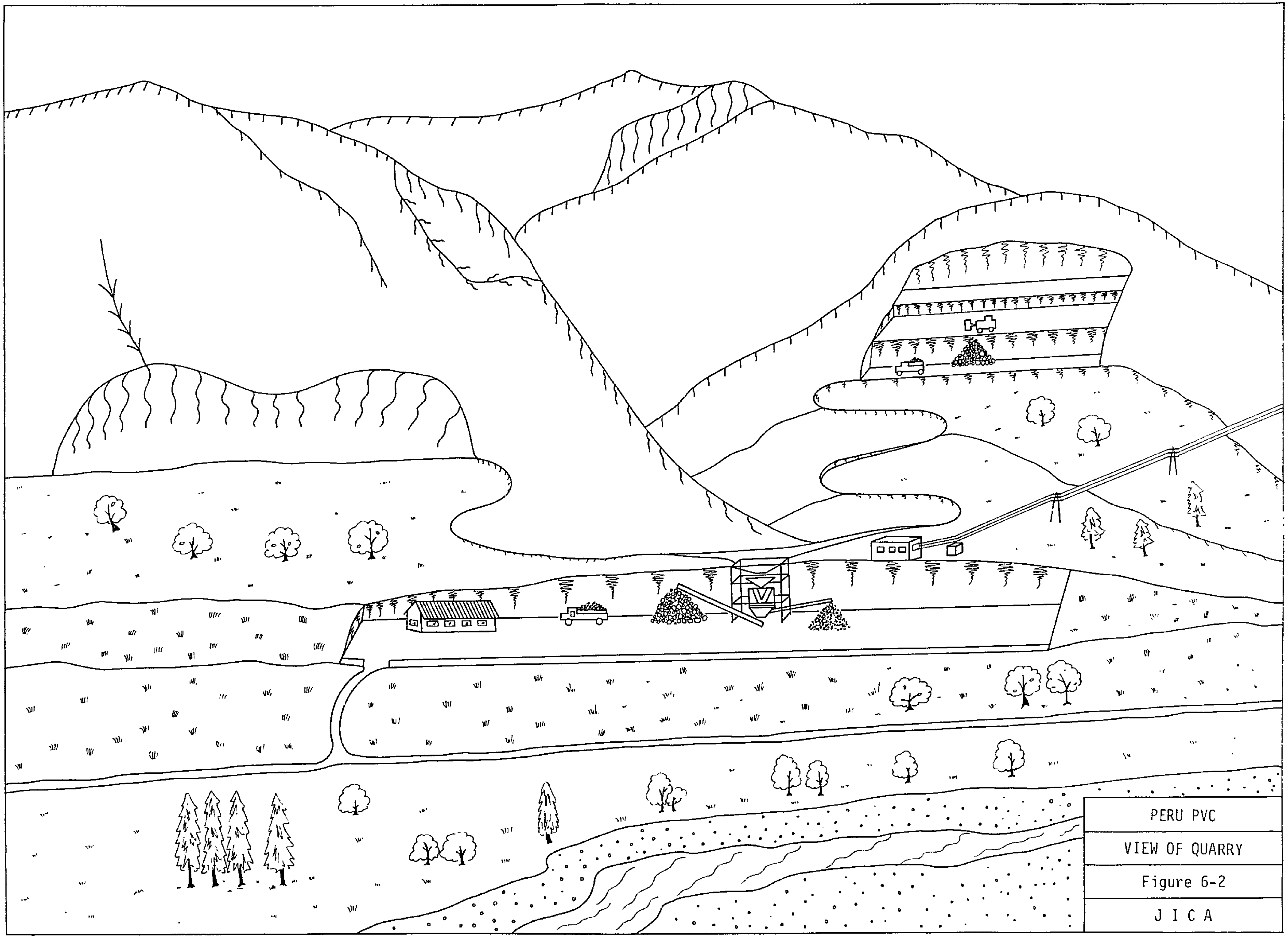


Figure 6-1 Topography of Pariahuanca Area

LEGEND

(hatched ellipse)	Limestone deposit	(box)	Town
PA–PE	Location of sampling	(dashes)	Village
(solid line)	Asphalt road	(thick line)	River
(double dashed line)	Sand road		

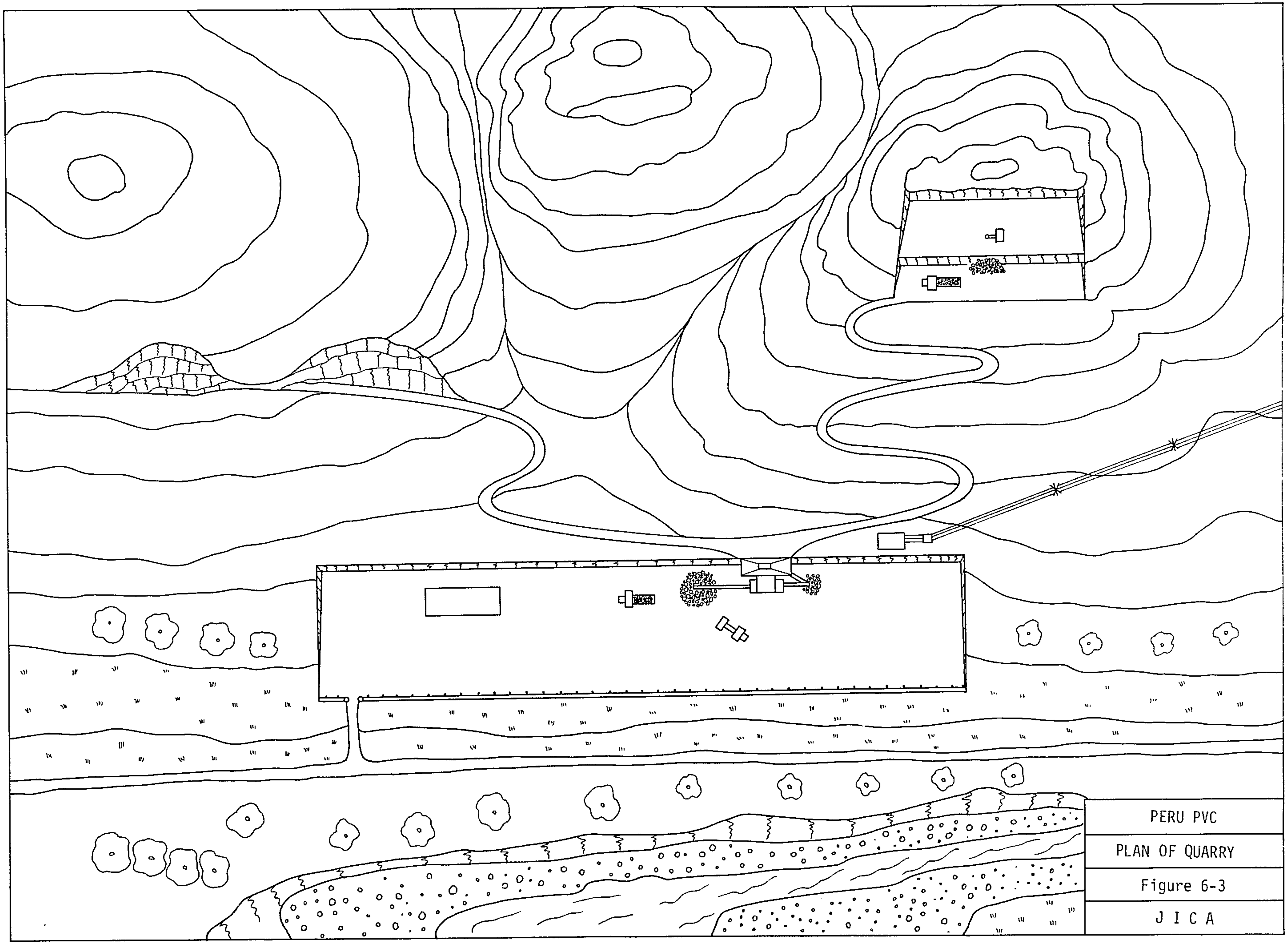


PERU PVC

VIEW OF QUARRY

Figure 6-2

J I C A

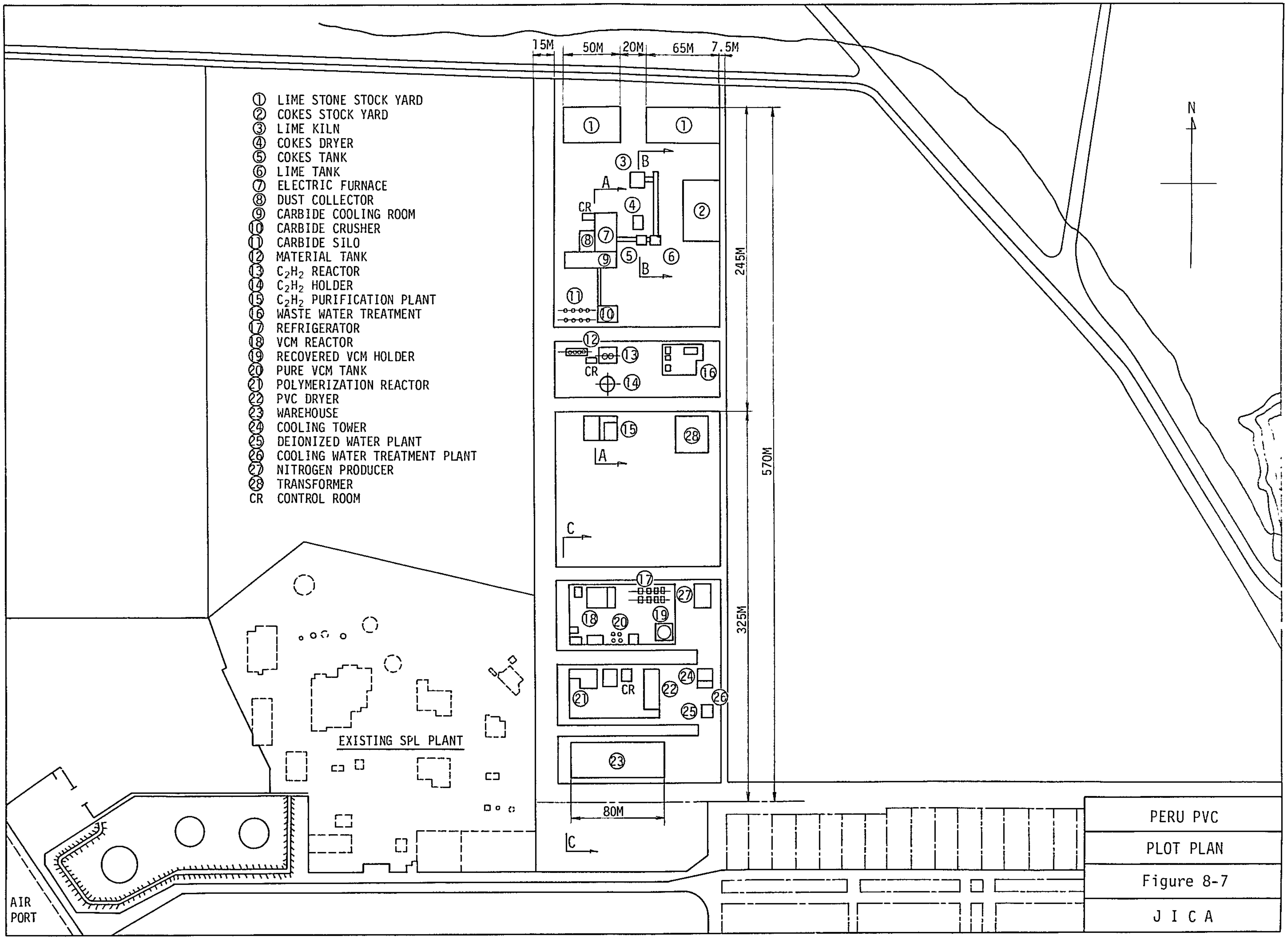


PERU PVC

PLAN OF QUARRY

Figure 6-3

J I C A



PERU PVC

PLOT PLAN

Figure 8-7

J I C A

CONTENTS

CHAPTER		PAGE

CHAPTER		PAGE

CHAPTER		PAGE

APPENDIX

1. Computer Output
2. Scope of Work
3. Minutes of Meeting, February 2, 1983
4. Minutes of Discussion, July 12, 1983
5. Limestone Cost
6. Example for Calculating Customs Duties
7. Industrial Statistics (Salary Data)
8. Utility Taxes
9. Example, Reinvestment Income Tax Credit
10. General Tax to the Sales
11. Standard Tariff for Truck Transportation
12. SPL's Answers to JICA's Question
13. Field Survey Schedule

LIST OF TABLES

LIST OF FIGURES

TITLE		PAGE

CHAPTER 12 FINANCIAL EVALUATION

CHAPTER 1 BACKGROUND

1.1 Background of the study

There is a firm and growing demand for PVC in Peru, particularly for manufacture of PVC pipes, sheets and films, shoes and electric wires. The domestic production meets about half of the domestic demand, the rest being supplied by import. SPL, the only manufacturer of PVC in Peru, had been producing PVC from fermentation alcohol made from molasses until November 1981. The reason for suspending this operation is that price of alcohol became too expensive as well as unstable. Ever since SPL has been producing PVC from imported EDC.

