6 INSTITUTIONAL CONDITIONS

6.1 Organization of the Ministry of Public Works

The MOP's is broadly divided in to two type of direction, the national directions and regional directions. The national directions have ten (10) departments/institutes s brain stuff department and three (3) directions as executive direction. The functions of the ten (10) departments are to plan, direct, manage, coordinate and control the plans, programs, projects developed by the MOP and the investment budget.

6.1.1 Organization of Ministry of Public Works (MOP)

The duties of the National Direction of Administration of contracts and the National Direction of Terrestrial Transport is to administer, lead, coordinate, control and decide, on the necessary finance and the application of the appropriate technology for the design, contract and acceptation of works that performs the Ministry by contract, settle down and give maintenance to the systems and procedures required, in order to coordinate the executin of the agreements of lends with International Financement Organisms; supervise the works road, performed by promoter and privae contracors, the ame as those peformed by the Executive Direction of the Minstry of Public Works.

(1) General Secretariat

a) To represent the Ministry for assignment of the Minister and/or Vice-Minister in the Directive Meetings or any other activity dterminated by the superior level.
b) To coordinate actions, between the Directors and the Superior Dispatch the same as, coordinate specify tasks in others MOP's administrative units for delegation of the Superior Dispatch.
c) To receive the correspondence that arrives to the Superior Authority and to make the revision, classification and distribution, according to matters of the Administrative Units with the purpose of making agile the corresponding answers.

(2) DIPDI:Institutional Development and Programming Direction.

a) To plan, direct and coordinate the elaboration of policies, plans, programs and projects developed by MOP in coordination with other institutions and the National Government.
b) To formulate, manage, perform and control MOP's functioning and investment budget, in coordination with the different performing units that comprise it. These

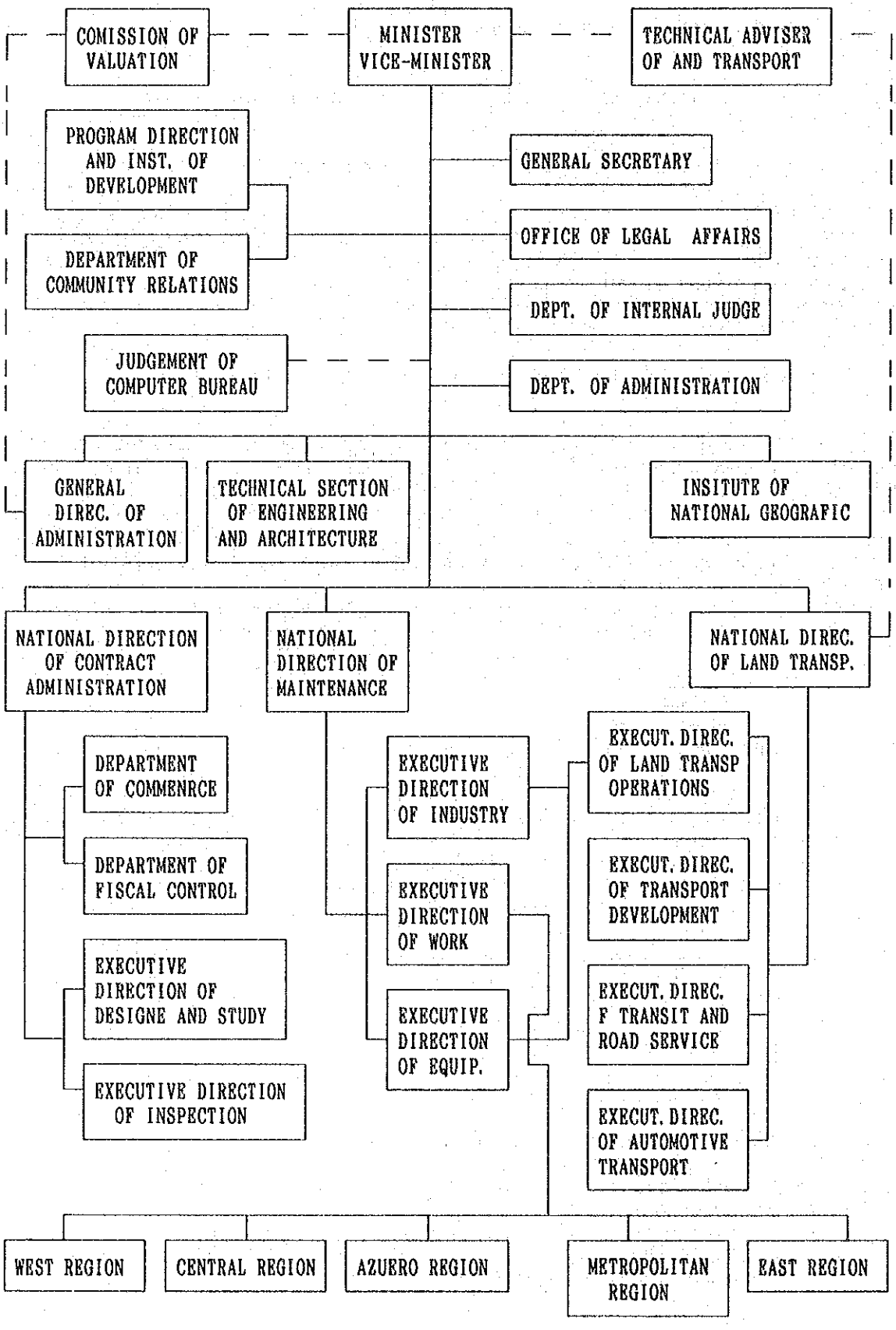


Figure 6.1.1 Organization of Ministry of Public Works (MOP)

units will determine the community's necessities and priorities, in coordination with authorities of the region.

c) To coordinate and continue the implementation process of the automation and institutional development implementation; expense control and works in performance.

d) In order to develop its function, this direction will have the following Administrative Units: Computer System Department, Programming and Planning Department.

(3) DINAC: Contract Administration National Direction

a) To manage, direct, coordinate, control and decide over the necessary resources and the applications of the appropriate technology for the design contracting that the Ministry performs by contract and acceptance of loans.

b) Settle down and follows the systems and prcedures required in order to coordinate the execution of the lends agreements with International Credit Organizations.

c) To supervise the road works performed by the promoters and private contractors as well as the one performed by MOP's Work Executive Direction.

(4) DINATRATE:Terrestrial Transportation National Direction

a) To implement the terrestrial transportation plan and policies throughout the country.

b) Design and develop the transportation patterns and establish the inversion programs.

c) To establish and perform the Plans for the Traffic Engineering and public transportation for people and assets.

d) Bring out the politics and the Terrestrial Transport Plan in National level.

e) To be responsible for the Terrestrial Transportation Technical Board Secretariat.

6.1.2 Regional Directions

The regional directions are organized by the Maintenance National Direction and Terrestrial Transportation National Direction has three (3) Executive Directions and Administrative Supervision Sections. Each Executive Direction controls several regional directions and manage, the Industrial and Works Regional Directions have thirty one (31) divisions, considering their functioning importance shown as in attached drawing.

(1) Direction:

a)Coordinate with the authorities legally established in the region, the determination of the necessities and strategies for the soluton of themself.

b)Supervise and control the programs of work performed by each Divisin in charge, according to the assigned budgetary in the official budget and /or official contracts.

(2) Industrial Executive Direction

a) To control the producing and sale of industrial products utilized in the maintenance, rehabilitation and /or construction works, through a invoicing and accounting of costs of their producing, in agreement with the norms and establishd procedures.
b) To secure the maintenance and good functioning of plants and industrial equipment (rolling stocks, general industrial machines, heavy equipments such as trucks and tractors, etc.).
c) Provide the industrial material necessary for the realization of works and promote in the local market the purchase of the surplus materials.

(3) Administrative Supervision

a) To plan, direct, perform and control all the administrative, countable and financial services required for the good functioning of all the performing units of the Direction.
b) To fulfill the normative and regulative basis for the adequate use of the human resources.
c) To promote the performance of training programs, orientated to the development of human resources.
e) To maintain disciplinary rules according to the laws and regulations.
f) To maintain the finance register, control and management.
g) To provide the services of communication, security, and vigilance; cleaning, maintenance, transportation, reproduction, post offices and library serves.

(4) Work Executive Direction

a) Watching for the fulfillment of regulations, policies and procedures of plan and programs which rule the maintenance and construction, streets roads and highway administration, and the maintenance of buildings pertaining to the state throughout the country.
b) Coordinating the function of the Regional Directions and its divisions in the fulfillment of its annual work program and offering support in the quickness and steps of its resources requests (materials and supplies, equipment, human resource).
c) Coordinate the elaboration of the preliminary budget design, by the Resional Directions for their presentation and sustenance in front of the National Direction of Maintenance, in order to be contemplated in the MOP's general budget.

e) Watching that commitments with Credit International Organizations concerning the maintenance of the road network.
f) Watching for the control of environment impact caused by the works which are under the Work Executive Direction according to agronomist cultural, forestal, norms and methods.
g) Trying to make monthly evaluation of the maintenance work in the road network throughout the country and presenting a report to the Maintenance National Direction.

(5) Equipment Executive Direction

To manage, supervise and coordinate the use of maintenance and conservation of all rolling equipment from MOP distributed in all and each of its Administrative Units.

