CHAPTER 1
INTRODUCTION

1 INTRODUCTION

1.1 Background of the Study

National Roads Route 2 and 7 stretch for 320 kilometers and are main arterial highways linking the capital city, Asuncion (population: approximately 700,000), with the country's second largest city, Ciudad del Este (population: approximately 62,000). From east to west across the country, this road leads to Brazil and Argentina and helps link the Atlantic and Pacific sides of the continent. Moreover, in terms of traffic volume, this is the busiest road in Paraguay and was given the status of the country's main artery in the Master Plan Study of National Transportation in Paraguay implemented by JICA in 1993.

Furthermore, from the relation with the establishment of MERCOSUR (Mercado Comun del Cono Sur: South American common market) in January 1995 as shown below, freight and traffic movement within Paraguay and with the neighboring countries has intensified. The volume of trade expanded by more than three times, and the number of automobiles by four times during the decade of the 1980s. Moreover, since 80% of domestic freight transportation is carried out on roads, the construction and improvement of roads is essential for developing industry and promoting trade in the country.

National Roads Route 2 and 7 have a paved width of only 6.5 meters (two traffic lanes) and do not have any lanes for left-turning and climbing over most of their length. With the growing traffic volume, it is forecasted that it will become increasingly difficult for the routes to accommodate traffic in the future.

It was against this background that the Direction of Roads of the MOPC, acting through the Government of Paraguay, requested the Government of Japan to provide cooperation in implementing the Feasibility Study for a plan to improve National Roads Route 2 and 7 and thus secure smooth traffic flow on the routes.

In response to the request of the Government of the Republic of Paraguay, the Government of Japan decided to conduct a Feasibility Study for the Improvement of the National Road Route 2 and 7 (hereinafter referred to as "the Study") in accordance with relevant laws and regulations as a technical cooperation program of the Government of Japan.

The Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for technical cooperation programs of the Government of Japan, was assigned to undertake the Study in close cooperation with authorities concerned of the Government of Paraguay. In November 1998, JICA dispatched a mission headed by Mr. Hiromi SAITO to Paraguay to carry out the preparatory work and to discuss the Scope of Work for the Study. Furthermore, the Scope of Work and Minutes of Meeting were concluded by consultation on November 25th, 1998.

1.2 Objectives of the Study

The objectives of the Study are the following;

1) to conduct a feasibility study for the Improvement of the National Road Route 2 and 7 to the year 2010; and
2) to transfer relevant technology to Paraguay side counterpart personnel in the course of the Study.

1.3 Study Area

The study area shall cover the route between San Lorenzo and Caaguazu of the National Road Route 2 and 7 respectively (approximately 169 kilometers).

1.4 Target Year

The year 2010 shall be defined as the target year for the Feasibility Study. However, the conditions in 2020 are well taken into account in order to consider the Study within the long-term view.

1.5 Study Flow

The Study shall be implemented in two phases. The major study items of each phase are described. The overall study flow is shown in the Figure 1.5.1.