Under such circumstances SPL formulated a plan to produce PVC from limestone abundantly available in Peru and hydrogen chloride that SPL was producing as a byproduct of caustic soda but was disposing of for lack of adequate uses. In August 1982, the Government of Peru asked the Japanese government for technical assistance in the form of a feasibility study of this concept. Upon receipt of the formal request, the concerned offices of the Japanese Government including JICA examined and found the project as a rational one. JICA sent to Peru a preliminary survey mission headed by Mr. Iwaguchi and finalized the scope of work with SPL. Thus this feasibility study was realized.

1.2 Purposes and Scope of Study

Needless to say, the purposes of this feasiblitly study are, in short, (1) to examine the technical and economic viability of this project, and (2) present appropriate recommendations regarding the execution of this project based on the overall assessment of this project. The full scope of work for this feasibility study agreed by SPL and JICA is shown in the APPENDIX. The scope of work consists mainly of : (1) studying marketing potential of the products; (2) studying technical aspects ranging from limestone quarrying, transportation of the limestone to the carbide plant site, all the manufacturing facilities from the limestone kiln and electric furnace to produce calcium carbide, a facility to generate acetylene, (a) faciliti(es) to produce vinylchloride monomer (VCM), (a) faciliti(es) to polymerize VCM to PVC and associated facilities to handle PVC, and related studies on site, utilities, auxiliary facilities, infrastructure; and (3) conducting financial and economic analyses of the project and presenting appropriate recommendations.

1.3 Methods of Study

The study flow diagram on the next page schematically illustrates the method of this feasibility study. The study period may be broadly broken down into four; namely, (1) Period of preparation for the field survey, (2) Field Survey, (3) Work in Japan, and (4) Draft meeting to the final report submission. As is seen on the study flow diagram the entire study may be considered as consisting of a total of 29 work units covering these four work periods.

Actually these work units were faithfully followed. The JICA study team made full preparations before the field survey. With full cooperation by SPL the field survey was very fruitful. At the closing stage of the field survey, the project scheme was formulated and agreed on by SPL and the JICA study team. The project scheme was checked again at Work Unit, C-6, and was reconfirmed again as the appropriate one. All the evaluations were done on the project scheme.

(1) Preparation for Field Survey

The purpose of all the works in this period lies in facilitating the activities in the field survey. There are five work units (A-1 to A-5); namely, A-1 Collection of information on quarry, quality of limestone, PVC demands and socio-economic environment, A-2 Preliminary design, A-3 Study on carbon source, A-4 Request for appointments and questionnaire, and A-5 Test on limestone samples.

(2) Field Survey

The purposes of the field survey are to: (1) collect information and data that are needed for the subsequent studies, (2) establish project scheme(s) with definitions of process flow, location of the facilities, capacities of the plants, implementation schedule and the methods of evaluation, (3) prepare the interim report summarizing major findings of the survey and presenting the proposed project scheme(s) with rationale supporting such (a) project scheme(s), and (4) present the interim report to SPL and discuss and agree with SPL on the project scheme(s) to be subjected to the subsequent studies, and finally record the the understanding in the form of minutes of discussion.

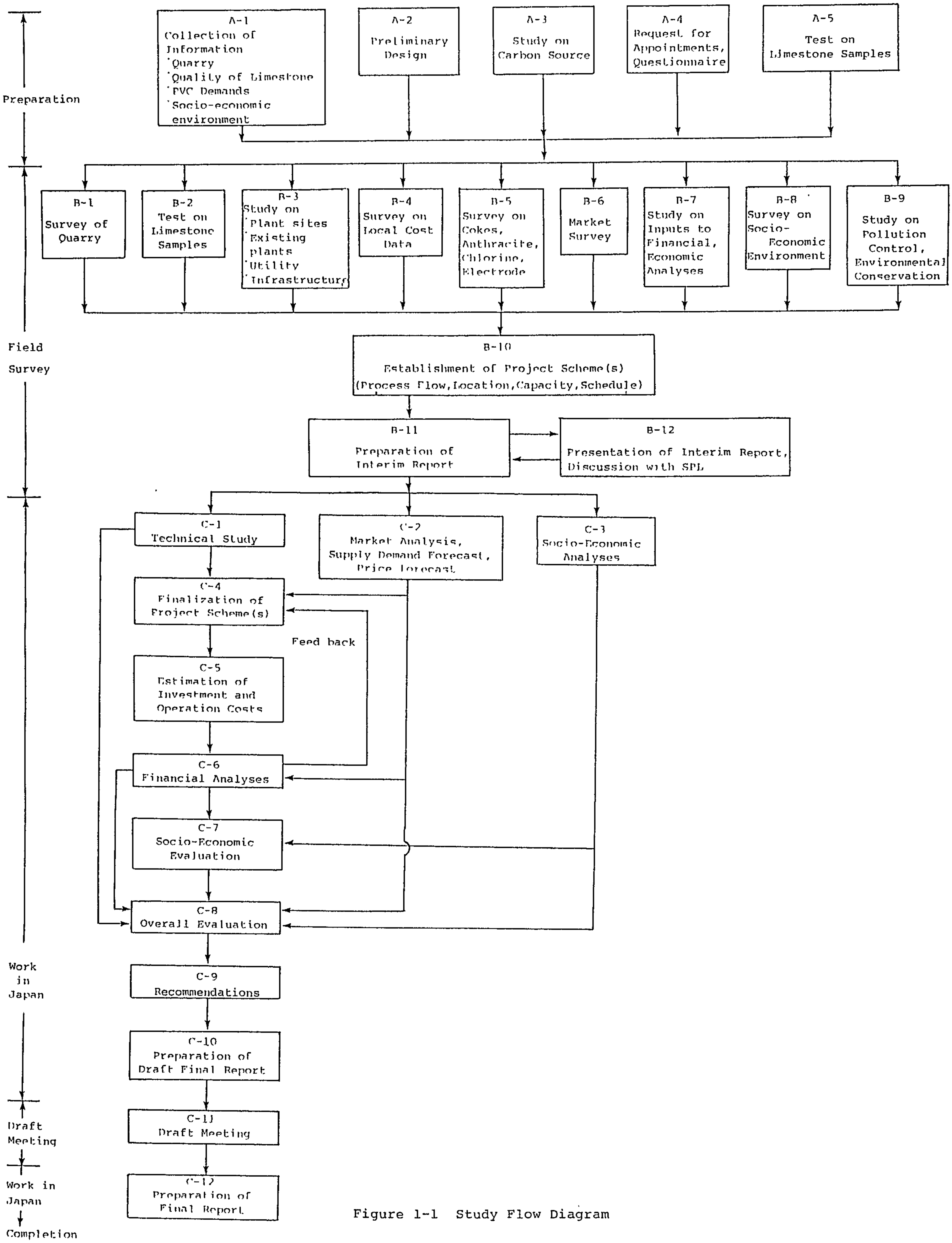


Figure 1-1 Study Flow Diagram

The project scheme(s) should naturally reflect all the major findings and at the same time should intend to maximize the benefit of the nation. All the subsequent works are to be done to the project scheme(s).

The work units to be carried out during the field survey are specifically:

B-1 Survey of Quarry

- Evaluation of the candidate quarries with respect to limestone mining, transportation of limestone to the plant, and quality of the limestone
- Ownership and mining right of the candidate quarries
- Estimation of mining and transportation cost
- Estimation of the reserves
- Evaluation of the site conditions of the carbide plant in case the carbide plant is decided to be located close to a quarry not in Paramonga
- Possibility of using rejected silica-rich limestone from the selected quarry for cement manufacturing

B-2 Test on Limestone Samples

- Collection of limestone samples from promising candidate quarries
- Test of limestone samples by laboratory of Denka

B-3 Study on Plant Sites, Existing Plants, Utilities, Infrastructure

- Study on natural conditions of the sites including meteorological conditions, geology, topography, bearing strength, ownership
- Study on the site conditions of all the plants from the limestone kiln down to PVC plant
- Investigation of the existing plants — general conditions, capacities, design specifications, performance records, degree of obsolescence, capacity of the salt electrolysis plant, all including discussions with counterparts engineers
- Investigation of the utility facilities — general conditions, capacities, design specifications, performance records, degree of obsolescence, with respect to supply capability to this PVC project
- Investigation of the infrastructure around the plant site — road, port and harbor, rails, communication and transportation, township

- Investigation of availability, reliability and prices of electricity and industrial water and drinking water

B-4 Survey on Local Cost Data

- Survey on the prices of locally available materials and equipment, labor and other local costs
- Duties on and other related costs of imported equipment and raw materials

B-5 Survey on Cokes, Anthracite, Chlorine, Electrode

- Confirmation of the outcomes of A-3 work unit
- Possiblility of using anthracite of Oyon
- Chlorine — Investigation of the existing electrolysis plant and of possibility of continuing import of EDC
- SPL's projects to use chlorine
- Electrodes — assumed to be imported
- Prices of these inputs
- Availability, prices and quality of other inputs and fuel

B-6 Market Survey

- Factor affecting PVC demands
  1) Economic indicators
  2) Present status of Peruvian industries, plastic processing industries
  3) PVC demands for construction and agriculture
  4) Demand and prices of substitute plastics; polyethylene, polypropylene and polystylene
  5) Visit to ANCOM for information on competing projects and their correlation with this project
  6) Distribution system of plastics
  7) Demand forecast by industry
  8) Movement of prices
- Demands of carbide for iron and steel industry... interviews with Siderperu
- Demands and prices of calcium cyanamide as fertilizer ... agricultural statistics and agricultural development plan, interview with Ministerio de Agricultura, ENCI

Note (Calcium cyanamide is manufactured rather easily by reacting calcium carbide and nitrogen at high temperatures.
Calcium carbide is not only a very good nitrogenous fertilizer but it acts as insecticide and soil neutralizer. Calcium cyanamide is particularly effective to farm products.)

- Possibility of chemical industries starting from calcium carbide and acetylene
- Marketability of spent slaked lime to cement industry

B-7 Study on Inputs to Financial, Economic Analyses

- Costs of various insurances
- Fixed assets tax
- Method of depreciation
- Income tax
- Other taxes, duties
- Compulsory insurances
- Labor costs and salaries
- Financial conditions and costs

B-8 Survey on Socio-economic Environment

- Local employment
- Local industries
- Tax incomes of the central and local governments
- Balance of payments
- Data concerning shadow prices

B-9 Study on Pollution Control, Environmental Conservation Survey on problems concerning pollution, environmental conservation, pollution control standards relative to:

1) Destruction of environment and prevention thereof associated with limestone quarry development
2) Water and air pollution control standards
3) Disposal of spent slaked lime

B-10 Establishment of Project Scheme(s) (Process flow, location, capacity, schedule, methods of evaluation)

- Identification of limestone quarry
- Location of the carbide plant
- Selection of carbon source
- Capacities of the plants

  The factors affecting the capacities:

  1) Demands for carbide other than for PVC manufac-turing
  2) Possibility of continuing EDC route operation
- Project schedule
- Methods of evaluation

B-11 Preparation of Interim Report

- Summary of major findings
- Project scheme(s) and rationale supporting the scheme(s)

B-12 Presentaton of Interim Report, Discussion with SPL

- Presentation of the results of the field survey
- Confirmation of major findings
- Confirmation of the project scheme(s)
- Exchange of minutes of discussion

With the presentation of the Interim Report, the field survey is combleted.

(3) Work in Japan

C-1 Technical Study

- Conduct a conceptual design based on the project scheme(s)
- Plant operation plan and organization

C-2 Market Analysis, Supply demand forecast, Price forecast

- Price and demand forecast of PVC, carbide, calcium cyanamide, spent slaked lime
- Correlation with other projects in Andes Group

C-3 Socio-economic Analysis

- preparation of input information to C-7, Socio-economic evaluaton and C-8, Overall Evaluation

C-4 Finalization of Project Scheme(s)

- Finalizaton of project Scheme(s) reflecting the outcomes of C-1, C-2, C-3 studies

C-5 Estimation of Investment and Operation Costs

- Estimation of Capital requirements (foreign and domestic capitals) — land, construction cost of plants and facilities, auxiliary facilities, preoperation cost, and operation cost

C-6 Financial analysis

- Estimation of working capital
- Expenditure schedule
- Plan for procurement of capital
- Production cost
- Projected balance sheet
- Projected income statement
- Projected flow statement
- Internal rate of return
- Sensitivity analysis with variations in:
  1) Investment cost
  2) Price of raw materials
  3) Sales prices
  4) Interest rate, and
  5) Operation cost

C-7 Socio-economic Evaluation

- Effect on employment opportunities and income
- Effect on local industries
- Effect on tax incomes
- Effect on balance of payments
- Effect on PVC price

- Economic internal rate of return

C-8 Overall Evaluation

- Overall evaluation based on the results of C-1, C-2, C-3, C-6 and C-7 studies

C-9 Recommendations

- Presentation of recommendations with respect to the conclusion and execution of the project
- Recommendation on government policies

C-10 Preparation of Draft Final Report

- Preparation of draft final report incorporating the above results.

