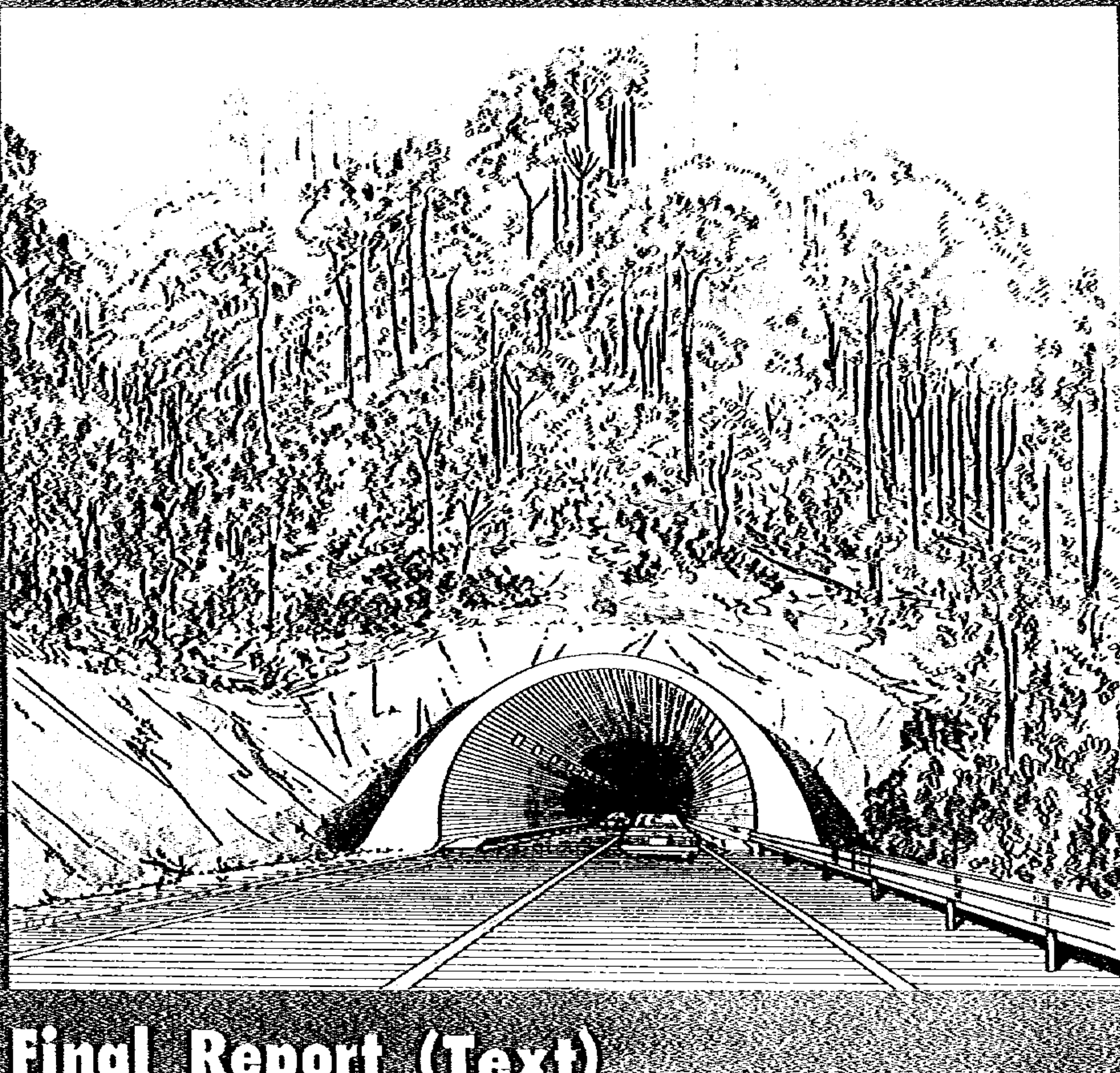
REPUBLIC OF THE PHILIPPINES

No. 7

THE FEASIBILITY STUDY ON DALTON PASS TUNNEL PROJECT



Final Report (Text)

March, 1982

Japan International Cooperation Agency

Republic of the Philippines

The Feasibility Study on Dalton Pass Tunnel Project

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PREFACE

In response to the request of the Government of the Republic of the Philippines, the Government of Japan decided to conduct a feasibility study of the Dalton Pass Tunnel Project and entrusted the study to the Japan International Cooperation Agency (JICA).

The JICA organized for the project a steering committee chaired by Mr. Ryuichi Okamoto, Geotechnical Counselor, Public Works Research Institute, Ministry of Construction, and sent to the Philippines in May 1981 a survey team headed by Mr. Jun Onishi, Katahira & Engineers, INC.

The team discussed the Project with officials concerned of the Government of the Philippines and conducted a field survey over a period of seven months. 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.

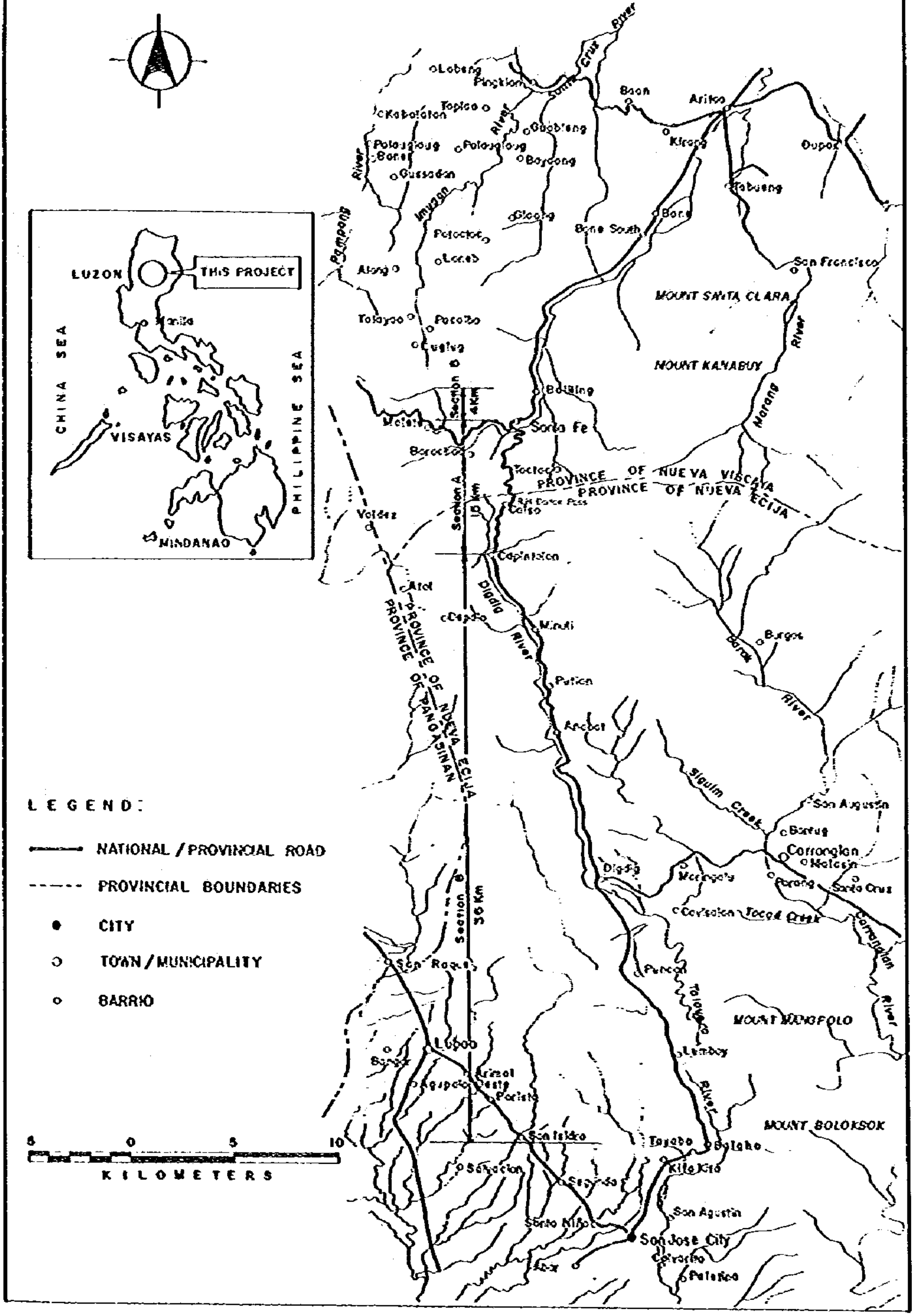
I wish to express my deep appreciation to the officials concerned of the Government of the Republic of the Philippines for their close cooperation extended to the team.

March, 1982

Keisuke Arita
President

Japan International Cooperation Agency

LOCATION MAP



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ABBREVIATIONS USED IN THE STUDY REPORT

A. <u>Authorities and Agencies</u>

GOP	Government of the Philippines
GOJ	Government of Japan
RP	Republic of the Philippines
JICA	Japan International Cooperation Agency
AASHTO	American Association of State Highway and Transportation Officials
ADB	Asian Development Bank
BCGS	Bureau of Coast and Geodetic Survey
BFAR	Bureau of Fisheries and Aquatic Resources
BFD	Bureau of Forest Development
CASUCO	Cagayan Sugar Corporation
IBRD	International Bank for Reconstruction and Development
MPWH	Ministry of Public Works and Highways
NCSO	National Census and Statistics Office
NEDA	National Economic and Development Authority
NTPP	National Transport Planning Project
PBM	Philippine Bureau of Mines
PPDO	Planning and Project Development Office

B. Other Abbreviations

ADT	Average Daily Traffic
AADT	Annual Average Daily Traffic
B/C	Benefit Cost Ratio
GNP	Gross National Product
GVA	Gross Value Added
IRR	Internal Rate of Return
LTPDP	Long Term Development Plan up to Year 2000
NPW	Net Present Worth
NPV	Net Present Value
OD	Origin Desitination
PW	Present Worth
NATM	New Austrian Tunneling Method
PCG	Pre-stressed Concrete Girder
PCSG	Pre-stressed Concrete Segmentary Girder
RCDG	Reinforced Concrete Deck Girder
RQD	Rock Quality Designation
ST	Steel Truss
m	meter
cm	centimeter
cu.m.	cubic meter (m^3)
lm	linear meter
km	kilometer
mm	milimeter
gt	gross ton
ha	hectare
kg	kilogram

STAFF ORGANIZATION

The complete staff who directly participated in the Study are the following:

A. Steering Committee Members of the Japanese Government

Ryuichi Okamoto (Chairman)	Ministry of Construction, GOJ
Masayoshi Matsunobu	Ministry of Construction, GOJ
Toshinori Mizutani	Ministry of Construction, GOJ
Etsuhiko Inami	Japan Highway Public Corporation
Keiichi Inoue	Ministry of Construction, GOJ

B. Steering Committee Members of the Philippine Government

Jose David (Chairman)	Ministry of Public Works & Highways
Prudencio Baranda	Ministry of Public Works & Highways
Jose Santos	Ministry of Public Works & Highways
Jose Salvador	Ministry of Public Works & Highways
Takeo Ashimi	JICA Consultant

C. JICA Study Team

Jun Onishi	Team Leader
Yasuhiro Kawabata	Highway Planner
Kunikazu Asami	Highway Engineer
Kakuro Shidara	Tunnel Planner
Kazumi Kakita	Tunnel Planner
Tomio Hirozumi	Sabo Engineer
Takeshi Kusano	Geologist
Eio Musashi	Structural Engineer
Yaichi Kobayashi	Transportation Economist
Natsuyoshi Tachioka	Survey Engineer
Masaki Uchimura	Survey Engineer

D. Counterpart Staff

Manuel Bonoan	Project Manager
Manuel Alconis	Highway Engineer
Avelino Samson	Highway Engineer
Geronimo Alonzo	Sabo Engineer
Romulo Lantin	Locating Engineer
Melanio Briosas	Locating Engineer
Jose Gloria	Transportation Economist
Antonio Alejo	Transportation Economist
Martina Montana	General Economist
Aniceta de la Cruz	General Economist
Graciano Yumul, Jr.	Geologist

SUMMARY AND RECOMMENDATIONS

SUMMARY AND RECOMMENDATIONS

1. The overall conduct of the feasibility study of the tunneling project involves two phases, both of which were carried out in accordance with Implementing Arrangements and Scope of Work as agreed between the Japan International Cooperation Agency and the Government of the Philippines.

   Phase I of the study was concerned with the conduct of general topographic and preliminary geological surveys by means of aerial photo mapping of the immediate influence area of the project.

   Phase II of the study involved the conduct of a detailed technical and economic feasibility of the tunneling project and for which this feasibility report is prepared.

2. The whole stretch for study was subdivided into two main sections called Section A and Section B, upon which the objectives of the study were correspondingly different for each section, as follows:

   (i) Section A -- mountainous section between Capintalan and Sta. Fe (about 15 km.). Studies on this section were treated to a full, and detailed technical and economic feasibility study level aiming for optimum solution for a tunneling project.

   (ii) Section B - this section is between Balaho-Capintalan and Sta. Fe-Baliling with an aggregate length of about 40 km. On these sections, the scope of the studies, was limited to assessment on the basis of field reconnaissance, concentrating on the "problem" sections. Recommendations on countermeasures and/or proposed improvement of these sections are supported with preliminary designs.

3. The project area is generally located at about 200 km. north of Manila along the Philippine-Japan Friendship Highway, in the Cagayan Valley Region. The topography of the project area is generally rugged and in difficult terrain as it lies directly on top of the Cordillera mountain ranges.

4. Cagayan Valley Region has a vast land area consisting of about 36.4 million hectares. The population of the region in the year of 1980 is 2.2 million with the lowest population density of only 61 persons per square kilometer.

5. Agriculture is the main industry of Cagayan Valley Region. Employment share of agriculture in 1975 is 75.89%. Rice is the staple crop and contributed 10.47% to the total production of the country with 785,600 metric tons in 1980. Corn is the second most important crop and contributed 10.23% to the total corn production of the whole country.

6. Total motor vehicles registered in Cagayan Valley in 1979 is 27,091 with the ratio of 20.46% of cars, 36.24% of trucks, 41.18% of motorcycles and motor-tricycles and 2.12% of trailers. Cars increased at an average annual rate of 7.24% (1970–1979 period), trucks at 9.85% and motorcycles and motor-tricycles at 22.53%.

7. In 1975, there were 92,496 km. of roads, while the figure grew to 149,863 km. in 1981, showing an annual growth rate of 8.37% per annum in the whole Philippines. Out of 149,503 km. of roads, national and provincial comprise 23,763 km. and 29,755 km. respectively, while city roads, municipal roads and barangay roads are 3,691 km., 11,445 km., and 81,209 km. respectively.

   At present, the existing road network consists of about 14% paved roads, 51% gravel and 35% earth roads. In 1975 Cagayan Valley had a total of 6,673 km. of roads. This rose to 11,740 km. in 1980 equivalent to an average increase of 11.96% per annum. Despite this rate of increase, the region's total road network was only equal to 7.85% of the country's overall total in 1980.

   Of its 11,740 km. of roads, 2,277 km. were categorized as national; 2,045 km. as provincial; 1,030 km. as municipal and 6,388 as barangay roads.

   At present, only 20% of the national roads in the region are concrete; 4% are asphalt; and the rest are either gravel or earth roads.

8. The results of the O-D survey undertaken in Sta. Fe indicated that commercial vehicle mixing rate was 68% which shows that Route 5 is a more important industrial highway than Route 3. The daily tonnage of grains of Cagayan Valley transported to Manila crossing Dalton Pass is 1,300 tons, say 500,000 tons per year. At present, when Dalton Pass section is closed, trucks patiently wait for the reopening of the section.

9. The daily traffic passing Dalton Pass section was counted as follows:

Vehicle Type	Traffic Volume (Vehicles per Day)
Cars	459
Big buses	204
Mini Buses	25
Big Trucks	811
Truck Trailers and semi-trailers	90
Others	39
Total	1,628

Since the seasonal variation was not observed from the available data, the traffic counted at Sta. Fe was assumed to be the Annual Average Daily Traffic for this study.

10. The forecast of future traffic was made in terms of future population and production in Cagayan Valley and then future vehicle registration in the same region. The future vehicle registration was estimated by Douglas Function.

The future induced traffic was estimated in terms of travel time and running cost between the two representative cities understudy.

The forecasted daily traffic in the year of 2015 (last year of project life) is 7,910 vehicles per day, which is still far less than the capacity which the tunnel section has.

11. The topography of the southern portal is mountainous consisting of steep slopes. The tectonic line including the fault, shearing zone and altered zone extends in the N-S direction. The topography of the northern portal predominantly consists of gentle slopes with flat ricefields, and is believed to be of landslide or debris-flow feature.

12. The geological distribution of the proposed tunnel formation consists mainly of andesite. However, near both portals of the proposed tunnel, tuff breccia and autoclastic andesite are intercalated with andesite.

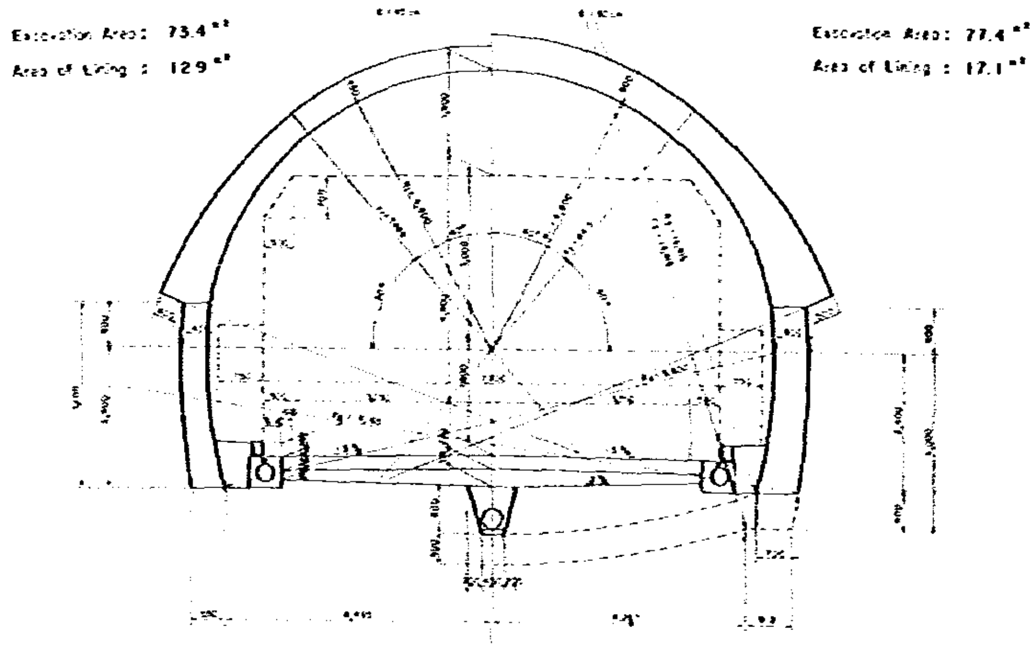
At Km.206+100, the tunnel alignment crosses the tectonic zone directly and abundant springwater is foreseen near the tectonic zone, thus making the geological condition poor.

Between Km. 207 + 300 and Km. 207 + 700, it is expected that geological condition will be very poor. This situation is further worsened by the presence of large amounts of springwater flowing out along tectonic lines. Moreover, the depth of the tunnel from the surface is less than 30 meters with topographic feature on the upper part of tunnel showing landslide topography and with the geology consisting of alternation of andesite, autoclastic andesite and tuff breccia. Facie change is remarkable.

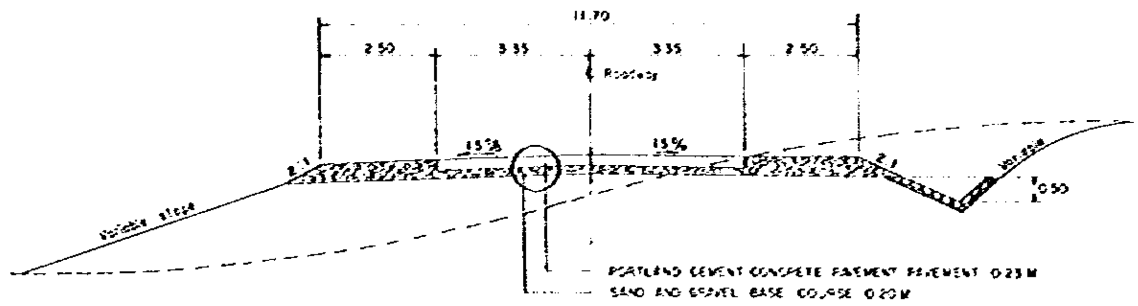
On the other sections, it is believed that good geological condition exists, since the base rock of the tunnel formation is fresh andesite and tectonic zones are not expected.