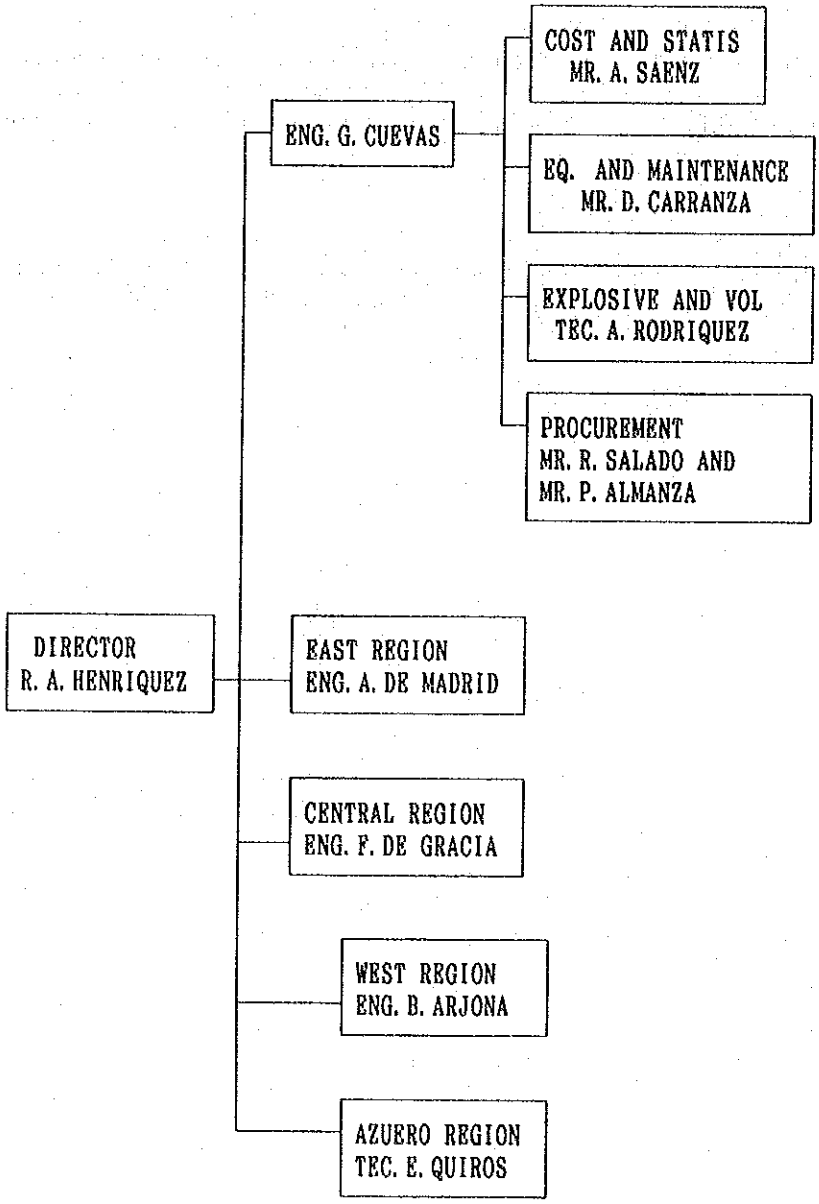


Figure 6.1.2 Organization of Industrial Executive Direction

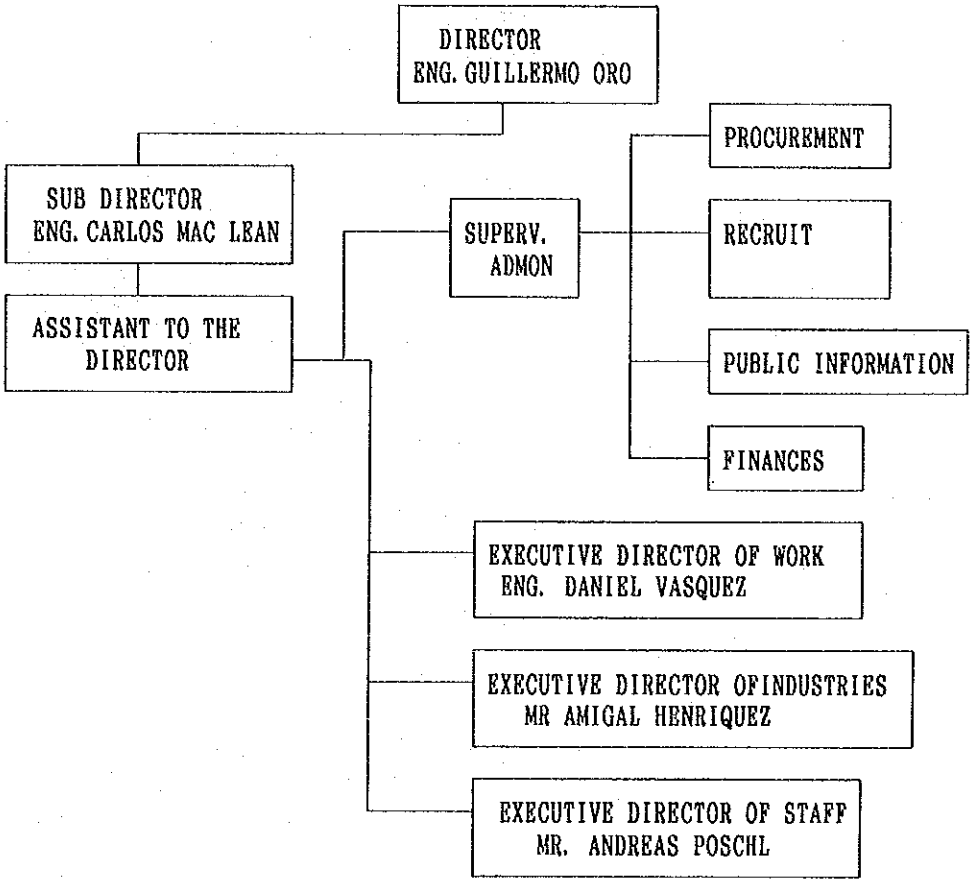


Figure 6.1.3 Organization of Administrative Supervision

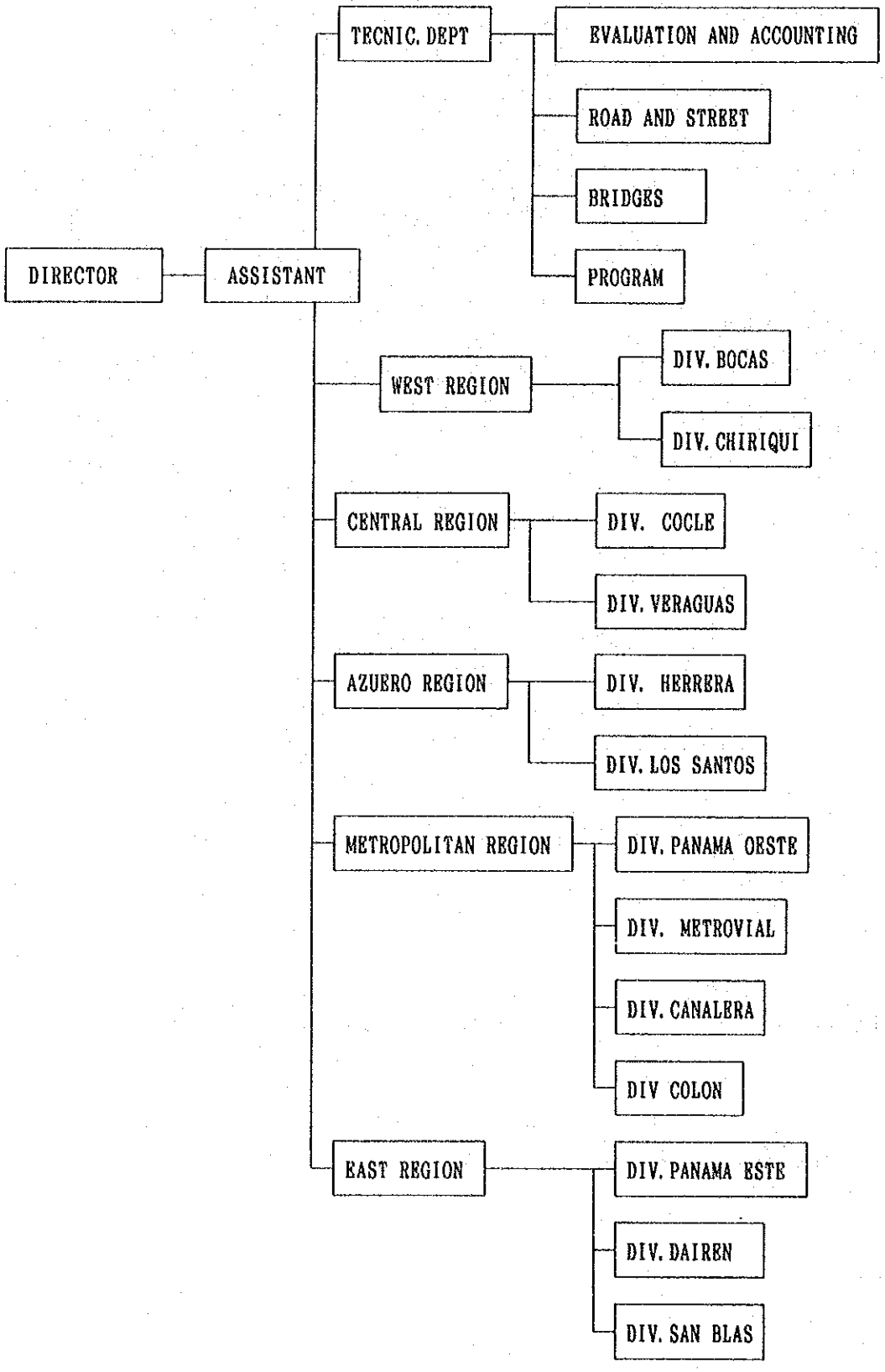


Figure 6.1.4 Organization of Work Executive Direction

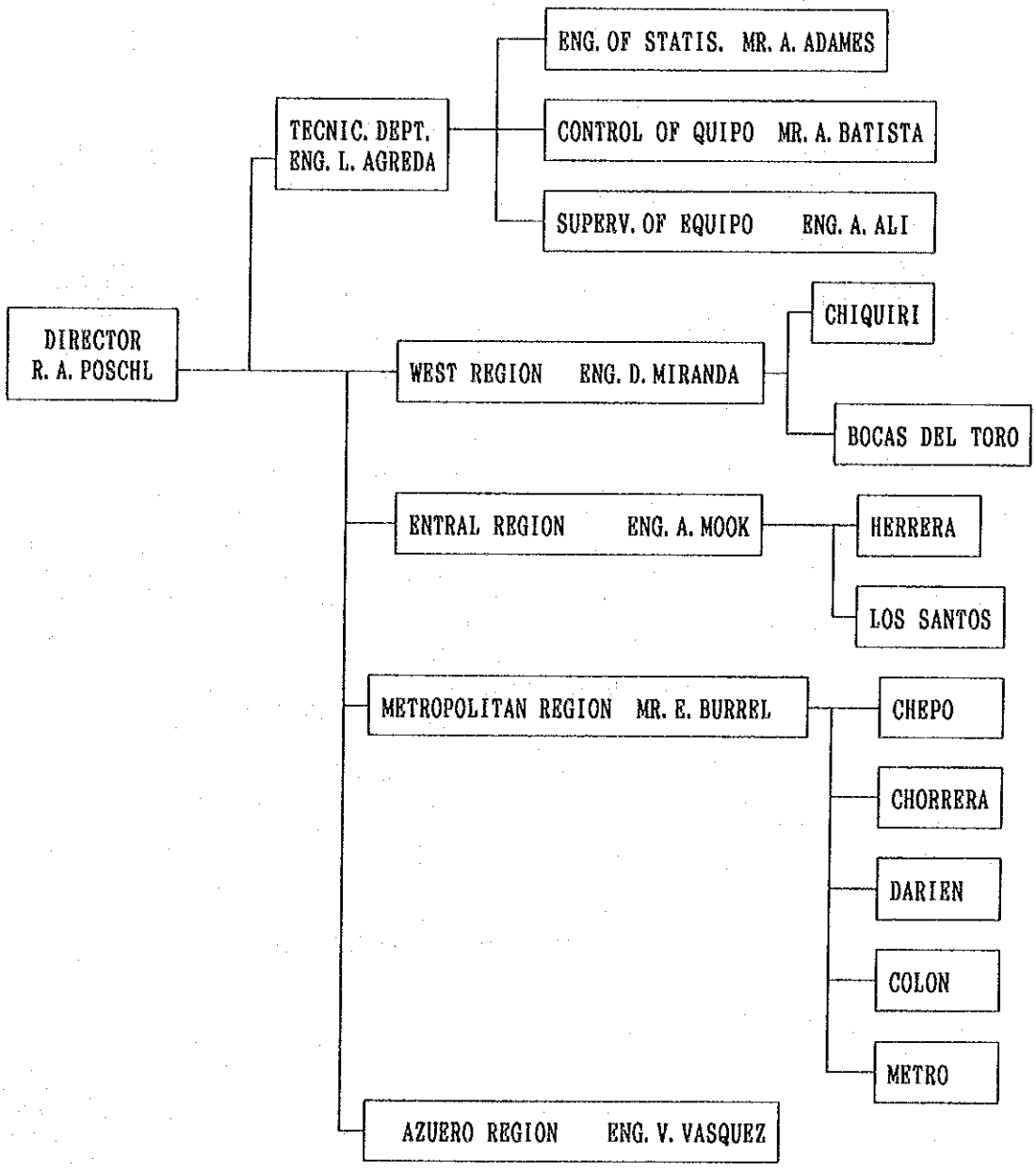


Figure 6.1.5 Organization of Equipment Executive Direction

6.2 Central Government Budget

According to "The Panamanian Official Gazette" published in Jan. 1992, the central government budget of fiscal year 1992 amounted to $1,454 million, excluding discentral budget external resources.

6.2.1 Revenue

Revenues for the budget were acquired from the following financial resources:

a) Direct taxes	21.0 %
b) Indirect taxes	27.7
c) Participations in utilities of state enterprises	12.0
d) Resources of loans	18.5
e) Others	20.8
Total	100.0 %

6.2.2 Expenditure

On the other hand, the above revenues are allocated into two categories of budgets; that is general account budget amounted to 1,248.40 million and investment budget amounted to $205.40 million.