C-11 Draft Meeting

- Presentation of the draft report to SPL
- Discussion with SPL on the draft

C-12 Preparation of Final Report

- Preparation of the final report incorporating the results of the draft meeting

Thus, this feasibility study is completed.

CHAPTER 2 PROFILE OF PERU AND ITS PLASTIC INDUSTRY

2.1 Natural Conditions and Population

Peru is the third largest country in South America with an area of about 1.3 million square kilometers, situated between 18th and 21st parallels south of the equator. Peru is bordered on the west by a 2,300 kilometers Pacific coast line. On the land Peru shares borders with Equador, Colombia, Brazil, Bolivia and Chile. The country may be broadly broken down into three geographical regions with distinct topographic and climatic characteristics; namely, a narrow coastal area, a mountaneous central zone and Amazon Basin called costa, sierra and selva, respectively. The selva occupies about half of the entire area, the rest being about equally divided into the costa and sierra.

Although Peru is situated in the tropical zone, the strong influence of a cold current known as Humboldt Current flowing northward along the coast makes the climate of the coastal area cooler than normal for such latitudes. The coastal area is very dry characterized by a wide stretch of arid barren terrain, except in river valleys and some low places where underground water seeps. Besides tempering the coastal climate, the cold current brings a variety of aquatic lives which provide the basis of the great Peruvian fishing industry.

The mountaneous central zone measures about 300 to 400 kilometers across with altitudes of 1,700 to 6,500 meters above sea level. The higher crests are covered with snow. Here are located principal mineral deposits. This area is also very rich in agricultural products like wheat, corn (maize), oats, potatoes, beans, etc.

The climate of Amazon Bazin is warm, humid with a heavy tropical precipitation reaching 2,500 millimeters a year or even more. The heat, rainfall, poor drainage and the resultant jungle growth combine to keep the population extremely low. This area has a great potential for agricultural development but presently the main industry in this area is forestry.

Peru's population is now estimated approximately at 18 million living mostly in the coastal and mountaneous areas with only a few percent living in Amazon Basin.

2.2 Socio-economic Background

Peru's present government under Fernando Belaunde assumed office in July 1980 after a long tenure of a military government which had lasted since 1968. The first priority of the Belaunde Government is to correct persistent economic problems. The Government is promoting economic development by encouraging more efficient utilization of resources, decontrolling the economy, and increasing participation of the private sector.

During the past years the economy of Peru has apparently expanded in terms of total GDP; however, the population increased faster than GDP.

Table 2-1 Gross Domestic Products

Gross Domestic Products

	Million of 1975 US$	Million of Current US$	Per Capita Current US$
1971	9,024	6,870	494
1977	10,914	12,267	757
1978	10,718	12,991	773
1979	11,123	14,945	864
1980	11,457	17,411	978
1981	11,902	19,892	1,087

(Source : Banco Continental)

Table 2-2 Population

	Million
1971	13.8
1977	16.2
1978	16.8
1979	17.3
1980	17.8
1981	18.3

Rate of growth over the period from 1971 to 1981 is 2.9 percent.

(Source: Banco Continental)

The sectorial breakdown of GDP is as follows:

Table 2-3 GDP Breakdown

	1973	1977	1978	1979	1980	1981
Agriculture	13.5	13.0	12.8	12.7	11.7	12.7
Fishing	0.8	1.0	1.3	1.3	1.2	1.1
Manufacturing	25.2	25.4	25.3	25.3	25.9	25.4
Mining & Petroleum	7.1	8.3	9.6	10.2	9.6	8.9
Construction	4.6	5.4	4.6	4.5	5.2	5.5
Government	7.9	8.2	8.3	7.9	7.8	7.7
Commerce & Service	40.9	38.7	38.1	38.1	38.6	38.7
Total	100.0	100.0	100.0	100.0	100.0	100.0

As is evident from Table 2-3 the industrial structure of Peru has remained basically static despite minor sectorial changes during the past decade.

With respect to contribution to export, mining and petroleum are predominantly important.

Table 2-4 Contribution to Export

(Million US$)

	1973**	1977**	1981*	1982*	Percent 1982
Fishery products	149	208	141	202	6.3
Copper	284	363	529	459	14.2
Other minerals	278	511	896	751	23.2
Petroleum	4	42	692	715	22.1
Agricultural products	246	391	172	218	6.7
Others	80	139	827	885	27.5
Total	1,041	1,654	3,255	3,230	100.0

Sources : * Institute Nacional de Estadistica
** Ministerio de Economia y Finanzas

The balance of payments position of Peru is not very good. As is evident from Table 2-6, Foreign Debt (Cummulative), the foreign debts both of the public and private sectors are very large.

Table 2-5 Balance of Payments

(Million US$)

	1975**	1980**	1981*	1982*
Trade balance	(1,099)	836	(548)	(557)
Export	1,291	3,898	3,255	3,230
Import	2,390	3,062	3,803	3,787
Service & transfer	(439)	(774)	(965)	(1,090)
Long-term capital account	1,135	460	635	1,264
Short-term capital account, SDR allocations, error	(173)	199	374	515
Overall balance	(576)	721	(504)	132

Sources : * Banco Nacional de Estadistica
** Institute Nacional de Estadistica

Table 2-6 Foreign Debt (Cummulative)

(Million US$)

	1975	1980	1981	1982
Long-term debt	4,352	8,125	8,172	9,629
Short-term debt	1,872	1,436	1,501	1,982
Total	6,224	9,561	9,673	11,611
Ratio of debt to GDP	0.45	0.56	0 .48	0.57
Breakdown of long-term debt				
Public sector	3,066	6,043	6,210	7,258
Central Bank	-	710	455	707
Private sector	1,286	1,370	1,507	1,664

(Source : Banco Central de Reserva)

Like many other Latin American countries, Peru has been chronically under heavy burden of foreign debt.

2.3 Plastic Industry

The manufacturing industry as a whole constitutes about 25 percent of GDP. Peru has a wide range of manufacturing industries to supply consumers' goods and durable household appliances. Besides these Peru has capital and technology intensive industries like the iron and steel mill in Chimbote, fertilizer plants in Talara, Cachimayo and Callao, automobile assembly plants, paper mill and sugar plants, and SPL's PVC plant.

In the field of upstream plastic industry, SPL's PVC plant is the only plant Peru has. While in the field of the downstream plastic industry Peru has a number of plants to process resin into pipes, sheets, films, bottles, toys, and other molded products.

Besides, there are industries which use resin as one of key raw materials. These industries include electric wire manufacturers, shoes makers, tile makers. Peru imports substantial amounts of polyethylene, polypropylane, PVC, polystyrene, all of which combine to reach some 40,000 tons per year.

CHAPTER 3 RAW MATERIALS AND ELECTRICITY

This chapter discusses availability in Peru of limestone, carbon source, electricity, chlorine, and electrode paste and their quality and cost based mainly on the results of the field survey. To sum up, limestone, electricity, and chlorine are domestically available whereas the carbon source and many of the auxiliary raw materials must, at least for the initial period of the project, be imported.

3.1 Quarry and Quality of Limestone

This section describes the results of the field survey on the quarries and limestone. The geological terms used are explained in Table 6-3 at the end of CHAPTER 6. The quarry must meet the following requirements:

(1)	$CaCO_3$ content, %	98 minimum
(2)	SiO_2 content, %	1.5 maximum
(3)	Heating test	Retain sufficient strength after heating at 1,300°C for 2 hours
(4)	$MgO + Al_2O_3$, %	1.0 maximum
(5)	Contain sufficient reserve to permit mining of 116,000 tons annual	
(6)	Acceptable cost of transportation to the plant site	

The Peruvian Andes is divided into eastern and western ranges;
the former composed of sedimentary and metamorphic rocks of the Paleozoic era the latter of geosynclinal sedimentary rocks and igneous rocks of the Mesozoic and Cenozoic eras. The Mesozoic sedimentary strata are principally those of the Jurassic and Cretaceous periods and they run parallel in NNW-SSE direction primarily on the western central heights. In these Mesozoic strata, particularly in those of the Cretaceous period exist many limestone deposits.

The typical Cretaceous strata include from bottom to top Oyon, Chimu, Santa, Carhuaz, Farrat, Pariahuanca, Chulec, Pariatambo, and Jumasha layers — the names, even of the same stratum, vary with the district.

The Casma layer of the middle Cretaceous period is found from coast to inland. They consist mainly of pillow lava, low-grade limestone, chert and pyroclastic rocks. The subduction that constinued from the Jurassic period to the Cenozoic era initiated the orogenic movements of the Andes, and volcanic activities in the Cenozoic tertiary period caused the formation of tonalite, granitic diorite, andesite and puroclastic rocks over a wide east-to-west area of the western range's sedimentary rocks. Cretaceous sedimentary rocks caught between these volcanic rocks were subjected to mineralization under the influence of intense folding as well as thermal metamorphism. They formed metasomatic deposits upon contact with metals.

The JICA survey team examined and took samples as necessary at Casma, Yautan, Tinta, Norca, Tarica, Pariahuanca, Tumac, Navas and Chacapalpa. These locations were shown on Figure 3-1. Of these limestone deposits Pariahuanca alone satisfies the requirement as feed. Limestones of Tumac, Chacapalpa are travertins. They show a good analysis but collapse upon heating. Tinta has a thick formation of Jumagha-layer limestone which has already been surveyed and tested by INDUPERU. JICA's analysis shows too much impurities to be serviceable as feed. Pariahuanca is not necessarily an ideal one but still it is the best among all the deposits examined. The quality satisfies the requirements. The reserve is sufficient. It is conveniently situated for excavation and transportation. Figure 3-2 is a geological map around Pariahuanca.

The limestone quality and mining plan will be described in CHAPTER 6.