13. The preliminary design of the "Most Likely Route" was undertaken following miscellaneous works that were conducted on selection of alternative routes, preliminary engineering study of alternative routes and selection of the "Most Likely Route".

14. The design standard adopted for the PJHL-Phase II, Laoag-Allacapan Road Project was adopted for this study considering the resemblance of the features and characteristics of both projects. However, since the design standards for tunnel has not been prepared in the Philippines, the Japanese standards applicable for this project were adopted. The section under study was classified as Category 3 - Grade 3 by Japanese Road Standards. The typical cross sections for tunnel and roadway adopted are shown below.



Typical Cross Section of Tunnel 1/50



TYPICAL CROSS SECTION FOR FLAT AND ROLLING SECTION

SCALE 1 : 100

15. Preliminary engineering designs and quantity estimates were made on the basis of available data and topographic maps of 1:5000 scale. Detailed plans were prepared on the appropriate larger scale. The unit costs of all the items except tunneling work for construction cost estimates were based generally adopting the latest experiences of similar projects in Luzon as of December 1980. As unit costs for tunneling work, the unit cost for tunnel of the Japanese experience was adopted with slight adjustment considering freight expenses of importing construction equipment.

16. The total length of new line for preliminary design is 9.56 km. starting at Km. 202 + 000 of the existing Route 5. Out of the total stretch, the tunnel of which length is 1870 m. is included with the bridges of total linear meter of 938 m. Countermeasures for Digdig and Sta. Fe rivers were also considered from the point of sabo engineering.

17. Considering traffic volume forecasted, stage construction was considered for the tunnel ventilation facilities. At the first stage, a ventilation system of jet-fan type, in which the number of fans can be increased depending on the increase of traffic volume was planned. When the traffic volume would have reached the capacity which jet-fan can no longer cope up with, the system shall be changed to the shaft type ventilation system.

The power supply for tunnel facilities shall be secured by constructing overhead distribution line with 3 phase-60 hertz-13,200 volts connecting with Gabut Substation to be constructed in 1982 and with capacity of 5000 KVA. The total length of the transmission lines will be approximately 35 km. All other facilities required in a tunnel was planned on the basis of Japanese standards.

18. The total construction cost on financial cost base including engineering services for detailed engineering is Five Hundred Twenty One Million Seven Hundred Fifty One Thousand Pesos (P521,751,000).

The percentage of foreign currency components is approximately 75% which is fairly high compared to other previous civil works undertaken in the Philippines.

The main reason for this high percentage of foreign currency is because the construction of tunnel is mainly undertaken by machines and equipment and also the facilities are presumed to be imported. The construction costs of tunnel use up almost 60% of the total construction costs with 80% foreign currency components.

19. The maintenance cost of the existing road sections quoted at the moment which is approximately P36,000 per kilometer per year will be deleted upon the completion of new road. The total amount for the section from Km. 207 to Km. 217 with a total length of 15 km. is estimated at P540,000 per year.

Maintenance cost for tunnel section was estimated considering the nature and the facilities related to the tunnel based on the experience in Japan.

20. The number of unskilled labors required for the construction during the period of five years was estimated assuming the output of major works as follows:

Concrete	3.14 men/m^3 (Tunnel - 2.6 men/m^3)
Reinforcing Steel Bar	0.64 men/100 kg.
Excavation	1.17 men/m^3 (Tunnel - 0.77 men/m^3)
Channel work	3.16 men/m^2

The total number of unskilled labors required for this construction project was estimated at 840 persons a day.

21. As an excavation method for this tunnel, the upper-half heading method is adopted for the main work and side drifts method is partially adopted.

Preliminary design of tunnel was planned presuming that the prevailing construction method in Japan will be adopted. However, the New Austrian Tunneling Method (NATM) should also be studied as an alternative method when more detailed geo-technical information is gathered during the detailed engineering phase.

22. Since the construction period of tunnel is considered critical, the construction schedule of the same was at first programmed based on the construction quantities and assuming the progress or accomplishment per month for each construction item and classification. This requires five years.

The period for other activities before construction were determined based on the previous experience. The comprehensive implementation schedule is shown below:

IMPLEMENTATION SCHEDULE

DESCRIPTION	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
REVIEW OF FEASIBILITY STUDY AND DETAILED ENGINEERING			———	———						
LAND ACQUISITION AND COMPENSATION				———	———					
BIDDING PROCESS					······					
CONSTRUCTION AND SUPERVISION										
EARTHWORKS						———	———	———		
BRIDGES & STRUCTURES						———	———	———	——	
PAVEMENT									———	
TUNNEL						———	———	———	———	———
SABO AND CHANNEL WORK						———	———			
OTHERS							······	······	······	······
SUPERVISION						———	———	———	———	———

NOTE: Installation of additional facilities for tunnel incurred later on is not included in the construction period.

23. Since the project is located in the isolated mountainous region of Cagayan Valley, the impacts on the health of human beings is presumed to be very minimal except water and air pollution.

Control measures against pollution of surface water (rivers) were considered in the planning and designing phase. However, more careful and greater attention must be given to this problem during the execution of construction work.

The impacts of exhaust gas from the tunnel were also assessed. The amount of exhaust gas from these vehicles is not very appreciable and the impact on the surrounding trees and natural vegetation is presumed to be very minimal.

The impact on the beauty or aesthetics of the natural environment is just as critical. Special attention was given to maintain the natural beauty of the project area or even enhance the attractiveness of the landscape. Where applicable, the slope design incorporates countour tree planting as erosion control measure.

The architectural design of the tunnel portals has likewise been given careful attention and it was decided that the bell-mouth type will be adopted. This blends beautifully with the surrounding natural environment and will preserve the aesthetic elements in the area.

Impacts on other environmental elements are presumed to be very minor. The negative effect of drying up of ground water resources is one of the most serious impacts. Efforts were exerted to altogether avoid or even just minimize this impact of the project. Therefore, more detailed analysis and study of this impact shall be further undertaken.

24. The quantified benefit derived for this study are as follows:

i) Saving in vehicle running cost (Normal and Induced traffic)
ii) Time cost savings (Normal and Induced traffic)
iii) Detour traffic benefit
iv) Maintenance cost saving of existing road
v) Net increase in local labor's income
vi) Residual value of the final year

Detour traffic is defined herein as the prospective traffic originating in Cagayan Valley that is compelled to give up the trip to Manila due to cut-off at Dalton Pass section for 14 days a year and will reappear on Dalton Pass section after opening of the proposed tunnel.

The net increase in local labor's income is considered as opportunity cost for the unskilled local labor which may be composed of totally or semi-unemployed labor and will be employed through the construction of the proposed tunnel.

25. Sensitivity analyses are carried out for the four cases as follows:

Case 1 : Best estimates (actual costs and benefits figures)
Case 2 : Plus 10% on construction cost
Case 3 : Plus 20% on Traffic Growth Factor, minus 20% on construction cost
Case 4 : Minus 20% on Traffic Growth Factor, plus 20% on construction cost

The main criterion used as indicator of economic feasibility of the proposed investments in the tunnel project is the Internal Rate of Return (IRR). However, additional indicators are also calculated such as the project's Net Present Value and Benefit/Cost (B/C) ratios, presented at four different discount rates. The results of the sensitivity analyses are summarized below:

Case	IRR (%)	B/C Ratio				NPV (₱100,000)			
		12%	14%	16%	18%	12%	14%	16%	18%
1	17.8	1.67	1.38	1.16	0.98	2350	1278	509	– 52
2	16.6	1.53	1.26	1.05	0.90	2011	950	191	–361
3	22.5								
4	14.0								

The results shown above indicate that the investments, given the cut-off rate of economic return for marginal profits as 15%, is economically feasible and may be given due consideration by the government. It must be remembered that these indicators include only the benefits quantified in the analyses and thus may further appreciate if all the benefits are quantified.

26. As the project is technically sound, economically viable and socially desirable, it is worthy to take necessary moves towards its early implementation. It is recommended that arrangements be made promptly with the agencies concerned for financing the project implementation and commencing the detailed engineering.

27. Referring to the Scope of Work for Section B, the studies were limited to assessment on the basis of field reconnaissance, concentrating on the "problem" sections. Recommendations on countermeasures and/or proposed improvement of these sections were prepared with preliminary designs.

The main work items of countermeasures considered on preliminary design are as follows:

Slope Failure	:	Slope protection by vegetation or structure, recutting
Landslide	:	Cutting, drainage, counterweight embankment, piling
Debris Flow	:	Sabo dam, ground sill, etc.
Erosion by river	:	Revetment, spurdike, etc.

28. The estimated total construction cost of countermeasure works for Section B is Fifty Five Million Four Hundred Eighty Four Thousand Pesos (₱55,484,000) with the following breakdown:

Major Works	₱53,301,000
Reconstruction of bridges	1,030,000
Culverts and retaining walls	1,153,000
Total	₱55,484,000

Likewise, for Section A the cost is Nineteen Million Nine Hundred Thirty Two Thousand Pesos (₱19,932,000) broken down as follows:

Major Works	₱19,459,000
Culverts and retaining walls	473,000
Total	₱19,932,000

29. The number of sites to be improved or rehabilitated is as follows:

Section(Sites) \ Category	A	B	C	Total
A	3	1	4	8
B	4	4	10	18

Note:

Category A : Very serious and needs urgent improvement or rehabilitation

Category B : Serious and early improvement required

Category C : Sections where improvement or rehabilitation is recommended.

Chapter 1.

INTRODUCTION

CHAPTER 1
INTRODUCTION

The Government of the Philippines (GOP) has contemplated on the construction of a tunnel in the Dalton Pass area, along the Philippine-Japan Friendship Highway, aimed to solve the perennial problem of having the section frequently impassable as a consequence of disasters brought about by landslides, road cuts and erosion, especially during the rainy seasons.

For the last few years, the problem has become increasingly serious, that the upkeep of the section now requires beyond ordinary maintenance and technical considerations. Consequently, the uncertainty of travelling conditions, and more importantly, the interruption of traffic, has exerted serious setbacks upon the socio-eocnomic activities between the Cagayan Valley Region and the rest of the country.

Cognizant of the seriousness of the problem and the would be disastrous effects should the situation continue to remain unresolved, the GOP has placed priority and emphasis to the earliest possible realization of the project.

The feasibility study of the tunneling project was prepared by the Japan International Cooperation Agency (JICA) upon request for technical assistance by the GOP. The overall conduct of the study has been divided into two phases, both of which were carried out in accordance with Implementing Arrangements and Scope of Work, as agreed between the JICA/GOJ and the GOP.

Phase I of the study was concerned with the conduct of general topographic and preliminary geological surveys, by means of aerial photo mapping of the immediate influence area of the project. The output of the Phase I activities include, among other things, a detailed topographic mapping, field reconnaissance, aerial photographic interpretation on geology and geological mapping. All in all, the output of Phase I has provided valuable basic data and information upon which Phase II was pursued.

Phase II of the study involved the conduct of a detailed technical and economic feasibility of the tunneling project and for which this feasibility report is prepared. The feasibility study of Phase II was carried out mainly by a Study Team composed of eleven Japanese experts in various disciplines, with the assistance of a group of counterparts coming from relevant government agencies, particularly with the Ministry of Public Works and Highways, as the lead agency, and the Bureau of Mines and Geo-Sciences.

Organization of the Report

The feasibility report consists of three physical volumes as follows:

(i) Text Volume contains 9 chapters which generally presents the methodologies and procedures adopted in pursing the technical and economic studies for the project. It also contains brief descriptions of the various activities, investigations, and analysis carried out upon which a comprehensive presentation of the results are included.

(ii) Drawing Volume contains a set of detailed technical drawings of all structures and facilities relevant to the project.

(iii) Appendix Volume contains all other data, documents and analysis procedures, supportive to the discussion in the Text Volume.

1-1 Background of the Project

The proposed tunneling project is located in the Dalton Pass section of the Philippine-Japan Friendship Highway, otherwise called the Cagayan Valley Road (Route 5), which is within the province of Nueva Vizcaya, about 200 km. north of Manila in the Philippines.

The Cagayan Valley Road or Route No. 5 (hereinafter referred to as Route 5) of the Philippine National Road system is part of the Philippine-Japan Friendship Highway, which traverses the whole length of the archipelago starting from Aparri, Cagayan in the northernmost part of Luzon down to Davao City in Mindanao. The highway has now assumed the role as the primary trunkline in the country's road system. Thus, Route 5, being part of this primary trunkline, assumes a vital role as the main access of the Cagayan Valley Region, to the rest of the country. The Cagayan Valley Region, generally located in the northeastern part of Luzon is composed of six provinces, namely: Nueva Vizcaya, Ifugao, Isabela, Quirino, Kalinga-Apayao and Cagayan.

However, for the last decade or so, the Dalton Pass section of Route 5 has become an increasingly problem area. Almost certainly every year, during the rainy season, landslides and/or road cuts occur, mainly due to the poor geological conditions and the steep topographical features. In 1980, the section was hit by Typhoon Aring, one of the worst disasters, which rendered the section impassable for quite sometime, due to landslides, roadcuts, collapsed bridges, etc. During that period, and in similar situations, access to the Cagayan Valley Region via Route 5 was completely cut off, leaving the commuters no choice but to take the only logical alternative route around the island through the Manila North Road via Ilocos Norte, which is a rather circuitous and very much longer route.

Despite efforts to restore and maintain the section throughout the years, the condition has been persistently becoming worse, that it now requires beyond ordinary maintenance and technical attention. This situation has prompted the Philippine government to initiate a more tangible countermeasure by way of proposed tunneling project.

Aware however, of the magnitude of the technical and financial requirements of the project, which would be difficult to implement within the limited local resources, the GOP has likewise sought assistance from the GOJ, for the early realization of the tunneling project in the Dalton Pass.

1-2 Objective of the Study

The purpose of this study is to examine the techncial and economic feasibility of a tunneling project based on the Implementing Arrangements between GOJ and GOP. The objectives are twofold:

i) First, the feasibility study for the construction of a tunnel in the Dalton Pass area along the section between Capintalan and Sta. Fe, a stretch of about 15 km.

ii) Second, recommendation for the improvement of the remaining existing road sections, including slope and embankment protection and geometric realignment, if necessary, between Balaho and Capintalan, and Sta. Fe and Baliling, with a length of about 40 km.

1-3 Scope of the Study

In accordance with the agreed Implementing Agreement, the scope of the project area was identified within the limits of about 55 km. strech along the Dalton Pass section of Route 5, starting from Balaho (Nueva Ecija), Km. 166 to Baliling (Nueva Vizcaya), Km. 221. However, the whole stretch was subdivided into two main sections called Section A and Section B, upon which the treatment of the study was correspondingly different for each section as follows:

(i) Section A - mountainous section between Capintalan and Sta. Fe (about 15 km.) Studies on this section were treated to a full and detailed technical and economic feasibility study level, aiming for optimum solution for a tunneling project.

(ii) Section B - this section is between Balaho-Capintalan and Sta. Fe-Baliling with an aggregate length of about 40 km. On these sections, the scope of the study was limited to assessment of the basis of field reconnaissance, concentrating on the "problem" sections. Recommendations on countermeasures and/or proposed improvement of these sections are supported with preliminary designs.

The feasibility study for Section A was undertaken, assuming that all the necessary proposed improvements in Section B will be implemented before the completion of the tunnel.

1-4 Aspect of Operations

1-4-1 General Activity of the Project

The Plan of Operation to carry out the feasibility study was divided mainly into three parts aimed to systematically accomplish the necessary and vital phases of works to be undertaken within the study period of May 1981 to March 1982, as follows:

Part I - Pre-Study in Japan
Part II - Field Work (all related activities in the Philippines and the project area)
Part III - Preparation of Final Report

General Work Flow Diagram showing the inter-relationships of the activities involved in each part is shown in Fig. 1-4.1

1-4-2 Pre-Studies in Japan (Part I)

Preliminary studies were carried out in Japan for orientation purposes and in order to obtain a conceptualized idea of the nature and scope of the project in preparation for the initial plan of operation and the Draft Inception Report which is required in the project's Scope of Work.

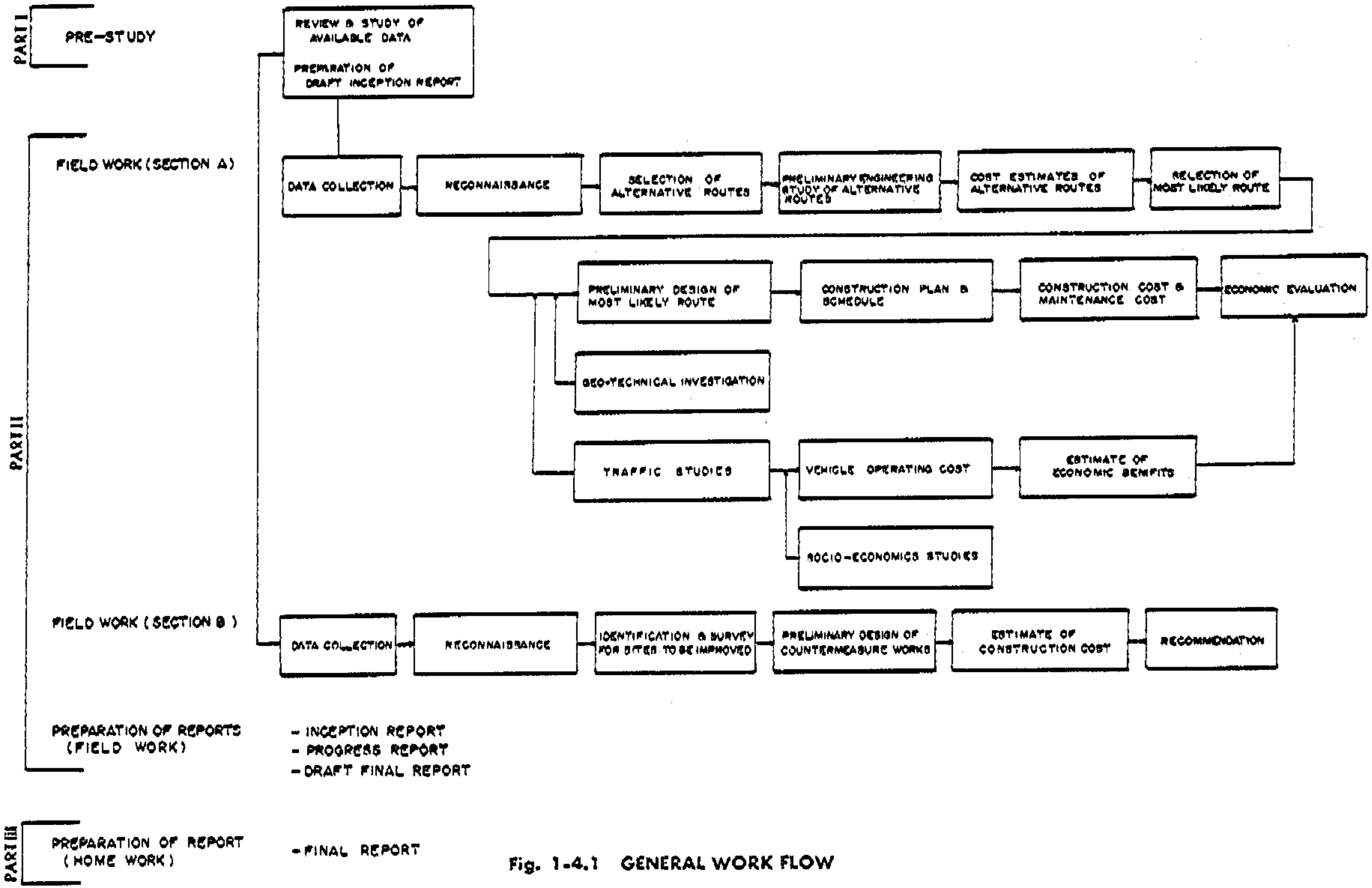


Fig. 1-4.1 GENERAL WORK FLOW

Available data and information were gathered from various sources and agencies in Japan, including the report of JICA (GOJ) missions on the particular project and other related reports pertaining to similar projects elsewhere. All these data and information gathered were reviewed and analyzed in Japan and used as the main basis in the preparation of the preliminary Plan of Operation and Inception Report. The Inception Report was submitted and consequently deliberated by the GOJ and GOP in May 1981.

1-4-3 Field Work (Part II)

Part II of the Plan of Operation was the "Field Work" which entailed all the necessary activities undertaken in the Philippines, in general, and the project area in particular. These activities involved among other things, gathering of additional socio-economic activities undertaken in the Philippines, in general, and the project area in particular. for the study.

As mentioned earlier, the study for the identified Sections A and B were treated independently from each other. Likewise, "field work" for each section was undertaken separately.