The general account budget is allocated to the following government organs and payment of loans as expenditure.

a) Legislative Organ	$ 33.30 million	(2.7%)
b) Executive Organ	831.40	(66.6)
c) Judicial Organ	37.40	(3.0)
d) Debt	337.70	(27.0)
e) Electoral Organ	8.60	(0.7)
Total	$1,248.40 million	(100.0%)

6.2.3 MOP's Budget

MOP acquires it's budget from the executive Organ of the general account budget and the investment budget. Amounts of the budgets are as follows:

a) From Executive Organ budget	$23.70 million
b) From investment budget	$49.20 million

The investment budget for MOP is estimated in the following items.

a) Construction of asphalt-paved roads
b) Construction of drainages
c) Rehabilitation and maintenance of existing roads
d) Construction and improvement of streets and avenues
e) Construction and rehabilitation of bridges.
f) Administration expenses.

6.3 Private Sector in Construction Field

Geologically, the Isthmus of Panama consists of sedimentary rocks mainly constituted in Pre-tertiary to early Oligocene. In early Miocene, lava were erupted breaking through the sedimentary rocks and turned to volcanic rooks such as andesite and basalt.

In the vicinity of the Panama-Colon Highway, some quarry sites are developed and operating to extract these rocks. Limestones existing among the Caimito Formation and the Gatuncillo Formation, are also quarried and supplied to cement factories nearby as new material. Construction materials in this area are classified into three categories which have different origins. Quarry sites of these categories exist as bellow.

6.3.1 Inland Sand-Gravel

Generally, materials are distributed in the Pacific Ocean side. Sand-gravels cleaned and screened at sites are transported to Panama City.

6.3.2 River Sand-Gravel

Materials are extracted from the Rio Chagres and the Rio Gatun. Selected materials are provided to Panama and Colon City.

6.3.3 Crushed Stone

Course aggregates for concrete and asphalt pavement are produced at crushing plants near quarry sites. Volcanic rock such as andesite and basalt, and sedimentary rocks such as limestone and graywacke are supplied for the aggregates.

Concrete bathing plants exist in both cities of Panama and Colon. So ready-mixed concrete can be transported to anywhere along the Panama-Colon Highway in an hour. The location of construction materials produced sites and the concrete factories along the Panama-Colon Highway are illustrated in Figure 6.3.1.

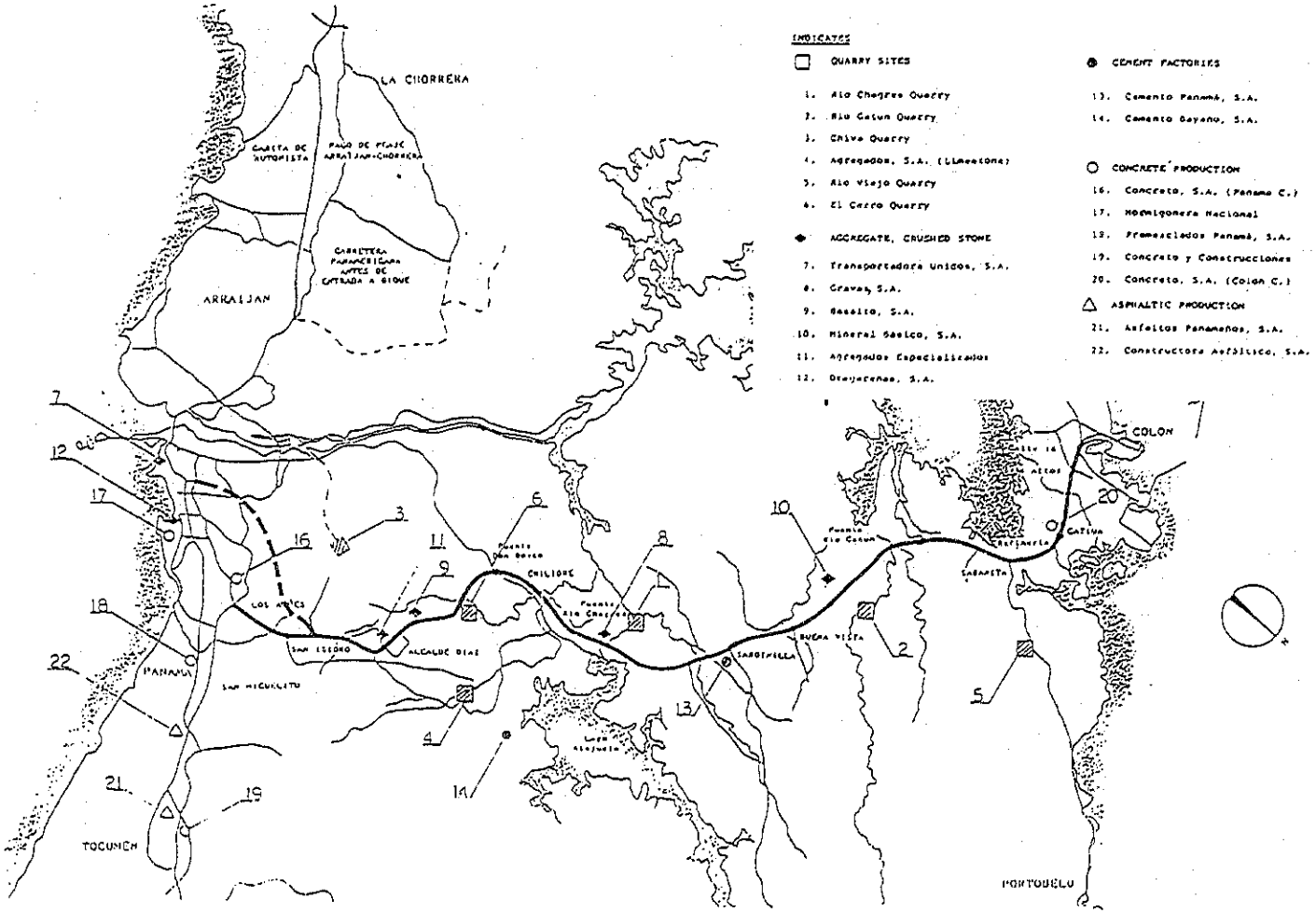


Figure 6.3.1 Distribution of Stone and Concrete Factories

7 PAST RELATED STUDIES

7.1 Road Related Studies

The existing Panama-Colon Highway was constructed by the United States in 1940. In 1973, full scale rehabilitation works were carried out unit. Full scale rehabilitation work has been cared out since 1973.

There are various road development plans or study related Panama-Colon Highway, as shown below:

a) Autopista Panama-Colon Highway
b) Autopista Arraijan-Panama
c) Corredor Norte
d) Corredor Sur
e) Rehabilitation Plan for Panama-Colon Highway
f) Others

7.1.1 Autopista Panama-Colon Highway Development Plan

This development plan was prepared by MOP in March 1973 as a technical and economic feasibility study on the Panama-Colon Freeway.

The road was designed as a full access control road with a 4-lane dual carriageway and the lane width adopted was 3.65 meters. Despise the feasibility study neither the detailed design nor construction of this road have taken place yet. The general horizontal alignment of the route is shown in Figure 7.1.1 and the outline of this study are summarized as shown in Table 7.1.1.

7.1.2 Autopista Arraijan-Panama Development Plan

This development plan was prepared by MOP for a full access control road over 10 years ago and the detailed design was completed in 1982. However, at the present, the construction of the road has still not been started.

The horizontal alignment of the road starts at the end of the existing Arraijan-Chorrera toll road and crosses the Panama Canal at 1.0 kilometers north of the Miraflores Locks and continues through the National Park, to finally connect to the existing Panama-Colon Highway at San Isidro.

This road was designed as a full access control road with a 4-lane dual carriageway and adopted lane width 3.65 meters. The general horizontal alignment and the outline of this plan are shown in Figure 7.1.1 and Table 7.1.1.

7.1.3 North Corridor Development Plan

The feasibility study for the Corredor Norte development plan was prepared in 1983 by JICA and MOP and the detailed design was completed in 1988 by MOP. This road has not been constructed yet due to financial problems in Panama.

The Corredor Norte links the center of Panama City and the existing Panama-Colon Highway at a point in the northern part of the San Isidro area with a 4-lane dual carriageway. The road was designed as general road (not toll road) and the lane width adopted was 3.65 meters.

Considering the importance of the road in soling traffic congestion in Panama city, MOP would like to commence its construction as far as possible.

The general horizontal alignment and design parameters of this plan is shown in Figure 7.1.1. and Table 7.1.1, respectively.

7.1.4 Corredor Sur Development Plan

The feasibility study for this development plan was cared out 1988 by JICA and MOP. The detailed design has not been commenced yet.

The horizontal alignment of the road is located along the cost as shown in Figure 7.1.1. and the design speed adopted was 60 to 80 km/h. 4 or 6-lane dual carriageway was adopted depending on future traffic volume. MOP would now like to commence the detailed design, but it can not due to financial problems.

7.1.5 Full Scale Rehabilitation Plan

Since 1973, maintenance of the existing Panama-Colon Highway has been carried out gradually.However, this maintenance is not enough to care with the increased traffic volume.

The detail design for rehabilitation of the existing Panama-Colon Highway was commenced in March 1993 by MOP. The construction according to this plan will be commenced when the detailed design will be completed. The main rehabilitation works consist of the following:

a) Improvement of pavement structures
b) Improvement of drainage structures
c) Establishing climbing lanes
d) Road widening
e) Improvement of slop protection
f) Improvement of intersections

7.1.6 Other Road Development Studies

The two publications listed below give details of two plans for toll road development between The cities of Panama and Colon.

a) Autopista Panama-Colon Highway in 1990
b) Autopista Panama-Colon Highway in 1991

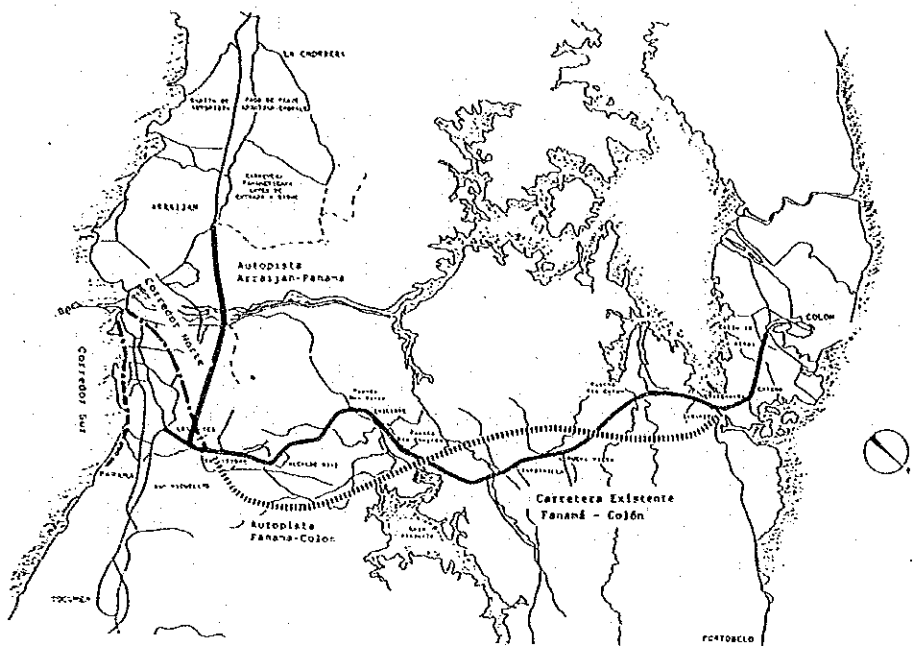


Figure 7.1.1 Planned Routes Location Map

Table 7.1.1 Outline of Related Road Plans

Project Name	Toll	Stage	Construction Year	Road Condition			
				Design Speed	Cane No.	Width	Surface
Present Panama-Colon	Free	----	Constructed in 1941	----	1+1=2	----	Asphalt
Panama-colon Rehabilitation	Free	D/D	Constructed in 1973	80 km/h	1+1=2	3.65 (1.50)	Asphalt
Panama-Colon Highway	Toll	E/F	-	80 km/h 110 km/h	2+2=4	3.65 (1.50, 3.00)	Concrete
Panama-Arraign Highway	Toll	D/D	-	80 km/h 110 km/h	2+2=4	3.66 (1.50, 2.70)	Concrete
North Corridor	Free	D/D	-	100 km/h	2+2=4 3+3=6	3.66 (1.50, 3.00)	Concrete
South Corridor	Free	E/F	-	60 km/h 80 km/h	*Cane Addition Widening	3.65 (2.00, 3.00)	Concrete
Panama-Colon Rehabilitation	Free	D/D	-	80 km/h	2+2=4	3.00 3.65	Concrete
Panama-Colon Highway	Toll	Plan	-	110 km/h	-	3.65	Asphalt
Panama-Colon Highway	Toll	Plan	-				Concrete

7.2 Related Development Plans

7.2.1 Centerport Development Plan

(1) Concept of the Plan

Since 1987, the Centerport Development Plan is discussed by the National Authorities of the Republic of Panama and other related Agencies or Companies.