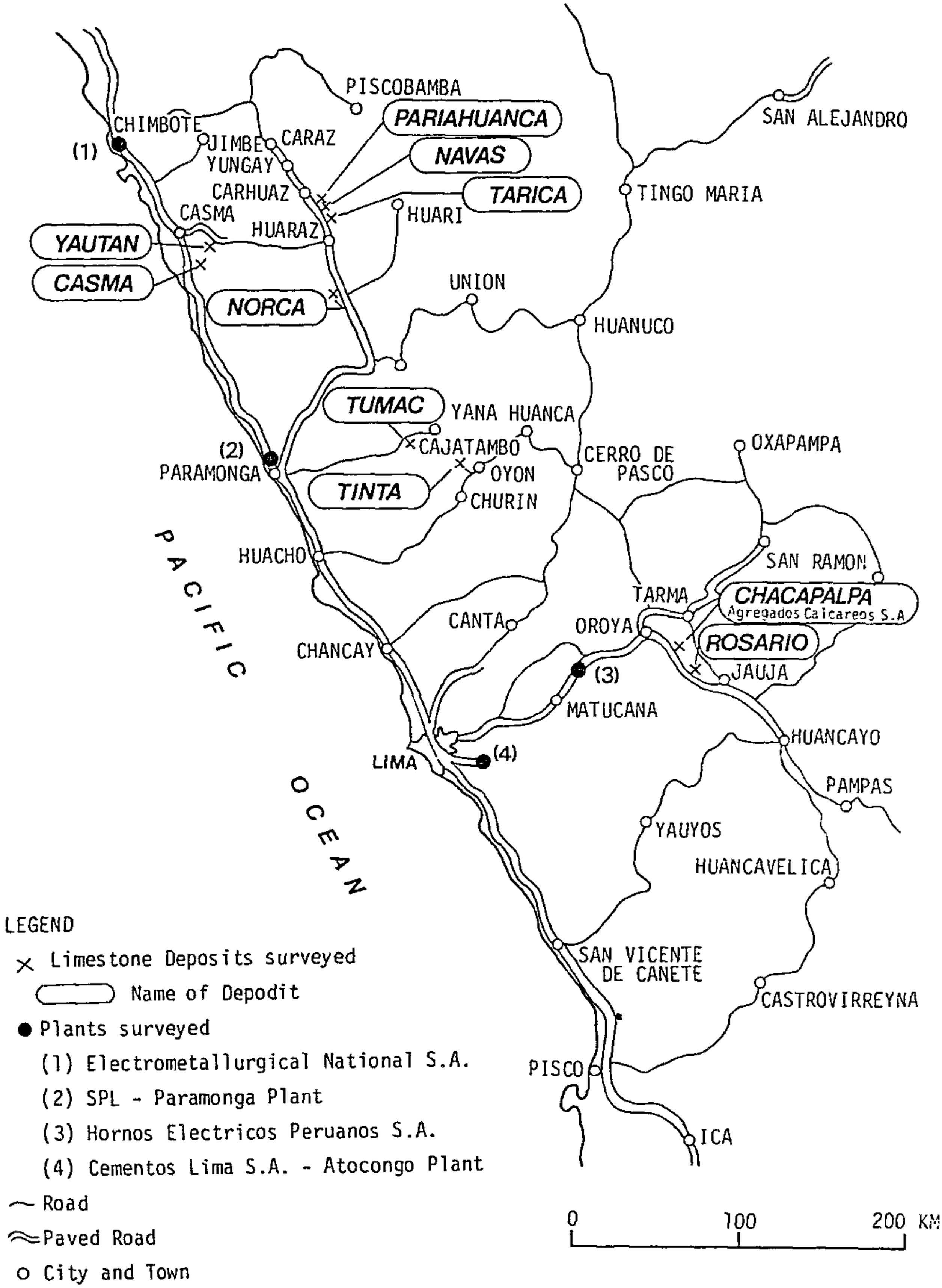
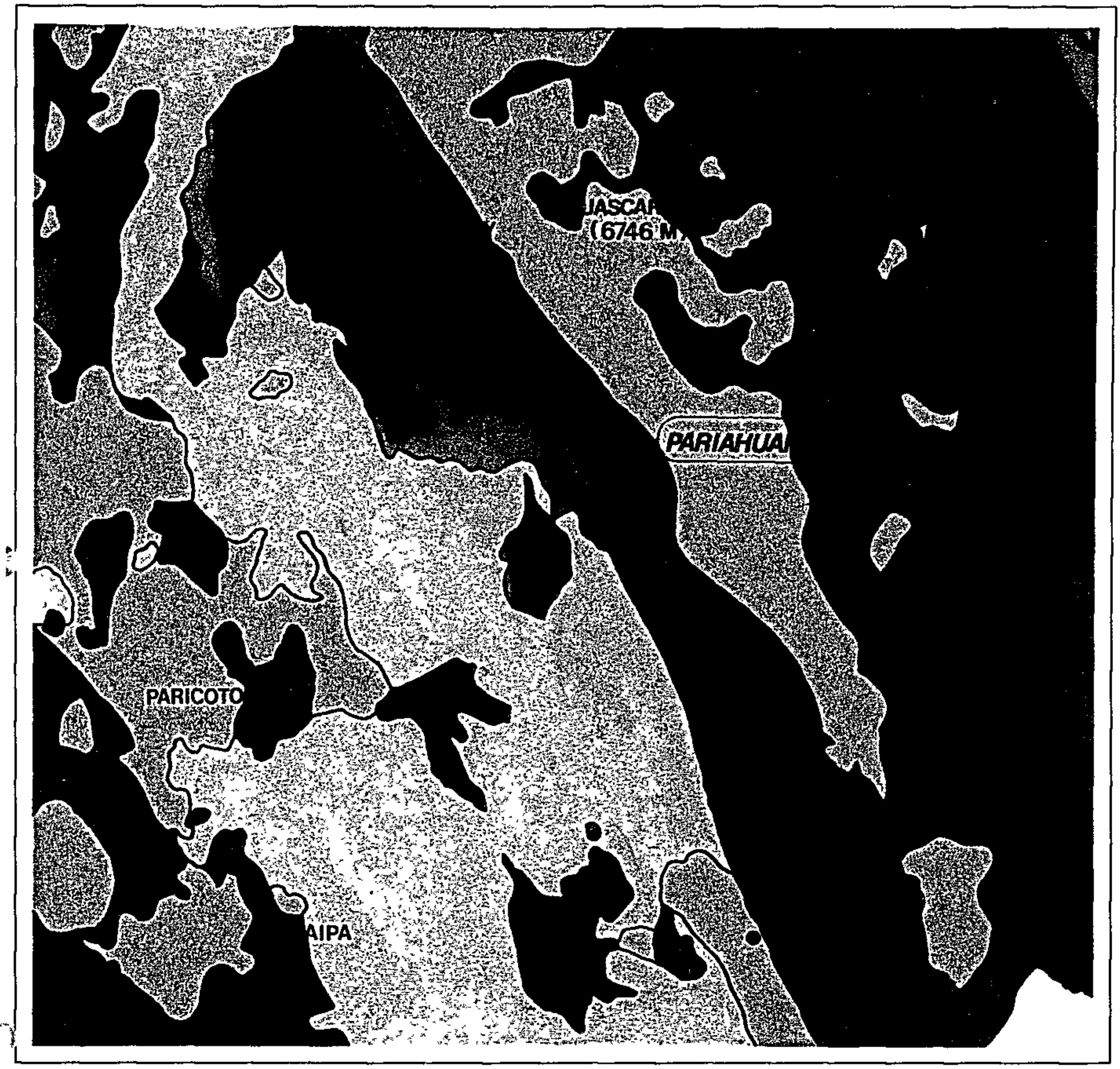


Figure 3-1 Location Map of the Surveyed Limestone Deposits and Plants



LEGEND

● Town
▲ Mountain

0 10 20 KM

Geological Classification

Age	Mark & Color	Formation or Rock
Quaternary	Q	Gracial deposit
Tertiary	KTi-a	Adamellite, Granite
	Ts-i	Ignimbrite
	KTi-t	Tonalite, Granodiorite
	KTi-vca	Calpuy form. Andesite Pyroclastic
	KTi-g	Gabbro, Diorite
Cretaceous	Ki-c	Casma form
	Ki-a	Pariahuanca form
	Ki-saca	Carhuaz form
	Ki-chim	Chimu form
Jurassic	Js-chi	Chicama form

Figure 3-2 Geological Map of Pariahuranca Area

3.2 Carbon Sources

The sources of carbon used for calcium carbide manufacturing are required to have the following properties:

1. High specific electrical resistance
2. Good reactivity and high porosity
3. High fixed carbon content
4. Low ash content.

Table 3-2 shows representative chemical compositions of typical sources of carbon for calcium carbide manufacture.

The effect of the ratio of ash to carbon on the quality of manufactured carbide in terms of liter of acetylene produced per one kilogram of carbide is shown in Table 3-2. Another factor in the selection of the source of carbon is the quantity of fine particles with a diameter of 3 mm or less. After drying the fine particles are used by directly feeding them into the reaction zone of the electric furnace through the hollow of the hollow electrode placed inside of the normal electrode.

Therefore, the quantity of the fine particles is restricted to within a range in which the above treating is possible. During the initial years of the operation use of imported metallurgical coke and petroleum coke in a ratio of 70 to 30 is considered recommendable to satisfy the above requirements. Cost of imported coke available in Peru is considered to be 186.65 US$/ton.

When, in the future, sources of carbon of satisfactory quality is domestically produced in sufficient quantities, the use of such materials exclusively or in blends with imported materials may be considered.

Table 3-1 Representative Chemical Composition of Sources of Carbon for Calcium Carbide Manufacture

(Unit; weight percent)

	Fixed carbon (%)	Ash (%)	Volatile matter(%)	Moisture (%)
Metallurgical coke	88-89	9-11	0.8-1.0	9-10
Petroleum coke	90-91	0.3-0.5	8-9	10-12
Anthracite	85-90	4.5-5.5	5-6	4-5

Total sulfur,	%	2.0	maximum
Total phosphorus,	%	0.04	maximum

Table 3-2 Effect of Ash/fixed Carbon Ratio on Grades of Calcium Carbide

Ash/fixed carbon, %	Calcium carbide grade, l/kg
5-10	310-280
10-15	300-260
15-20	280-240

Table 3-3 Chemical Analysis of Samples of Sources of Carbon Materials Available in Peru

(Unit; weight percent)

	Mitsubishi Chemicals coke (imported)	Metallurgical coke produced in Peru	Charcoal Produced in Peru (lump)
Moisture	0.5	0.3	9.6
Ash	10.1	8.4	3.6
Volatile matter	1.4	1.3	9.2
Fixed carbon	88.5	90.3	87.2

(Analysis on samples supplied on June 29, 1983 by Hornos Electricos Peruanos S.A.)

3.3 Electricity

Because the manufacture of calcium carbide employs the electric furnace process which consumes a considerable amount of electricity, electricity may be regarded as the most important raw material rather than a mere utility. Accordingly, the conditions for the supply of electricity, particularly price and stability, are important factors affecting the viability of the carbide manufacturing facilities.

The current total power generation of Peru is approximately 3,300 MW, 55 percent hydraulic and 45 percent thermal. Several new hydroelectric power plants currently in the construction planning stage will, due to favorable geographic conditions, add an estimated 58,400 MW of hydroelectric power generation. The government is very active in its efforts to double hydroelectric power generation by 1988. This plan, however, has encountered difficulties among which steep rise of construction costs due to inflation and the difficulty of raising funds are most serious. Whether or not electricity will be secured at a reasonable cost is a crucial factor to this project.

Peru has seven electric power companies which are all government-owned corporations, including Electroperu, the largest. These companies have their own territories to supply, but electricity can also be supplied mutually. Hidrandina is the company that supplies electricity to the Paramonga city area via branch lines from the Hidrandina trunk line to the SPL Paramonga Plant. A total of 55 MVA (27.5 MVA x 2) from two Hidrandina power stations plus 50 MVA from an Electroperu station is supplied to this trunk line. At present, SPL Paramonga Plant has a receiving facility for 42,000 KW. The additional 20,000 KW which will be required by the new plants can also be supplied by this trunk line.

As described in Chapter 7, the present price for SPL Paramonga Plant is approximately US$ 0.035/kwh (average as of June 1983).

3.4 Chlorine Source

The existing salt electrolysis plant has a capacity to produce 42,000 tons per year of caustic soda and 37,275 tons per year of chlorine, with a hydrochloric acid synthesis capacity of 43,750 tons per year. Present consumption of chlorine or hydrochloric acid (liquid chlorine, bleaching solution, etc.) is approximately 12,000 to 17,500 tons per year, thus giving an excess of approximately 20,000 to 25,000 tons per year of chlorine.

The existing salt electrolysis and hydrochloric acid synthesis facilities were built in 1959 and are still operational. As is explained in the preceding paragraph they have sufficient capacities to provide 15,300 tons per year of hydrochloric acid required by the present project. SPL indicated 159,424 Soles per ton as price of Chlorine. The cost of hydrogen chloride is calculated as follows:

$$\text{Cost of chlorine gas (159,424 Soles/ton)} \times \frac{35.5}{36.5} = 154,633$$

Therefore, cost of hydrogen chloride is 154,633 Soles per ton or 100.6 US$ per ton.

3.5 Other Inputs

(1) Electrode paste

Hornos Electricos Peruano S.A., a Peruvian manufacturer of carbide uses a Söderberg-type electrode paste manufactured by Carboindustrials S.A. of Brazil under license of Elkem S.A. This electrode paste is considered to be of substantially the same quality as those in general use in large-capacity closed-type electric furnaces.

Table 3-5 below shows the specifications of this paste. As far as the specifications indicate, this paste is considered applicable to this project although a more detailed test would be required before actual use.

Table 3-4 Specifications of Söderberg-type Electrode Paste
Manufactured by Carbon Industrials S.A.

Unbaked paste	
Apparent density, kgr/m^3	1,550
Plasticity, %	20-40
Softening point, ^{o}C	80-100

Volatile matter, %	13 (max 17)
Ash, %	4 (max 6)

Baked paste

Apparent density, kgr/m^3	1,360
Thermal conductivity, kcal/m.hr.^{o}C	6.9
Electric resistance at 1,000^{o}C, mm^2/m	40 (max 70)
Compressive strength, kg/cm^2	200
Bending strength, kg/cm^2	38
Young's modulus, kg/cm^2	35×10^3

The FOB Brazil price of this electrode paste is US$ 392 per ton. The estimated Peruvian price is US$ 1,240 per ton.

CHAPTER 4 MARKET AND DEMAND

4.1 Overview of Plastic Market

The domestic plastics market is relatively small. PVC consumption per capita is only 0.9 kilograms. Peru consumes such general-purpose plastics as PVC, polyethylene (PE), polypropylene (PP) and polystylene (PS), while consumption of special plastics like engineering plastics is virtually none. Diversification of plastic use will, however, proceed as industrization and modernization proceeds in Peru. Intensification of construction activity and substitution for wooden and leather products by PVC will increase demand of PVC. PVC demand in Peru is now about 14,000 tons per year, half of which is supplied domestically by SPL the only manufacturer in Peru. Other general-purpose plastics (PE, PP, PS) are all supplied by import. The approximate amounts of import in 1982 are PE 25,000, PP 4,000 and PS 5,000 tons per year. Concerning the prices of imported plastics, PVC is the cheapest at 1,100 US$ per ton followed by low-density PE (LDPE) and high-density PE(HDPE) in the range of 1,200 to 13,00 US$ per ton, and PP and PS around 1,600 US$ per ton. The fact that PVC is sometimes imported at prices lower than the domestic produce creates a difficult situation to the domestic industry. Therefore the domestic PVC users wish for improvement of product quality and competitive and stable price vis-a-vis imported PVC. Major uses of PVC are rigid pipes, films and shoes which together account for more than 70 percent of the total consumption. The economy of Peru has not entirely recovered from the economic recession which holds down growth of PVC demand. PVC export from Peru is small, chiefly in the form of PVC finished products. Neighboring Andean countries are big potential markets for export. However the export to such countries is not necessarily easy. As will be explained this project is justified by the domestic market and the export market is treated as a supplement.