Field Work - Section A
Based on inital information and data available on this section, the following activities were undertaken for Section A:

- Data Collection
- Reconnaissance
- Selection of Alternative Routes
- Preliminary Engineering Studies of Alternative Routes
- Cost Estimates of Alternative Routes
- Selection of "Most Likely Route"
- Geo-Technical Investigations
- Traffic Studies
- Socio-Economic Studies
- Preliminary Design of "Most Likely Route"
- Construction Plan and Schedule
- Construction and Maintenance Costs
- Vehicle Operating Cost (VOC)
- Estimate of Economic Benefits
- Economic Evaluation

Field Work — Section B

Field Work and other related activities suitable to the Scope of Work for Section B were undertaken, which includes the following:

- Data Collection
- Reconnaissance
- Identification and Survey for Sites to be Improved
- Preliminary Design of Countermeasures Works
- Estimate of Construction Cost
- Recommendation

1-4-4 Preparation of Final Report (Part III)

The final report, organized from the Draft Final Report was prepared in Japan, after receipt of the comments from the GOP, incorporating all revisions deemed appropriate by the Study Team.

Chapter 2.

OUTLINE OF THE PROJECT AREA

CHAPTER 2
OUTLINE OF THE PROJECT AREA

2-1 General Location and Influence Area

The project area is generally located at about 200 km. north of Manila along the Philippine-Japan Friendship Highway in the Island of Luzon in the Philippines. The specific project site lies between Km. 166 in Balaho and Km. 221 in Baliling, approximately 55 km. stretch within the provinces of Nueva Ecija and Nueva Vizcaya. These two provinces would thus comprise the immediate project influence area. However, since the section is part of the main trunkline system to the other provinces north of Nueva Vizcaya in the Cagayan Valley Region, the whole region is considered also as a direct influence area of the project.

The Cagayan Valley Region in the Philippines, occupies the northeastern part of Luzon. It is made up of six provinces, namely: Cagayan, Isabela, Kalinga-Apayao, Ifugao, Quirino and Nueva Vizcaya. With the inclusion of the province of Batanes, an island province north of Luzon, the Cagayan Valley Region is Region II of the twelve administrative regions in the Philippines.

For general location, see the Location Map.

The Dalton Pass Section where the proposed tunneling project is located, is largely within Nueva Vizcaya.

2-2 Geography

The Philippine archipelago is composed of 7000 islands of which only about 35 major islands are inhabited. The archipelago is divided generally into three main groups of islands, namely, Luzon, Visayas and Mindanao. Luzon, which is the largest island in the country, lies in the northern part, the Visayan group occupies the center and Mindanao, the second biggest island, comprises the southern part of the country.

The Cagayan Valley Region lies generally at the northeastern coastal section of Luzon, with the provinces of Cagayan and Isabela located on the eastern coastal side facing the Philippine Sea. The other four provinces are inland and generally located at the middle of the island. The Region is bounded in the north by the Babuyan Channel, in the west by the Ilocos Region and in the south by Region II, called Central Luzon.

Cagayan Valley, as it is called, is in between two mountain ranges, the Sierra Madre and Cordillera mountains. The Valley extends about 190 km. along the Cagayan River basin starting in Aparri in the northern coast of Cagayan down to the province of Isabela, with an average width of 65 km. The Cagayan River and its tributaries that drain the basin runs approximately 26,000 km. The Sierra Madre mountain range, which remains largely unexplored rises steeply on the eastern part and near the ocean side, while the Cordillera mountain range, extending in a north-south direction, lies west of the Valley.

The project area lies southwest of the Cagayan Valley and in the southern part of the Cordillera mountains at about 900 meters above sea level.

2-3 Topography

The Philippines has a wide variety of topograhical features, from low marshes to high mountain masses. Typically, the islands are characterized by mountainous terrain and intermittent valleys. The mountains form part of a great chain of volcanoes that ring the Pacific. Rivers and lakes abound in the valleys, between the mountain ranges.

Among these mountain ranges are many fertile valleys and coastal plains, however these areas suffer from erosion brought about by heavy rains and improper use by man.

In the project area, the topography is generally rugged and in difficult terrain, as it lies directly on top of the Cordillera mountain ranges. Both sides of the existing highway are steep mountainous slopes, characterized by erosions and landslides. Most of these slides are distributed at the western side of the highway and are generally found along the tectonic line of north-south direction. These lineaments however, consist mainly of faults, sheared zones and hydrothermally altered zone.

In the Dalton Pass area are several rivers and streams running in several directions. Two of the major rivers are the Sta. Fe River and Digdig River, with catchment area of approximately 25 and 140 square kilometers, respectively. The Sta. Fe River runs along the north side of the highway and drains in north-northwest direction. On the other hand, Digdig River is located on the south side of the highway and drains in a northeast direction. Serious damages on some sections of the roadway and nearby slopes, caused by scouring are often inflicted by these two rivers especialy during typhoons and heavy rains

2-4 Climate

The Philippines has basically four types of climates that are generally categorized on the basis of dry and wet seasons, induced by minimum or maximum rain periods, instead of temperature differences as follows:

<u>First Type:</u> This is characterized by long dry and wet seasons. Dry seasons usually last about 5 months, starting from November to April. The rest of the year is generally wet, with rains induced by the southwest monsoon and cyclonic storms.

<u>Second Type:</u> This type is characterized by the absence of a dry season but of pronounced maximum rain period from November to January in regions along or very near the eastern coast, and not sheltered from the northern tradewinds or cyclonic storms.

<u>Third Type:</u> With seasons relatively dry from November to April and wet during the rest of the year. The maximum rain periods are not very pronounced but with a short, dry season lasting from one to three months.

Regions with this type of climate are partly sheltered from the northern and tradewinds but open to the southwest monsoon and frequented by cyclonic storms.

<u>Fourth Type:</u> This type of climate is characterized with rainfall more or less evenly distributed throughout the year.

Mountain climates may reasonably form another type which, however, may be reduced to any one of the above types with regards to certain climatological elements. This is with the exception of temperature which decreases with a gain of altitude, and rainfall which generally increases with elevation.

The climate in the project area (Cagayan Valley Region) generally belongs to the third type, which means that the area has a relatively long wet season and a short dry season. During the wet season, Cagayan Valley, including the project site is neither spared from the monsoon rains and cyclonic storms which frequent this part of the country. There are at least 7 typhoons a year passing through the area, some of which are destructive and causing extensive damages to the region. This represents about 31% to 40% of the average number of typhoons affecting the country per year. The last destructive typhoon recorded was Typhoon Aring which passed the project area in November 1980 and rendered the Dalton Pass section closed for several days due to landslide and road cuts.

From the rainfall statistics gathered from the two nearest guaging stations from the project site, (San Jose City and Sta. Fe), the wettest period is from May to September with an average rainfall of 2,508 mm. per year. The records also show that in the last decade the project site was visited by three major typhoons, occuring in a 4-year interval as follows: Yoling-November 1972, Didang-May 1976 and Aring-November 1980.

The rainfall statistics gathered from the two stations are shown in Tables 2-4.1 and 2-4.2 while the typhoon data observed is shown in Table 2-4.3.

Fig. 2-4.1 shows in detail the four types of climate distributed over the Philippine archipelago. The project area is indicated herein.

TABLE 2-4.1 MAXIMUM MONTHLY RAINFALL AT STA. FE.

Month / Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1976	95.3	9.0	43.2	82.5	1,117.9	584.5	241.7	297.1	347.5	210.9	47.0	17.8
1977	7.6	7.6	49.6	1.3	185.4	162.4	321.1	257.5	381.2	46.9	277.9	2.5
1978	1.3	2.6	27.9	35.6	112.0	156.8	243.4	653.2	462.9	561.4	133.9	103.2
1979	3.8	0	45.5	84.5	140.8	359.4	239.3	220.6	271.5	27.5	56.3	36.3
1980	22.5	15.2	30.4	90.4	203.4	152.2	773.8	159.3	527.5	138.7	1,037.7	54.8
Total	130.5	34.4	196.6	294.3	1,715.3	1,819.3	1,819.3	1,587.7	1,990.6	1,245.4	1,552.8	214.6
Mean	26.1	6.9	39.3	58.9	351.9	343.1	363.9	317.5	398.1	249.1	310.6	42.9

TABLE 2-4.2 MAXIMUM MONTHLY RAINFALL AT SAN JOSE

Month / Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1976	0	0	52.1	54.9	1,363.9	616.1	269.0	374.8	377.5	16.9	44.7	17.8
1977	10.2	0.8	0	0	97.9	49.6	469.2	507.5	414.1	18.0	127.1	0
1978	0	14.5	7.6	12.1	171.0	319.4	297.7	723.8	377.8	451.8	16.5	3.8
1979	11.9	4.8	0	9.1	318.4	220.1	436.4	394.1	153.2	198.2	47.3	28.2
1980	9.9	0	15.2	0	296.4	33.7	481.0	228.3	284.3	127.0	451.1	3.0
Total	32.0	20.1	74.9	76.1	2,247.6	1,238.9	1,953.3	2,228.5	1,606.9	811.9	686.7	52.8
Mean	6.4	4.0	15.0	15.2	449.5	247.8	390.1	445.7	321.4	162.4	137.3	10.6

TABLE 2-4.3 AMOUNT OF RAINFALL AND WIND VELOCITY DURING REMARKABLE TYPHOONS

Typhoon	Date	Amount of Rainfall, mm. San Jose City N.E.	Sta. FE N.V.	Maximum Center Wind Velocity, KPH
Didang	May 20, 1976	4.8	21.6	130
	May 21, 1976	158.0	116.3	
	May 22, 1976	424.9	193.0	
	May 23, 1976	255.6	127.0	
	May 24, 1976	238.3	401.8	
	May 25, 1976	182.1	326.4	
	May 26, 1976	27.5	49.5	
Aring	Nov. 1, 1980	5.1	9.1	260
	Nov. 2, 1980	1.3	4.1	
	Nov. 3, 1980	0	T	
	Nov. 4, 1980	133.7	197.6	
	Nov. 5, 1980	280.2	732.0	
	Nov. 6, 1980	4.6	39.6	

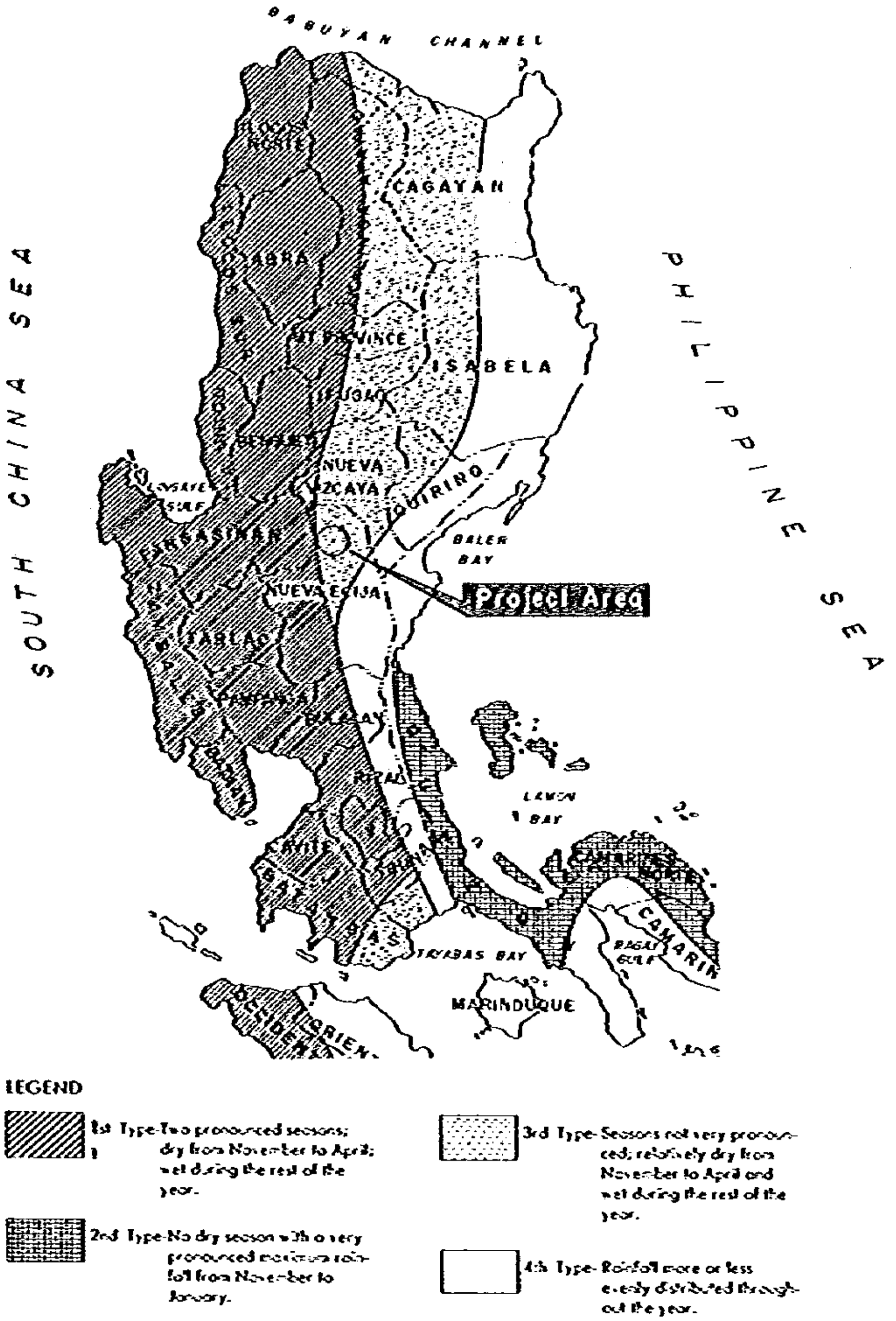


Fig. 2-4.1 CLIMATE

2-5 Geology

In general, the geological formation of the Philippines is of volcanic origin. Almost all principal types of rocks are found. On a basement complex of igneous rocks there are many thousand meters of sediment, mainly Tertiary stage with some outcrops of misozoic rocks, and these in turn are succeeded by lava of andesitic type, with great accumulation of more recent tuffs, and considerable areas of coral limestone.

From recent studies[1] conducted in the northern part of Luzon, including the project area, it has been deduced that the area is divided into four tectonic provinces, namely: Sierra Madre Area, Cagayan Valley Basin, Cordillera Central Region and the Coastal Folded Belt. It was also discerned that the area which started as a marginal sea basin attained its present topographic features due to the presence of two subduction zones, one on each side of the Luzon Island Arc. K-Ar dating shows that tectonic activities of the eastern subduction zones, better known as the Philippine Trench, started earlier than that of the Manila Trench, the western subduction zone. Tectonic activities on the Philippine Trench led to the intrusion of several batholitic masses which are believed to have originated from the same plutonism and magma chamber.

The Coastal Batholith was believed to have been intruded during the Upper Eocene-Oligocene with the Dupax Batholith following suit. (RP-Japan Project-NE Luzon). The activities were termed by Gervasio (1966) as the Sierra Madre Orogenesis. These geological formations are believed to have direct influence in the structural setting of the project area because of their proximity to the site.

After the emplacement of the batholitic masses, the Philippine Fault which is left lateral fault became active. The Philippine Fault located on the southern part of the project site is the most influential factor in the structural setting of the area, since most of the lineaments in the study area can be recognized as sympathetic to this major fault.

The pattern of direction of Tectonic line in Northern Luzon are as follows:

NE—SW, NNW—SSE, N—S, E—W, and NW—SE

Among them, tectonic line consisting of NW—SE direction indicated the same direction along with the Philippine Fault occuring in the southern part of the project area. (It was believed that this fault occured in the later stage.)

The Philippine fault is considered as a big horizontal fault shifting to the left side.

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[1]Technical Assistance provided by JICA and under the auspices of the Philippine Bureau of Mines.

2-6 Resource Profile

Cagayan Valley has a vast land area consisting of about 36.4 million hectares, second to the largest region in the country, the largest being the Southern Tagalog Region with 47 million hectares. Cagayan Valley has also a total of about 413,000 hectares of potential cropland which may be cultivated for temporary and permanent crops.

Cagayan River Basin, considered the biggest of the six major river basins in the country, has a drainage area of 2,811,000 hectares and an area of major ground water resource of about 1,020,000 hectares. Its public forest land of about 2,625,000 hectares constitute 72% of its total land area and equal to about 15% of Philippine public forests.

Due to its landlocked position except on the northern and eastern sides, the region is not considered a rich fishery resource. However, if its fishery resource areas are fully developed, it would be substantial enough to meet domestic requirements. the Luzon Strait in the north and the Pacific coastal area in the east are rich areas with untapped potentials. Substantial lake and swamp areas consistute about 16,185 hectares. This inland fishery potential consists of mangrove swamps, freshwater swamps and minimal area of lakes.

It may not be among the mineral-rich regions but its rivers, when fully tapped, will supply power to the Luzon Power Grid and consequently bolster the electrification and industrial projects in the immediate surroundings. Table 2-6.1 illustrates the untapped power resources.

TABLE 2-6.1 WATER POWER SOURCE

Source	Underdeveloped Power Capability (1000 kw)	Installed Generating Capacity (1000 kw)
Abulug River	126	212
Chico River	1,275	(1)
Magat River	90	(2)
Littu River	10	—

Note: 1) A series of four power projects with 1,010 Mw. total installed capacity is in the pipeline.

2) The on-going Magat River Project includes a hydroelectric plant of 300 Mw installed capacity, operational by 1986.

Source: National Irrigation Administration
Magat Project Feasibility Study

2-7 Land Use

Land use pattern in the region in 1975 is presented in Table 2-7.1. It shows that out of the total land area of 36.4 million hectares, 57.55 was forest land, about 23.4% was open land, 17.7% was farm land and barely 1.4% was utilized for housing, commercial and industrial purposes.

Considering the development strategies and programmes for the Region, changes in land use is anticipated to occur within the next few years, as presented in Table 2-7.1. The share of total farmland area will increase from 17.3% in 1975 to 22.5% in 1982 and then to 29% in 1987. The area of open lands, lakes and swamps will decrease slightly within the ten-year planning period since parts of these areas will be converted into farmlands, forests and urban areas.

TABLE 2-7.1 LAND USE PATTERN IN CAGAYAN VALLEY
1975, 1982 and 1987

	1975		1982		1987	
	1000 ha	%	1000 ha.	%	1000 ha.	%
Total	3,640	100.0	3,640	100.0	3,640	100.0
Farmland	631	17.3	820	22.5	1,054	29.0
a. Cropland	504	13.8	552	15.2	769	21.1
1. Permanent Crops	21	0.6	27	0.7	32	0.9
2. Temporary Crops	483	13.3	525	14.4	737	20.2
b. Pasture	103	2.8	254	7.0	276	7.6
c. Fishpond	1	0.0	2	0.1	3	0.1
d. Idle	23	0.6	12	0.3	6	0.2
Forest	2,093	57.5	2,122	58.3	2,148	59.0
Openland	850	23.4	623	17.1	363	10.0
Urban	51	1.4	54	1.5	55	1.5
Lakes/Swamps	15	0.4	21	0.6	20	0.6

Source: Cagayan Valley Five-Year Development Plan, Table 2.8.

2-8 Socio-Economics

2-8-1 Population

(1) Present Population

The development of population in the Cagayan Valley for the last decade is shown in Table 2-8.1.

Although it occupies more than 12% of the Philippine total land area, Cagayan Valley contained only an average of 4.57% of the country's total population in the census years 1970 and 1975, the least populated among the region. In the most recent survey undertaken (1980) however, it has become the second least populated among the twelve regions, this time the least populated being Eastern Mindanao.

In the same census year of 1980, Cagayan Valley has also the lowest population density level with only 61 persons per square kilometer, way below the national density level of about 160 persons per square kilometer.

Population within the valley was unevenly distributed over the six provinces comprising it. Of the total 2208 thousand population in 1980, 39.40% was concentrated in Isabela, 32.25% in Cagayan, 10.91% in Nueva Vizcaya, 8.61% in Kalinga-Apayao, 5.07% in Ifugao and 3.76% in Quirino.

TABLE 2-8.1 POPULATION DEVELOPMENT IN CAGAYAN VALLEY
1970 to 1980

	POPULATION (In Thousands)			LAND AREA (1000 Sq Km.)	POPULATION DENSITY persons per square kilometer)	AVERAGE GROWTH 1970-75	ANNUAL RATES 1975-80
	1970	1975	1980				
PHILIPPINES	36,684	42,071	47,914	300	159.7	2.78	2.63
Cagayan Valley	1,680	1,921	2,203	36.4	61.0	2.72	2.82
Cagayan	581	644	712	9	79.1	2.07	2.03
Ifugao	93	105	112	2	41.2	2.51	1.25
Isabela	643	730	870	11	81.7	2.42	3.57
Kalinga-Apayao	136	163	190	7	27.0	3.68	3.10
Nueva Vizcaya	172	213	241	4	61.7	4.36	2.43
Quirino	50	66	83	3	27.2	5.71	4.82

Source: 1931 Philippine Yearbook

An average population growth rate of 2.72% per annum was recorded for the period 1970-1975. This was relatively the same as the national growth level of 2.78% for the same period. In the 1975-1980 period, average population growth rate rose to 2.82% in the valley, while the national level average was reduced to 2.63%.