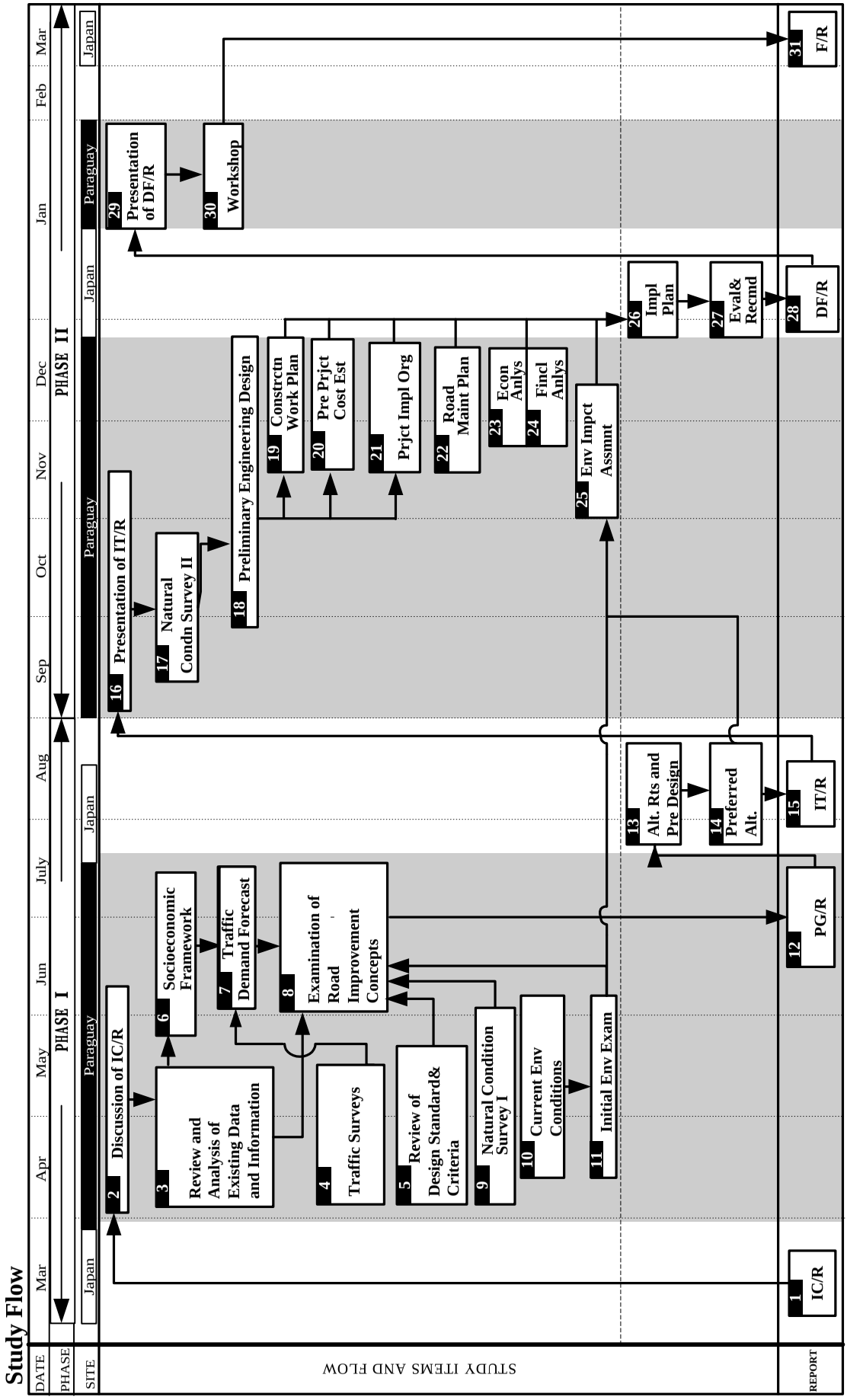

Figure 1.5.1 Study Flow

1.6 Study Organization

The Study is conducted jointly by the JICA Study Team and MOPC, which is to act as the counterpart agency, and also as a coordinating body in relation with other governmental and non-governmental organizations concerned. A Steering Committee will be organized for a smooth implementation of the Study. The study organization is shown in the Figure 1.6.1.