The details of the Centerport Development Plan are summarized below. This is an extract from the Panama Centerport report published by the Nationdl Port Authority:

a) The Centerport will generate a large amount of jobs, as a result of the increase in the commercial and industrial activities related to goods and services required for port operations, shipping lines and users, as well as other opportunities to be derived from this project.

b) The Centerport includes complementary fatalities such as the development of a commercial-industrial zone, and the setting up of container repair and rental companies, storage areas and shipping line offices, in addition to other related businesses.

c) The Centerport concept serves to reinforce Panama's geographical advantage. It will integrate the Canal into the Panamanian economy thereby strengthening its role in the maritime transport sector.

(2) Estimated Transportation Volume

The estimated transportation volume of the Centerport Plan as described in the Panama Centerport report is;

a) A two segment market would be formed: One for world traffic passing through the Panama Canal and are for the Caribbean and Latin American countries.

b) For 1990, the cargo volume was estimated at more than 50,000 TEU's and for 2003 at 1.3 million TEU's (20 feet long containers).

c) This transshipment market would be served by two systems, the "Interpol" and the "Feeder". The first is developed under and interchangeable cargo system between the main shipping lines, expanding their ships' capacities.

d) Approximately 60 percent of Centerport potential market is formed by this system.

e) The other type of service is based on the use of "feeding ships". Their operation takes place between main line ships with major volume cargo and a smaller ship with less volume on different routes. The market for the "feeding type" ship is the Caribbean and Latin America, and it represents around 40 percent of the potential cargo volume.

In addition to the above, the more detailed estimated volume is described in Report "Strategic Master Plan for the Development of Panama Centerport".

Table 7.2.1 Future Transport Volume
(Unit: 1000 of 20 foot-containers)

Shipping Lines	1990	1993	1997	2003
Line A	137.4	166.6	194.6	268.6
Line B	151.4	190.6	231.2	324.4
Line C	14.0	24.0	36.6	55.8
Line D	100.0	113.2	139.6	171.8
Line E	--	--	120.8	188.0
Domestic	126.2	140.2	193.0	265.6
Totals	529.0	634.6	915.8	1,274.2

7.2.2 Balboa Port Development Plan

The National Port Authority is presently preparing the Balboa Port Development Plan for submittal to higher governmental authorities.

According to this proposal (Justification de la Solicited de Anexion de Nuevas Areas para Desarrollo Portuario) which is prepared by the National Port Authority, the Balboa Port Development Plan consists of the five (5) related developments shown below;

a) Port operation area development
b) Cargo storage development
c) Port administration development
d) Industrial area development
e) Port influence area development

(1) Port Operation Area Development Plan

The area to be developed is about 234 hectors including the areas related to docks, and also the land near them, such as container yards. In this area are also found areas used for ship repair, the electrical and machinery work shops, the passenger terminal that will be located in Dock 18, the railroad workshop, etc.

The main function of this area is cargo movement and ships. This area includes the ground area corresponding to the Balboa Yacht Club and the buildings of the old quarters of the American Legion, which could be developed as a tourist entertainment area.

(2) Cargo Storage Development Plan

The area to be developed is about 133 hectors located near the port operation area.

It comprises land conceded to private businesses, dedicated exclusively to cargo storage. In this zone, we can find warehouses, hangars and storehouses under roof for import and export products handled by the port; petroleum and combustible storage tanks (existing special area); containers prepares,warehouse for the assembly of export goods; and the filling and unloading of containers. The playing fields located near the port, should be relocated away from this area, which should be dedicated to cargo management.

(3) Port Administration Development Plan

The area to be developed is about 44.4 hectors including the buildings where the main office of the National Port Authority and the Port Administration will be located. It also includes the rehabilitation or construction of buildings for use by shipping companies, security agencies, restaurants, lawyers, international representatives and others. There are two alternative definition of this area:

a) The present grounds and buildings of the Panama Canal College,
b) The buildings of the Balboa High School.

The Port Authority has designated the Balboa High School buildings because of they are located nearer the Port.

(4) Industrial Area Development Plan

The area to be developed is about 168 hectors and locates to industries that need to be strategically located in the surroundings of the port because of their activities. These are businesses dedicated to assembly, general business, multisectorial exportation zones, etc. The application of rules and regulations that contribute to environmental conservation will be taken in to account.

(5) Port Influence Area Development Plan

The area to be developed is about 181 hectors Although this area is not part of the Port of Balboa, its proximity to the port makes it convenient for the location of businesses dedicated to cargo handling activities. In this area, existing buildings can be used as warehouses, storehouses and offices in general.

7.2.3 Colon Free Zone Development plan

(1) Conditions of Colon Free Zone

The Colon Free Zone was established in 1948 in accordance with Law No. 18 of the Republic of Panama. The main items dealt with in the Colon Free Zone are high value-added goods such as household appliances, textiles and clothing, medical articles, equipment etc. The main function of Colon Free Zone is as a transit center for the export of goods to Central and South America. At present, more than 1,500 companies are operating in this area. The three major features of this area is are follows:

a) Transit for warehouses
b) Direct trades by documentation without importing goods into Panama
c) Processing of imported raw materials

(2) Development Plans

Since 1948, the development of the Colon Free Zone has increased gradually, and now the area of the existing Colon Free Zone is fully occupied.

There are several development plans for the Colon Free Zone as shown below:

1) France Field

The France Field Development Plans are progressing gradually, but, the land preparation of about 40 ha in it completed in 1992 and some warehouses of private companies are under construction.

2) Coco Solo

The administration of the Colon Free Zone has a plan called the Coco Solo Development Plan for a 114 hectors wide area. Its construction will be completed in 1997 depending on the participation of private companies and the ground conditions (swamp area).

7.2.4 Colon City Development Plan

The Colon City Development Plan includes a housing development plan, the Colon Free Zone development plan and other institutional development plans being prepared by the Ministry of Housing and other related agencies.

According to this development plan, there are sixteen development plans in Colon city. Some development plans included in the above mentioned development plans, such as the housing development plan along the Panama-Colon Highway are now being implemented.

7.2.5 Panama Canal Development Plan

(1) Facilities of Panama Canal

The Panama Canal, is a lock-type canal linking the Pacific Ocean and Atlantic Ocean, with a total length of 80 kilometers from deep water to deep water. The minimum width of the navigation channel is about 150 meters and the depth is about 12 meters depending on the amount of water available in canal storage area.

There are three locks: Miraflores Lock, Pedro Miguel Locks and Gatun Locks. The Miraflores and Pedro Miguel Locks are one step, Gatun Lock is 3 steps. These three locks are about 305 meters long and 33.5 meters wide, limiting the size of ships that can transit the Canal to 65,000 dwt fully loaded and 85,000 dwt partially loaded.

(2) Toll Rates

The toll rates are different depending on the type of ship as described below:

a) For merchant vessels, Army and Navy transports, hospi tal ships, supply ships and yachts when carrying passengers or cargo, $ 2.01 per net vessel ton of 100 cubic feet of actual earning capacity, as determined in accordance with the Rules of Measurement of Vessels for the Panama Canal.
b) For such vessels in ballast, without passengers or cargo, $1,60 per net vessel ton
c) For other floating craft, $1.12 per ton of displacement. These rates have been in effect since October 1, 1989.

(3) Development Plan

On the basis of the treaty between the United States of America and the Republic of Panama in 1978, Alternative plans for the canal were examined by the Panama Canal Alternative Study Commission which was established in 1985.

After the examination of the alternatives an additional high rise lock canal for 150,000 DWT ship size was recommended.

7.2.6 Cristobal Port Development Plan.

(1) Conditions of Cristobal Port

Cristobal Port is the largest port in Panama and Balboa Port is the second largest. Recently, the handling volume of Cristobal Port has been more than 30 percent of the total national traffic by the maritime sector and the volume handled by Balboa Port is

one half that handled by Cristobal Port. The volume handled during the period from 1990 to 1993 for the main ports in Panama are shown in the Interim Report of the Study in Table 8.7.1.

Cristobal Port has about 4,000 meters long and more than 1000 vessels are operated. The maximum water depth is 12 meters and the main berths are divided into three finger piers, namely piers No.6, No.7 and No.8 and two marginal wharves, namely piers No.9 and No.10.

(2) Development Plan.

The development plan for the Cristobal Port was commenced in 1992 by JICA and the National Port Authority. The plan is divided into two parts, one is as the target year a Master Plan with the year 2010, and the second is a feasibility study based on the selected project in conduction with a short-term Port development for the year 2000.

In December of 1992, the progress report for this plan was presented to the Government of Panama and the Draft Final Report in September of 1993

7.2.7 Panama-Colon Railway Development Plan

(1) Outline of the Panama-Colon Railway.

In the year 1843, a group of American entrepreneurs, headed by William Henry Aspinwall, decided to construct the Panama-Colon Railway, which would earn large amounts of money from the avalanche of people in search of gold in California. Who traveled from the Atlantic to the Pacific through Panama.

During the construction of the Panama Canal, the railway made a great contribution. After completion of the Panama Canal, the usefulness of the Panama Railway has decreased and since the year 1988,it has not carried any passengers, only cargo. In the year 1993, there were only two trips per day with 14 containers per one trip carried from Panama to Colon. In addition railway facilities such as rails, train, platform etc, are run down due to lake of maintenance.

(2) Development Plan.

There are many development plans since 1973, however, the implementation of these plans have not been commenced yet. At present, the following ideas are examined by National Railway and related Agencies and the private sector.

a) Operation of tourist trains.
b) Reinforcement railway facilities for implementation of Centerport Project.
c) Hand over railway to private sector operation.

8 PLANNING POLICY

8.1 Planning Policy

8.1.1 Planning Policy for the Whole Study

(1) Objectives of the Plan

Considering the existing problems and the nature of the Panama-Colon highway, the following objectives are proposed:

a) To provide for balanced economic development in the republic.
b) To create the transportation axis between the Panama Metropolitan area and Colon City.
c) To secure the traffic safety for the users and preserve the good environment for the citizens.

(2) Targets of the Plan

The following concrete targets are considered from the above objectives:

a) To realize the mobility with high velocity.
b) To secure the high standard of traffic services.
c) To pursue a safety oriented plan.
d) To secure the preservation of environment.
e) To utilize for the public transport.
f) To cope with the traffic demand.
g) To ensure the alternative function for the other mode.

(3) Necessary Road Functions

The following road functions are proposed in order to realize the above targets:

a) To serve as a primary national highway in the national road network skeleton, especially as a trans-isthmian highway between two oceans.
b) To serve as a corridor to transport passengers and goods between Panama Metropolitan area and Colon City which has the second position in the country.
c) To assist urban infrastructure development in the Panama Metropolitan area, Colon City and their vicinities.
d) To meet with the daily commuter traffic demand
e) To ensure the strategic alternative to the Canal and the railway in the case.