4.2 The Domestic Market

(1) Market Size

Total demand for PVC in the domestic market in 1982 was 14,460 tons. Given the total population of approximately 18 million, this turns out to be 0.8 kilograms PVC consumption per annum per capita, a relatively small amount. Table 4-1 shows the size of the domestic market for PVC over the past eight years since 1975.

Table 4-1 Historical PVC Market in Peru

Year	Demand (t/y)
1975	10,376
1976	12,849
1977	14,270
1978	12,057
1979	11,454
1980	14,153
1981	16,280
1982	14,460

(Source : SPL)

In studying demand, any estimate would be inaccurate unless inventories are properly taken account of. SPL developed of its own a market study by sector the results of which were provided to JICA. The SPL study assumes that product inventories were held constant throughout the years. Given the ups and downs of the Peruvian economy, this assumption does not hold always true and the results should be accepted with proper consideration to this assumption. However, it should be noted that SPL has conducted a study of the leading 49 PVC-customer companies in order to more accurately grasp the domestic market. The study by SPL indicates that the market has grown at an average rate of 9.5 percent per annum for the five years from 1975 to 1980. Much of this growth may be attributable to the outstanding growth in piping, hosing, flooring materials, and electrical cable insulation particularly between 1970 and 1980.

After growing at 15 to 20 percent per annum since 1979, demand growth fell below 10 percent in 1982 and is currently experiencing a slow growth as would be expected in a period of recession.

(2) Demand by Sector and Use

1) Main uses for PVC

PVC resin is used for the production of a very wide range of products mostly consumed within Peru for its relatively low price, outstanding physical and chemical properties, and easiness of processing.

Generally, PVC resins are used for film, synthetic leather, electrical insulation, flooring material, piping materials, textiles, and many more applications. It is generally compounded with additive materials, calender processed, injection molded, and otherwise molded for use. Amoung the more common compounding materials are plasticizers, stabilizers, pigments, fillers and lubricants. Hard and soft PVC products are produced depending upon the amount of plasticizer added.

The main uses for PVC in Peru are:

a) Daily necessities
   - Edible oil containers
   - Cosmetic product containers
   - Film
   - Sheet
   - Shoes
   - Records

b) Construction materials
   - Piping and associated products
   - Flooring materials
   - Electrical insulation

c) Medical supplies
   - Transfusion and infusion equipment (disposable) Tubing

d) Miscellaneous

2) Market scale by use

As shown in Table 4-2 construction materials accounted in 1982 for nearly 55 percent of the total demand for PVC products. Other areas of strong demand were film, footwear, and containers, each accounting for 10 percent or more of the market.

These same market trends have held generally steady since 1978, and it is felt that the demand for hard PVC will be a major determinant of the growth in the total PVC demand.

3) Features of demand sectors

a) Edible oil bottles

Edible oil is sold in PVC bottles (1 litre, 0.5 litres, and 0.25 litres) cans and 5-litre drums. While the market for edible oil has been averaging 5 percent per annum growth, the market for PVC edible oil bottles has been growing at a strong 10 percent per annum. This is largely due to the consumers responding to the higher prices of edible oil by shifting away from large-volume cans to smaller-volume PVC bottles. Today, 85 percent of all vegetable oil and 10 to 35 percent of all animal oil is sold in PVC bottles. By size, 1 litre bottles account for 60 percent of the PVC bottle market, 0.5 litre bottles 35 percent and 0.25 litre bottles the remaining 5 percent. Although PE bottles are also used for edible oil market, they account for only about 20 percent of the market and the remaining 80 percent is in PVC bottles. An official in charge of sales for Compania Oleoginosa del Peru S.A. (COPSA), which occupies 40 percent of the edible oil market, estimates that PVC resin demand for bottle use will grow at about 4 percent per annum.

b) Cosmetic and pharmaceutical bottles

The growth of PVC demamd in this field is slow as a result of the inroads made by PE. This is because the cosmetics and pharmaceutical companies recently prefer PE on the ground that PVC, particularly free residual monomer, can be

Table 4-2 PVC Demand Breakdown

(Unit: tons per year)

Year	Pipes	Film/Sheet	Bottle	Insulation	Shoes	Record	Floor	Others	Total
1978	5,115	1,438	1,473	1,315	1,922	399	367	28	12,057
(%)	(42.4)	(12.0)	(12.2)	(10.9)	(16.0)	(3.3)	(3.0)	(0.2)	(100.0)
1979	4,580	1,780	1,460	1,042	1,790	487	290	25	11,454
(%)	(40.0)	(15.5)	(12.7)	(9.2)	(15.6)	(4.3)	(2.5)	(0.2)	(100.0)
1980	5,100	1,743	1,770	1,500	2,754	703	500	83	14,153
(%)	(36.0)	(12.3)	(12.5)	(10.6)	(19.5)	(5.0)	(3.5)	(0.6)	(100.0)
1981	6,100	2,420	2,000	1,940	2,870	500	350	100	16,280
(%)	(37.5)	(14.9)	(12.2)	(12.0)	(17.7)	(3.0)	(2.1)	(0.6)	(100.0)
1982	6,250	2,370	1,730	1,110	2,070	340	240	50	14,460
(%)	(43.1)	(16.3)	(11.9)	(11.0)	(14.3)	(2.4)	(1.7)	(0.3)	(100.0)

harmful to the health. Accordingly, it is considered possible to reverse this trend with the supply of low-monomer products. Many of the pharmaceutical bottles have changed from glass to PVC. Recently there is a shift to sealings by PVC or PE film lined with aluminum, and the demand for PVC bottles here is on the decline. Not only is this film sealing inexpensive, but convenient to carry.

c) Film and sheet

PVC film is used primarily for shampoo packets and book covers. There is stable demand for shampoo in single-use sizes sealed in PVC film, and overall PVC film demand is increasing. However, paper containers lined with aluminum foil have recently been placed on sale which are easier to open and easier to print on than PVC, although they suffer from being more expensive. Small-volume PE containers are also on trial sale.

Demand for PVC film for book covers has shown a strong growth ever since that product was introduced to the market. Although there has been some seasonal variations in sale because this market was first developed for school textbooks, efforts are made to extend the market to companies and office operation. This market will continue to enjoy stable growth.

PVC synthetic leather and sheets are much in demand for renovating used cars. The very high prices of new cars sustains this market.

Synthetic leather is widely used because of its low cost and attractive finish. There is also a growing demand for paper products reinforced by PVC film on exterior. The demand is growing presumably because of their colorful appearance. Although this is indicative of possible diversificaton of the PVC market, it should be noted that demand or these products is still very small. In addition, PVC products are being imported from Columbia which are both quality-competitive and lower priced than the domestic PVC.

d) Shoes

Sport shoes are most important of all kinds of shoes. In the past, there were sport shoes made entirely of PVC, but recently there is a trend toward increasing use of textile fabrics.

According to Fabrica de Calzado Peruano S.A. (FCPSA), the market for sport shoes with PVC sole will grow. Although one pair of shoes uses relatively little PVC, the consumer population is large and the market is expected to grow with the economic recovery and the increasing popularity of sports. FCPSA currently exports work shoes using PVC, approximately one percent of its total production, to Chile and other Latin American countries, and it is continuing with marketing efforts to develop the very promising export market for sport shoes.

e) Records

Demand for PVC for records was only 340 tons per year in 1982, and records accounted for less than 5 percent of the total PVC demand. By market stratum, the higher-income consumers have been the main market for long-playing records and the lower-income consumers the main market for extended-play records. PVC demand is largely determined popularity of music.

f) Piping and related products

This demand sector is closely tied to construction activity, and it is therefore closely related to government public works projects as well as preferential taxation treatment, interest rates, and other policies to encourage private-sector construction. Over the past five years, this sector has consistently accounted for approximately 40 percent of the total PVC market, and it will be a major pillar of PVC demand in Peru. Private-sector construction expenditures have been on the decline in recent years presumably because of the high interest rates on construction loans. However, according to Plasticos Fort S.A. the government is currently planning major housing construction projects as part of its public works program for the next 2 to 3 years, and all PVC piping manufacturers are making intensive sales efforts to these housing projects.

Although there is little demand at present for PVC piping for water supply and sewage disposal, this is a very large potential market to be developed with infrastucture improvments. Extensive use of PVC in this field will be a major factor in the expansion of overall PVC demand.

g) Flooring material

Colored PVC tiles have found widespread use as a flooring material, and demand has grown steadily closely related with housing construction. However, this field has been suffering from sluggish growth as a result of the recent slump in housing construction. Under such a circumstance, however, export of PVC flooring materials is doing rather fine. Pisopak del Peru S.A., the largest firm in this field, exports 40 to 50 percent of its total production to Chile, Venezuela, and other latin American countries. However, there are also increasing imports of low-cost PVC flooring materials from Columbia, Japan, and other sources.

h) Electrical insulation

PVC insulation is superior to rubber insulation in many ways. In addition to its outstanding electrical resistance, PVC is also non-flammable, durable, oil-resistant, and chemically stable. This sector is also closely tied to the construction industry, electrical power facilities, and telephone installation. Demand in this field has been down over the past two years because of the sharp decline in large-scale construction projects as a result of the recession. According to Indeco Peruano S.A., which accounts for 40 percent of electrical wire production, the demand growth in electrical power transmission lines and telecommunication lines will be greatest. This forecast is based upon the trend to build an increasing number of medium-capacity electrical power generating stations as well as on the increasing number of telephones being installed as the standard of living improves.

i) Medical equipment

As qualiy medical care begins to cover the entire population there will be incresing use of PVC infusion and transfusion equipment. Disposable equipment will become more popular.

j) Miscellaneous

Other uses including adhesives, telephone sets, and toys account for a very small proportion of the total demand. In 1982, PVC consumption for these uses amounted only to 50 tons per year.

4) Price

The prices of PVC resin and compounds sold domestically by SPL as of June 14, 1983, are shown in Table 4-3.

Table 4-3 SPL Domestic Sales Prices

Product	Price (US$/t)
Resin	
Homogenized polymer	1,100
Copolymer	1,316
Compounds	
Shampoo containers	1,794
Covering film	1,794
Medical equipment	1,868
General-use containers	1,868
Break-proof containers	1,943
Records	1,890
Dynamite fuses	1,645
Shoes	1,645
Shoes soles	1,868
Electrical insulation	1,566
Hosing	1,566
Tubing	1,418
Edible oil bottles	1,764

4.3 Import of Plastics

Peru imported in 1982 a total of 7,200 tons of PVC resin, amounting to almost half the total PVC demand. This section studies the importation of plastics and competitiveness of the domestic PVC.

(1) PVC

1) Import volume and price

Table 4-4 shows PVC demand and importation. As seen from the table Peru has been dependent on import during the past seven years for more than 50 percent supply.

Table 4-4 Historical PVC Demand and Import

Year	Demand (t/y)	Import (t/y)	Share (%)
1976	15,720	8,483	54
1977	18,443	12,468	68
1978	11,975	3,837	32
1979	13,392	6,166	46
1980	13,574	6,649	49
1981	16,280	10,087	62
1982	14,400	7,150	50

PVC imported is chiefly of suspension type and import of emulsion type PVC is very little.

Table 4-5 shows import price of PVC since 1982. FOB price fluctuates between 400 and 530 US$ per ton. A recent price as of June 1983 was about 450 US$ per ton. CIF price as of June 1983 is estimated from the FOB price at 558 US$ per ton. Many kinds of taxes and commission fees have to be paid. The total of these additional costs amounts to 56 percent of CIF price. The inland transportation cost is added to obtain the PVC market price.

Table 4-5 Price of PVC Resin (Homopolymer)

(Unit: US$/ton)

Year/Month	FOB	C & F	CIF
1982			
1	538.6	665.3	
2	528.8	637.9	
3	502.9	597.0	
4	497.2	577.1	
5	533.0	672.0	
6	435.0	552.4	
7	533.1	658.9	
8	500.5		521.8
9	441.0		566.7
10	457.3		562.[illegible]
11	448.0		563.1
12	467.1		564.[illegible]
1983			
1	445.4		576.0
2	490.2		614.1
3	434.4		560.9
4	398.5		622.1

Total cost of imported PVC as of June 1983 was 871 US$ per ton. A typical example for calculating total cost of imported PVC is shown in Table 4-6.