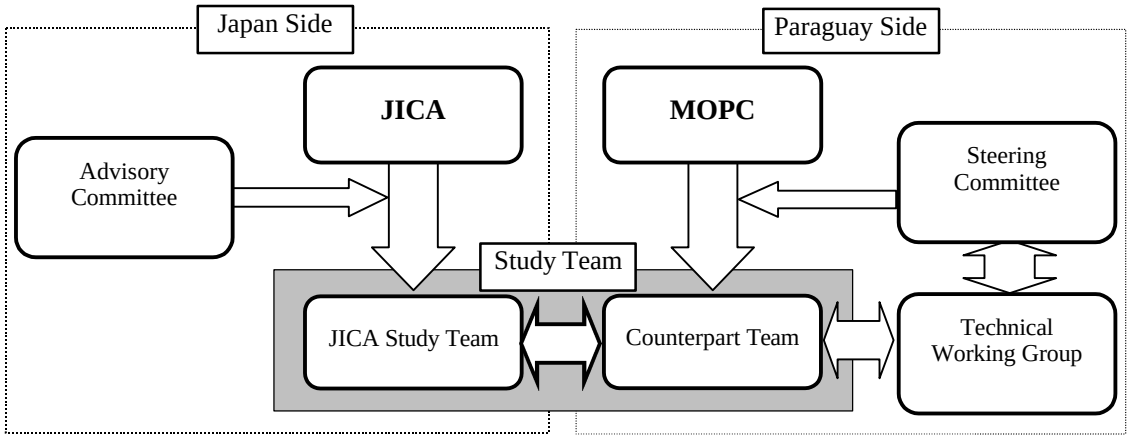

Figure 1.6.1 Study Organization

(1) Steering Committee Member

Mr. Ramón MALLEN OLMEDO	Vice Minister Ministry of Public Works and Communications
Mr. Felix ZELAYA MENDEZ	Director of Highway Directorate Ministry of Public Works and Communications
Dr. Mario RUIZ DIAZ	Director of International Cooperation Technical Planning Secretariat
Mr. Celso AYALA MARTINEZ	Infrastructure Sector Technical Planning Secretariat
Mr. Tomoaki NAKAI	Secretary, Embassy of Japan
Mr. Kaoru YANAGIDA	Embassy of Japan
Mr. Satoshi MUROSAWA	Vice Resident Representative, JICA Paraguay Office
Mr. Yoji OZAKI	Coordinator of Technical Cooperation, JICA Paraguay Office

(2) MOPC Counterpart Team (Key Staff only)

Eng. Reinaldo MACCHI	Chief, Department of Road Planning
Eng. José Ramón GOMEZ	Chief, Plans and Programs Division (DPP)
Lic. José Luis ARGAÑA	Director, Office of Transport Integral Planning (OPIT)
Econ. Manuel AQUINO	Chief, Department of Planning and Programming (OPIT)
Eng. Genaro PAREDES	Chief, Department of Transport Engineering (OPIT)
Eng. Federico GANDOLFO	Engineer, Hydrologic Study
Eng. Luis CABALLERO	Chief, Environmental Unit (UA)
Eng. Juan Carlos BALBUENA	Chief, Study and Project Division (DPP)
Eng. Yoshihiro WADA	JICA Expert

(3) Technical Working Group

Mr. Fermin LUJAN	General Secretary Ypacaraí City
Mr. Renan YEGROS	Mayor, San Jose City
Mr. Gilberto AMARILLA	Mayor, Caaguazú City
Mr. Celso AYALA	Infrastructure Secretary, STP

(4) JICA Advisory Committee

Mr. Hiromi SAITO	Chairman, Tohoku Reg. Construction Bureau, Ministry of Construction
Mr. Yoshiaki YATSUHASHI	Committee, Hokuriku Reg. Construction Bureau Ministry of Construction
Mr. Susumu YUZURIO	First Development Study Division, Social Development Study Department, JICA

(5) JICA Study Team

Mr. Toshihiro HOTTA	Team Leader / Road Plan
Mr. Mamoru SHIBATA	Regional/Transport Plan
Mr. Tetsuo HORIE	Traffic Survey/Demand Forecast
Mr. Yoshiaki NISHIKATSU	Road Design
Mr. Masashi BESSHO	Structural Design
Mr. Yoshinori TANAKA	Implementation Plan/Cost Estimates
Mr. Sanggyoon LEE	Natural Condition Survey
Mr. Kenji IGARASHI	Environmental Impact Assessment
Mr. Naoki HARA	Economic/Financial Analysis
Mr. Hiroyuki AKASO	Project Coord./Toll Road Operation Survey

1.7 Technology Transfer

Regular Technical Working Group meetings shall be held during the course of the Study, and technology shall be transferred to the counterpart. The objectives of the technical working group are to promote transfer of technology to Paraguayan engineers via joint work, and to promote technical exchange between the technical staff in Paraguay by gathering staff from related departments. To ensure a good management of the Study, it is hoped to adopt different approaches to the transfer of technology in the first and second phases of the Study in Paraguay.

Phase-1

The Study Team shall introduce its ideas about the study structure, while the local side shall provide information on local conditions and both sides shall examine important issues related to study implementation. Some members of the counterpart team have experiences of technical training programs of JICA and have good understanding of the program. In reality, however, it is difficult to apply that knowledge partially because of their workload in Paraguay. Although the Study team helped them build an inventory of roads and bridges, the lack of data accumulation made it difficult to create a good data management system. Since it is very important to create and constantly update the inventory of roads and bridges and the observation of road traffic for road maintenance and improvements, it is strongly recommended that the counterpart agency continue to strive for the establishment of such a system.

Phase-2

The Study Team shall explain the work and seek a good understanding through the project activities leading up to the Study findings (explanations at this point shall be separated from the Steering Committee that reports and discusses the preliminary study findings), while the Paraguay side shall promptly identify problems. In this way, it is anticipated that the quality of the final output of the Study will be improved.