8.1.2 Planning Policy for Master Plan Stage

(1) Procedure for Formulation of Master Plan

The main objectives of formation of Master Plan are as follows;

a) To draw up a long term plan for a highway between Panama City and Colon City and it's development program
b) To clarify the functions and characteristics of Pana a-Colon Highway for the long-term.
c) To examine the coordination between the Panama-Colon Highway development and other planned trunk road development

(2) Premixes for the Master Plan Study

The nature of the Master Plan as a long-term Plan requires the following premises in the Study of the Master Plan.

a) To use a full scaled future road network including planned roads proposed by ESTAMPA Master Plan and related studies for the Study of future traffic assignment and evaluation of the Highway Alternatives.
b) A future traffic demand forecast on the Highway in the combination with the forecast in ESTAMPA Master Plan
c) Future socioeconomic indices solely for the Study, because of the lack of studies on long term development plan in Panama.
d) It should use topographic maps with a scale of 1:50,000 for preliminary engineering and rough cost estimation for the Highway Alternative plan.
e) It should use financial costs in stead of economic costs for the comparison of the Highway Alternative Plans at the Master Plan stage.

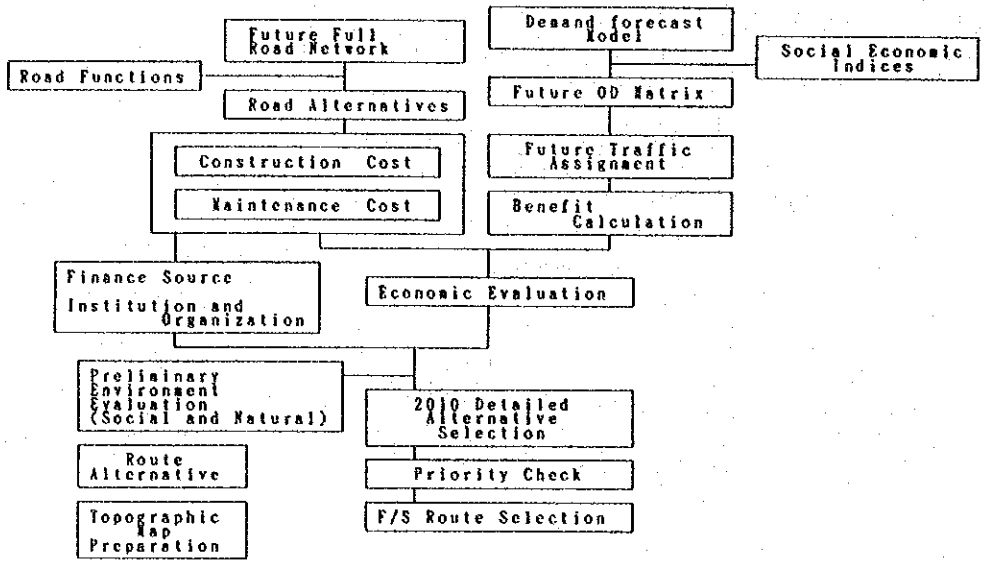


Figure 8.1.1 Flowchart of Master Plan Stage

8.2 Regional Planning Concept

In order to define future road functions, future development of a region related to a road should be clarified. However, in the case of the Study, no long term integrated regional development plan exists now. For the estimation of future traffic demand, authoris future socio-economic indices are necessary, but very few studies exist now. Therefore future development concept is necessary to be studied within the Study, and this concept is to be solely used in the Study.

(1) Development Strategy

Panama City has grown up as the administrative, economic, cultural and financial center of Panama and recently has been developed as an international banking center of Latin American countries. Colon City is the second biggest city in the country and has the biggest free zone in Latin American countries.

However in the area including both cities has many questions to be solved such as follows;

a) All of socio-economic activities has concentrated to the Panama metropolitan area and this phenomenon has been accelerated recently.

b) The population growth of San Miguerito district is significantly high in these two decades. The gravity center in the sense of population is removing to the direction of North-East within the metropolitan area.

c) On the other hand, the growth rate of population of Colon city is not high. Now Colon city has many kinds of social and economic problems such as high unemployment rate.

d) Between Panama and Colon city there lies huge area of Panama Canal watershed so called " Cuenca",and it's importance does not only come from the use of water for the canal operation but also from the presence of rare tropical forests and their dependencies,floura and fauna. However many immigrants have invaded into Cuenca and now Cuenca is loosing it's forest area.

e) The large areas in Panama Canal Area (old Canal Zone) are being reverted to the government of Panama based on the new panama canal treaty. These areas have a great potential for development.

Taking the above into consideration three development patterns of the Panama Metropolitan Area and colon City are proposed as shown in Figure 8.2.1.

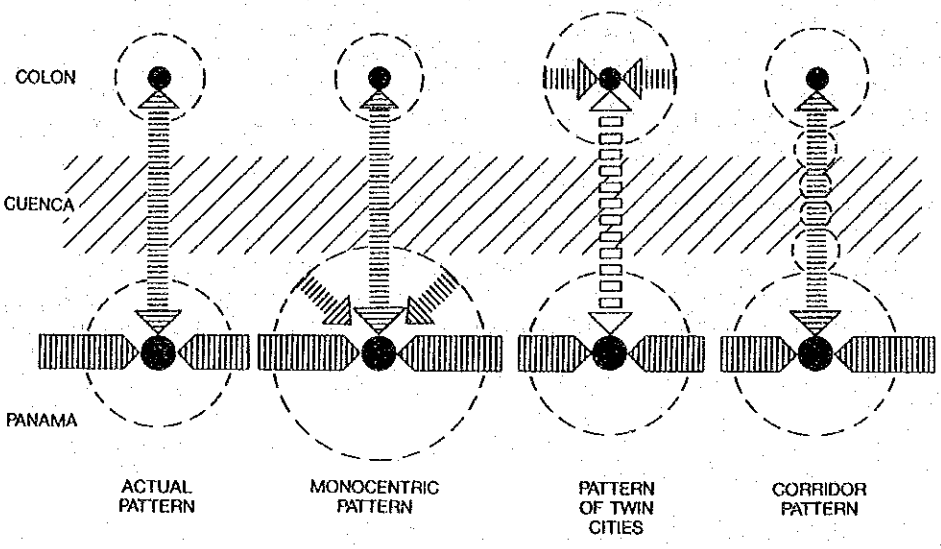


Figure 8.2.1 Development Patterns

(2) Characteristics of Development Pattern

The characteristics of the existing pattern and the three proposed development pattern are summarized as follows;

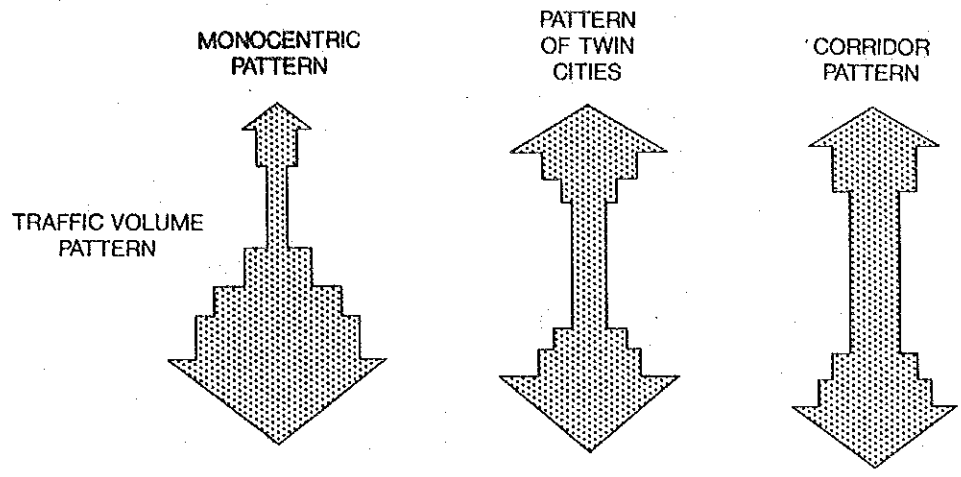
a)Existing Pattern: This patterns shows the concentration of the whole socio-economic activities into Panama Metropolitan Area.

b)Mono-Centric Pattern: This pattern shows that only Panama Metropolitan Area grows up and Colon is abandoned as existence. This pattern would probably appear in the case of no-policy.

c)Twin City Pattern: This pattern shows that the growth of Colon is significant, while the growth of Panama Metropolitan Area is steady. The urban infrastructure development and job supply in Colon would be required.

d)Corridor Pattern: This pattern shows that the areas between Panama and Colon are developed along the highway. The development in Cuenca would cause environment problem.

(3) Relationship between the Development Pattern and the Functions of the Panama-Colon Highway.



Principal Function of the Highway	.Colon side and Mid section are same as present	.Within Colon and Panama urban area serves for commuter traffic	.To serve for the regional development
	.Panama side serves as a commuter traffic road.	.Mid section serves as a transportation of goods and passengers	.To serves as a road for activities of inhabitants
Type of Improvement	.Existing road improvement and new construction in Panama urban area.	.In Colon and Panama urban area widening or new construction of road. .In Mid section new construction.	.Improvement or widening of existing road and new construction in Panama urban area.

(4) Selected Development Pattern

After the examinatons and discussions on the three development patterns, the Twin Cities Pattern was selected with the following principal reasons;

a) The over capacity concentration of socio-economic activities to Panama Metropolitan Area should be restricted in any how.
b) Colon city must not be abandoned and the way to be developed should be sought.
c) In Cuenca area the development activities should be

9 SOCIO-ECONOMIC FRAMEWORK

9.1 Population

In 1982, the Ministerio de Planification y Economia (MIPPE) forecast the future population growth of Panama until 2025.

According to their forecast, in 2010, the total population of Panama will be between 3,180,000 and 3,476,000, an average forecast of 3,324,000. They also forecast that the yearly population growth would be 2.14 percent between 1980 and 1990, 1.80 percent between 1990 and 2000, and 1.40 percent between 2000 and 2010, and would decrease about 0.4 percent every 10 years. In the results of the 1990 census, the population growth rate between 1980 and 1990 was close to the MIPPE estimate. The results of the censuses and the forecasts rode by MIPPE are listed in Table 9.1.1 for each survey zone in Panama.

Table 9.1.1 Population by Survey Zone
(Unit; Person)

Year	1980	1990	2000	2010
Panama	470,700	584,800	716,800	760,000
San Miguelito	156,600	243,000	303,100	350,000
Colon	109,300	140,900	213,700	368,700
Chagres	7,700	9,200	11,500	14,300
Total:	744,300	977,900	1,245,100	1,493,000

9.2 Employment

The unemployment rate in the survey zone is increased by 3 percent between 1980 and 1990, but the ratio of employees to the total population has been increasing. In Table 9.2.1 below, current data for number of employees and future estimates are tested for each zone. The employees are divided into Primay, Secondary, and Tertiary Sectors based on current trends and composition.

Table 9.2.1 Workers by Survey Zone

(Unit; Person)

Year		1990	2000	2010
Panama	Primary	5,900	5,600	4,700
	Secondary	33,000	41,500	45,500
	Tertiary	161,900	203,700	223,400
	Sub-total:	200,800	250,800	273,600
San Miguelito	Primary	1,000	600	300
	Secondary	16,800	24,000	31,600
	Tertiary	61,400	87,500	115,100
	Sub-total:	79,200	112,100	147,000
Colon	Primary	2,700	4,400	8,100
	Secondary	7,300	12,500	24,300
	Tertiary	31,000	53,600	103,900
	Sub-total:	41,000	70,500	136,300
Chagres	Primary	1,700	2,000	2,400
	Secondary	200	300	400
	Tertiary	500	700	900
	Sub-total:	2,400	3,000	3,700
Total:		323,400	436,400	560,600

9.3 Students

The number of students is assumed to be as shown in Table 9.3.1, from a consideration of the total population, number of employees, and characteristics of each survey zone.

Table 9.3.1 Students by Survey Zone

(Unit; Person)

Year	1980	1990	2000	2010
Panama	96,500	162,200	198,200	202,700
San Miguelito	25,600	78,200	93,000	102,600
Colon	25,400	42,600	63,400	106,500
Chagres	1,800	2,400	3,000	4,000
Total:	149,300	285,400	357,600	415,800

10 FUTURE TRAFFIC DEMAND

10.1 Vehicle Ownership

The number of vehicles registered in Panama, Colon and San Miguelito Districts in 1990 was 118,000, and the number of persons per vehicle was 8.2. Since 1970, the number of vehicles has increased about 2.9 times (from 41,000) and the persons per vehicle has dropped by about 44 percent (from 14.7). The average growth rate of registered vehicles for the last two decades was 5.4 percent, and the rate is increasing recently. Single and multiple regression analyses regarding the number of vehicles registered, population, and GNP, showed a high correlation coefficient and low standard error.