(2) Future Population

There are at present several on-going projects which are actively being pursued for the development of specific areas in the Cagayan Valley. These projects are especially mentioned in a separate section in this report. These on-going projects are geared towards the development of the region's economy which will consequently increase per capita income and job opportunities. With these projects, areas of particular future development may be pointed out and thus migration to these areas will considerably take place.

The abundance of potential arable lands that are still undeveloped and the development prospects present in the region are significant factors that would attract migrants and settlers and reduce out-migration in the area, thereby making it a factor for population growth. Thus, estimated future growth in population is expected to continue.

(3) Employment

Table 2-8.2 presents distribution of employment by major industries in the project area for 1975. Out of a total population of 1,921,307, about 30% or 568,087 were gainfully employed. Of the employed, 75.88% were engaged in the primary industries which include agriculture, fishery, and forestry. Construction and manufacturing had a share of 8.53% while employment in the services sector was equal to 15.59%.

TABLE 2-8.2 DISTRIBUTION OF EMPLOYMENT BY MAJOR INDUSTRIES CAGAYAN VALLEY — 1975

INDUSTRIES	Total	Cagayan	Ifugao	Isabela	K-Apayao	N. Vizcaya	Quirino
Agriculture	431,083	128,747	42,587	159,594	42,370	42,933	14,852
Manufacturing	26,322	8,993	1,198	10,749	545	3,663	1,174
Construction	9,423	3,803	191	3,289	356	1,637	147
Commerce	23,041	7,849	443	9,646	680	3,927	496
Transport	12,732	5,142	187	4,989	316	1,901	197
Services	58,259	19,896	2,470	21,875	4,114	8,357	1,547
Others	7,227	2,742	183	2,763	878	553	108
Total	568,087	177,172	47,259	212,905	49,259	62,971	18,521

Source: National Census & Statistics Office
National Economic Development Authority

2-8-2 Agriculture

Agriculture is the main activity of Cagayan Valley. Employment share of agriculture in 1975 was 75.89% and 49.18% for the region and the whole country, respectively. The region's land use pattern also revealed that 17.8% of its total land area was farmland.

(1) Present Production

The present cropping pattern is dominated by palay which is 48.4% of the total cropped area. Corn is also grown relatively at the same level with palay, comprising 42.3% of the total cropped area. Sugarcane production in the area before the establishment of Cagayan Sugar Corporation (CASUCO) in 1978 was considerably low, limited to the manufacture of basi (native wine) and vinegar and mostly for local consumption. However, when CASUCO started operation, production of sugar cane has been continuously increasing. Table 2-8.3 shows the production of major crops in the region from 1975 to 1980.

TABLE 2.8.3 PRODUCTION OF MAJOR CROPS, CAGAYAN VALLEY REGION
1975-1980 (In 1000 Metric Tons)

CROP \ Year	1975	1976	1977	1978	1979	1980[1]
Palay	712.6	741.1	812.9	802.1	847.7	785.6
Corn	277.0	292.6	286.0	309.6	330.0	325.0
Sugar Cane[2]	--	—	—	73.2	146.6	159.6
Tobacco	17.3	14.9	12.5	12.4	12.7	12.9

[1]Preliminary Estimates
[2]Total cane ground at Cagayan Sugar Corporation

(2) Rice Production

Rice is the staple crop in the region and contributed 10.47% to the total production of the country in 1980. A considerable surplus has been observed during the past years except in 1973 when there was a decrease in production due to the occurence of floods and typhoons. Despite the seemingly high surplus of the region, average yield per hectare of 2.52 tons still lags behind the target production of 4.95 tons per hectare. However, productivity of palay is expected to increase with the completion of new schemes and rehabilitation of irrigation systems in the region. National Irrigation Administration expects to complete the following projects in the next five years:

(a) Chico River Irrigation Project, Stages I & II--49,000 hectares
(b) Magat River Multi-Purpose Project—104,000 hectares
(c) Cagayan Integrated Agricultural Development Project—13,200 hectares.

Aside from the above-mentioned projects of NIA, the intensification of new package of technology development which includes extension and information services, supervised credit, use of high yielding varieties, increased use of farm inputs such as fertilizer and pesticides and intensified marketing services extended to farmers would also boost production.

Assuming a constant per capita consumption rate of 121.1 kilos[1] and 3.6% allowance for waste and seed requirements and a milling recovery of 60%, past and present rice surplus of the region would be shown in Table 2-8.4.

TABLE 2-8.4 RICE SURPLUS OF CAGAYAN VALLEY REGION
1975-1980 (In 1000 Metric Tons)

1975	184.9
1976	195.1
1977	230.6
1978	217.3
1979	237.0
1980	193.1

Interviews with the National Food Authority show that palay and/or rice surplus of the region are brought either to Manila, Bulacan, Laguna and other parts of Luzon, using land transportation passing through Dalton Pass.

(3) Corn Production

Corn is the second most important crop of the region. Considering that the people in the region are by nature rice eaters (rather than corn) only 10% of the total production are used for local consumption. The remaining amount is sold to National Food Authority (NFA) and then distributed to corn deficit areas.

The present corn productivity level of 1.0 ton per hectare is below current development target of 2.5 tons per hectare. During the past five years, the region contributed 10.23% to the total corn production of the whole country. It is expected that productivity would increase with the massive intensification of the new package of technology being undertaken by the government as discussed in the preceding section.

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[1]Regional Consumption Patterns for Major Foods, 1974--1978, Department of Agriculture

(4) Sugar Cane Production

Sugar cane production is fast becoming a valued and profitable commercial crop in the region especially in Cagayan province. Data gathered from Cagayan Sugar Corporation showed that the total cropped area was continoulsy increasing from 1,803; 3,886; 4,552 and 7,446 hectares in 1978, 1979, 1980 and 1981 respectively. The present productivity level of 34.42 tons/hectare is expected to increase to 36.9 ton/hectare[1] in the next five years.

The trend of raw sugar production of CASUCO is estimated at 6,841; 17,468; 16,942 and 23,960 in 1978, 1979, 1980 and 1981 respectively. Of the total raw sugar production about 90% are brought to Central Luzon and Manila via Dalton Pass.

Molasses produced for the period 1979 to 1981 is estimated at 21,651.6 tons and exported to Japan via Aparri.

(5) Tobacco Production

The region is the second biggest producer of tobacco in the country, Northern Luzon being the first. However, due to limited data available it is difficult to determine the profitability of tobacco industry in the area. The 1975 average yield of 1.0 ton/hectare is expected to increase to 1.52 ton/hectare in 1987 as shown in the Five-Year Development Plan of the Region.

(6) Other Crops and Livestock

There are also a considerable number of minor crops like peanuts, mongo and other rootcrops but the volume involved is insignificant for the purpose of the study.

Animal husbandry is carried out on a backyard scale and productivity level is low to be considered as major export of the region.

2-8-3 Forestry

The topography of the Cagayan Valley Region, which is embraced by the high peaked ranges of the Caraballo mountains in the south and the Cordillera in the west is such that it allows scanty space for agriculture and much larger areas for forestry. Of the 3,640,300 hectares total land area, only 1,014,983 hectares or 28% are alienable or disposable lands, while 2,625,317 hectares or 72% are forest lands. This constitutes about 15% of Philippine public forest land and ranks second among all regions. Table 2-8.5 shows the status of land classification in the region as of 1980.

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[1]Cagayan Valley Region II Five Year Development Plan, 1978-1982, Table 3.4.

TABLE 2-8.5 STATUS OF LAND CLASSIFICATION CAGAYAN VALLEY REGION, 1980

	Area (ha.)	%
TOTAL	3,640,300	100
Alienable and disposable	1,014,983	28
Forest Land	2,625,317	72
Classified forest land	1,292,020	35
Forest Reserve	549,529	15
Timberland	702,421	19
National Parks	1,011	—
Civil Reservations	2,229	—
Others	36,830	—
Unclassified public forest	1,333,297	37

Source: Bureau of Forest Development (BFD), 1980

As the 1980, Cagayan Valley has a total of 49 logging companies and 60 sawmills. Their combined output has resulted in the following log and lumber production figures in 1976 and 1980 as compared to the national figures. See Table 2-8.6.

TABLE 2-8.6 LOG AND LUMBER PRODUCTION, 1976 & 1980 (PHILIPPINES & REGION II)

	Philippines		Cagayan Valley	
	1976	1980	1976	1980
Logs (cu.m.)	8,645,835	6,352,300	1,942,404	1,062,000
Lumber (bd.ft.)	682,294	1,529,100*	209,240	312,651*
Plywood (cu.m.)	705,741**	552,870	33,161**	48,890
Veneer (cu.m.)	1,367,457**	659,873	164,992**	57,481

Note: *1980 figures for lumber is in cubic meter
**1976 figures for plywood and veneer are in square fet.

Based on the 1980 data of BFD, about 110,158 cu.m. or 10% of total production of logs and 97,260 cu.m. or 31% of total production of lumber in the region were exported to different countries utilizing the facilities of local ports such as Irene, Aparri and Claveria or delivered to Manila, using the Dalton Pass for transhipment abroad since Manila has larger port facilities. The rest was either consumed locally in the region or also delivered to Manila for local consumption.

Although the forest resources of the region are vast, it can be observed from the above production figures that log output decreased during the period 1976-1980 while other forest products showed a minor increase. This may probably be due to the selective government ban on logging activities and the minimal reforestation effort on the part of private, as well as government sectors.

To conserve and develop the region's forest, the government created programs and targets as given in the Cagayan Valley (Region II) Five Year Development Plan, which will give emphasis on forest protection and conservation, better utilization of forest products , reforestation, promotion of commercial tree farming and educational campaigns. Thus, to reach the planned forest cover of the region, about 144,000 hectares will have to be reforested. Table 2-8.7 below indicates that as of 1980, a total of 113,023 hectares is now programmed for reforestation. Of this total, about 22% or 24,908.85 hectares have been planted.

TABLE 2-8.7 REFORESTATION PROJECT, CAGAYAN VALLEY REGION as of 1980

Region/ Province	Total Area Programmed (has.)	Total Area Planted (has.)
Cagayan Valley	113,023	24,908
Cagayan	17,536	4,376
Isabela	3,905	2,318
Nueva Vizcaya	45,925	14,712
Quirino	2,657	1,138
Ifugao	43,000	2,362
Kalinga-Apayao	—	—

Source: Bureau of Forest Development
Region II, Tuguegarao, Cagayan

2-8-4 Fisheries and Aquatic Resources

As mentioned in 2-6 Cagayan Valley may not be considered a rich fishery resource region because of its landlocked location except on the northern and eastern sides. However, the untapped potentials of the Luzon Strait in the north and the Pacific coastal area in the east are the region's rich fishing grounds. These fishing grounds are presently inaccessible to the rest of the province, but with several government access road projects and other programs to develop fishing industry along these areas, target growth of the fishing industry in the region is foreseen.

The estimated 1980 total fish production in Cagayan Valley Region by province, based on the data provided by the Region II Bureau of Fisheries and Aquatic Resources (BFAR) Office is given in Table 2-8.8.

The figures in Table 2-8.8 show that among the provinces of Cagayan Valley Region, Cagayan is the highest producer of fishery products, followed by, Isabela, both occupying the northern and easternmost portion of the region.

TABLE 2-8.8 FISHERY STATISTICS, CAGAYAN VALLEY REGON
1980 (In Metric Tons)

	MUNICIPAL		COMMERCIAL		FISHPOND	
	No. of Bancas	Production	No. of Vessels	Production	Area (has.)	Production
Cagayan Valley	3,766	5,895.8	95	1,340	3,225.69	726.46
Cagayan	2,983	5,620	95	1,340	2,788.87	592.37
Isabela	693	200	—	--	311.6	93.48
N. Vizcaya	12	15.8	--	—	26.45	10.58
Kalinga-Apayao	14	10	—	—	33.77	10.13
Ifugao	—	—	--	—	2	1
Quirino	64	50	—	--	63	18.9

Source: BFAR, Region II

The region accounted for only 1% of the national fish production in 1979, chiefly from coastal fishing. However, in addition to coastal fishing the region has substantial lake and swamp areas for inland fishing totalling about 16,185 hectares, which constitutes 2% of Philippine lake and swamp areas. Of the total lake and swamp areas, about 3,225 hectares or 20% have been developed and the rest are potential for development.

Based on the government established per capita fish consumption/requirement of 44 kg.[1], fishery resources in the region is considered to be insufficient to meet its domestic requirements. Total 1980 estimated regional fish production is only 8,449.26 tons which is very low as against its total population of about 2,220,000 persons. Thus, the region's per capita fish consumption would only be 3.83 kg. which is way behind the established fish consumption pattern.

To supplement the need of the region, fish products are believed to be coming from Manila or other nearby provinces such as Pangasinan and La Union by land transportation from Dalton Pass. Based on the Origin-Destination survey undertaken in Sta. Fe for this study, a total of 9,938kg. of fish products (fresh and dried sardines) coming from Manila; 600kg. of fresh fish from La Union and 8 tons of salt and dried fish from Pangasinan were recorded to be going to the Cagayan Valley Region during the one-day, 24-hour count.

[1]Per capita fish allowance (requirement) as established by the Food and Nutrition Research Center was 44 kg. in 1978.

In order to increase fish production in the region, the government created programs and projects under the Five-Year Development Plan for Region II among which were: fingerling production and dispersal, fishery extension services on fishpond management, fishpond potential survey, commercial fishing development through the improvement of two commercial vessels per year during the planning period, modernization of fishing methods and equipment used in municipal fishing and formation of fishermen cooperatives. Based on the said Development Plan, fish production is expected to increase at the rate of 6.4% per year up to 1987 --- the end of the planning period.

2-8-5 Transportation and Communications

(1) Overall Transport System

The modes of travel in the Philippines consist of land (roads and railroads), water and air. Due to the archipelagic form of the country, air transport and coastal shipping generally serve the interisland movements of people and commodities. Land travel is limited to intraisland transport.

(2) Motor Vehicle Registration

Total vehicles registered in the Philippines in 1979 was 1,186,357. This gives an annual growth rate of 8.6% when compared with the 1970 total of 564,577 or for the nine-year period, 1970-1979. Total motor vehicle fleet in Cagayan Valley increased at a relatively higher rate than the national average for this same period at 12.61% annually.

Motor Vehicle Registration statistics for the Philippines, the Cagayan Valley and the six provinces comprising it for 1970 to 1979 are given in Table 2-8.9. These were derived from the detailed official statistics provided by the Bureau of Land Transportation, Metro Manila headquarters.

Of the 1979 total registered vehicles in Cagayan Valley, 20.46% were cars, 36.24% were trucks (includes jeepneys and buses), 41.18% were motorcycles and motor-tricycles and 2.12% were trailers. Cars increased at an average annual rate of 7.24% (1970-1979 period), trucks at 9.85% and motorcycles and motor-tricycles at 22.53%.

TABLE 2-8.9 VEHICLE REGISTRATION, CAGAYAN VALLEY
1970-1979

Year	Cars	Trucks	Motorcycles Mototricycles	Trailers	Total
Philippines					
1979	502,277	412,377	249,558	22,145	1,186,357
1976	391,800	301,137	177,822	14,597	885,356
1973	318,461	252,884	150,155	13,651	735,151
1970	268,425	189,862	92,065	14,225	564,577
Cagayan Valley					
1979	5,543	9,817	11,157	574	27,091
1976	4,367	7,629	6,336	535	18,867
1973	3,532	5,823	4,934	533	14,822
1970	2,953	4,214	1,792	344	9,303
Cagayan					
1979	1,771	2,258	3,786	161	7,976
1976	1,010	2,613	2,152	113	5,888
1973	939	1,675	2,382	101	5,097
1970	1,044	1,439	814	125	3,422
Ifugao					
1979	113	702	170	—	985
1976	59	99	33	—	191
1973	12	13	9	—	34
1970		N.A.			
Isabela					
1979	2,901	5,108	5,293	325	13,627
1976	2,357	3,455	2,651	307	8,770
1973	1,694	2,810	1,236	353	6,093
1970	1,443	2,228	615	204	4,490
Kalinga-Apayao					
1979	256	627	332	1	1,216
1976	93	336	181	3	613
1973	186	331	228	—	745
1970	113	193	94	4	404
Nueva Vizcaya					
1979	340	503	1,341	75	2,259
1976	678	831	1,021	81	2,611
1973	484	619	635	63	1,801
1970	353	354	269	11	987
Quirino					
1979	162	619	235	12	1,028
1976	170	295	298	31	794
1973	217	375	444	16	1,052
1970					

Source: Bureau of Land Transportation

(3) Road System

The roads in the Philippines are classified into national, provincial, city, municipal and barangay roads. National roads serve as the main trunkline of the country.

In 1975, there were 92,496 km. of roads. This figure grew to 149,863 km. in 1981, showing an annual growth rate of 8.37% per annum. Out of the 1981 figure, national and provincial roads comprise 23,763 km. and 29,755 km., respectively, while city roads, municipal roads and barangay roads are 3,691 km., 11,445 km., and 81,209 km. respectively.

In Cagayan Valley, the region is bisected by Route 5 which runs through the capital towns of Nueva Vizcaya, Isabela and Cagayan up to Aparri in the north. Linked to both sides of this main highway are networks of road connecting the western and eastern portions of the region making the whole valley the influence area of Route 5. Although Cagayan Valley is accessible from Region I through the western boundaries of Cagayan, Kalinga-Apayao and Nueva Vizcaya, the eastern coasts of Cagayan and Isabela are still to be connected to the middle of the valley.

In 1975 ,Cagayan Valley had a total of 6,673 km. of roads. This rose to 11,740 km. in 1980, equivalent to an average increase of 11.96% per annum. Despite this rate of increase, the region's total road network was only equal to 7.85% of the country's overall total in 1980.

Of its 11,740 km. of roads, 2,277 km. were categorized as national, 2,045 km. as provincial, 1,030 km. as municipal and 6,388 km. as barangay roads. The valley's road density was estimated as follows:

Road Km/Sq. Km	=	0.32
Road Km/1000 inhabitants	=	5.32

At present, only 20% of the national roads in the region are concrete , 4% are asphalt, and the rest are either gravel or earth roads. Of the region's 1980 total road network, 31.3% was concentrated in Isabela, 28% in Cagayan, 17.88% in Nueva Vizcaya, 10.55% in Kalinga-Apayao, 7.1% in Ifugao and 5.17% in Quirino. Table 2-8.10 shows the distribution of existing network in the Region.

TABLE 2-8.10 EXISTING ROAD NETWORK: 1980

	National	Provincial	Mun/City	Barangay	Total
Cagayan	650	589	209	1,844	3,292
Ifugao	253	176	44	357	830
Isabela	358	655	416	2,243	3,672
Kalinga-Apayao	444	173	58	565	1,240
Nueva Vizcaya	320	346	237	1,196	2,099
Quirino	252	106	66	183	607
Total	2,277	2,045	1,030	6,388	11,740

(4) Ports (Sea and Air)

Currently, Cagayan Valley has five national and one municipal seaports. Four national ports are located in Cagayan (Irene, Aparri, Claveria and San Vicente) and one in Isabela (Bicobian). The only municipal port, the Port of Casambalangan, is also in the province of Cagayan.

Although most of these ports are located in primary growth centers, berthing space and wharfing facilities are inadequate. Except the Port of Aparri, all of these ports are open to interisland and coastwise cargo shipping and hence, serve domestic needs. The Port of Aparri, on the other hand, is used both for transporting oil and petroleum products from Batangas and Bataan to supply the needs of the Cagayan Valley and for exporting forest products to Japan, Taiwan and other foreign countries. These forest products are mostly round logs which are shipped abroad. Some are sent to San Fernando, La Union and to Manila.

Cagayan Valley also has five national airports; one primary airport in Tuguegarao, Cagayan; two secondary airports in Cauayan, Isabela and Bagabag, Nueva Vizcaya; and two minor airports in Aparri, Cagayan and in Palanan, Isabela.

All strategic points of the region are linked by airports except Tabuk, Kalinga-Apayao. Planes land in these airports with considerable difficulty due to poor navigational facilities. Most of these airports have gravel runways.

The strategy for sea-air ports development is to concentrate investments in strategically located areas. Four feeder airports (Aparri, Palanan, Fuga Island and Lal-lo), two secondary airports (Cauayan and Bagabag) and one trunkline airport (Tuguegarao) are due for rehabilitation/construction in the next five to ten years.