JICA has set up an Advisory Committee in Japan to assist the Study Team by providing advice and suggestions from time to time.

In order to enable them to conduct traffic demand forecast with JICA STRADA, the Study team opened a one-week seminar to counterpart members related to traffic forecasts as well as members of a consulting firm engaged in transport studies. Furthermore, as confirmed in Phase I, a good maintenance system of infrastructure will lead to better quality and an avoidance of fatal failure. Therefore, the Study team suggested that the counterpart agency establish an organization in charge of a data management system for road operation and maintenance.

How to Advance a Workshop

The time of their themes and dates are shown in the table below with other meetings to come. The dates and the number of future meetings shown in the table below are only provisional and shall be finalized in consultation with the counterpart agency. In addition to officials from MOPC departments, the Technical Working Group continues its efforts to include representatives from environmental and city planning departments of local governments. The final structure of each meeting shall be determined in consultation with the MOPC.

Table 1.7.1 The Held Workshop Schedule

No.	Theme	Date
Phase- 1		
1	Outline and content of the Study, traffic surveys and demand forecast methodology, initial environmental examination	April 1999 (Completed)
2	Current socioeconomic conditions in the study area and Paraguay, initial environmental examination methodology	May, 1999 (Completed)
3	Present conditions and demand forecast of traffic, Road design, Conditions and structure of bridges and its design.	June, 1999 (Completed)
4	Presentation of the Progress Report	July, 1999
Phase- 2		
5	Evaluation of alternative routes and road structural plans, and selection of a preferred alternative	Sep., 1999
6	Preliminary road design	Nov., 1999
7	Structure design, cost estimates, implementation program, operation and maintenance plan	Dec., 1999

1.8 Study Schedule

The study commencing in March 1999 will be completed by March 2000 with two phases. The study schedule is shown in the next page.

Table 1.8.1 Time Schedule of the Study

Study Item	1999										2000		
	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
PHASE I													
Work in Japan													
1 Preparatory Work													
Work in Paraguay													
2 Discussion of Inception Report													
3 Review and Analysis of Existing Data and Information													
4 Traffic Surveys													
5 Review of Existing Design Standard and Criteria													
6 Formulation of Socioeconomic Framework													
7 Traffic Demand Forecast													
8 Examination of Road Improvement Concepts													
9 Natural Condition Survey I													
10 Survey of Current Environmental Conditions													
11 Initial Environmental Examination													
12 Preparation of Progress Report and Presentation to Paraguay Side													
Work in Japan													
13 Examination of Alternative Routes and Preliminary Road Structure Designs													
14 Selection of Preferred Alternative													
15 Preparation of Interim Report													
PHASE II													
Work in Paraguay													
16 Presentation of Interim Report													
17 Natural Condition Survey II													
18 Preliminary Engineering Design													
19 Construction Work Planning													
20 Preliminary Project Cost Estimates													
21 Examination of Organizations for Project													
22 Establishment of Road Maintenance Plan													
23 Environmental Impact Assessment													
24 Economic Analysis													
25 Financial Analysis													
Work in Japan													
26 Formulation of Project Implementation Plan													
27 Comprehensive Evaluation and Recommendations													
28 Preparation of Draft Final Report													
Work in Paraguay													
29 Presentation of Draft Final Report													
30 Workshop													
Work in Japan													
31 Preparation and Presentation of Final Report													

CHAPTER 2
PHYSICAL PROFILE OF THE STUDY AREA

2 PHYSICAL PROFILE OF THE STUDY AREA

2.1 Topography

Paraguay is divided by the Paraguay River into the eastern (Oriental) and the western (Occidental) regions. The Oriental Region landform ranges from lowlands to mountains, the highest elevations occurring near the border with Brazil. Chaco's vast low plain - more than 60 percent of Paraguay's total land area - is alternately flooded and parched. About 95 percent of the population is concentrated in the Oriental Region. The area of the land is 406,750 square kilometers, which is 1.1 times greater than Japan.

Although landlocked, Paraguay is bordered and crisscrossed by navigable rivers. The Paraguay River divides the country into strikingly different eastern and western regions. Both the eastern region — officially called Eastern Paraguay (Paraguay Oriental) and known as the Oriental region — and the western region — officially Western Paraguay (Paraguay Occidental) and known as the Chaco — gently slope toward and are drained into the Paraguay River, which thus not only separates the two regions but unifies them. The lowest point of elevation is the junction of Paraguay River and Parana River at 46 m. Eastern Paraguay occupies approximately 39 % of the total area of Paraguay, and contains woody hills and plains.