Table 10.1.1 Result of Multiple Regression Analysis

	Parameter		Constant	Multiple Correlation Coefficient	Standard Error
	Population (100 Person)	GNP (US$)			
Passenger Car	-27.6	17.40	33,635	0.978	3,748
Bus	11.0	0.34	-6,124	0.912	596
Truck	-22.2	4.55	15,426	0.912	1,495

Vehicle registration in the future is estimated by using parameters from the multiple regression analysis. The GNP growth rate has a strong influence on this. From 1980 to 1990, the GNP growth rate stayed at 3.4 percent for political reasons. During the 1990's a high growth rate of 7.0 percent is expected due to political stability. After the year 2000, GNP growth is expected to stabilize, and the average growth rate has been set at 4.5 percent. According to our calculations, the number of vehicles registered in Panama, Colon and San Miguelito Districts will reach 212,000 in 2000, and vehicle ownership will be 5.8 persons/vehicle. In 2010, the numbers will be expected as 319,000 vehicles and 4.6 persons/vehicle. The historical number of vehicle registration is shown in Figure10.1.1.

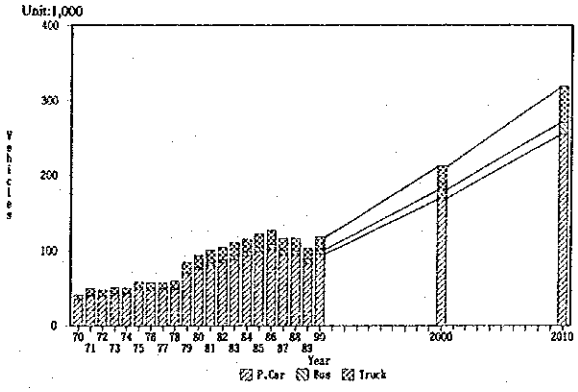


Figure 10.1.1 Vehicle Registration

10.2 Traffic Demand Forecast Model

10.2.1 Method of Traffic Demand Forecast

The traffic demand forecast is made from the vehicle generation/attraction sub-model and the traffic assignment model. The procedure for the traffic demand forecast is shown in Figure 10.2.1.

10.2.2 Vehicle Generation/Attraction Sub-Model

The vehicle generation/attraction sub-model is made as follows:

Prepare the PCU (Passenger Car Unit) OD Table for 1993 based on the OD (PCU) for 1990 and 2000 and correlate with the results of the survey. Then carry out a multiple regression analysis with the socio economic characteristics listed below and make models for vehicle generation, vehicle attraction and vehicle type.

a) Population by survey zone
b) Secondary sector employees by survey zone
c) Tertiary sector employees by survey zone
d) Average income by zone

As shown in Table 10.2.1, the following PCUs are used for the preparation of the 1993 PCU OD Table in this survey.

Table 10.2.1 Passenger Car Equivalent

Vehicle Type	PCU
Passenger Car	1.0
Taxi	1.0
Micro Bus	2.0
Bus	3.0
Pick-up/Van	1.0
Truck	3.0
Semi/full Trailer	3.0

The four types of vehicle listed below were used for making the OD tables.

a) Passenger car
b) Taxi
c) Bus
d) Truck

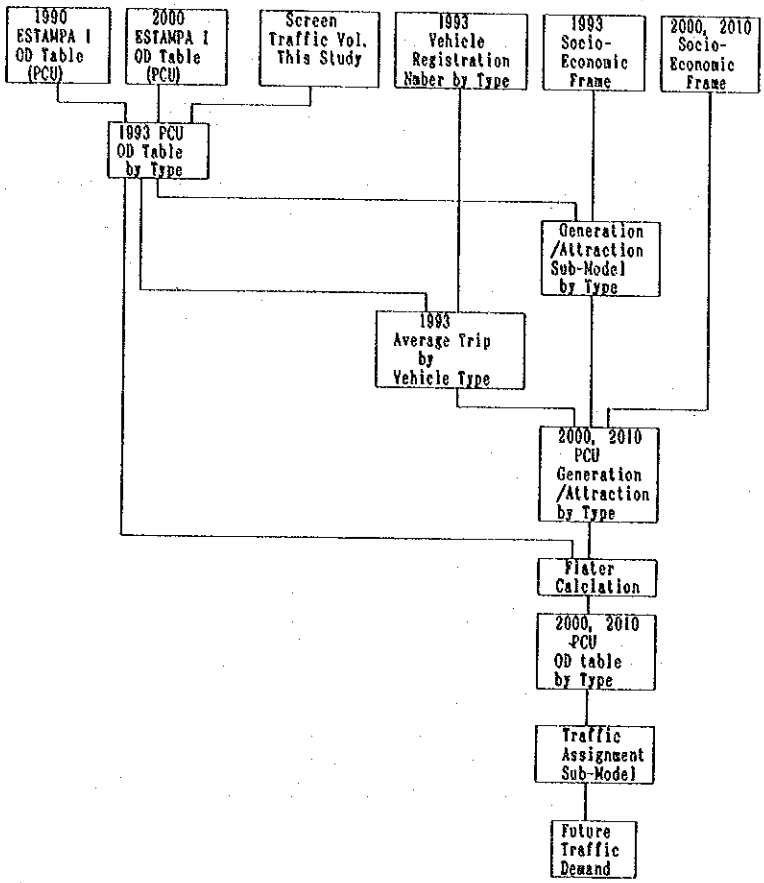


Figure 10.2.1 Procedure of Traffic Demand Forecast

Table 10.2.2 shows the parameters for the vehicle generation/attraction sub-model. As the multiple correlation coefficient for vehicle generation/attraction and socioeconomic parameters always show a high correlation, each model is accurates enough to be used to make forecasts.

Table 10.2.2. Parameters of Generation/Attraction Sub-Model

Vehicle Type	Generation / Atraction	Parameter						Multiple Correlation Coefficient
		Population	Employee Secondary	Employee Tertiary	Students	Income	Const	
Car. P	Generation	2. 1092	-8. 808	0. 2312	-4. 355	78. 6970	-25676	0. 9360
	Attraction	2. 4697	-7. 955	-1. 9180	-3. 991	137. 3800	-42920	0. 8775
Taxi	Generation	0. 4826	-2. 756	-0. 6290	-0. 336	10. 9360	-1912	0. 8907
	Attraction	0. 5187	-2. 645	-0. 8700	-0. 273	17. 1270	-4610	0. 8943
Bus	Generation	0. 3335	-0. 871	-0. 1440	-0. 647	4. 9670	-1350	0. 9243
	Attraction	0. 3485	-1. 466	-0. 2940	-0. 464	9. 9368	-2734	0. 9182
Truck	Generation	0. 8086	-	-2. 1380		40. 2170	-14709	0. 9045
	Attraction	0. 6959	-	-1. 9040		34. 7450	-11479	0. 8792

10.2.3 Traffic Assignment Sub model

(1) OD Assignment to Links

The process by which traffic between survey zones are assigned to the links is shown in Figure 10.2.2.

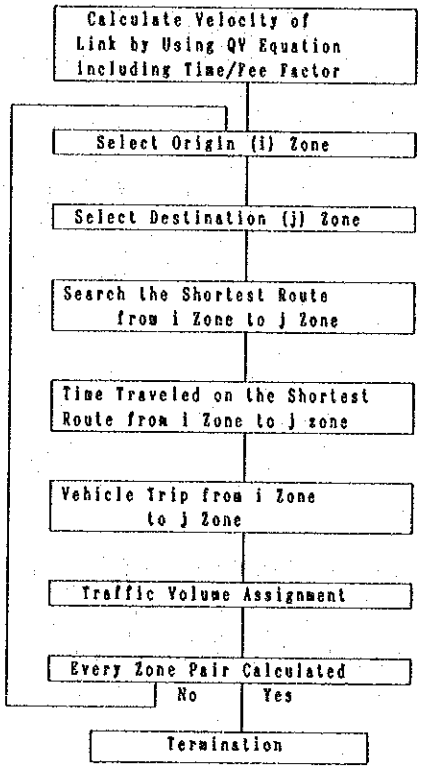


Figure 10.2.2 Process of Traffic Assignment

10.3 Future OD Table

10.3.1 Trip Production

Future trip productions by vehicle type are shown in Table 10.3.1.

Table 10.3.1 Future Trip Production in the Study Area
(Unit: PCU)

Year	Generation/Attraction P. Car	Taxi	Bus	Truck	Total
1993	326,887	44,739	61,259	114,497	547,382
2000	433,191	72,083	82,432	151,098	738,804
2010	649,363	76,090	107,175	216,399	1,049,027

10.3.2 Generation/Attraction

Future trip generation/attraction and the growth rate by zone are shown in Table 10.3.2 and Figures 10.3.1 to 10.3.3.

Table 10.3.2 Future Trip Generation/Attraction by Zone

Unit : PCU

Zone	Generation 1993	2000	Growth Factor	2010	Growth Factor	Attraction 1993	2000	Growth Factor	2010	Growth Factor
1	24,570	47,115	1.92	51,037	2.08	10,822	42,169	3.90	47,826	4.42
2	65,249	61,275	0.94	88,541	1.36	98,400	76,859	0.78	106,353	1.08
3	161,506	108,848	0.67	114,363	0.71	123,718	84,667	0.68	89,010	0.72
4	840	12,825	15.27	25,363	30.19	477	16,974	35.58	31,722	66.50
5	1,697	6,595	3.89	14,979	8.83	2,284	8,355	3.66	19,809	8.67
6	1,014	8,467	8.35	16,298	16.07	780	8,094	10.38	17,560	22.51
7	4,103	43,123	10.51	55,286	13.47	6,693	43,036	6.43	57,356	8.57
8	18,920	36,557	1.93	55,829	2.95	13,209	39,559	2.99	61,441	4.65
9	6,771	27,036	3.99	31,523	4.66	7,238	22,677	3.13	26,478	3.66
10	2,502	16,251	6.50	24,846	9.93	2,023	15,534	7.68	25,487	12.60
11	5,707	24,196	4.24	33,230	5.82	5,577	22,602	4.05	29,085	5.22
12	4,269	34,384	8.05	34,587	8.10	3,971	31,311	7.88	28,626	7.21
13	3,444	12,130	3.52	17,694	5.14	3,198	12,109	3.79	17,714	5.54
14	34,893	27,407	0.79	45,763	1.31	37,000	34,708	0.94	53,961	1.46
15	4,939	19,089	3.86	38,954	7.89	4,412	27,945	6.33	49,985	11.33
16	3,664	19,735	5.39	38,580	10.53	4,774	18,904	3.96	35,928	7.53
17	5,103	15,562	3.05	31,666	6.21	5,266	14,499	2.75	29289	5.56
18	5,494	15,947	2.90	32,005	5.83	3,998	15,651	3.91	28,043	7.01
19	5,535	20,962	3.79	41,491	7.50	6,399	23,992	3.75	39,203	6.13
20	0	0	0.00	0	0.00	9	0	0.00	0	0.00
21	384	3,137	8.17	8,395	21.86	216	3,004	13.91	7,527	34.85
22	2,163	14,069	6.50	32,162	14.87	2,244	16,397	7.31	33,854	15.09
23	23	0	0.00	1,235	53.70	26	0	0.00	8,521	327.73
24	111	222	2.00	6,221	56.05	145	265	1.83	9,551	65.87
25	1,258	8,087	6.43	22,011	17.50	1,018	10,077	9.90	25,005	24.56
26	1,660	957	0.58	7,536	4.54	1,349	885	0.66	9,046	6.71
27	160	0	0.00	44	0.28	99	0	0.00	390	3.94
28	1,001	649	0.65	5,650	5.64	603	609	1.01	8,700	14.43
29	497	0	0.00	300	0.60	214	0	0.00	357	1.67
30	524	997	1.90	4,435	8.46	723	41	0.06	3,450	4.77
31	113	449	3.97	1,448	12.81	154	0	0.00	417	2.71
32	26,372	28,371	1.08	37,418	1.42	25,567	26,157	1.02	32,172	1.26
33	60,006	39,152	0.65	42,865	0.71	74,997	35,281	0.47	33,455	0.45
34	3,536	29,104	8.23	33,055	9.35	3,756	28,835	7.68	31,883	8.49
35	89,354	56,106	0.63	54,217	0.61	96,023	57,608	0.60	49,823	0.52
Total	547,382	738,804	1.35	1,049,027	1.92	547,382	738,804	1.35	1,049,027	1.92