Table 4-6 Typical Cost of Imported PVC

(as of June 14, 1983)

(1)	FOB	450 US$/ton
(2)	Freight	100 "
(3)	C & F	550 "
(4)	Insurance ((3) x 1.5%)	8.25 "
(5)		558.25 "
Taxes		
(6)	40 % CIF	223.30
(7)	Freight marine ((2) x 10%)	10.00
(8)	Financial Cost	37.80
(9)	Commission etc. ((6)+(7)) x 15%	34.995
(10)	Total Taxes	306.095
(11)	Freight (Callao to Lima)	7.000
(12)	Grand Total (5)+(10)+(11)	871,354 US$/ton --- Total Cost

$$\text{Relation} : \frac{(12)}{(1)} = 1.936$$

$$: \frac{(12)}{(5)} = 1.56$$

2) Sources of Import and Users

PVC is now imported mainly from South Africa, United States, West Germany, Mexico and Belgium. Major exporters are AECI of South Africa, B. F. Goodrich and CONOCO Chemicals of United States and Chemishe Werke Hüls of West Germany. Import from south Africa and United States account for more than 70 percent of the total.

Table 4-7 lists major users of imported PVC.

Table 4-7 Principal Users of Imported PVC

1. PVC Suspension
    1) Viplastik Peru
    2) Plasticos Fort
    3) Planinsa
    4) Plasticos "El Pacifico"
    5) CERPER Conductores Electricos
    6) Calzado Duramil
    7) Industrias del Cobre
    8) Tubo Plast S.A.
    9) Industrias Santa Maria
    10) Corporacion de Industrias Plasticas

2. PVC Emulsion
    1) Sinteticos del Peru
    2) Industrias Santa Maria
    3) Viplastik Peru
    4) Fbrica de Calzado Peruano
    5) Bakelita y Anexos

(2) PE

1) Import volume and price

Import volume of PE for last five years is given in Table 4-8. HDPE and LDPE account for 60 and 40 percent of the total import of PE, respectively. Average FOB prices were 810 and 740 US$ per ton for HDPE and LDPE.

Table 4-8 Volume of Imported PE

Year	Volume
1978	18,961
1979	18,296
1980	26,472
1981	25,677
1982	25,019

2) Sources of import and users

Major sources of import of PE to Peru is listed in Table 4-9.

Table 4-9 Major Sources of Import of PE

Country	Users
United States	Gulf Oil
	Union Carbide
France	Ato Chemie
Colombia	Policol
Canada	Dupont
West Germany	Hoechst
Chile	Petro Dow

Main users of imported PE are listed in Table 4-10.

Table 4-10 Principal Users of Imported PE

1) Plasticos SAM S.A.
2) Bakelita y Anexos
3) IDIESA Articulos Plasticos
4) Van Wer del Peru

5) Industrial TiCo Plast
6) Peru Plast S.A.
7) Plastimold
8) Recolite Peruano
9) Industrial Cocer S.A.
10) Andes Plast

(3) PP, PS

1) Import volume and price

Import of PP and PS for the last five years is shown in Table 4-11.

Table 4-11 Volume of Imported PP and PS

Year	PP Volume (t/Y)	PS Volume (t/y)
1978	10,392	2,401
1979	6,837	3,286
1980	8,574	4,348
1981	4,455	4,680
1982	3,984	4,987

Average FOB price in 1982 of PP and PS are 830 and 742 US$ per ton. respectively.

2) Export source and major users

Major sources of imports are listed in Table 4-12

Table 4-12 Sources of Import of PP and PS

PP	United States	Union Carbide
		Phillips Petroleum Disc
	Brazil	Polypropileno

PS	West Germany	BASF
	Venezuela	Estireno de Zulia
	Colombia	Dow Colombiana

Table 4-13 gives major uses of PP and PS.

Table 4-13 Principal Users of PP and PS

PP	1)	Carlos Koch Pratts
	2)	Norsac S.A.
	3)	Industrial Tico Plast
	4)	Cia. Envasadora de Alimentos
	5)	Plasticos SAM S.A.
	6)	Peruplast S.A.
	7)	Bakelita y Anexos
	8)	Andes Plast
	9)	A.W. Faber Castell
PS	1)	Plasticos SAM S.A.
	2)	IDIESA Articulor Plasticos
	3)	Coldex S.A.
	4)	Fores Plastix S.A.
	5)	Bakelita y Anexos
	6)	Termotechnia S.A.
	7)	A.W. Faber Castell
	8)	Nova Plast Industrial S.A.

4.4 Price Trend

(1) General

PVC price in Peru fluctuates very much. FOB prices of imported PVC from 1975 to 1983 are shown in Table 4-14.

Table 4-14 FOB Price of Imported PVC

Year	FOB Price (US$/t)
1975	549
1976	357
1977	471
1978	441
1979	618
1980	741
1981	577
1982	490
1983 (Jan-Apr.)	442

In 1980 FOB price reached the highest of 741/US$ per ton and after that the price has been gradually decreasing. Against the background of global oversupply situation of PVC products as well as dull demand for last several years, coupled with the export offensive of dumping sale of PVC, FOB price came down to 450 US$ per ton June 1983.

(2) Production cost and sales price

Production costs of SPL's PVC in May 1983 are 914 US$ per ton for resin and 1,500 US$ per ton for compound. As for cost breakdown of resin, fixed cost accounts for 30 percent and the rest 70 percent variable cost of which imported EDC constitutes 44 percent. On the other hand the cost of imported resin was, as mentioned in the previous section, about 871 US$ per ton in June 1983 that was 43 US$ per ton cheaper than the domestic products. The difference between imported FOB price. 450 US$ per ton, and domestic production cost, 914 US$ per ton, is as much as 464 US$ per ton. However, in Peru, the amount equivalents to about 55 percent of CIF price is imposed as taxes, which reduces the difference to 43 US$ per ton. Sales prices of PVC resin as of June 1983 are 1,100 US$ per ton for domestic PVC and 1,032 US$ per ton for imported PVC. Table 4-15 shows historical PVC sales prices aince 1977. Owing to the price control by the government, domestic PVC was cheaper than the imported PVC until 1979 but since then the situation has been changed; in other words, the imported PVC has been cheaper. Estimated average price difference for 1983 is 55 US$ per ton.

Table 4-15 Historical Sales Price of PVC

(Unit: US$ per ton)

Year	Domestic	Imported	
1977	892 *	-	
1978	961 *	-	
1979	995 *	1,310	
1980	1,434	1,119	
1981	1,119	980	
1982	843	825	
1983	1,107	1,052	Estimated

This difference prompted many domestic processors to change to imported sources.

The trade within the region is exempt from the 40 percent import duty on FOB price that is imposed on import from outside the region to stimulate intra-regional trade. Colombian manufacturers are reportedly planning to take advantage of this situation to offer Peruvian importers 750 US$ per ton C & F or Lima delivered price of 850 US$ per ton. As will be explained in CHAPTER 12 these prices are lower than the price of PVC to make this project viable. This situation should be considered in terms of protection of the domestic industry still not strong enough to compete with dumped products.

(3) Future Trend of Price

According to the recent information about chemical market, PVC demand in the United States is picking up with firm price along with general economic recovery. JICA generally agrees with this view. Future PVC demand is anticipated to maintain a stable price. Against such a background it appears more reasonable as well as realistic to assume there will be much less excess PVC dumped in the international market at sub-cost prices.

4.5 Demand Forecast by Use Category

A forecast is made here of PVC demand until 1990 by use category by projecting from the past consumptions and the current trends. Also taken into consideration are the forecasts by major manufacturing companies in the various fields. In so doing, the demand by each use category is first forecast and the total forecast is obtained by summing the individual demands.

The following eight major use categories are employed for demand forecast.

1. Piping and related materials
2. Film and sheeting
3. Containers
4. Electrical insulation
5. Shoes
6. Reconds
7. Flooring material
8. Others

(1) Piping and related material

Although the demand for piping and related materials fluctuates in close relation to construction activities, demand is currently down for a variety of reasons as mentioned above and is unlikely to show a high rate of growth until the current construction slump ends.

The forecast GNP growth by Bureau of National Statistics for the construction sector is shown in Table 4-16. It Should be noted that these forecasts were made in 1980 and that they should be revised downward in the light of the recession the Peruvian economy has been experiencing since then.

Table 4-16 Forecast of Construction Sector Growth

Year	GNP (Million Sales)	Growth Rate (%)
1980	17,145	
1981	19,031	11.0
1982	21,220	11.5
1983	23,766	12.0
1984	26,618	12.0
1985	30,078	13.0
Average period		11.9

It is expected that the present recession will end around 1985; therefore, growth rates of 3 to 5 percent until 1985 and 8 percent thereafter are assumed.

Table 4-17 Demand for PVC Pipe and Accessories

Year	Demand (t/y)	Growth Rate (%)
1982	6,250	
1983	6,440	3.0
1984	6,750	5.0
1985	7,290	8.0
1986	7,870	8.0
1987	8,500	8.0
1988	9,180	8.0
1989	9,920	8.0
1990	10,710	8.0

(2) Film and Sheeting

Among the products included in this category are book covers, shampoo packets, medical equipment, synthetic leather, and table cloths. In addition to the stable traditional demand for book covers for school textbooks, it is expected that there will be increasing demand for book covers at government offices and companies. Although there is some concern about the use of cellophane and other substitute materials, this category is expected to achieve growth of approximately 7 percent per annum. Shampoo packet demand is expected to benefit from the increasing awareness for hygiene which accompanies higher standards of living, and strong consumption growth of 8 percent per annum is therefore forecast. There is also a strong latent market for medical equipement. This depends on the overall scale of medical care expenditures which cannot be expected to grow as fast as 5 to 6 percent per annum. In the synthetic leather and tablecloth categories, a continuing strong growth of approximately 10 percent per annum is anticipated. However, achieving this kind of growth would only be possible by holding down imports and supplying the market from domestic production.

Putting all these factors together an aggregate average 8.5 percent demand growth is estimated for the film and sheeting category in 1985 and beyond.

Table 4-18 Demand for PVC Film and Sheeting

Year	Demand (t/y)	Growth Rate (%)
1982	2,370	
1983	2,440	3.0
1984	2,560	5.0
1985	2,780	8.5
1986	3,020	8.5
1987	3,270	8.5
1988	3,550	8.5
1989	3,850	8.5
1990	4,180	8.5

(3) Containers

Of the major uses for PVC containers — shampoo, edible oil, and cosmetics — shampoo Container demand is down as a result of competition with the film packets as mentioned before. According to a study by Bureau of Statistics of Ministry of Agriculture, consumption of edible oil is expected to increase appfoximately 6 percent per annum. However, use of smaller containers as mentioned before, will mean even greater growth in the demand for containers. Although there will be competition with PE products, consumers are expected to favor PVC containers. Containers for cosmetics account for approximately 20 percent of all container demand and they will increase at a maximum rate of 5 percent. Overall, the aggregate average growth rate for the container category is forecast at 6 percent per annum.

Table 4-19 Demand for PVC Containers

Year	Demand (t/y)	Growth Rate (%)
1982	1,730	
1983	1,780	3.0
1984	1,850	4.0
1985	1,960	6.0
1986	2,080	6.0
1987	2,200	6.0
1988	2,340	6.0
1989	2,480	6.0
1990	2,630	6.0

(4) Electrical Insulation

The electrification and increased use of telephone is the key to the growth in this demand Category. Given the need for the improvement of social infrastructure, rapid demand growth is anticipated once the current recession ends. In addition, steady growth of demand is also foreseen for PVC for dynamite fuses in mining and road construction. As a result, demand in this category is expected to grow by 10 percent per annum in 1985 and beyond.

Table 4-20 Demand for Electrical Insulation

Year	Demand (t/y)	Growth Rate (%)
1982	1,410	
1983	1,480	5.0
1984	1,580	7.0
1985	1,740	10.0
1986	1,920	10.0
1987	2,100	10.0
1988	2,320	10.0
1989	2,550	10.0
1990	2,800	10.0

(5) Shoes

With increasing standard of living in recent years, there has been a shift in the sport shoe market from shoes made entirely of PVC material to shoes made of textile fabric with only the soles and decorative reinforcement made of PVC material. Although one pair of shoes contributes little to PVC demand, the increase in the number of people wearing shoes and the greater replacement demand are expected to yield an average growth of 7 percent per annum on a stable basis in 1985 and beyond. Exports are also doing well, and are expected to grow further due to a wider variety of shoes and fashionable designs available.

Table 4-21 Demand for PVC Shoe Material

Year	Demand (t/y)	Growth Rate (%)
1982	2,070	
1983	2,150	4.0
1984	2,260	5.0
1985	2,420	7.0
1986	2,590	7.0
1987	2,770	7.0
1988	2,960	7.0
1989	3,170	7.0
1990	3,390	7.0

(6) Records

Extended-play records are an important amusement of the middle and lower income strata and the purchase by them is an important factor determining PVC demand in this category. Forecasting their purchases is difficult because of inherent uncertainty of people's taste. Here 6 percent growth rate forecast by the record industry is used.