The elevation of the study area is approximately 320m, about the same as the capital city, Asuncion. Paraguay is surrounded by three substantially larger countries: Bolivia, Argentina, and Brazil.

Figure 2.1.1 Location Map of Study Area

In the study area, the route passes through the Departments of Cordillera and Caaguazu (See Figure 2.1.1).

The Oriental region is drained primarily by rivers that flow westward to the Paraguay River, although some rivers flow eastward to the Paraná River. Low-lying meadows, subject to floods, separate the eastern mountain from the Paraguay River. In the east, the heavily wooded Paraná Plateau extends its full length from north to south and up to 145 kilometers westward from the Brazilian and Argentine borders. The Paraná Plateau's western edge is defined by an escarpment that descends from an elevation of about 460 meters in the north to about 180 meters at the subregion's southern extremity. The plateau slopes moderately to east and south, its remarkably uniform surface interrupted only by the narrow valleys carved by the westward-flowing tributaries of the Paraná River.

The Tebicuary River – a major tributary of the Paraguay River – bisects the swampy lowland, which is broken in its central portion by rounded swells of land up to three meters in height. The main orographic features of the Oriental region include the Cordillera de Amambay, the Cordillera de Mbaracayú, and the Cordillera de Caaguazú. The Cordillera de Amambay extends from the northeast corner of the region south and slightly east along the Brazilian border. The average height of the mountains is 400 meters above sea level, although the highest point reaches 700 meters. The main chain is 200 kilometers long and has smaller branches that extend to the west and level out along the banks of the Paraguay River in the Northern Upland.

The Cordillera de Amambay merges with the Cordillera de Mbaracayú, which reaches eastward 120 kilometers to the Paraná River. The average height of this mountain chain is 200 meters; the highest point of the chain, 500 meters, is within Brazilian territory. The Paraná River forms the Salto del Guairá waterfall where it cuts through the mountains of the Cordillera de Mbaracayú to enter Paraguayan territory. The Cordillera de Caaguazú rises where the other two main mountain ranges meet and extends south, with an average height of 400 meters. Its highest point is Cerro de San Joaquín, which reaches 500 meters above sea level. This chain is not a continuous massif but is interrupted by hills and undulations covered with forests and meadows. The Cordillera de Caaguazú reaches westward from the Paraná Plateau into the Central Hill Belt.

A lesser mountain chain, the Serranía de Mbaracayú, also rises at the point where the Cordillera de Amambay and Cordillera de Mbaracayú meet. The Serranía de Mbaracayú extends east and then south to parallel the Paraná River; the mountain chain has an average height of 500 meters.

2.2 Climate

Paraguay experiences a subtropical climate in the study area. This area is humid, with abundant precipitation throughout the year and only moderate seasonal changes in temperature. During the Southern Hemisphere's summer, which corresponds to the northern winter, the dominant influence on the climate is the warm sirocco winds blowing out of the northeast. During the winter, the dominant wind is the cold pamper from the South Atlantic, which blows across Argentina and is deflected northeastward by the Andes in the southern part of that country. Because of the lack of topographic barriers within Paraguay, these opposite prevailing winds bring about abrupt and irregular changes in the usually moderate weather. Winds are generally brisk. Velocities of 160 kilometers per hour have been reported in southern locations.

The study area has only two distinct seasons: summer from October to March and winter from May to August. April and September are transitional months in which temperatures are below the midsummer averages and minimums may dip below freezing. Climatically, autumn and spring do not really exist. During the mild winters, July is the coldest month, with a mean temperature of about 18°C in Asunción and 17°C on the Paraná Plateau. There is no significant north-south variation. The number of days with temperatures falling below freezing ranges from as few as three to as many as sixteen yearly, and with even wider variations deep in the interior. Some winters are very mild, with winds blowing constantly from the north, and little frost. During a cold winter, however, tongues of Antarctic air bring subfreezing temperatures to all areas. No part of the Oriental region is entirely free from the possibility of frost and consequent damage to crops, and snow flurries have been reported in various locations.

Moist tropical air keeps the weather warm in the study area from October through March. In Asunción the seasonal average is about 24°C, with January – the warmest month – averaging 29°C. During the summer, daytime temperatures reaching 38°C are fairly common. Frequent waves of cool air from the south, however, cause weather that alternates between clear, humid conditions and storms. Skies will be almost cloudless for a week to ten days as temperature and humidity rise continually. As the soggy heat nears intolerable limits, thunderstorms preceding a cold front will blow in from the south, and temperatures will drop as much as 15°C in a few minutes.