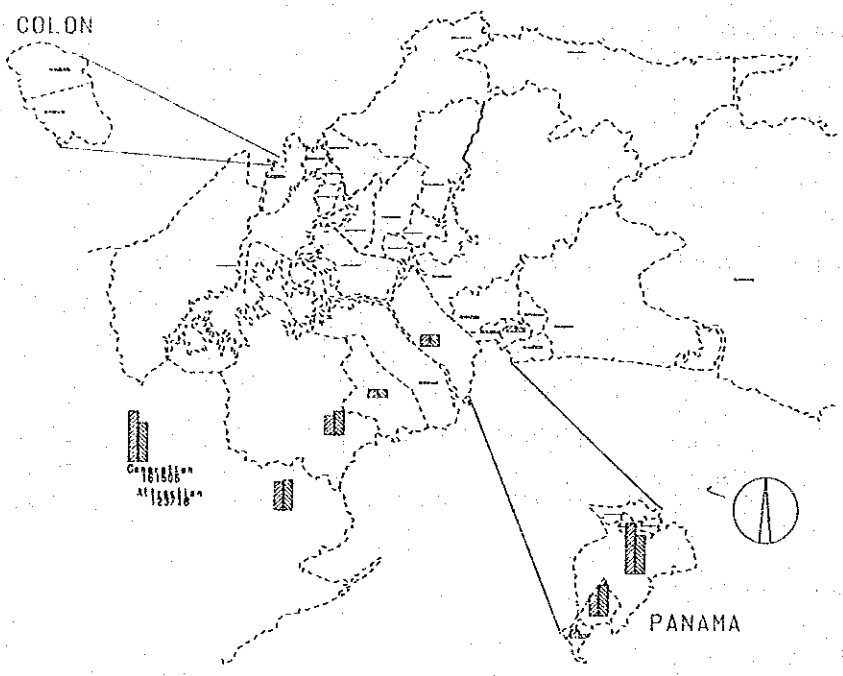


Figure 10.3.1 Generation/Attraction (1993)

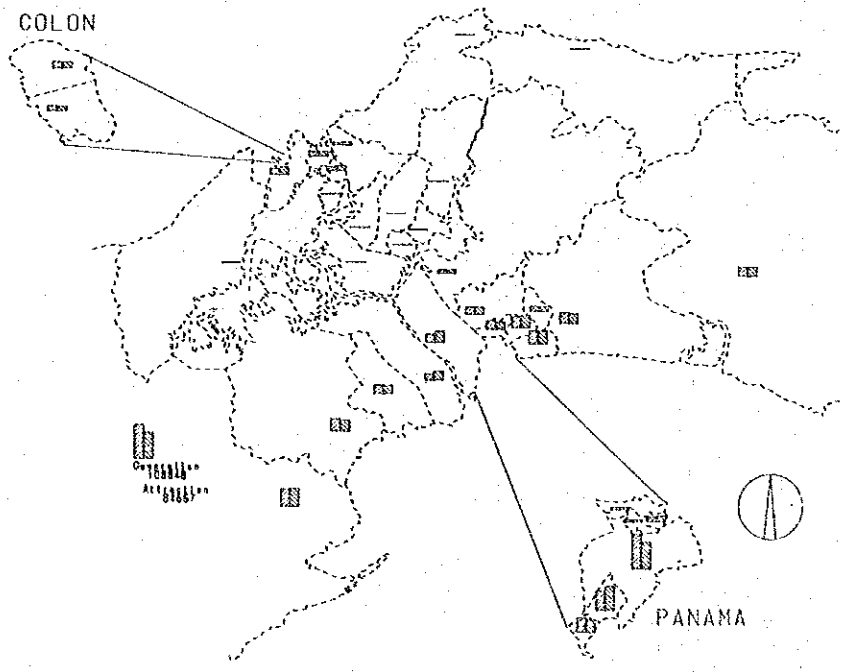


Figure 10.3.2 Generation/Attraction (2000)

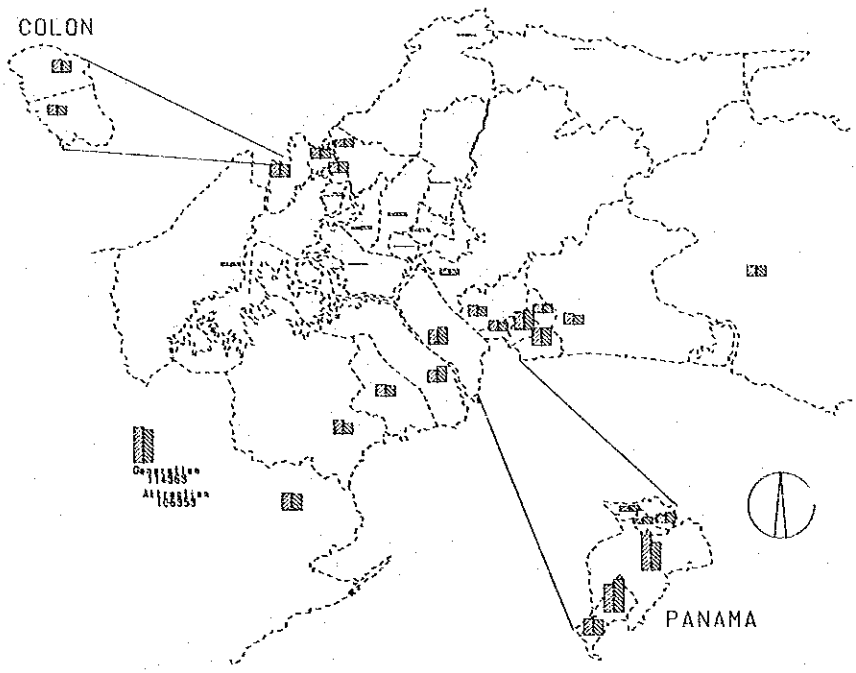


Figure 10.3.3 Generation/Attraction (2010)

10.3.3 Future OD Table

The future OD table has been prepared using Frater model calculations based on the future trip generation/attraction in Table 10.3.2 and the current OD pattern.

Figures 10.3.4 to 10.3.6 show the current and future OD tables.

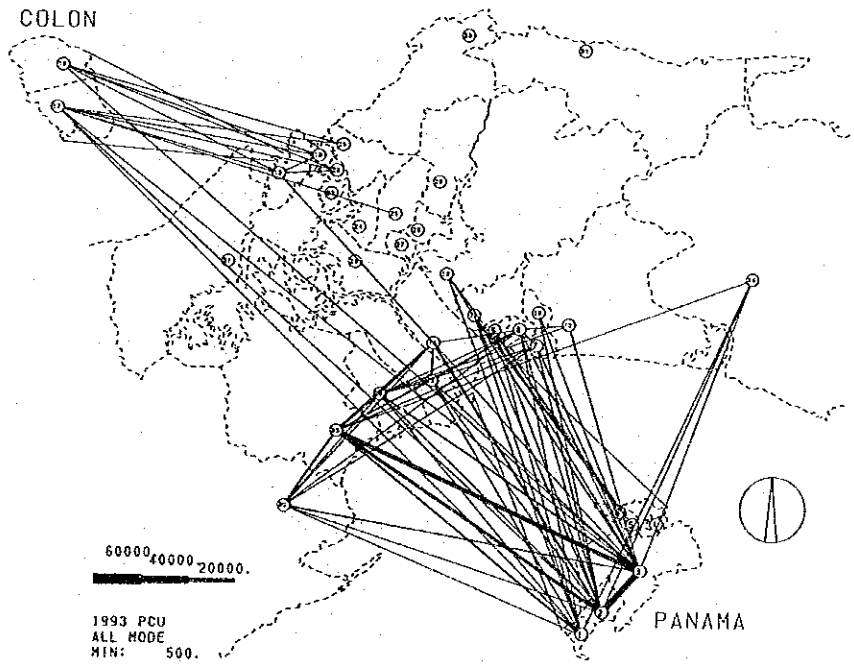


Figure 10.3.4 Traffic Demand (1993)

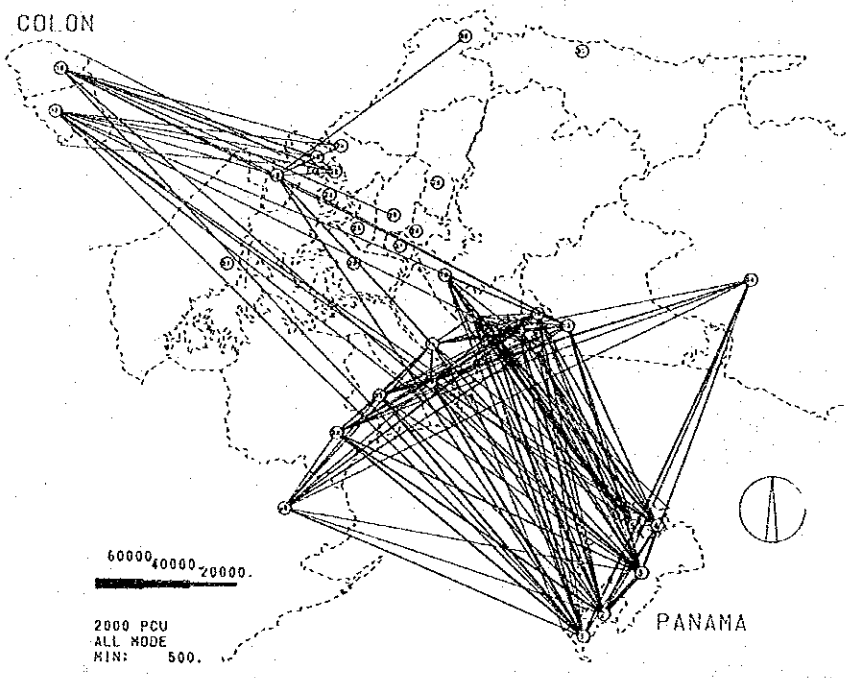


Figure 10.3.5 Traffic Demand (2000)

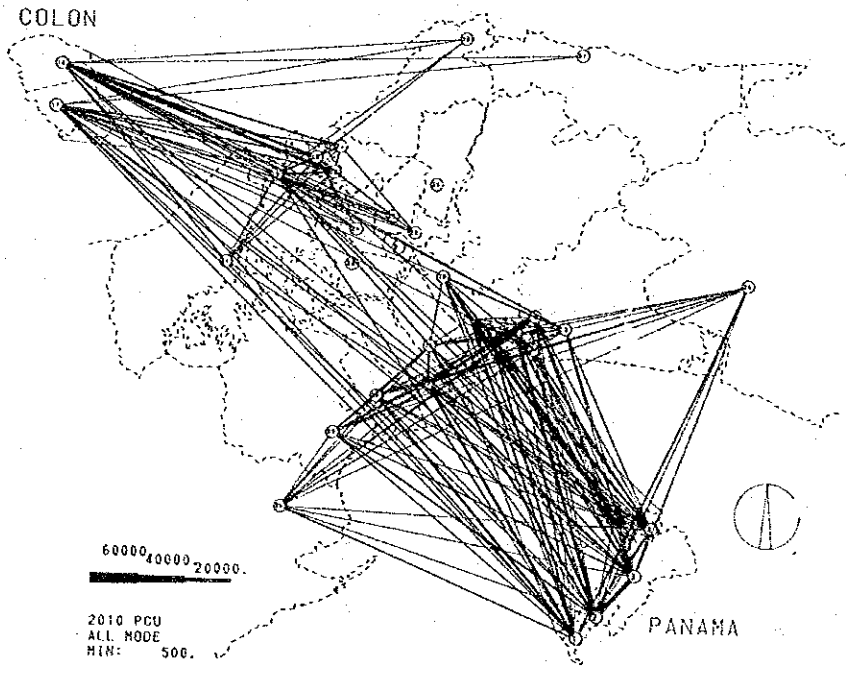


Figure 10.3.6 Traffic Demand (2010)

10.4 Future Traffic Demand

Traffic demand between Panama and Colon is shown in Figure 10.4.1. The traffic demand has the following features:

a) Traffic going directly between Panama and Colon, which is about 9,000 PCU/D in 1993, will double rising to about 18,000 PCU/D in 2010.
b) Traffic of workers and students from the outskirts of Colon into Colon city, which is about 9,000 PCU/D in 1993, will increase over 15 times rising to 137,000 PCU/D in 2010.
c) Short-distance trips along the Panama to Colon route will grow by between 3,000 and 10,000 PCU/D at any point. For the section between Chagres and Cristobal, growth will be 1.6 times.