2-8-6 Other Development Projects

Varied social and economic development activities are actively being pursued in the region in view of meeting existing as well as projected demands of the area's population. Government investments are geared towards the realization of the following general objectives:

a) Improvement of living standards
b) Agricultural and industrial development
c) Equitable distribution of income
d) Employment generation
e) Promotion and development of tourism and travel

Under the Five-Year Development Plan, the government has programs to attain these objectives. In addition to the programs and projects previously mentioned, other development projects in the area are currently being undertaken which includes the following:

(1) Power and Electrification

Starting 1980, a hydro-electric power project is being initiated in the region. The Abulog River Power Project (Kalinga-Apayao) is expected to contribute 200 megawatts power by 1985, and its total 400 megawatts power capacity by 1987. Total project cost is placed at ₱4.0 Billion.

By 1983, the Magat River Power Project (Isabela) shall be contributing an initial 360 megawatts power to the Luzon Grid. In 1987, the estimated 300 megawatts power potential of this project is expected to be totally harnessed. Total project cost is estimated at ₱4,313.4 Million.

The National Power Corporation proposes a series of four storage dams for hydro-power generation in the Chico River. Total installed capacity of the four power projects will be 1,010 megawatts and the total average annual energy to be generated was estimated to be 2,000 GWH.

The Cagayan Valley Electrification Project utilizes the power sources from the Ambuklao Power Plant in Benguet. For the next three years there are eight more electric cooperatives programmed to serve an additional 75 municipalities, with a population of around 1.5 million.

In addition to this, the Cagayan Integrated Agriculture Development Project (CIADP) also has electrification projects in Cagayan province scheduled to be implemented by 1983. Total area covered is 13,200 hectares distributed in the following places: Iguig, 600 hectares; Alcala-Amulong, 1,400 hectares; and Lower Cagayan, 11,200 hectares. Electrification facilities will be set up in five towns: Buguey, Aparri, Camalaniugan, Lal-lo and Gattaran.

(2) Water Resources

1) Irrigation — In order to increase agricultural production and farmers' income in the Cagayan Valley Region, three major irrigation projects are on-going, which will irrigate a total of about 166,000[1] hectares of cropland in the region.

The Magat River Multi-Purpose Project (MRMP) has irrigation and power generation as its major functions. Secondary functions would concentrate on domestic water supply, fish conservation, flood control and recreation. The Magat Project hopes to irrigate 104,000 hectares of agricultural land to serve the entire service area in Isabela and Quirino. Expected completion of the project is by 1983.

The Chico River Irrigation Project is composed of two stages: Stage I and Stage II (Irrigation Development) covering the provinces of Cagayan, Kalinga-Apayao and Isabela. Stage I consists of the construction of a diversion dam on the Chico River, the rehabilitation and upgrading of a total of about 19,700 hectares. The diversion dam would be designed to function as after bay regulator for the storage dam of Stage II. Stage II would consist of the construction of the necessary main connecting canals, structures and irrigation services and facilities to irrigate an additional area of 29,300 hectares. Target completion of the project is by 1984. Total project cost is ₱996.07 Million.

The Cagayan Integrated Agricultural Development Project includes also irrigation projects consisting of construction of new irrigation system for about 13,200 hectares utilizing the Cagayan River as its source of water supply. The project is expected to be completed by year 1983. Total project cost is ₱260.395 Million.

2) Water Supply — During the periods 1978 to 1982 and 1983 to 1987 waterworks systems are scheduled for construction in each province in the region. By 1982, total supply from the waterworks system is expected to reach 15.0 million gallons, and by 1987 it would increase to 17.0 million gallons. By province, the water supply targets are as follows:

---

[1]Based on the latest National Irrigation Administration (NIA) estimate

TABLE 2-8.11 TARGET TOTAL OUTPUT OF WATERWORKS SYSTEMS (In 1000 gallons)

Province	1982	1987
Cagayan	4,500	6,240
Ifugao	760	920
Isabela	6,000	6,210
Kalinga-Apayao	1,200	1,350
Nueva Vizcaya	1,800	1,920
Quirino	640	680
Total	14,900	17,320

Source: Cagayan Valley Five-Year Development Plan

Simultaneous with the waterworks projects are the Artesian Wells and Springs Development Programs in each province. A total of 260 units of Artesian Wells shall be constructed/rehabilitated during the five-year period.

3) Flood Control — The three major multi-purpose projects utilizing the power and water sources of the region's major rivers, i.e., Cagayan, Chico and Magat will help prevent inundation of urban and agricultural areas especially in areas along these major rivers. Also, a total of 46,645 L.M. of concrete revetments are scheduled to be constructed by 1987 as one measure for flood control development.

Chapter 3.

TRAFFIC STUDY

CHAPTER 3
TRAFFIC STUDY

3-1 Origin-Destination Survey

3-1-1 Purpose of the O-D Survey

The O-D survey was carried out with the following purposes:

(1) To fully comprehend the existing social and economic relationship between Dalton Pass and Cagayan Valley

(2) To determine the distribution of zonal O-D pairs of traffic between National Road No. 5 and No. 3.

3-1-2 Survey Procedure

The procedure used in the O-D survey is the "roadside interview" method in which drivers or operators are requested to stop at a selected point or station along the road, then are interviewed on some aspects of his particular trip such as the trip origin, final destination, intermediate stops made, total number of persons on board the vehicle, seat capacity, type and weight of commodity carried.

Roadside interviews were undertaken at two survey stations: in Pasuquin, Ilocos Norte, 10 July 1981 and in Sta. Fe on 17 July 1981, continously on a 24-hour basis on both flow directions—to and from Manila. The survey stations were located in places where local trips may not distort the sampling.

(1) Vehicle Classification

For this study, the Study Team has adopted the following classifications:

1) Car (including vans and wagons)
2) Big Bus (with seat capacity more than 30)
3) Mini Bus (including jeepneys)
4) Big Truck (with more than 6 tires)
5) Semi-Trailer and Full Trailer
6) All others (vehicles not categorized above, excluding motorcycles)

The classification "All Others" at Pasuquin, Ilocos Norte, includes tricycles but does not include any tricycle at the Sta. Fe station, principally because of the excessive gradient at Dalton Pass which tricycles could not hurdle.

(2) Commodity Classifications

For the analysis of commodity flow through the Pass, commodities were grouped into seven main classifications namely:

1) Cereals and Unprocessed Agricultural Grains
2) Forestry Products
3) Mineral Oil Products
4) Cement
5) Building and Other Construction Materials
6) Soft Drinks, Beer, Wines
7) All Others

(3) Sampling Rate

A 100% traffic data sample size has been set as the target and this target was actually achieved mainly because of the very satisfactory performance of the government counterpart.

(4) Field Sheet

The Field Sheet used in the survey is shown in Table 3-1.1. This is an abridged version of the PPDO-MPWH standard form.

(5) Zoning

For purpose of assessing the transport generating potentials of smaller geographical subdivisions, the broad influence area of the Project has been subdivided into traffic attraction and generation zones as shown in Table 3-1.2 and Fig. 3-1.1, which gives the location of each zone center.

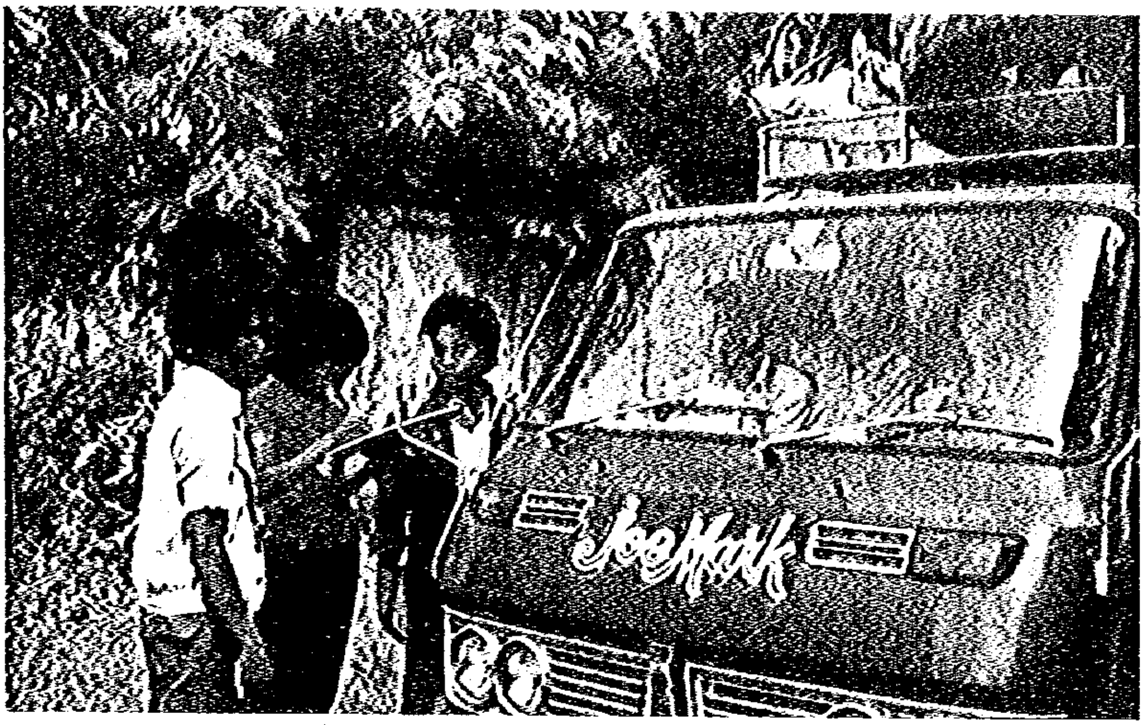
TABLE 3-1.1 DALTON PASS TUNNEL PROJECT FEASIBILITY STUDY
O-D INTERVIEW FIELD SHEET 1981

STA.No.________ DATE:__________ HOUR:__________ PROVINCE:______________
DIRECTION:____ FROM:____________________ TO:____________________

1. VEHICLE TYPE	☐ 1. CARS ☐ 2. BIG BUS ☐ 3. MINI BUS (INCLUDING JEEPNEYS)		4. BIG TRUCK (WITH 6 OR MORE TIRES) ☐ 5. TRUCK-TRAILERS AND SEMI-TRAILERS ☐ 6. ALL OTHERS ☐
	2. ORIGIN	3. DESTINATION	4. INTERMEDIATE STOP
BARRIO			
CITY/MUNICIPALITY			
PROVINCE			
5. NUMBER OF PERSONS (INCLUDING DRIVER AND CONDUCTOR (S))			
6. SEAT CAPACITY (ONLY FOR BUS, JEEPNEY)	PASSENGER SEATS		
7. COMMODITY TYPE	TYPE 1.		
	TYPE 2.		
	TYPE 3.		
	TYPE 4.		
Empty ☐	TYPE 5.		
8. COMMODITY WEIGHT	TYPE 1. WEIGHT		KGS
	TYPE 2. WEIGHT		KGS
	TYPE 3. WEIGHT		KGS
	TYPE 4 WEIGHT		KGS
	TYPE 5 WEIGHT		KGS
9. TOTAL COMMODITY WEIGHT			KGS
10. NET LAOD CAPACITY			KGS

TABLE 3-1.2 ZONAL DIVISIONS

Zone No.	Zone Name (Zone Center)		
01	San Fernando	La Union (all municipalities)	
02	Bontoc	Mountain Province (all municipalities)	
03	Bulnao	Kalinga-Apayao (all municipalities)	
04	Bayombong	Nueva Vizcaya, Ifugao (all municipalities)	
05	Cordon	Cordon, Santiago	
06	Magapit	Cagayan:	Aparri, Buguey, Calayan, Camalaniugan, Gonsaga, Lal-lo, Sta. Ana, Sta. Teresita Abulug, Allacapan, Ballesteros, Claveria, Lasam, Pamplona, Sanchez Mira, Langangan Alcala, Amulung, Baggao, Gattaran Iguig, Magapit
07	Tuguegarao	Cagayan:	Tuguegarao, Enrile, Penablanca, Solana
08	Alicia	Isabela:	Alicia, Angadanan, Cauayan, Echague, Jone, Luna, Reina Mercedes, San Agustin, San Guillermo, San Isidro, Cabanatuan, Aurora, Benito, Dimapiguit, Mallig, Quezon, Roxas, San Manuel, San Mateo, Ramon
09	Ilagan	Isabela:	Ilagan, Soliven, Burgos, Cabagan, Divilican, Gamu, Macanacon, Magsayasay, Naguilian, Palanan, Quirino, San Mariano, San Pablo, Sta. Maria, Sto. Tomas, Tumanuini
10	Urdaneta	Pangasinan	(all municipalities and cities)
11	Sta. Rita	Bulacan	(all municipalities except Valenzuela)
12	Sta. Rosa	Nueva Ecija:	Sta. Rosa, Cabanatuan, Gapan, Gen. Tinio, Penaranda, San Leonardo, Jaen, San Antonio, San Isidro, Cabiao, Aliaga, Licab, Quezon, Zaragona, Palayan City, Bongabon, Gabaldon, Natividad, Laur, Llaneza, Pantabangan, Rizal
13	Talavera	Nueva Ecija:	Guimba, Cuyapo Nampicuan, Talugtug, Talavera, Sto. Domingo
14	San Jose	Nueva Ecija:	Carrangalan, Lupao, Munoz, San Jose City
15	Metro Manila	Metro Manila, Rizal, Cavite, Laguna, Batangas, Quezon, Albay, Camarines Norte, Camarines Sur, Sorsogon, (all municipalities and cities)	
16	Tarlac	Tarlac (all municipalities and cities)	
17	San Fernando	Bataan, Pampanga, Zambales (all municipalities)	
18	Laoag	Ilocos Norte (all cities and municipalities)	
19	Vigan	Abra, Ilocos Sur (all municipalities)	
20	Baguio	Benguet (all cities and municipalities)	



O-D SURVEY. Above photo shows the typical "roadside interview" method in the Origin-Destination survey. The driver was requested to stop at a selected point and was interviewed on vital aspects of his trip. The O-D survey was undertaken at Pasuquin and Sta. Fe on a 24-hour basis on both flow directions.

TRAFFIC COUNTING. To determine the total volume of base year traffic and distribution by classification, traffic counting was carried out manually at the same location as the O-D survey on a 24-hour basis with each vehicle type counted separately and by directional flow.

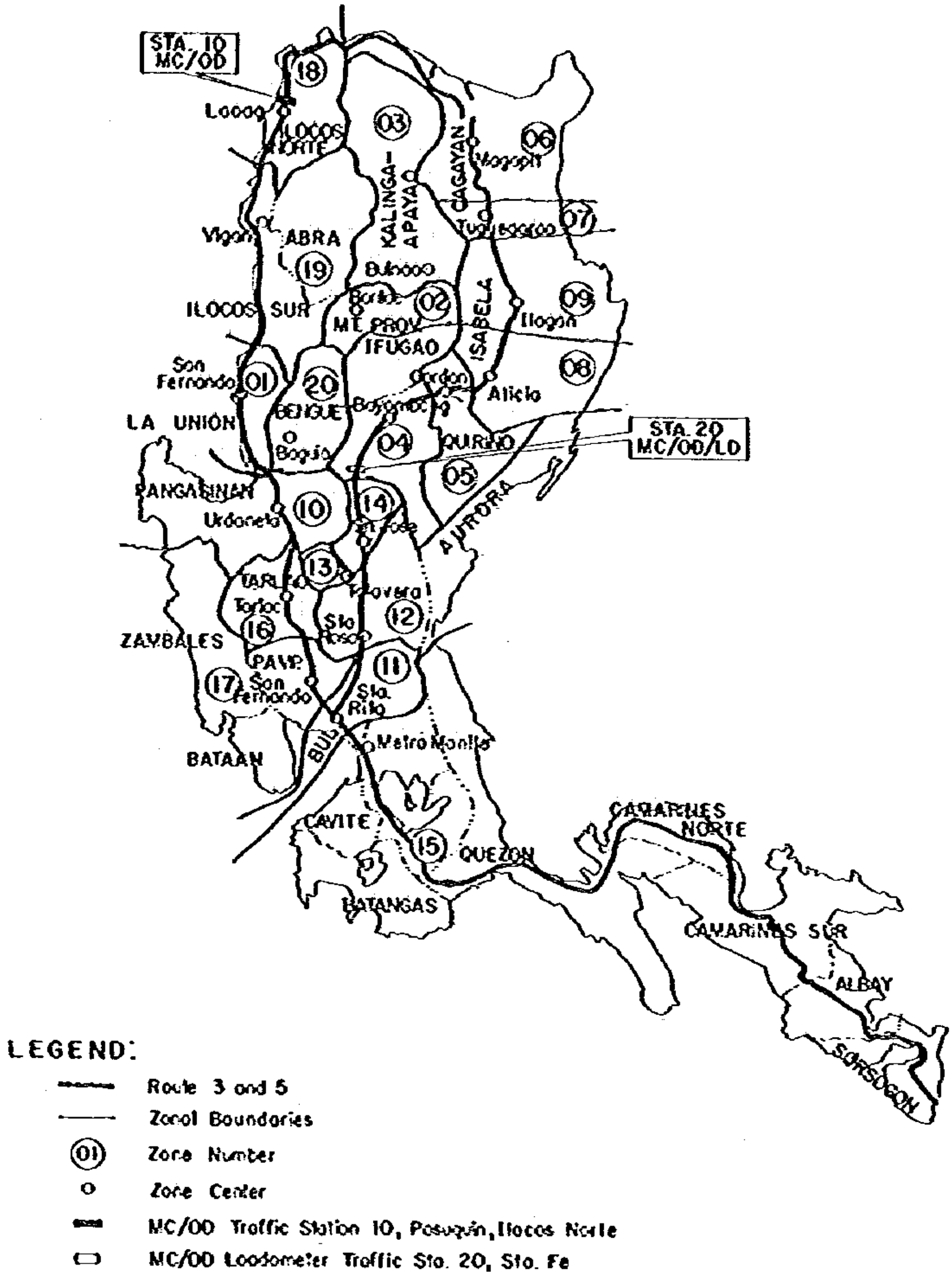


Fig. 3-1.1 ZONAL DIVISION

3-1-3 Result of the Survey

(1) Outline

1) The results of the O-D Survey are shown in Table 3-1.3, Table 3-1.4, Fig. 3-1.2 and Table 3-1.5.

2) From the results of the O-D survey undertaken in Sta. Fe, it was indicated that the commercial vehicle mixing rate 68% was very high. Compared with National Route No. 3, (commercial vehicle mixing rate =17%) Route No. 5 may be considered as a more important industrial highway.

3) All of the marketable surplus grains of Cagayan Valley is transported to Manila crossing Dalton Pass. According to the O-D survey, the daily tonnage of this grain traffic is 1,300 tons, say 500,000 tons per year. This volume may be backed up with the following estimation:

$$(\underset{(1)}{786{,}000} + \underset{(2)}{325{,}000}) \times \underset{(3)}{0.6} = 666{,}000 \quad (3\text{-}1.1)$$

where (1) is palay production of Cagayan Valley in 1979 (See Table 2-8.3)
(2) is corn production of Cagayan Valley in 1979 (also see Table 2-8.3)
(3) is marketable surplus ratio in Cagayan Valley

4) Cargo and passenger traffic on the Dalton Pass may be summarized as shown in Table 3-1.5.

5) All cargo except lumber wholly depends on Dalton Pass. About one-half of the lumber produced in Cagayan Valley are shipped out via Aparri.

6) From the O-D survey at Pasuquin, Ilocos Norte, a certain portion of the traffic as hereunder indicated which ought to use Dalton Pass, unwillingly detoured via Patapat because they were not then informed that the Sta. Fe Bridge which was destroyed by a recent typhoon had been repaired:

About 1% of cars, small trucks and minibuses
About 2% of big trucks

The above percentage may be considered as the portion of the traffic which, when Dalton Pass is closed to traffic, will detour via National Road. No. 3 without waiting for the reopening of Dalton Pass.

TABLE 3-1.3 THE RESULT OF O.D. SURVEY AT STA. FE
(Vehicles/day, tow-way-1981)

NORTH OF DALTON PASS / SOUTH OF DALTON PASS	(04) BAYOMBONG (Including) BONTOC	(05) CORDON	(08) CAWAYAN	(09) ILAGAN	(07) TUGUEGARAO (including) BULNAO	(06) MAGAPIT (Including) APARRI	TOTAL
(14) SAN JOSE	17	5	7	3	4	5	41
(13) TALAVERA	10		1	7 (1)		1	19 (1)
(12) STA. ROSA	24	24	13	15	24	12	112
(11) STA. RITA	29	16	39	28	14	14 (1)	140 (1)
(15) METRO MANILA	167	107	261 (2)	168	152 (3)	104 (9)	959 (14)
(01) SAN FERNANDO, LA UNION	13	12	6	5	9	(3)	45 (3)
(20) BAGUIO	19						19
(10) URDANETA	22	13	35	9	13	8 (1)	100 (1)
(16) TARLAC	14	1	12	4	6	3	40
(17) SAN FERNANDO, PAMPANGA	12	14	15	36	8 (1)	2 (5)	87 (6)
TOTAL	327	192	389 (2)	275 (1)	230 (4)	149 (19)	1,562 (26)

NOTE: The figures in parenthesis are traffic which ought to use Dalton Pass, unwillingly detoured via Patupat because they were not then informed that the Sta. Fe bridge which was destroyed by a recent typhoon had been repaired.