Rainfall in the study area is fairly evenly distributed. Although local meteorological conditions play a contributing role, rain usually falls when tropical air masses are dominant. The least rain falls in August, when averages in various parts of the region range from two to ten centimeters. The two periods of maximum precipitation are March through May and October to November. For the whole area in the country, the difference between the driest and the wettest months ranges from ten to eighteen centimeters. The annual average rainfall is 127 centimeters, although the average on the Paraná Plateau is 25 to 38 centimeters greater. Asunción has recorded as much as 208 centimeters and as little as 56 centimeters of annual rainfall (See Figure 2.2.1).

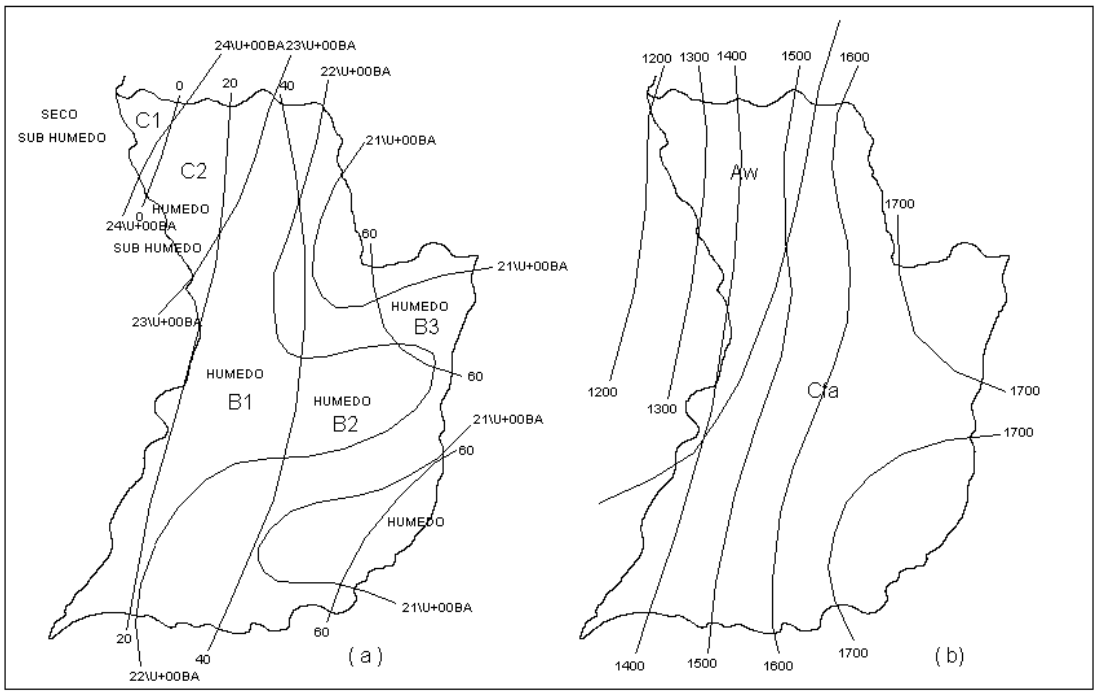

Figure 2.2.1 Climate Classification

2.3 Geology

The western Area of Paraguay River consists of deposits of the third and the fourth periods. The Geological condition in the eastern area of Paraguay River is based on the Carboniferous period in the Paleozoic era, basalt, sandstone, limestone, granite and formations of the Jurassic and Triassic period. The basalt-originated soils contain red colored fertile soil called tierra Rusia, and are distributed along the Parana River. This is considered one of the best soils in the tropical and subtropical regions of South America.

The reddish yellow soil originating from sand stone is called Asuncion soil and has the characteristics of poor permeability and a tendency towards landslides and gully erosion due to surfacial erosion (See Figure 2.3.1 Soil Map).

In the Western Chaco region, there are soils called nut-brown soil or brown soil which are saline and strongly alkaline.

Figure 2.3.2 shows the Hydro-geology.
Figure 2.3.3 shows the Geological Map of the Study Area.