Table 4-22 PVC Demand for Records

Year	Demand (t/y)	Growth Rate (%)
1982	340	
1983	350	3.0
1984	370	5.0
1985	390	6.0
1986	410	6.0
1987	440	6.0
1988	460	6.0
1989	490	6.0
1990	520	6.0

(7) Flooring Materials

PVC is used as flooring material in vinyl tile and sheets. Because they are easy to color and clean the demand in this category will increase along with increased houSing construction. There has also been a considerable diversification of product line, and the potential for demand expansion is very good counting their recent adaptation of PVC to walling materials. Accordingly, growth in this category has been forecast at 7 percent per annum in 1985 and beyond.

Table 4-23 PVC Demand for Flooring Material

Year	Demand (t/y)	Growth Rate (%)
1982	240	
1983	250	3.0
1984	260	5.0
1985	280	7.0
1986	300	7.0
1987	320	7.0
1988	340	7.0
1989	360	7.0
1990	390	7.0

(8) Miscellaneous uses

Miscellaneous uses include adhesives, molded products like toys, telephone receivers, fabrics, etc., none of which commands any considerable volume. The overall growth for this miscellaneous category is set at 5 percent per annum.

Table 4-24 PVC Demand for Miscellaneous Uses

Year	Demand (t/y)	Growth Rate (%)
1982	50	
1983	50	5.0
1984	60	5.0
1985	60	5.0
1986	60	5.0
1987	60	5.0
1988	70	5.0
1989	70	5.0
1990	70	5.0

Table 4-25 Demand Forecast by Use

(Unit: tons)

Year	Pipes	Film/Sheet	Bottle	Insulation	Shoes	Record	Floor	Others	Total
1982	6,250	2,370	1,730	1,410	2,070	340	240	50	14,460
1983	6,440	2,440	1,780	1,480	2,150	350	250	50	14,940
1984	6,750	2,560	1,850	1,580	2,260	370	260	60	15,690
1985	7,290	2,780	1,960	1,740	2,420	390	280	60	16,920
1986	7,870	3,020	2,080	1,920	2,590	410	300	60	18,250
1987	8,500	3,270	2,200	2,100	2,770	440	320	60	19,660
1988	9,180	3,550	2,340	2,320	2,960	460	340	70	21,220
1989	9,920	3,850	2,480	2,550	3,170	490	360	70	22,890
1990	10,710	4,180	2,630	2,800	3,390	520	390	70	24,690

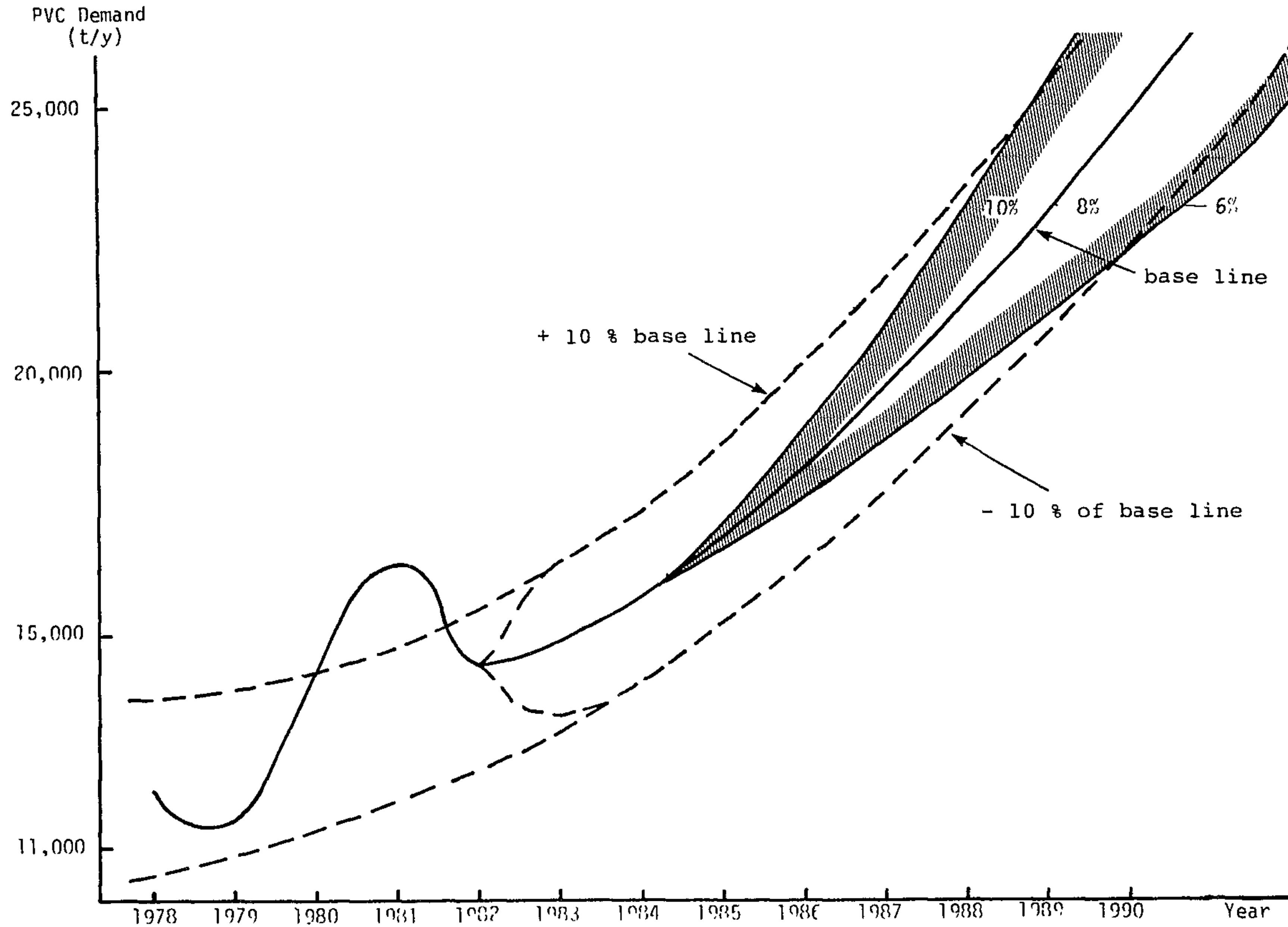


Figure 4-1 Historical PVC Demand and its Forecast until 1990

These growth projections for the various demand caterories are put together in Table 4-25. From the total demand of 14,460 tons per year for 1982, the demand grows at a modest rate of 3 to 5 percent per annum through 1984 as a result of the aftereffects of the recession and picks up to approximately 8 percent per annum thereafter. By the time the project starts in 1988, the demand is expected to grow to approximately 21,200 ton per year, and in the Second year, 1989, approximately 22,900 tons per year. When the operation at capacity is realized in 1990, total demand will be 24,700 tons per year. Calculating running rates from these demand estimates, capacity utilization is about 85 percent in 1988, 92 percent in 1982, and 99 percent in 1990. These figures would justify the assumed capacity utilization values of 80, 90 and 100 percent for 1988, 1989 and thereafter. The actual demand from 1978 through 1982 and forecast demand after 1982 are shown in graph form in Figure 4-1.

The breakdown of the estimated market demand by category through 1990 is as shown in the table below, indicating that piping, film, and sheet will be the major demand categories.

Table 4-26 Market Demand Breakdown

Product	Percentage of Total Demand
Piping	43
Film and sheet	17
Containers	11
Electrical insulation	11
Shoes	14
Records	2
Flooring materials	2
Total	100

Figure 4-1 shows two dotted lines each representing a demand growth 10 percent higher and lower than the forecast growth. The shaded area beginning from 1984 indicates the range of demand if demand varies between 6 and 10 percent per annum. With such possibility of variation taken into account the demand in 1988 is forecast to be at least 19,000 tons per year.

Figure 4-2 shows the aggregated demand thus estimated until 1990 as well as the extrapolated values for 1995. Also shown are projections assuming growth rates 10 percent higher as well as, 10 percent and 15 percent lower than the base case. As is seen from the base line, 1995 demand is estimated at approximately 29,6500 tons per year. The 25,000 tons per year demand figure will be reached in 1989 if growth is 10 percent higher than forecast, 1992 if it is 10 percent lower than forecast, and mid-1993 if it is 15 percent lower than forecast.

4.6 Demand Forecast by Correlation Analysis

As no single method is completely dependable, correlation analysis was applied to future demand forecast of PVC in Peru along with forecast by use category. Relations between Gross Domestic Product (GDP) per capita and PVC demand per capita was studied based on such data for 30 countries at various levels of economic development.

(1) Method of analysis

The original data given in Table 4-27 are plotted on a graph with GDP per capita and PVC consumption per capita on the horizontal and vertical axis, respectively, and a logistic curve which best fits these data was sought. By this method forecast GDP per capita at a target year is first obtained by estimating the growth rates of GDP and population then PVC demand per capita is read from the forecast GDP per capita on the graph. A logistic curve is applied because demands of this kind have a tendency to grow rather slowly at a low GDP level but suddely pick up when the threshold value is reached but again slows down when GDP per capita reaches a certain high level.

The formula of logistic curves is shown as follows:

$$y = \frac{k}{1 + me^{-ax}}$$

Where K: The maximum to which y approaches, in this study the maximum among original data is input.

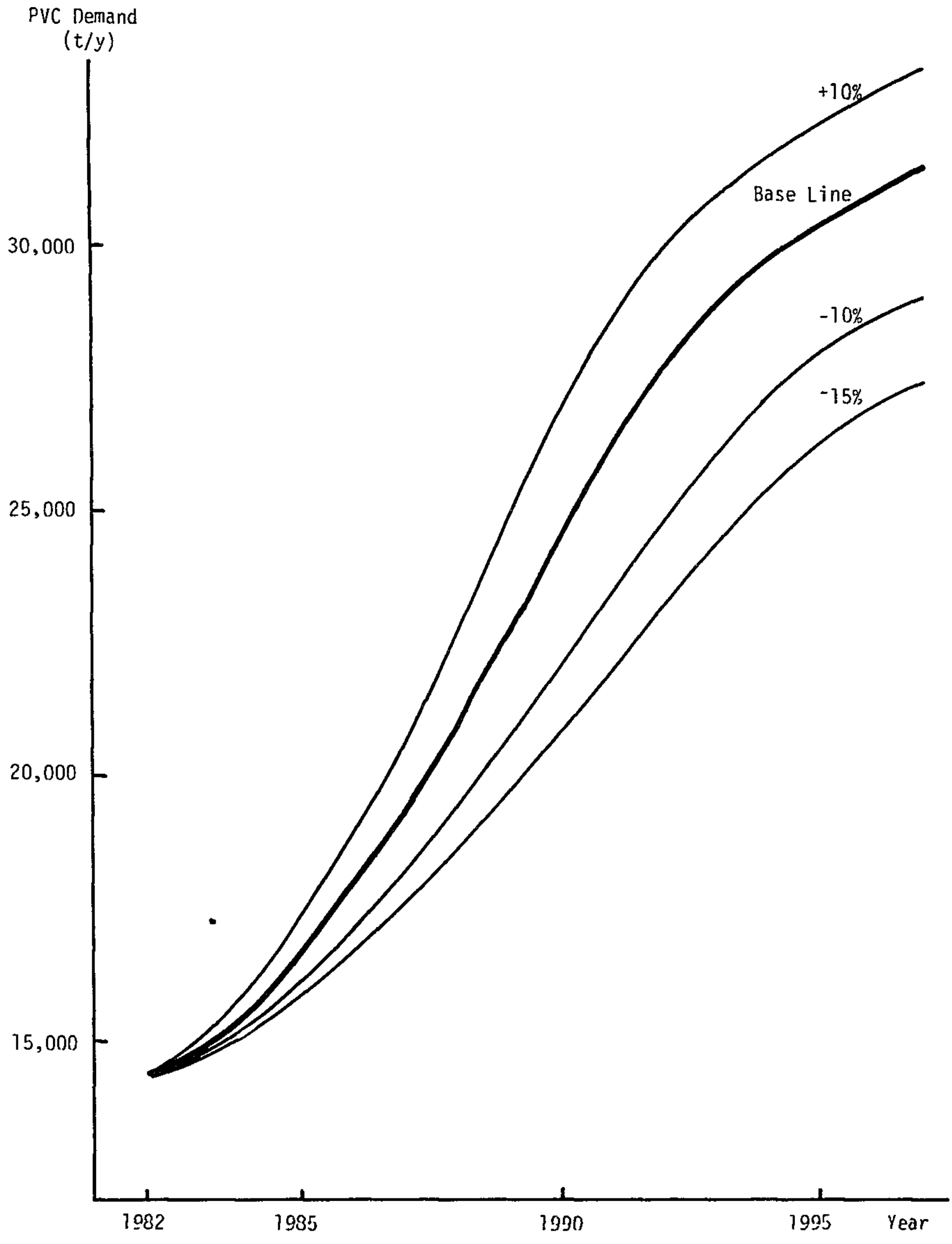


Figure 4-2 PVC Demand Forecast until 1995

The calculation gives:

$$a = 2.914443046 \times 10^{-4}$$
$$m = 17.97929059$$

Figure 4-3 shows both original plots and the logistic curve obtained.