TABLE 3-1.4 O.D. MATRIX

Station Number: 10 PASUQUIN, ILOCOS NORTE Vehicle Type: All Vehicles

O \ D	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	TOTAL
1						3												1			4
2																					
3											1						1	10		1	13
4																					
5																		1			1
6										1	1				9		5	47	35		101
7															3			6	1		10
8															2			1			3
9													1					58	1		60
10																		1			2
11																					2
12																					
13																					1
14																					
15																		11			25
16																					
17																					6
18																					136
19																					37
20																					1
																					402

NOTE: Intra-zonal trips are excluded.

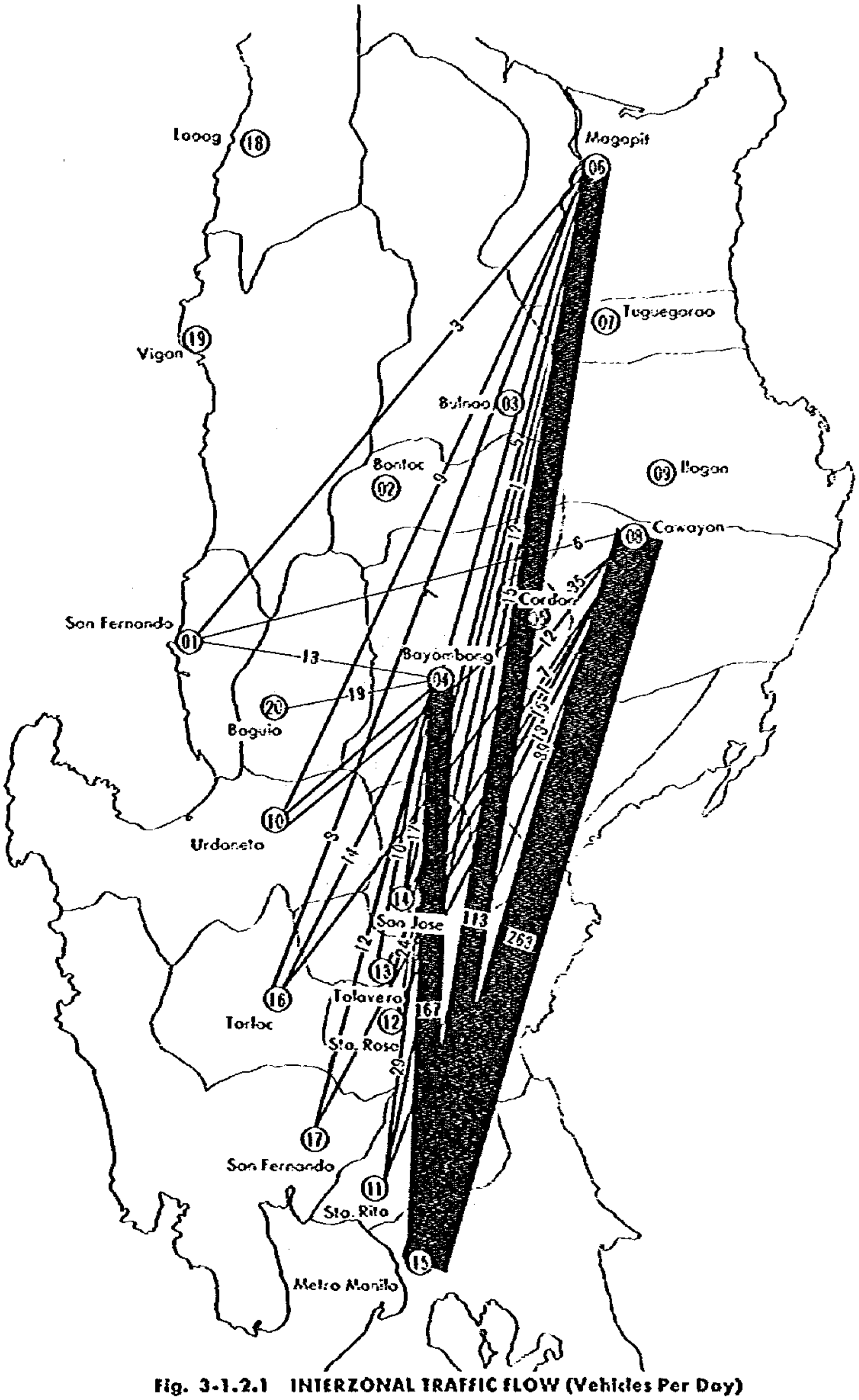


Fig. 3-1.2.1 INTERZONAL TRAFFIC FLOW (Vehicles Per Day)

1mm = 25Vehicles

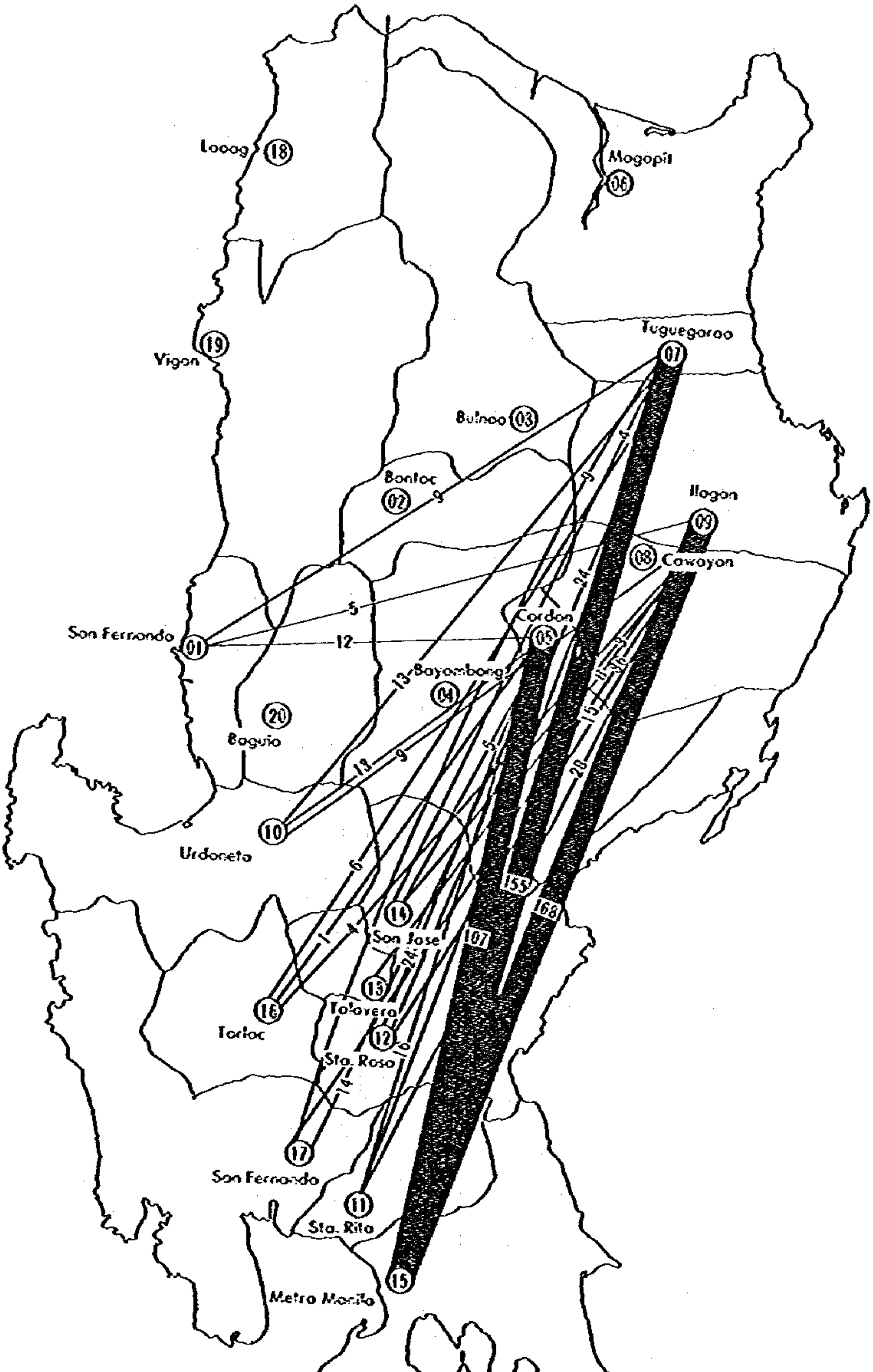


Fig. 3-1.2.2 INTERZONAL TRAFFIC FLOW (Vehicles Per Day)
1mm = 25Vehicles

TABLE 3-1.5 SUMMARY OF TRAFFIC ON DALTON PASS

in 1981

		Daily Traffic by O.D. Survey			Estimated Annual Traffic (2)			Annual Marketable Surplus in Region II
		Out-going from Cagayan Valley	Incoming to Cagayan Valley	Total	Out-going from Cagayan Valley (4)	Incoming to Cagayan Valley (4)	Total	
Cargo (in tons)	Forestry	2,966	3	2,969	1,083,000	--	--	714,000 (1)
	Grain	1,312	64	1,376	479,000	--	--	666,000 (3)
	Cement	0	795	795	—	290,000	--	--
	Mineral Oil Products	47	338	355	--	123,000	--	-
	Construction Material	75	189	264	-	69,000	--	--
	Soft drinks, Beer, Wines	0	216	216	--	79,000	--	--
	All others (grocery in main)	70	560	630	--	204,000	--	--
	Total	4,470	2,165	6,635	1,562,000	765,000	--	—
Passenger	Auto	—	--	1,836 (5)	--	--	545,000	--
	Bus	--	-	5,325 (6)	--	-	1,944,000	--
	Total	—	--	7,161	--	--	2,489,000	—

(1) 1,000,000 × 0.714 = 714,000
1,000,000: logs and lumber production 1981 in Cagayan Valley, see "Interim Report on Central and Northern Luzon" Part III NTP, VIII -- 37
0.714: the factor which converts cu.m to ton, VIII -- 38
(2) estimated annual traffic = daily traffic × 365
(3) See equation 3-1.1
(4) The irregular reverse movement has been excluded in annual traffic estimation
(5) 459 cars × 4 passengers = 1,836 passengers
(6) (204 big buses × 27 passengers) + (25 mini buses × 9 passengers) = 5,325 passengers

7) Closure of Dalton Pass is a serious drawback to Cagayan Valley because there is no other alternative route that could be used except through National Road No.3.

8) Official freight rate is ₱0.70 per ton-km., but due to competition, actual freight rate is ₱0.30 to ₱0.45 per ton-km. Ordinarily, however, ₱0.50 is applied to the Dalton Pass section.

9) Actual load of trucks seldom surpasses its capacity because of the difficult passage of Dalton Pass.

10) Groceries and construction materials from Manila are usually transported as back load of the trucks that transport palay to Manila.

(2) Grain Transportation

1) When Dalton Pass is closed, the price of rice in Cagayan Valley sometimes declines slightly. The price in Manila however, does not change because of its large stock.

2) About 60% to 70% of palay and corn produced in Cagayan Valley is marketable surplus. All of these are brought to Manila crossing the Dalton Pass.

3) Even when Dalton Pass is closed, rice trucks never detour via Patapat. They patiently wait for the re-opening of the Pass.

4) Grain production in Cagayan Valley is slowly but steadily increasing.

(3) Lumber Transportation

1) About one-half of the lumber produced in Cagayan Valley goes to Port Aparri. The remaining half goes to Manila across the Dalton Pass.

2) Shipping lumber to Aparri or to Manila is decided by market condition or contract agreement, not by the condition of Dalton Pass.

3) Even when Dalton Pass is closed, lumber trucks never detour via Patapat.

4) Price of lumber does not change, either in Manila or in Cagayan Valley, even when Dalton Pass is closed.

(4) Fuel Transportation

1) All fuel stations north of Alicia, Nueva Vizcaya, are supplied with fuel from Aparri. All the stations south of Alicia are supplied from Manila. Alicia is the splitting point.

2) When Dalton Pass is closed, all the fuel stations in Cagayan Valley are supplied with fuel from Aparri.

3) Fuel stations cannot raise their selling price of the fuel, even when Dalton Pass is closed, due to government control.

4) Tank lorries never use the detour via Patapat.

3-2 Traffic Counting

3-2-1 Purpose of the Traffic Counting

The purpose of traffic counting is to determine the total volume of the existing or base year traffic and the distribution of the total volume by vehicle classification, although other useful information like hourly variation and daily variation if counting is done on a continous seven-day period may also be obtained.

3-2-2 Traffic Counting Procedure

Traffic counting was carried out manually, at the same location as the O-D survey station in Sta. Fe, on a 24-hour basis last July 17, 1981. Each vehicle type is counted separately and by directional flow. The vehicle classification or type used are those enumerated in Section 3-1-2 above.

3-2-3 Results of Traffic Counting

Shown in Table 3-2.1 are the results of the manual classification count. The hourly tally by individual vehicle type and the 24-hour summary are shown.

TABLE 3-2.1 TRAFFIC COUNT

STA. NO. 20 LOCATION C.V.R. Sta. Fe, Nueva Vizcaya 17, July 1981 (BOTH DIRECTIONS)

HOUR	VEHICLE TYPE						
	CARS	BIG BUS	MINI BUS Including Jeepneys	BIG TRUCK 6 or more tires	TRUCK-TRAILER & SEMI-TRAILER	ALL OTHERS	TOTAL
24-01	9	4	—	50	3	1	67
01-02	7	4	—	39	1	1	52
02-03	8	3	—	27	3	—	41
03-04	5	1	1	31	1	—	39
04-05	3	1	—	24	4	—	32
05-06	7	—	—	31	3	—	42
06-07	15	2	1	32	1	8	58
07-08	24	4	—	37	3	7	75
08-09	27	5	2	23	5	5	67
09-10	26	10	4	28	1	—	69
10-11	41	21	3	27	4	3	99
11-12	30	21	1	24	4	4	84
12-13	29	25	3	14	—	—	71
13-14	25	24	—	24	10	3	86
14-15	29	8	—	11	1	—	49
15-16	33	20	2	33	8	—	96
16-17	25	7	—	37	7	—	76
17-18	29	9	5	45	9	1	98
18-19	17	3	1	39	9	—	69
19-20	24	4	—	44	3	—	75
20-21	12	7	1	47	1	—	68
21-22	11	6	—	54	1	—	72
22-23	11	8	—	47	2	6	74
23-24	12	7	1	42	6	—	68
Σ 24 hrs.	459	204	25	811	90	39	1,628

To check the reliability and consistency of results of the 24-hour count with the Annual Average Daily Traffic (AADT) the data collection on the seasonal factors for the section was made. However, no data on seasonal factors applicable for the section was available. The data available on seasonal factors of the nearest station is in San Jose and approximately 60 km. south of Sta. Fe. Therefore, the traffic count in Table 3-2.1 has been assumed to represent the AADT at Dalton Pass. For reference, the seasonal factors at San Jose are shown in Table 3-2.2.

TABLE 3-2.2 SEASONAL FACTORS FOR JULY IN SAN JOSE

Cars	1.08
Big Bus	1.16
Mini bus	1.02
Big Truck	1.02

Source: NTPP/NEDA/MPH Traffic Survey 1979

3-3 Forecast of Traffic

3-3-1 Basic Concept

(1) The traffic on Dalton Pass is composed mainly of the vehicle trips between Manila and Cagayan Valley. The socio-economic capacity of Cagayan Valley is very small as compared with that of Manila. Accordingly, the traffic on Dalton Pass should be considered to depend not on the capacity of Manila but on that of Cagayan Valley.

(2) The socio-economic capacity of the Cagayan Valley may be expressed in the transportation demand in the Valley.

(3) The growth of transportation demand may be collectively expressed in the vehicle registration in the Valley.

(4) Thus, the growth factor of the traffic on Cagayan Valley may be equal to the growth factor of the vehicle registration in the Valley.

(5) Thus, the system of the future traffic estimation on Dalton Pass may be summarized as shown in Fig. 3-3.1.

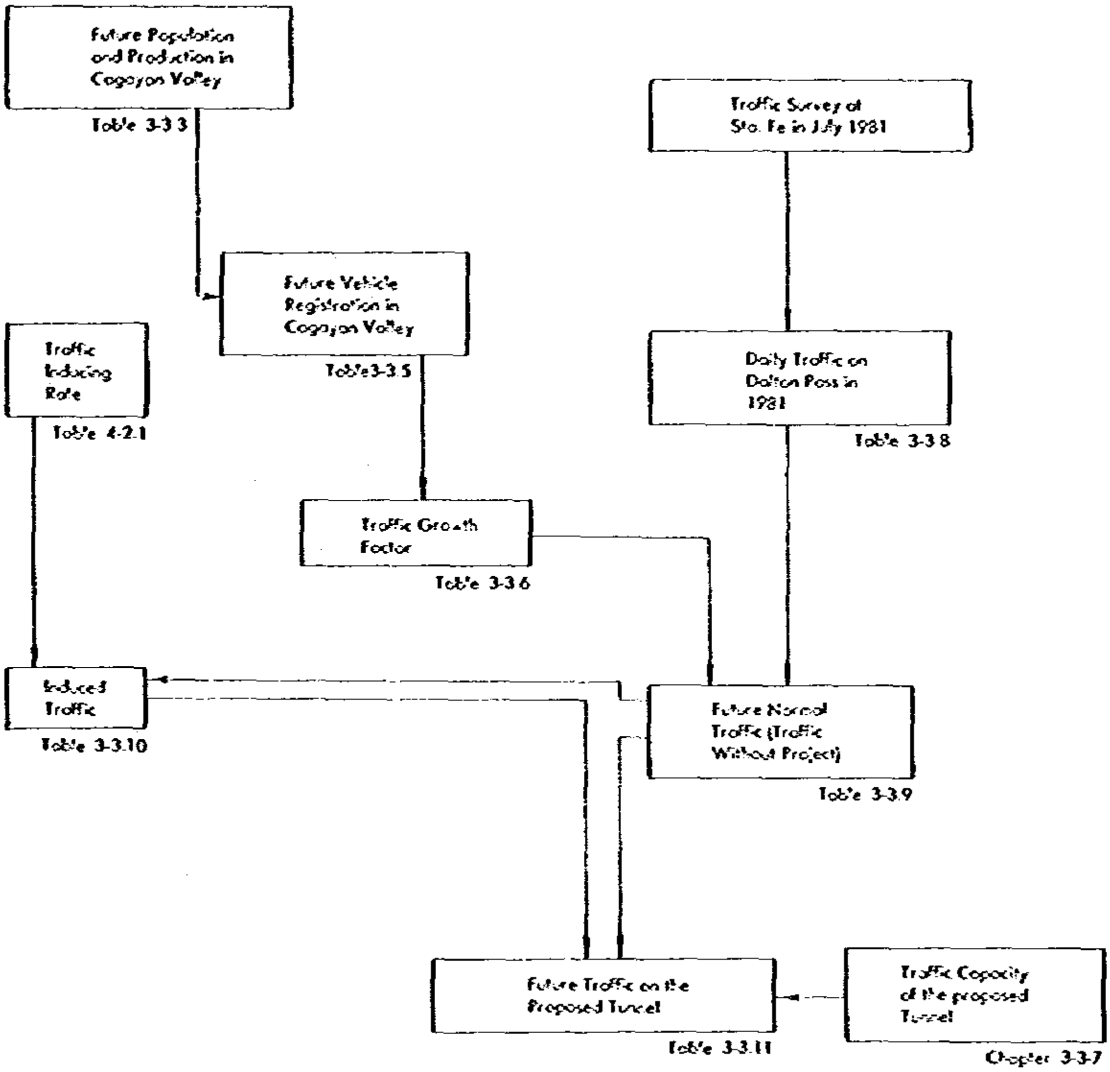


Fig. 3-3.1 SYSTEM OF FUTURE TRAFFIC ESTIMATION

3-3-2 Economic Growth of Cagayan Valley

Economics of future demographic development and regional production are taken from the "Cagayan Valley Five Year Development Plan 1978-1987". The Development Plan predicts the Cagayan Valley 1981 population of about 2,275,000 to increase to 2,696,000 in Year 1987. Likewise, regional Gross Value Added is projected to go up to ₱4,953 Million also in Year 1987 in constant prices. Please refer to Table 3-3.1 below.