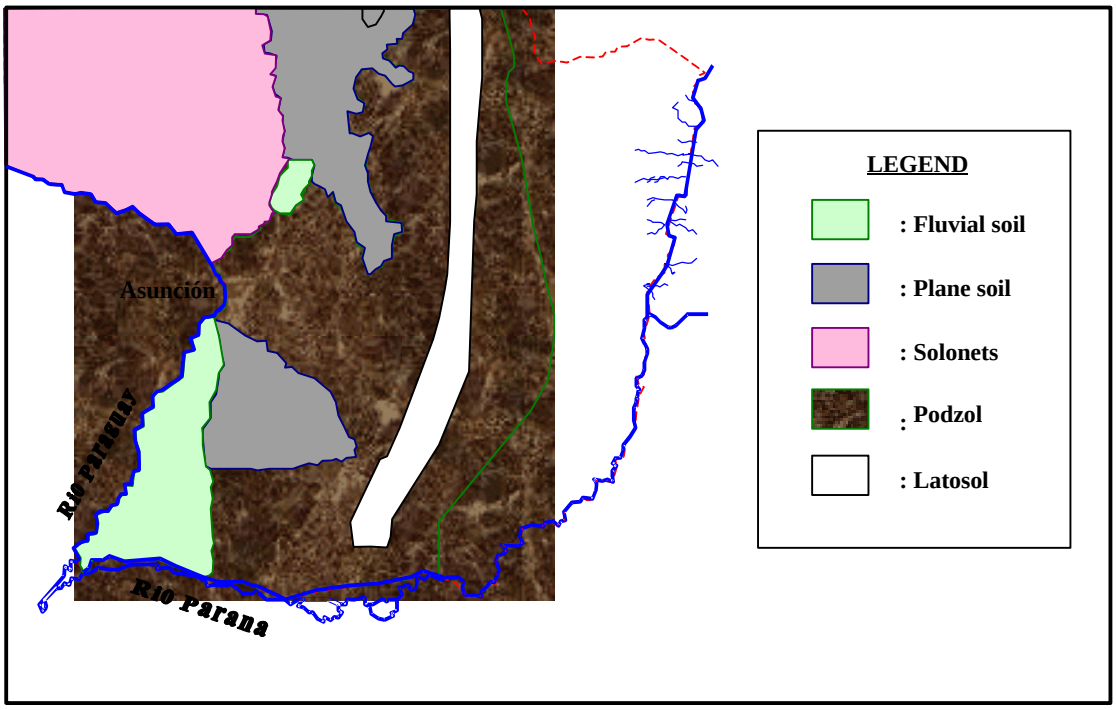

Figure 2.3.1 Soil Map

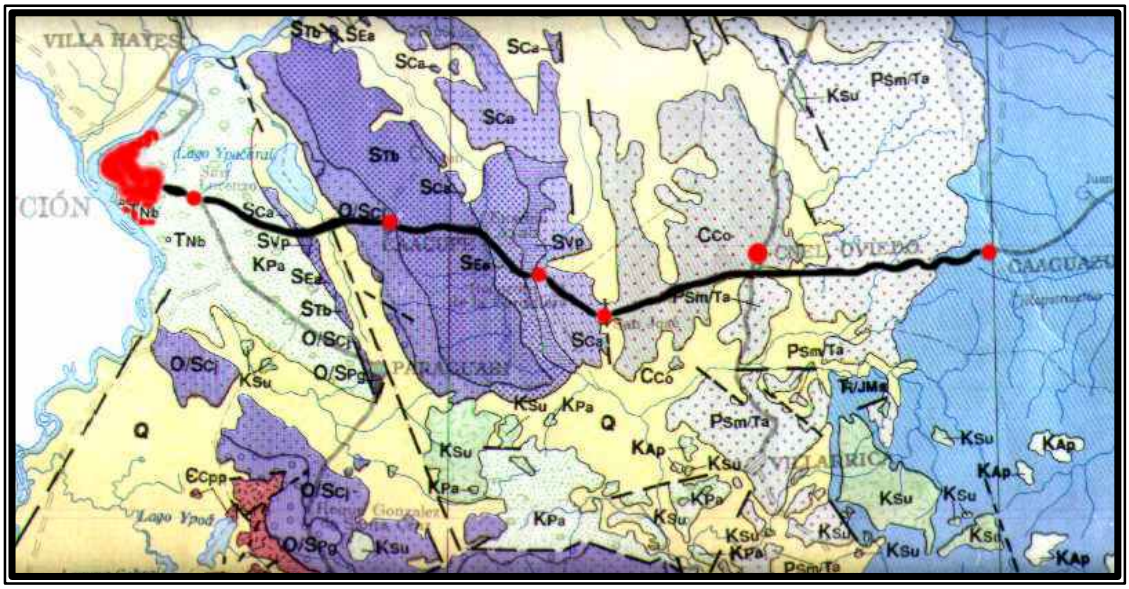