(2) Result and Discussion

Although the original data somewhat scatter but with the exception of a few data they lie along the logistic curve indicating existence of correlation between GDP and PVC demand, which means that PVC demand per capita can be obtained on a set of assumptions from GDP per capita. A range of growth rates from 2 to 6 percent are assumed to calculate the future GDP. Population is assumed to grow at 2.8 p.a. Using the 1982 data, 18.28 million people, the number of population in 1988 will reach 22.18 million. By multiplying the PVC demand per capita and population, PVC total demand in 1988 was calculated. The results are summarized in Table 4-27. In 1981 GDP per capita of Peru was 1,100 US$ against which PVC demand per capita was 0.89 kg, a small consumption of less than 1.0 kg. However, if GDP per capita increases at 2 percent p.a., a rather low growth rate, 34,600 tons per year of PVC demand will be expected by 1988. This demand is much larger than the forecast demand obtained by end use category, which is about 21,200 tons per year in 1988, as presented in previous Section 4.5. This means that Peru consumes less PVC on per capita basis compared with other countries of the same GDP level. We conclude, therefore, that the forecast demand by correlation analysis is too much on the optimistic side in view of the present market situation of Peru and it shoud not be used to support a more optimistic project size. Instead, it should be interpreted as an indication of the level of consumption Peru could attain through industrialization and modernization of the society.

Table 4-27 GDP vs. PVC Demand

No.	Country	GDP per capita (US$)	PVC demand per capita (kg)	Remarks
1	Korea	1,698	6.28	
2	Japan	9,878	9.65	
3	Thailand	765	1.12	
4	Malaysia	1,680	2.29	
5	Philippines	785	1.09	
6	Indonesia	456	0.72	
7	India	241	0.12	*
8	Australia	10,888	11.10	
9	Canada	11,724	9.38	
10	United States	12,569	12.79	
11	France	10,561	13.68	
12	Spain	5,640	5.48	*
13	Greece	4,181	4.90	*
14	Rumania	6,227	9.25	**
15	Turkey	1,254	0.64	*
16	Hungary	2,334	10.55	
17	Norway	13,937	17.07	
18	Sweden	13,521	14.42	
19	Denmark	11,246	13.48	
20	United Kingdom	9,353	5.81	*
21	Netherland	9,798	11.94	
22	Belgium	12,080	10.75	*
23	W. Germany	11,142	20.66	
24	Switzerland	15,926	8.32	*
25	Mexico	2,591	1.75	*
26	Colombia	1,218	1.16	*
27	Venezuela	4,315	4.46	*
28	Peru	1,100	0.89	
29	Chile	2,530	1.17	*
30	Brazil	2,021	2.82	*

Remarks: * 1980 data
** 1980 GNP data

Table 4-28 Result of Correlation Analysis

GDP per capita (US$)	PVC demand per capita (kg)
500	1.27
1,000	1.45
1,500	1.67
2,000	1.90
2,500	2.17
3,000	2.47
3,500	2.81
4,000	3.18
4,500	3.59
5,000	4.05
5,500	4.55
6,000	5.09
6,500	5.67
7,000	6.29
7,500	6.95
8,000	7.64
8,500	8.37
9,000	9.11
9,500	9.87
10,000	10.63
11,000	12.15
12,000	13.60
13,000	14.93
14,000	16.11
15,000	17.11
16,000	17.95
17,000	18.64
18,000	19.18
19,000	19.63
21,000	19.95

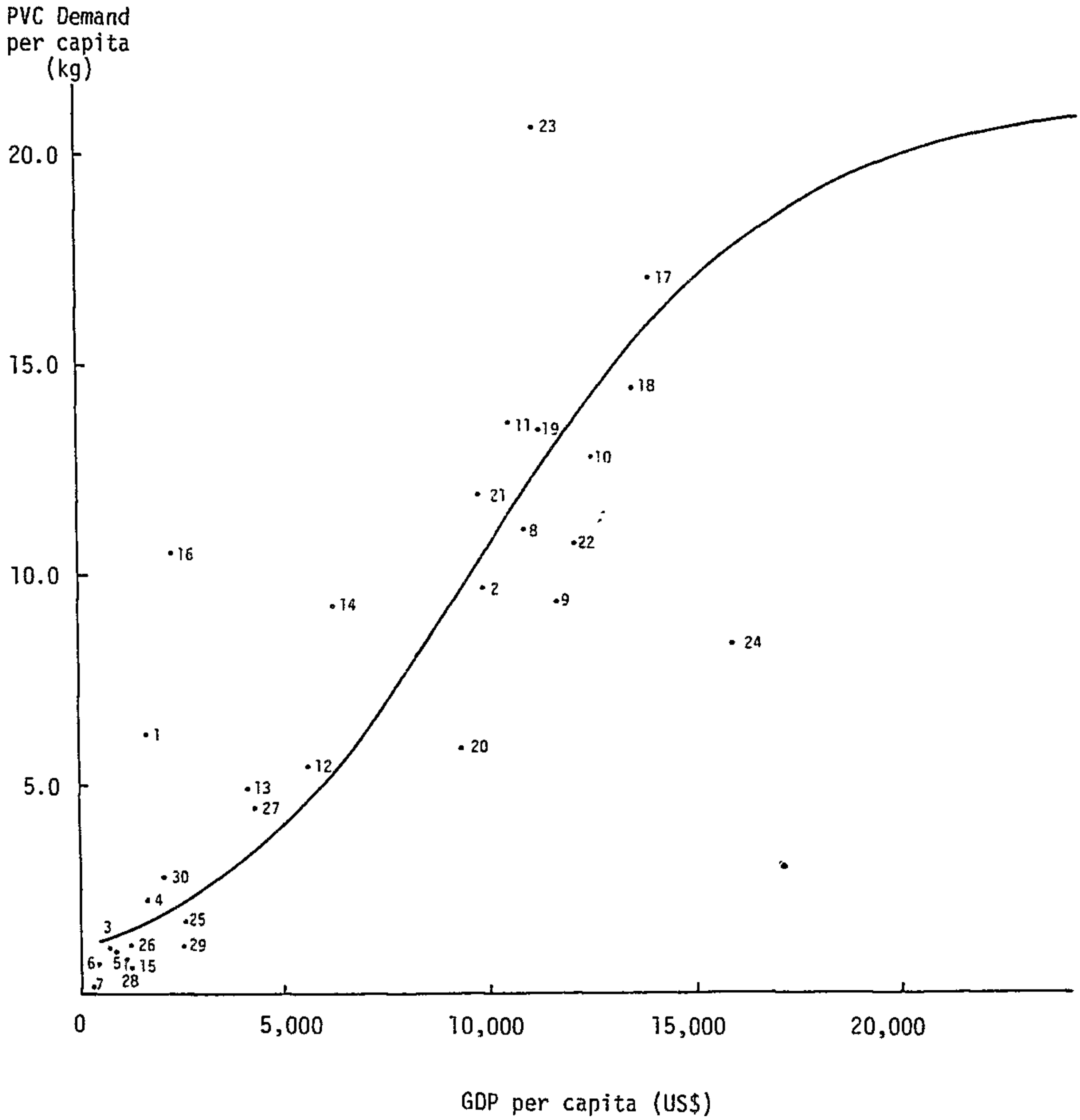


Figure 4-3 Original Plot and Logistic Curve for Correlation Analysis

Table 4-29 GDP Growth Rate vs. PVC Demand

GDP per capita Growth Rate (%)	1988 GDP per capita (US$)	PVC demand per capita (kg)	PVC demand in 1988 (t/y)
2	1,264	1.56	34,600
3	1,353	1.60	35,500
4	1,448	1.64	36,400
5	1,548	1.69	37,500
6	1,654	1.74	38,600

4.7 Possibility for Substitution for Other Plastics

As explained in Section 4.3 on imports, the demand for non-PVC plastics is largely for PE, PP, and PS, all of which are supplied by imports. In addition, there is also a small amount of PET (Polyethylene terephthalate) beginning to be used for soft-drink bottles.

A comparison of 1982 FOB average prices of the competing plastics is given in Table 4-30.

Table 4-30 Plastic Price Comparison

Product	Price (US$/t)
PVC resin	490
PVC compound	920
HDPE	810
LDPE	740
PP	830
PS	742

The cost advantage of PVC remains unchanged even with plasticizers, stabilizers, and other additives added.

Although PS competes with PVC in some hard products, it is not suited to flexible uses as film and sheeting, and PVC and PS are considered basically not mutually competitive.

Fabrication methods and uses of PP and PE products are generally very similar for a wide range of products like electric appliances, household furnishing, tableware, toys, cords and strings for packages, cases for beer bottles and other similar products. PE also finds wide application in piping, hosing, and electric insulation. In these fields, PE competes with PVC, and there is a possiblitliy that, depending upon pricing, PE could replace PVC in these areas. Other fields of possible substitution are shampoo and edible oil containers. HDPE is used for buckets and other uses requiring both heat-resistance and rigidity, and thus HDPE competes with PVC in these areas.

One area in which PVC could substitute for other plastics is packing film. Currently in Peru foodstuffs, medical supplies, clothing, and some other products are wrapped generally in paper, although PE is also used. PE film is considered very well suited to wrapping fresh food because it is virtually impermeable to moisture but is permeable to carbon dioxide and air. If PVC is to be used for wrapping foodstuffs and medical supplies, it is important that product specifications, particularly residual monomer contents, be improved.

There is possibility of PVC and other plastics, particularly, PE and PP, replacing each other. It is hard to draw any definitive conclusion as to which replacement is more likely. Therefore, this possibility for substitution is not counted in PVC demand forecast.

4.8 Exports to Other Andean Countries

(1) PVC Production and Demand in the Andean Countries

There are three Andean countries currently producting PVC. They are Columbia, Venezuela, and Peru. Supply capacities are shown in Table 4-31.

Table 4-31 PVC Production Capacities for Andean Countries

Country	Production Capacity (t/y)
Columbia	46,500
Venezuela	36,000
Peru	7,200
Total	89,700

The manufacturers in Colombia are Petroquimica Colombiana and Colcarburo, in Venezuela Petroplas and Tablazo, and in Peru SPL.

Given that total PVC demand for the Andean countries in 1981 was approximately 120,000 tons per year, the supply shortage of approximately 32,000 tons per year had to be met with imports.

Petroquimica Colombiana plans to expand the capacity from 42,000 to 72,000 tons per year. Colcaruburo of Colombia is also studying the feasibility of raising its carbide-method production capacity from 4,500 to 12,000 tons per year. If both plans are implemented, Colombian production capacity will increase to 84,000 tons per year with a significant surplus to be exported to other Andena countries.

Venezuela is currently suffering from shortages of PVC due to inadequate supplies of hydrogen chloride and there is no announced plan for plant expansion.

Table 4-32 below gives the PVC demand and capacity for the Andean countries projected by Dow Chemcials of the United States. According to these projections, the three Andean countries will have a supply shortage of bout 75,000 tons per year in 1985. As may also be seen, Dow Chemicals has done projections assuming a very rapid 13.56 percent per annum growth in PVC demand for 1980 to 1985.

Table 4-32 Projected PVC Supply and Demand in Andean Countries

(Unit: ton/year)

	1980	1981	1982	1983	1984	1985
Demand	106,942	119,857	136,493	155,485	177,165	201,927
Capacity	80,100	88,000	91,000	109,000	127,000	127,000
Shortage	26,842	31,857	45,493	46,485	50,165	74,927

(2) Possibility of Exporting PVC to the Other Anden Countries

Table 4-33 shows projected Andean PVC demands up to 1988, the year the proposed project is scheduled to start, on assumed growth rates of 10 and 5 percent per annum.

Table 4-33 Forecast PVC Demand in Andean Countries

(Unit: ton/year)

	1980	1981	1982	1983	1984	1985	1986	1987
10% growth	119.9	131.9	145.1	159.6	175.5	193.1	212.4	233.7
5% growth	119.9	125.9	132.2	138.8	145.7	153.0	160.7	168.7

Table 4-34 shows the balance of supply and demand derived from the foregoing discussions for Andean countries with the added supply by this project included. The supply shortage will be supplemented by imports from outside the region. This may be taken to indicate that there is possibility of this project exporting to other Andean countries if the domestic demand does not achieve the projected level of approximately 20,000 tons per year in 1988. This in turn further substantiates the conclusion that markets exist to sustain this proposed project.

Table 4-34 PVC Supply and Demand in 1988

(Unit: ton/year)

Country	1982	1983
Columbia	46,500	84,000
Venezuela	36,000	36,000
Peru	7,200	25,000
Total	89,700	145,000
Estimated Demand	131,900	233,700 (168,700)
Supply Shortage	42,200	88,700 (23,700)