TABLE 3-3.1 FUTURE POPULATION AND PRODUCTION
(Estimated Figures)

YEAR	POPULATION (in 1000 Persons)	GROSS VALUE ADDED (In Million ₱ and 1972 prices)
1981	2275	3026
1982	2341	3263
1987	2696	4953

Source: Cagayan Valley Five-Year Development Plan 1978--1987

On the other hand, the "Long Term Development Plan up to the Year 2000" (LTPDP) estimates the population of Cagayan Valley in the Year 2000 at 3,660,000. The LTPDP also estimated the N.D.P. (Net Domestic Products) of the whole Philippines in the Year 2000 at 403,203 Million Pesos (in constant 1972 prices) and the share of Cagayan Valley in the said N.D.P. in same year at 3.3% respectively (See p. 18 and p. 14, LTPDP).

Therefore, the Gross Value Added of Cagayan Valley in the Year 2000 may be estimated by the following equation:

$$403{,}203 \times 0.033 \times 1.2 \times 0.8 = 12{,}773 \quad \text{.......................... 3-3.1}$$

where:

403,203	=	N.D.P. for whole Philippines in 2000 (In Million Pesos and in 1972 prices) (LTPDP)
0.033	=	Share of Cagayan Valley in the above N.D.P. (LTPDP)
1.2	=	the factor which converts N.D.P. to gross value added (obtained empirically from the relevant figures in LTPDP)
0.8	=	the downward modification factor which considers the economic stagnation in recent years.
12,773	=	the gross value added of Cagayan Valley in 2000 (In Million Pesos and in 1972 prices)

Thus the target of the National Development Plan may be summarized as shown in Table 3-3.2.

TABLE 3-3.2 TARGET OF CAGAYAN VALLEY

YEAR	POPULATION (in 1000 Persons)	GROSS VALUE ADDED (In Million P and 1972 prices)
1981	2275	3026
1982	2341	3262
1987	2696	4953
2000	3660	12,773

Applying the linear interpolation to the intermediate years and extrapolation beyond the year 2000, a forecast of population and future economic growth of Cagayan Valley has been derived as shown in Table 3-3.3.

3-3-3 Traffic Growth Factor for Dalton Pass

The future vehicle registration in Cagayan Valley is estimated by the following equation (so-called Douglas Function).

$$Q = \alpha \cdot Y^{\beta} \cdot P^{\gamma-\beta} \quad \text{(3-3.2)}$$

where :

Q = Vehicle Registration (100 vehicles)

Y = Gross Value Added (In Million Pesos in 1972 prices)

P = Population (1000 persons)

α, β, γ = Parameter

Table 3-3.4 shows the parameters obtained from registration analysis.

TABLE 3-3.3 ECONOMIC GROWTH IN CAGAYAN VALLEY

Year	Population (in 1000 persons)	Gross Value Added (in million pesos and in 1972 prices)	Growth Factor of per capita G.V.A. (1981=1.00)
1981	2275	3026	1
1982	2341	3263	1.04792
1983	2412	3601	1.12243
1984	2483	3939	1.19267
1985	2554	4277	1.25901
1986	2625	4615	1.32177
1987	2696	4953	1.38121
1988	2770	5555	1.50771
1989	2844	6157	1.62762
1990	2918	6759	1.74144
1991	2993	7361	1.84902
1992	3067	7963	1.95198
1993	3141	8565	2.05009
1994	3215	9167	2.14367
1995	3289	9769	2.23305
1996	3363	10371	2.3185
1997	3438	10973	2.39956
1998	3512	11575	2.47787
1999	3586	12177	2.55295
2000	3660	12779	2.62499
2001	3734	13381	2.69418
2002	3808	13983	2.76068
2003	3882	14585	2.82464
2004	3957	15187	2.88548
2005	4031	15789	2.94479
2006	4105	16391	3.00196
2007	4179	16993	3.0571
2008	4253	17595	3.11033
2009	4327	18197	3.16173
2010	4402	18799	3.21068
2011	4476	19401	3.25870
2012	4550	20003	3.30519
2013	4624	20605	3.35017
2014	4698	21207	3.39374
2015	4772	21809	3.43596

Note: The growth factor of Per Capita G.V.A. in this table is referred to hereafter in this report as the time value growth factor.

TABLE 3-3.4 PARAMETERS FOR EQUATION 3-3.2

VEHICLE	α	β	γ	R
Car	1.1×10^{-5}	1.0×10^{-5}	2.0	0.98
Bus	2.664×10^{-7}	0.26	2.2	0.95
Truck	5.984×10^{-5}	0.03	1.8	0.94

The data used for regression are shown in Table 3-3.5.

Equation 3-3.2 using the data shown in Table 3-3.5 would thus give the estimated future (1985-2015) vehicle registration of Cagayan Valley as shown in Table 3-3.6. For the reasons stated in Chapter 3-1, the Study Team has decided to use the growth factor in Table 3-3.6 as the traffic growth factor for Dalton Pass.

Table 3-3.7 shows the yearly increasing rate which is translated from the growth factor in Table 3-3.6, and is assumed as the yearly increasing rate of traffic at Dalton Pass in the future.

For estimating the traffic growth factor, three methods applicable for this Study were considered.

i) Method utilizing the growth trend based on past statistics

ii) Prevailing model being applied in the Philippines.
Traffic Growth Factor = CP · (1+(I−1) · E)
where: CP = Population
I = Per capita GVA
E = Elasticity (1.8 for car, 1.0 for bus)

iii) The traffic forecast model used in the Study which is a function of the vehicle registration statistics.

However, for the first method, no sufficient and reliable data applicable for the Study could be obtained. To determine whether the second or third method mentioned above shall be applied to the Study, the effectiveness of the methods was calibrated by applying the past actual statistics from 1978 to 1979.

Growth factors computed on the basis of traffic volume and vehicle registration are shown below:

Item \ Year		1978	1979	Growth Factor 1978~1979
Average Traffic Volume of three Stations on Route 5 in Cagayan Valley (Sta 1100, 1110, 1112) Vehicles/day	Car	657	762	1.16
	Bus	197	237	1.20
Vehicle Registration in Cagayan Valley vehicles	Car	4900	5500	1.12
	Bus	500	600	1.20
Growth Factor estimated by the Prevailing Philippine Models TGF =CP. (1+(I−1) · E)	Car			1.22
	Bus			1.13
Population in Cagayan Valley (in 1000 persons)		2100	2159	1.03 (CP)
Per capita GVA in Cagayan Valley (Pesos/Persons)		1101	1211	1.10 (I)

Source : Average traffic volume was taken from the internal materials of Feasibility Study Division of PPDO, MPWH

Note 1 : Other socio-economic statistics were taken from Table 3-3.5

Note 2 : Trucks were not included for the analysis because of insufficient data.

The results of analysis shows that the growth factor by vehicle registration with the actual recorded rate is better than that estimated by the prevailing Philippine model. Thus, the Traffic Growth Method by vehicle registration was adopted for this study.

TABLE 3-3.5 DATA USED FOR THE REGRESSION ANALYSIS OF THE EQUATION 3-3.2

YEAR	Population (in 1000 persons) (1)	Gross Value Added (In Million ₱ and 1972 prices (1)	Vehicle Registration		
			Car	Bus	(2) Truck
1971	1737	1742	3200	200	3700
1972	1784	1903	3300	400	4200
1973	1832	2157	3500	400	4000
1974	1881	2062	3600	500	4900
1975	1932	1809	4500	500	5200
1976	1986	2040	4400	500	5200
1977	2042	2150	4700	600	6800
1978	2100	2313	4900	500	5500
1979	2159	2615	5500	600	5400
1980	2220	2707	5600	700	6500
1981	2275	3026	5800	700	6800
1982	2341	3263	6100	800	7100
1983	2412	3601	6400	800	7400
1984	2483	3939	6600	900	7700
1985	2554	4277	6900	900	8000

Note:

1. The figures up to 1980 are actual results gathered from the internal materials of the Feasibility Study Division of PPDO. As for the estimated figures after 1981, see Chapter 3-3-3.
2. See "Interim Report on Central and Northern Luzon, Part III (Book I or 3)" Table III-I-A.3 and Table III-I-A.5, National Transport Planning Project.

TABLE 3-3.6 FUTURE VEHICLE REGISTRATION AND ITS GROWTH FACTOR IN CAGAYAN VALLEY

Year	Vehicle Registration			Growth Factor of Vehicle Registration (1981=1.00)		
	CAR	BUS	TRUCK	CAR	BUS	TRUCK
1985	7200	1000	8300	1.26	1.36	1.24
1986	7600	1000	8700	1.23	1.47	1.30
1987	8000	1100	9100	1.40	1.58	1.37
1988	8400	1200	9600	1.48	1.71	1.44
1989	8900	1300	10100	1.56	1.85	1.51
1990	9400	1400	10600	1.65	1.99	1.59
1991	9900	1500	11100	1.73	2.14	1.66
1992	10300	1600	11600	1.82	2.29	1.74
1993	10800	1700	12200	1.91	2.45	1.82
1994	11400	1800	12700	1.99	2.60	1.90
1995	11900	1900	13200	2.09	2.77	1.98
1996	12400	2000	13800	2.19	2.94	2.07
1997	13000	2200	14400	2.98	3.11	2.15
1998	13600	2300	14900	2.38	3.29	2.24
1999	14100	2400	15500	2.48	3.47	2.33
2000	14700	2500	16100	2.58	3.65	2.42
2001	15300	2700	16700	2.69	3.84	2.51
2002	15900	2800	17300	2.80	4.04	2.60
2003	16600	3000	18000	2.91	4.24	2.69
2004	17200	3100	18600	3.02	4.45	2.79
2005	17900	3200	19300	3.13	4.66	2.89
2006	18500	3400	19900	3.25	4.87	2.99
2007	19200	3600	20600	3.37	5.09	3.08
2008	19900	3700	21200	3.49	5.31	3.19
2009	20600	3900	21900	3.61	5.54	3.29
2010	21300	4000	22600	3.74	5.78	3.39
2011	22000	4200	23300	3.87	6.02	3.50
2012	22800	4400	24000	4.00	6.26	3.60
2013	23500	4500	24700	4.13	6.51	3.71
2014	24300	4700	25500	4.26	6.77	3.82
2015	25000	4900	26200	4.39	7.03	3.93

Note: The growth factor of vehicle registration in this Table is referred to hereafter in this report, as the traffic growth factor for Dalton Pass.

TABLE 3-3.7 YEARLY INCREASING RATE OF VEHICLE REGISTRATION IN CAGAYAN VALLEY

YEAR	CAR	BIG BUS AND MINI BUS	BIG TRUCK AND OTHERS
1985	.058	.079	.054
1986	.056	.076	.052
1987	.055	.073	.051
1988	.056	.086	.053
1989	.054	.081	.051
1990	.053	.077	.049
1991	.052	.074	.049
1992	.050	.070	.047
1993	.049	.067	.045
1994	.048	.065	.044
1995	.047	.063	.043
1996	.046	.060	.042
1997	.045	.059	.042
1998	.044	.057	.040
1999	.043	.055	.039
2000	.042	.054	.038
2001	.041	.052	.037
2002	.040	.051	.037
2003	.039	.049	.036
2004	.039	.049	.036
2005	.038	.047	.035
2006	.037	.046	.034
2007	.036	.045	.033
2008	.036	.044	.033
2009	.035	.043	.032
2010	.035	.043	.032
2011	.034	.041	.031
2012	.033	.041	.030
2013	.033	.040	.030
2014	.032	.039	.029
2015	.032	.038	.029

3-3-4 Present Daily Traffic at Dalton Pass

The volume and composition of the present traffic on the Dalton Pass section was determined through a 24-hour manual traffic classification count conducted on 17 July 1981 at Sta. Fe. Shown by vehicle type in Table 3-3.8 is the present daily traffic.

TABLE 3-3.8 PRESENT TRAFFIC AT DALTON PASS
(Vehicle/24 hours)

TYPE	TRAFFIC VOLUME	
Cars	459	(including vans and wagons)
Big Bus	204	(with capacity more than 30)
Mini bus	25	(including jeepneys)
Big Truck	901	(with 6 or more tires)
Others	35	(vehicles not categorized above)
Total	1,628	

3-3-5 Future Traffic on Dalton Pass

Applying the growth factor in Table 3-3.6 to the present daily traffic in Table 3-3.8, the future traffic on Dalton Pass in Table 3-3.9 is obtained.

The traffic in Table 3-3.9 is the total traffic "without the project" and at the same time, is equal to the normal traffic on the proposed tunnel.

The induced traffic on the proposed tunnel are shown in Table 3-3.10. The method for estimating the induced traffic is discussed in full detail in Chapter 7. The Table 3-3.11 gives the total daily traffic on the proposed tunnel, equal to the summation of the normal traffic on Table 3-3.9 and the induced traffic on Table 3-3.10.

3-3-6 Impact of On-going Construction Projects

The present traffic on the project road includes passenger trips and commodity transfers generated by the on-going construction of the multi-purpose (power generation, irrigation, water supply and flood control) Magat River Project in Ramon, Isabela. This traffic therefore, would cease to exist after completion of construction which is expected in December 1982.

The volume of Magat construction traffic has been assessed through the results of the origin-destination survey undertaken, as part of the feasibility studies at Sta. Fe on July 16, 1981.

TABLE 3-3.9 DAILLY NORMAL TRAFFIC OF THE PROPOSED TUNNEL

YEAR	CAR	BIG BUS	MINI BUS	BIG TRUCK	OTHER	TOTAL
1986	610	300	37	1171	51	2169
1987	643	322	40	1234	53	2292
1988	679	351	43	1297	56	2427
1989	716	377	46	1370	59	2568
1990	757	408	50	1433	62	2710
1991	794	439	54	1505	65	2856
1992	835	469	58	1577	68	3007
1993	877	500	61	1649	71	3158
1994	918	532	65	1721	74	3311
1995	959	565	69	1793	78	3464
1996	1005	600	74	1865	81	3624
1997	1047	634	78	1946	84	3789
1998	1092	671	82	2027	88	3961
1999	1138	708	87	2099	91	4123
2000	1189	747	92	2180	94	4302
2001	1235	785	96	2262	98	4476
2002	1285	824	101	2352	102	4664
2003	1336	865	106	2433	105	4845
2004	1391	908	111	2523	109	5042
2005	1441	951	117	2604	113	5225
2006	1496	996	122	2694	117	5424
2007	1547	1040	128	2784	121	5619
2008	1602	1085	133	2874	124	5819
2009	1662	1132	139	2964	128	6025
2010	1717	1181	145	3063	133	6239
2011	1776	1230	151	3154	137	6447
2012	1836	1279	157	3253	141	6665
2013	1896	1330	163	3352	145	6886
2014	1955	1381	169	3451	149	7106
2015	2020	1434	176	3550	154	7333

TABLE 3-3.10 DAILY INDUCED TRAFFIC ON THE PROPOSED TUNNEL

YEAR	CAR	BIG BUS	MINI BUS	BIG TRUCK	OTHER	TOTAL
1986	0	0	0	0	0	0
1987	0	0	0	0	0	0
1988	0	0	0	0	0	0
1989	0	0	0	0	0	0
1990	0	0	0	0	0	0
1991	52	37	4	129	4	225
1992	55	39	4	135	4	237
1993	57	42	4	141	4	249
1994	60	44	5	147	4	261
1995	63	47	5	154	4	273
1996	66	50	5	160	5	285
1997	68	53	6	167	5	298
1998	71	56	6	174	5	312
1999	74	59	6	180	5	325
2000	78	62	7	187	5	339
2001	81	66	7	194	6	352
2002	84	69	7	201	6	367
2003	87	72	8	208	6	381
2004	91	76	8	216	6	397
2005	94	79	8	223	6	411
2006	98	83	9	231	7	427
2007	101	87	9	238	7	442
2008	105	91	10	246	7	458
2009	109	94	10	254	7	474
2010	112	99	11	262	8	491
2011	116	103	11	270	8	507
2012	120	107	11	278	8	525
2013	124	111	12	287	8	542
2014	128	115	12	295	9	559
2015	132	120	13	304	9	577

Note: See Chapter 7-2 for estimation of Induced Traffic.

TABLE 3-3.11 TOTAL DAILY TRAFFIC OF THE PROPOSED TUNNEL

YEAR	CAR	BIG BUS	MINI BUS	BIG TRUCK	OTHERS	TOTAL
1986	610	300	37	1171	51	2169
1987	643	322	40	1234	53	2292
1988	679	351	43	1297	56	2427
1989	716	377	46	1370	59	2568
1990	757	408	50	1433	62	2710
1991	846	475	58	1634	69	3081
1992	890	508	62	1712	72	3244
1993	934	542	66	1790	75	3407
1994	978	577	70	1868	79	3572
1995	1022	612	74	1947	82	3737
1996	1071	650	79	2025	85	3910
1997	1115	687	83	2113	89	4088
1998	1164	727	88	2201	93	4273
1999	1213	767	93	2279	96	4448
2000	1266	809	98	2367	100	4640
2001	1315	851	103	2455	103	4828
2002	1369	893	108	2553	108	5031
2003	1423	937	114	2641	111	5226
2004	1482	984	119	2739	115	5439
2005	1535	1030	125	2827	119	5636
2006	1594	1079	131	2925	123	5851
2007	1648	1127	137	3022	127	6062
2008	1707	1176	143	3120	132	6277
2009	1770	1227	149	3218	136	6499
2010	1829	1280	155	3326	140	6730
2011	1892	1333	162	3424	144	6955
2012	1956	1386	168	3531	149	7190
2013	2020	1441	175	3639	153	7427
2014	2083	1496	182	3746	158	7665
2015	2152	1554	189	3854	162	7910

Note: Table 3-3.11 = Table 3-3.9 + Table 3-3.10

The 24-hour O-D survey revealed that about 5,850 tons of commodities are transported over the Dalton Pass section through Route 5 by about 580 heavy trucks and truck trailers per day. The rest of the truck trips recorded are empty backhaul. Portland cement and other construction materials represent approximately 15% of 1,060 tons. In terms of vehicles, this share would be roughly 70 heavy vehicles consisting of 25 to 30 ton trucks, truck trailers and bulk cement tanks mounted on low bed trailers. Then, by selecting the relevant O-D pairs of traffic zones, the corresponding Magat construction truck trips are estimated. For portland cement, Zones 10, 11 and 15 are the most likely zones of origin and Zone 8 which includes Ramon in Isabela is the destination; for steel products, Zone 15 is chosen as the zone of origin. The daily truck-trips, both ways, between the above zones has thus been calculated to be about 38 equal to 4% of the 901 truck trips per day through the Dalton Pass section, or 2% of the total 1628 vehicle per day in base year 1981 and being very minimal has not been given due consideration in further analysis.

The passenger vehicle trips generated by the Magat Project has not been estimated by the Study Team as this volume would be negligible.

3-3-7 Traffic Capacity of the Proposed Tunnel

The forecasted traffic in Table 3-3.11 is always lower than the traffic capacity shown below. The method of estimating the capacity is expressed in the equations hereunder. Since the capacity of a tunnel is considered critical, computation will be made for this section.

At first, the hourly traffic capacity was computed by the following equations:

$$C = C_B \times \gamma_L \times \gamma_C \times \gamma_T \times \gamma_I$$

where:

C = Hourly capacity (vehicles/day)

C_B = Basic capacity (2500 vehicles/hour)

γ_L = Modification factor by lane width
(In this case, γ_L=0.96)

γ_C = Modification factor by lateral clearance
(In this case, γ_C=0.75)

γ_T = Modification factor by big-size traffic; γ_T is computed by the following formula:

$$\gamma_T = \frac{100}{100 - P_T + E_T \cdot P_T} = 0.495$$

where:

P_f = Percentage of big size traffic (%)

E_f = Equivalent Factor to car

(In this case, I = 4%, T =68%, therefore E_f = 2.5)

γ_I = This factor is not applicable in this case

Applying all factors aforementioned, the hourly capacity is computed as follows:

$$C = C_B \times \gamma_L \times \gamma_C \times \gamma_T \times \gamma_I$$
$$= 2500 \times 0.96 \times 0.75 \times 0.495 = 891 \text{ vehicles/hour}$$

Finally the capacity per day was estimated by the following equations:

$$V = \frac{100\,C}{K}$$

where:

V = Capacity per day (vehicles/day)

C = Hourly capacity (in this case 891 vehicles/hour)

K = Peak hour ratio (6%)

therefore,

$$V = \frac{100\,C}{K} = \frac{100 \times 891}{6} = 14{,}850 \text{ vehicles/day}$$

3-3-8 Diesel Vehicle Ratio

In the Philippines, the share of diesel vehicles is very large. In the O-D survey undertaken for this study, the diesel vehicle sharing was not included. However, presented here is Table 3-3.12 showing the diesel vehicle share obtained from a survey at San Jose in 1980.