Figure 2.3.2 Hydro-geology

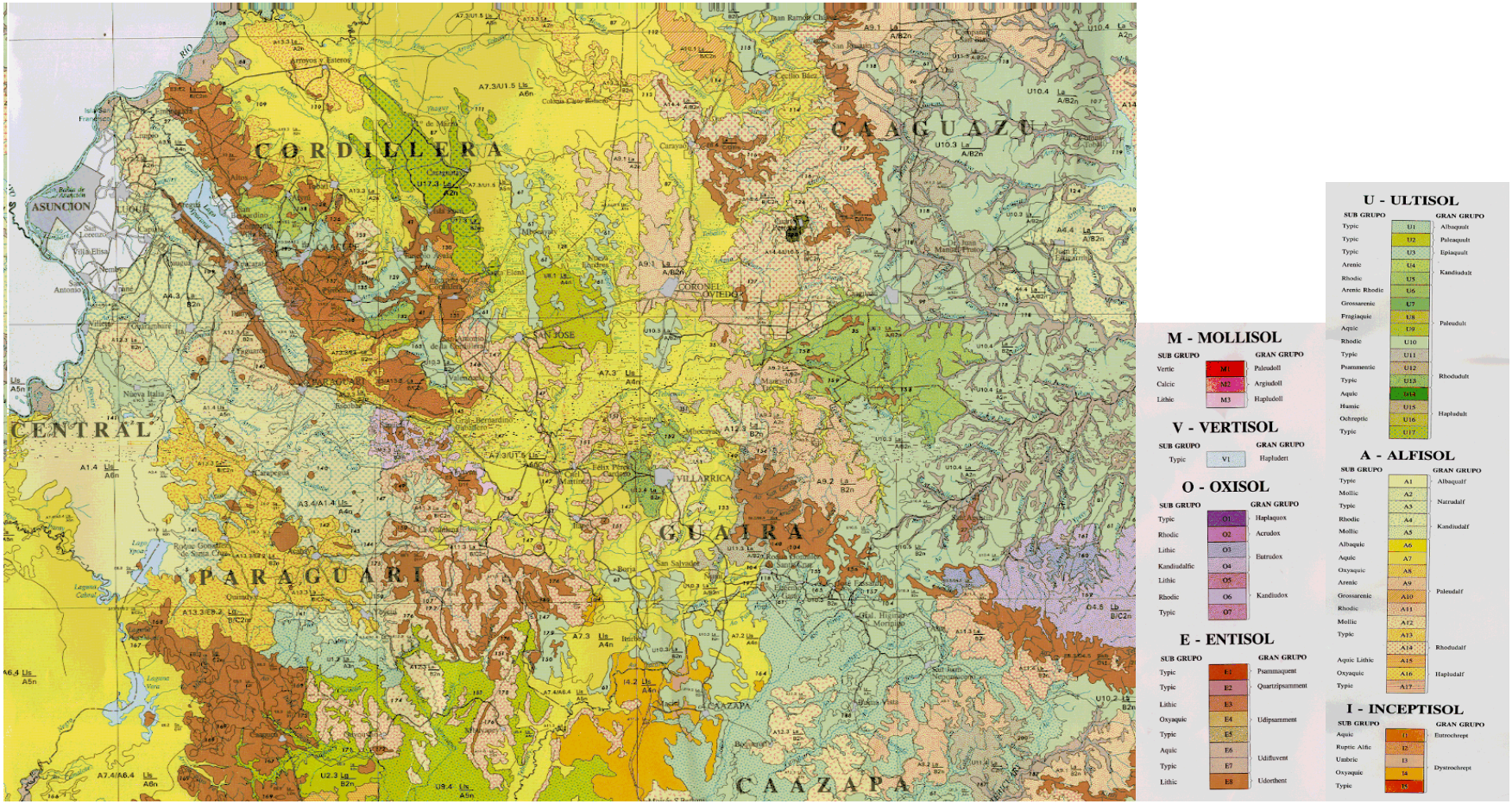

Figure 2.3.3 Geological Map of Study Area