TABLE 3-3.12 SHARE OF DIESEL VEHICLE OF SAN JOSE (In 1980)

AADT 1980	GAS		DIESEL		TOTAL	
	No. of Vehicle	%	No. of Vehicle	%	No. of Vehicle	%
Cars	424	72.6	162	27.6	586	100
Big Bus	4	1.9	204	98.1	208	100
Mini Bus	41	32.3	85	67.7	126	100
Big Truck	7	1.0	720	99.0	727	100
Trk/Tlr Sem/Tlr	1	1.4	101	98.6	102	100

Note: Trk = Truck

Tlr = Trailer

Sem/tlr = Semi-Trailer

Chapter 4.

STUDY OF TOPOGRAPHY AND GEOLOGY

CHAPTER 4
STUDY OF TOPOGRAPHY & GEOLOGY

4-1 Topographical Study

4-1-1 Topographic Mapping

(1) Objective

The objective of this survey (Phase I) is the compilation of a topographic map which will be used as the basic map for the study of the Dalton Pass Tunneling Project, and the Scope of Work includes the aerial photography, ground survey, and compilation work. Each work was thoroughly carried out so as not to impede the subsequent geological survey and feasibility study.

(2) Survey Items

1) Aerial photography

Scale	1:15,000	Area 125 km^2
Scale	1:8,000	Area 14 km^2

(See Drawing GS-25 for aerial photographic area)

2) Ground survey

Target signalization	13 point
Control point survey (traversing)	72 km
Leveling	120 km
Classification	55 km^2

3) Compilation work in Japan

Aerial triangulation	28 models
Compilation of topographic map (1:5,000 scale)	55 km^2

4-1-2 Topographic Characteristics of Section A

The topography of Section A, with a length of approximately 15 km lying between Capintalan Km. 202 and Municipality of Sta. Fe Km. 217 is generally in rugged and mountainous terrain characterized by steep slopes and serious landslides.

Parallel to the existing highway are various noticeable collapses and landslides with N-S direction. Most of these slides are distributed at the western side of the highway. It would seem therefore that the geological condition of the western side of the existing national highway is comparatively poorer than that of the eastern side. This is supported by the fact that based on the lineament map shown in Drawing GS-2 collapses and landslides are mostly found along the tectonic line of N-S direction with sympathetic NE-SW and NW-SE lines which is located on the western side of the highway. These lineaments consist of faults, sheared zones and hydrothermally altered zones.

4-1-3 Topographic Characteristics of Section B

Section B which is comprised of sections lying between Balaho-Capintalan and between Sta. Fe-Baliling, with an aggregate length of about 40 km. is characterized by flat and moderately rolling terrain made up mostly of alluvial deposits. Sediments deposited usually come from Digdig River, Sta. Fe River and other rivers that branch out from these two main rivers. However, some parts are characterized by steep slopes similar to that of Section A.

Based on the topographic map with Scale of 1:50,000, it has been observed that the side of Digdig River is almost on a straight line, with NNW-SSE direction showing a series of vertical cliffs on the western side of the river. From this point of view, it can be considered that Digdig River is a fault valley and geological condition is expected to be poor along the area near the river.

Serious damages on roadway and bridges are caused by scouring of river which occur usually during typhoons and heavy rains. Most damages are observed at the sections between Balaho and Puncan, between Digdig and Capintalan, and between Sta. Fe and Baliling.

4-2 Engineering Geology

4-2-1 General Geology

(1) Geological Sequence

Based on the reconnaissance, geological mapping has been done and the following sequence of the project site is presented in Table 4-2.1 with geological map shown in Drawing GS-3.

(2) Geological Summary

1) River Deposits

River deposits are distributed at the river beds of the Digdig River, Sta. Fe River and their respective auxillary rivers. These deposits which consisted mostly of pebbles, gravels, cobbles and sands are arranged in strata that are unsolidified. The shapes and sizes of the pebbles and gravels vary. The maximum diameter observed is more than 2.0 m.

TABLE 4-2.1 GEOLOGICAL SEQUENCE

GEOLOGICAL STAGE			STRATUM	ROCK
CENOZOIC	Quaternary	Alluvium	Alluvium	1) River deposits (sand and gravel)
				2) Talus (Breccia mixsoil and detritus)
		Dilluvium	Dilluvium	3) Terrace deposits (sand and gravel)
	Tertiary	Miocene	Sta. Fe Formation	4) Limestone
				5) Mudstone and sandstone
			Barali Formation	6) Liparitic group
				7) Intrusive Rock
		Oligocene	Caraballo Formation III	8) Andesite group
			Caraballo Formation II	9) Diabase group
MESOZOIC		Upper Cretaceous Eocene	Basement Rock	10) Granitic rock (Tonalite)

2) Talus

Talus deposits are distributed at the foot or middle parts of the mountain slopes in the project area. Talus deposits forming talus cones are unsolidified due to being recent deposits. Breccia mix clay, detritus and thin white clay are some of the materials that compose these talus deposits. The shape of the breccias observed range from sub-angular to angular with maximum diameter of less than 1.0 m.

3) Terrace Deposits

Terrace deposits are distributed on both sides of the Digdig River; its topographic features consists of several flat plains with flood plains characteristics. The strata are unsolidified; shape of breccia were observed to range from sub-angular to angular and from sub-rounded to rounded. The maximum diameter of breccia observed is less than 1.0 m.

4) Limestone

White-colored limestone included in Sta. Fe Formation is distributed around the Municipality of Sta. Fe. This area is characterized by karst topography. The limestones encountered exhibits no crack and are massive. Weathered portions of this limestone body is characterized by red-colored soils which are sometimes clayey. Such calcerous lateritic soils are called terra rossa.

5) Mudstone and Sandstone

The mudstone and sandstone bodies included in the Sta. Fe Formation are mapped on the southeastern side of the project area. The sandstone beds range from thinly bedded to thickly bedded sandstones some of which are massive. Most of the sandstones are buff in color. Mudstones are observed to be brownish to black in color and are very fine-grained. Spheroidal weathering has been observed on both sandstone and mudstone outcrops.

6) Liparitic Group

Barali Formation consists of liparite, its acidic tuff and tuff breccia. These rock types are mainly distributed around Capintalan and on the western side of Dalton Pass. This area is mountainous characterized by steep slopes. It has been noted that fresh ,unaltered parts of white-gray colored liparite are hard. Joints observed in liparite have space intervals of around 30 to 50 cm. with some protions of the liparite outcrops exhibiting columnar jointings.

7) Intrusive Rock

Intrusive rocks in the area include diorite quartz poryphyry and poryphyrite. In the course of the survey, it was found out that the quartz poryphyry and poryphyrite have limited extent and distribution. Diorite is observed to be distributed mainly on the part of the Dalton Pass area. The diorites are very hard and most of the cracks are closed. Joint interval is approximately 20 to 50 cm. The major direction of joints are NE. It has been noted that the diorites include xenoliths of sandstone and mudstone. Size of xenoliths range from 10 to 30 cm.

8) Andesite Group

The Caraballo Formation III consists of andesite, its pyroclastic rocks and the green tuff group. The distribution of the andesite group belonging to this formation is the most extensive compared to other rocks present in the area. Based on field observations, several types of andesite have been recognized as follows:

Andesite Lava
Autoclastic Andesite
Porphyritic Andesite
Andesite Tuff Breccia

The green tuff group is characteristically hard, compared with acidic tuff and forms good bedding. Alternations of thin bedded acidic tuff and green tuff have been encountered several times during the course of the survey. Average thickness is 3 to 5 cm. each and the direction of the bedding plane is N40E, 50-60W.

9) Diabase Group

Caraballo Formation II consists of diabase and its pyroclastic rocks. These rocks are mainly distributed on the eastern side of existing Route 5. Fresh parts of this group are colored green to dark green. The diabase seen within the vicinity of the existing highway is hydrothermally altered in which mineralization and clayzation have reached an advanced stage. The boundary of the andesite group and diabase is a fault contact where numerous collapses and landslides occurred.

10) Granitic Rock

Basement rock in the project site is the granitic rock which are distributed around the Municipality of Sta. Fe. Weathered parts are changed into massa-like, medium to coarse-grained sand which very often collapse during typhoons or heavy rains.

4-2-2 Geological Structure

(1) Process of Geological Activity

The geologic studies were made at Northern Luzon, the latest of which is the RP-Japan study made under the auspices of the Philippine Bureau of Mines and Japan International Cooperation Agency (JICA). From these studies, it has been deduced that Northern Luzon is divided into four tectonic provinces as shown in Fig.4-2.1: Sierra Madre area, Cagayan Valley Basin, Cordillera Central Region and the Coastal Folded Belt. It was concluded that Northern Luzon which started as a marginal sea basin attained its present topographic features due to the presence of two subduction zones, one on each side of the Luzon Island Arc. K-Ar dating shows that tectonic activities of the eastern subduction zones, better known as the Philippine Trench started earlier than that of the Manila Trench, the western subduction zone. Tectonic activities on the Philippine Trench led to the intrusion of several batholitic masses which are believed to have originated from the same plutonism and magma chamber. In this connection, the report will only concentrate on the Coastal Batholith and the Dupax Batholith because of their proximity to the project site and their effects on the structural setting of the area.

The Coastal Batholith was believed to have been intruded during the Upper Eocene-Oligocene with the Dupax Batholith following suit. (RP-Japan project-NE Luzon). The activities was termed by Gervasio (1966) as the Sierra Madre Orogenesis.

After the emplacement of the batholitic masses, the Philippine Fault which is a left lateral fault became active. The Philippine Fault located on the southern part of the project site is the most influential factor in the structural setting of the area, since most of the lineaments in the study area can be recognized as sympathetic to this major fault.

(2) Fault

Strong NNW-SSE lineaments observed are believed to be splays of the NNW- SSE trending Philippine Fault with N-S, NNE-SSW trending lineaments deduced as secondary sympathetic faults. It will be noted that the NNW-SSE faults are long and continuous, whereas the N-S and the NNE-SSE lines are short but are closely spaced. Cris-crossing fault lines can be observed on the project site with parallel faulting present on the northern part suggestive of step faulting.

Most of the faults are gravity faults with displacements ranging from a few centimeters to hundreds of meters. Some minor faults have been recognized as thrust faults.

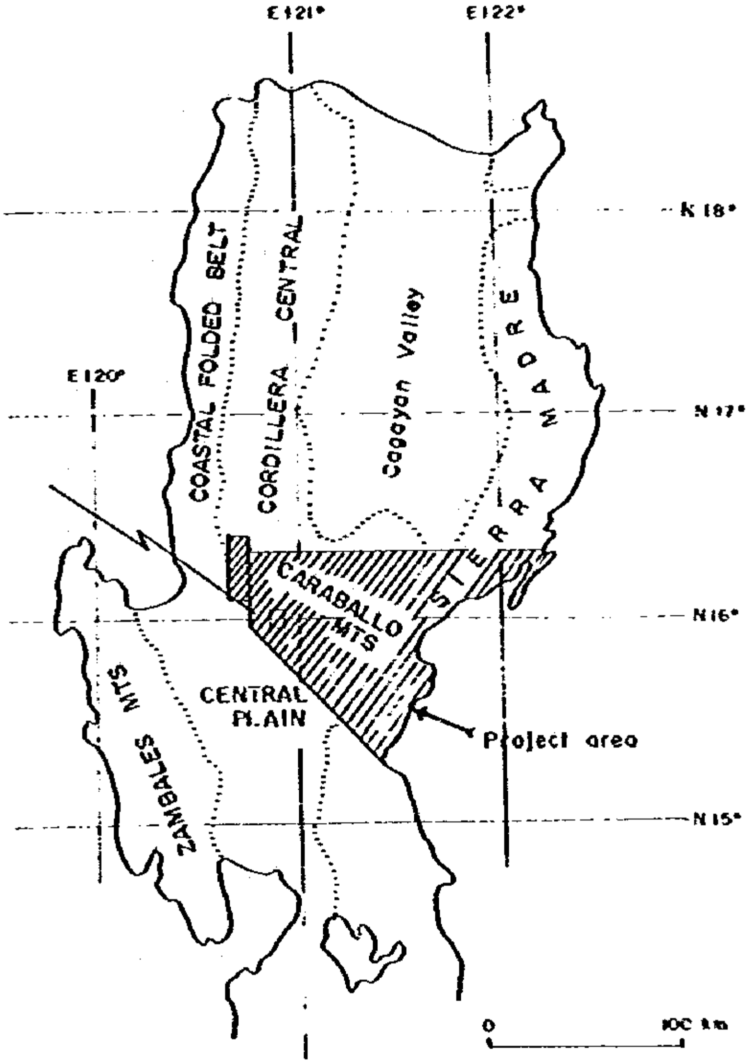


Fig. 4-2.1 TECTONIC PROVINCE

(3) Hydrothermal Altered Zone

Hydrothermal altered zone groundcheck of lineaments based on aerial photograph interpretations are characterized mostly of sheared zones with intense argillization, chloritization and at some instances serpentization. Hydrothermally altered zones have also been observed to coincide with the area where faults passed. This could be due to the fact that faults became passageways of hydrothermal/chemically active fluids that were responsible for such alterations.

Further geology of Northern Luzon is shown in Fig. 4-2.2.

4-2-3 Relation Between Failure/Landslide and Geological Condition

Based on Phase I study including Aerial Photo interpretation and field investigation, the area is considered to be dangerous zone and expected to bring disaster in the future.

In fact, many failures and landslides are distributed along the tectonic line and some of the failures were concentrated mostly in granitic rock (tonalite).

Aside from the above, most of the failures in granitic rock bear a fresh sliding plane, caused by heavy rains in a time frame of one year.

According to topographical and geological survey, many failures in this area were observed in the following geological conditions:

(1) Heavy Weathered Zone

In this area, weathering of tuff breccia and granitic rock is proceeding easily, consisting of thick weathred zone like topsoil of more than ten (10) meters under the condition of high temperature and heavy rain.

These strong weathered zone is easily eroded by heavy rains. The failures occurred mostly along the channels deepened by heavy rains, but in this case, size of the failure is relatively small.

(2) Strong Altered Zone

Strong altered zone was observed in the project site near the boundary of andesite and diabase formation. In this area, failure is arranged along the altered zone. In some places, size of failure is small but especially in the case of montimorillonite, included in the altered zone, failure develops into large landslide.

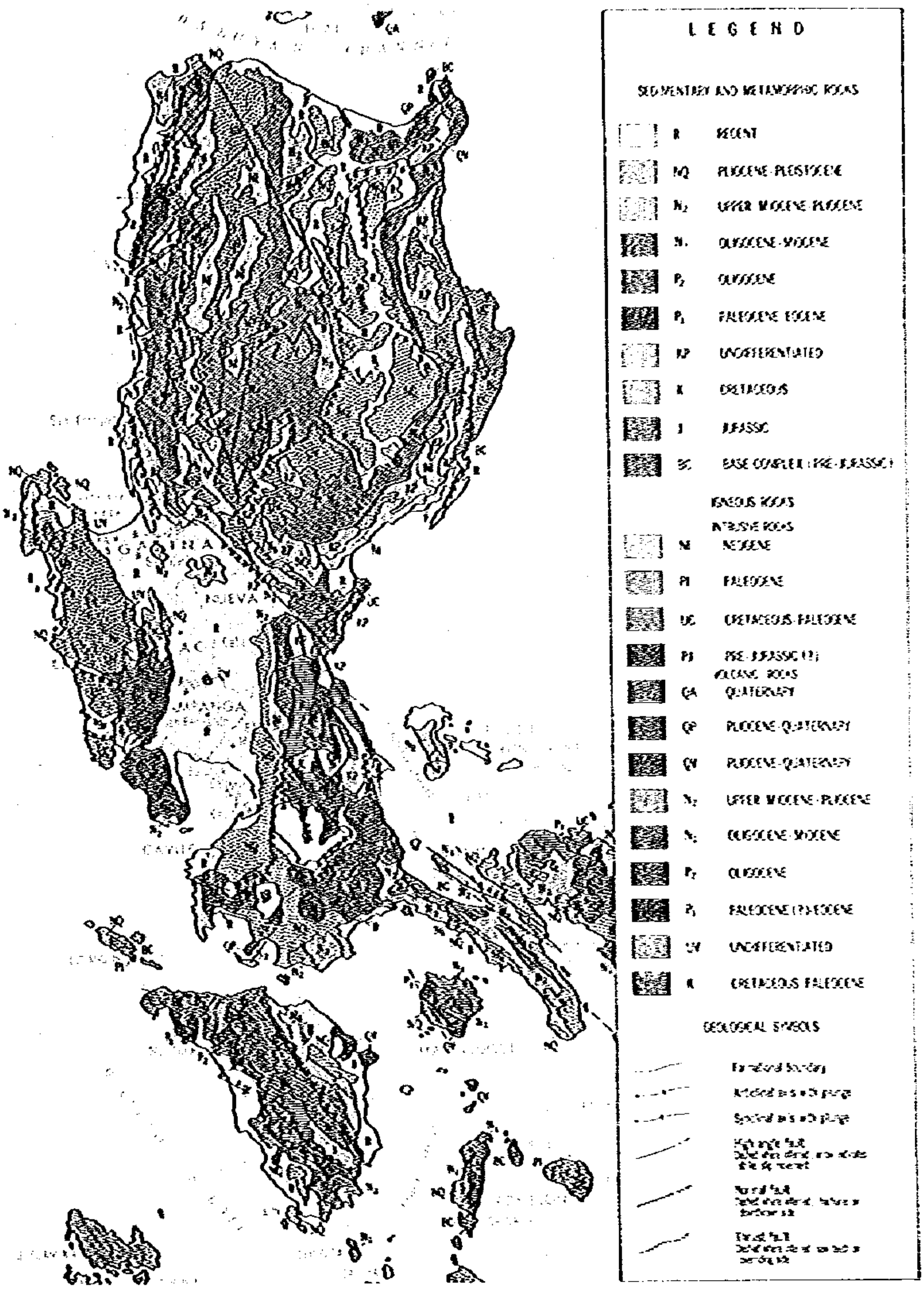


Fig. 4-2.2 GEOLOGY OF NORTHERN LUZON

Source: 1972 National Economic Atlas NND, BCGS

Generally, the altered zone connects the tectonic line with abundant ground water which is one of the causes of landslide in the area.

(3) Boundary of stratum

The boundary of stratum consists of hard rock and soft rock or topsoil, and in case the soft rock or top soil lies on the hard rock, failure occurs easily due to heavy rain because the ground water which passes through the boundary of two layers decreases the strength of boundary stratum.

(4) Lineament Failure

Some failures in this area are arranged along the lineament which generally shows the tectonic line, boundary of stratum, altered zone, etc.

4-2-4 Landslide Topography

In general, landslide topography shows a gentle slope including steep sliding cliff of arc line and most often marshes and small hills are observed at the foot of the landslide area.

Confirmation of landslide topography in the east of Sta. Fe, trending NNW and to the eastern side of Dalton Pass and to the southeastern side of Capintalan was confirmed by the aerial photograph.

Size of the landslide area is approximately 300 meters of sliding cliff and extending at 200 to 600 m.

But not all landslide topography is clear, based on aerial topography. From this point of view, it can be considered that these landslides were formed since before and were inactive.

4-2-5 Lineament of Section A

(1) Direction of Lineament in this Area

Based on the aerial photo map of Scale 1:10,000 the lineaments of Section A are as shown on Drawing GS-2.

1) The direction of lineament is excellent with N-S, NNW-SSE and NE-SW directions.

2) The lineament with N-S and NNW-SSE direction has a good continuity considering the existing tectonic line.

3) Among these three directions of lineament, the N-S direction is believed to have formed in the later stage, while the rest was formed in the same early stage.

(2) Relation between Lineament and Geology

The relation between lineament and geology is divided into four (4) areas, as shown in Drawing GS-2

1) The lineament in area A with a direction of N-S is developing remarkably, while the NW-SE direction was found branching from the N-S direction of lineament.

   Geology in this area consists of granite and diabase group relatively extending in a N-S direction. Therefore, the lineament of this area is controlled by geological distribution.

2) In area B, however, lineament trending N-S and NNW-SSE is developing through a greater distance and some of them have formed tectonic valleys. Relative to the above lineament, two other lineaments with direction of NW-SE and NE-SW are existing in short distance, thus, forming a lattice structure.

   It is considered that the lattice structure based on geology consists of granitic rock in this area.

3) In area C, a remarkable lineament trending NNW-SSE is shown running through a long distance. It is expected to have large tectonic line. On the other hand, lineament forming NNE-SSW, and N-S direction was seen with a shorter distance compared to lineament trending NNW-SSE.

   Geology of this area consists of andesite formation associated with pyroclastic rocks. Many failures were found along the lineament and is believed to exist on the tectonic line.

4) In area D, lineament trending N-S just like in area C is showing a remarkable development in long distance. In this same area, a SW-NS pattern is fast developing and was believed to consist of the base rock based on the joint direction of diabase and diorite.