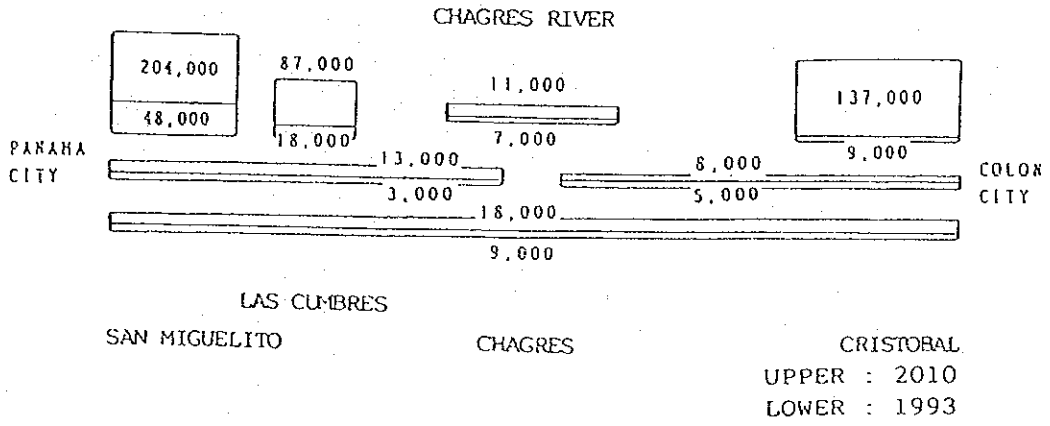


Figure 10.4.1 Traffic Volume by Trip Length (PCU)

11 ROAD NETWORK PLAN ALTERNATIVES

11.1 Road Network Planning Conditions

In Chapter 10 in this Report, the future traffic demand and traffic conditions in 2010 is forecasted. The future traffic volumes by passenger car unit per day (PCU/D) on the existing Panama-Colon Highway by road section are shown in Table 11.1.1.

Table 11.1.1 Future Traffic Volume

(Unit; PCU/D)

Road Segment			1993	2010
San Miguelito	-	Pan de Azucar	50,700	235,000
Pan de Azucar	-	San Isidro	33,000	87,000
San Isidro	-	Las Cumbres	25,000	87,000
Las Cumbres	-	Alcalde Diaz	11,000	42,000
Alcalde Diaz	-	Don Bosco	10,200	42,000
Don Bosco	-	Buena Vista	11,000	42,000
Buena Vista	-	Sabanitas	13,700	37,000
Sabanitas	-	Cativa	20,700	137,000
Cativa	-	Colon	35,900	137,000

In consideration of the road network configuration, the cities of Panama and Colon are connected by the National Primary Road and there is no alternative route between the two cities. The most parts of existing Panama-Colon Highway operates as a 2-lane road with a cement concrete pavement.

From the road inventory survey, the following problems became apparent;

a) There is no alternative road
b) There are many traffic accidents
c) A low design standard has been adopted
d) Poor maintenance

11.1.1 Planning Guidelines

By the year 2010, the populations of the cities of Panama and Colon will have increased by about 0.76 million and 0.37 million, respectively. The city of Panama is the capital and the largest city of Panama and the city of Colon is the second largest city. The highway under consideration connects these two cities. Therefore, it is obvious that the proposed road to be

The environment conditions within the Study Area are generally good, in particular the greenery in the Cuenca area, and a good supply of water for the operation of the Panama Canal. It is important that these good environmental conditions should be maintained in the future.

In addition to the above mentioned conditions, the pressure of population growth in the cities of Panama and Colon, is causing the expansion of housing development areas along the existing Panama-Colon Highway. The traffic situation on the existing Panama-Colon Highway in the suburbs of these two cities is becoming more congested with commuter traffic generated by the housing development.

Alternative Plans are prepared to examine the most effective road network between the cities of Panama and Colon. The following Alternative Plans are suggested, taking the future traffic demand and natural conditions into account.

a) Plan to widen the existing road
b) Plan to construct new road

11.2 Concepts of Alternative Plans

11.2.1 Function and Characteristics of Road

Roads in Panama are divided into the following four categories based on their functions.

a) Expressway (Auto pista)
b) National Primary Road
c) Regional Secondary Road
d) Local Road

According to the American Road Design Standard, that is the Policy on Geometric Design of Highway and Streets (AASHTO), roads are divided into five categories as shown below;

a) Expressway
b) Principal Arterial Road
c) Minor Arterial Road
d) Collector Road
e) Local Road

The functions and characteristics of the roads in the classifications have been examined for the purpose of road network planning in the Study Area. The functions and characteristics of the roads are summarized in Figure 11.2.1. The following are apparent from this Figure.

a) The function of the expressway and arterial roads is primarily to maintain mobility, so a high standard of road design criteria is required.
b) The function of a local road or minor road is primarily to maintain land access.
c) The function of a collector road is between that of the arterial road and local road.

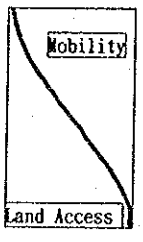
Function of Road	Characteristics of Road Traffic					Class of Road	Remarks
	Traffic Volum	Trip Length	Travel Speed	Mode of Transportation	Trip Purpose		
	Heavy	Long	High	Motor Vehicle	Business to Work	Arterial Road	
						Collecter Road	
	Low	Short	Low	Motor Cycle Bicycle Foot	To School Shopping	Local Road	

Figure 11.2.1 Function of a Road

The road network and traffic characteristics of a road are summarized in Figure 11.2.2, from which the following are apparent.

a) Expressways and arterial roads serve mainly for long or comparatively long trips with high traffic capacity and high speeds .
b) Local roads and minor roads provide mainly for short distance trips with low traffic capacity and low travel speeds.
c) The characteristics of collector roads are between those of the arterial and local road.

The road network system is arranged not only to contribute to socio-economic activities but also to form the basic infrastructure of the area.

	Road Characteristics				Traffic Characteriatics								
	City - City	To Town	Within Town	Access	Trip Length			Capacity			Running Speed		
					Long	Med.	Small	Big	Med.	Small	High	Med.	Low
Urban Highway		○	△		△	○		○			○		
Main Arterial	○	△			○	○		○			○	△	
Minor Arterial		○	△			○			○			○	△
Colecter			○	△		○	△		○	△		○	△
Local Road				○			○			○			○

○ : Main function
△ : Secondary function

Figure 11.2.2 Characteristics of a Road

Taking the above into account as well as the conditions governing the planning of the road, the functions and characteristics of the road are identified as follows:

a) To ensure high traffic mobility
b) To provide large traffic capacity for heavy traffic volumes.
c) To enable long distance trips to be carried out at high speeds.

11.2.2 Concept of Alternative Road Plans

(1) Alternative Plans to be Considered

Taking into account the functions and characteristics of the road, the condition of the existing road facilities and future traffic demand, the following two Alternative Plans are identified.

a) Plan for widening existing road
b) Plan for new road construction

(2) Concept of Alternative Plans

1) Plan for Widening Existing Road

As shown in Figure 11.2.3, the Plan for Widening the Existing Panama-Colon Highway involves widening from 2-lanes to 4-lanes and from 4-lanes to 6-lanes depending on the future traffic demand. Basically, the horizontal and vertical alignment of the planned road follows the alignment of the existing road, considers existing topographic features.

The traffic operation systems of the planned road are the same as these of the existing road. This means that traffic with various functions will be using the same road.

This plan will ensure the following characteristics and functions for the road.

a) Functions of a National Primary Road (Forming a trunk road network system in Panama)
b) Main industrial traffic flow contributes the socio-economic activities between the cities of Panama and Colon.
c) Functions of collector and local road (Access road network for inhabitants)
d) Characteristics of commuter traffic from housing areas in the cities of Panama and Colon to the centers of these cites.

2) New Road Construction Plan

As shown in Figure 11.2.4, the Plan for New Road Construction means that a new road being constructed between the cities of Panama and Colon but the existing road will not be widened. When the new road will be constructed, the cities of Panama and Colon will be connected by two roads; one of them a new road, and the other is existing road. The functions and characteristics of the existing road and the new construction road can be clearly separated.

The existing Panama-Colon Highway should be ensured the following functions and characteristics;

a) To ensure the functions of collector and local road
b) To ensure the characteristics of short distance traffic between housing areas and city centers

The new construction road should be ensured following functions and characteristics;

a) To ensure the functions of National Primary Road
b) To ensure the characteristics of main industrial traffic between the cities of Panama and Colon
c) To ensure to serve for the regional development

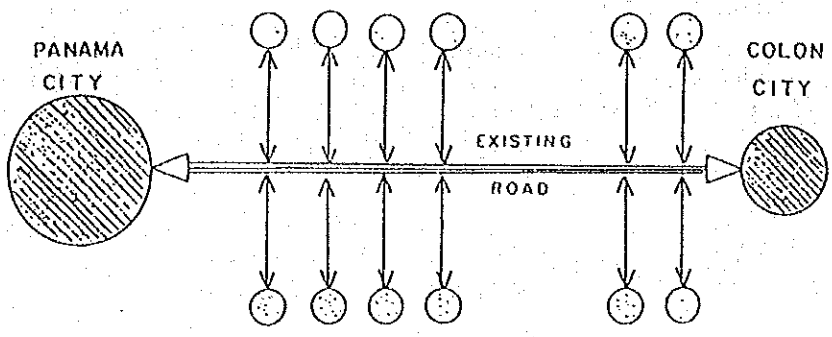


Figure 11.2.3 Conceptual Traffic Flows in Alternative Plan for Existing Road

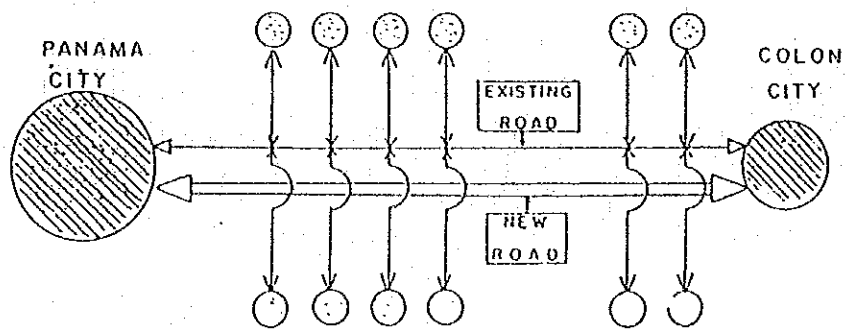


Figure 11.2.4 Conceptual Traffic Flows in Alternative Plan for Construction New Road

11.3 Preparation of Alternative Plans

11.3.1 Procedure for Preparation of Alternative Plans

The Alternative Plans is drawn up in consider alien of the traffic characteristics, future traffic demand and the existing topographic features in the Study Area. The procedure for preparation of the Alternative Plan is shown in Figure 11.3.1.

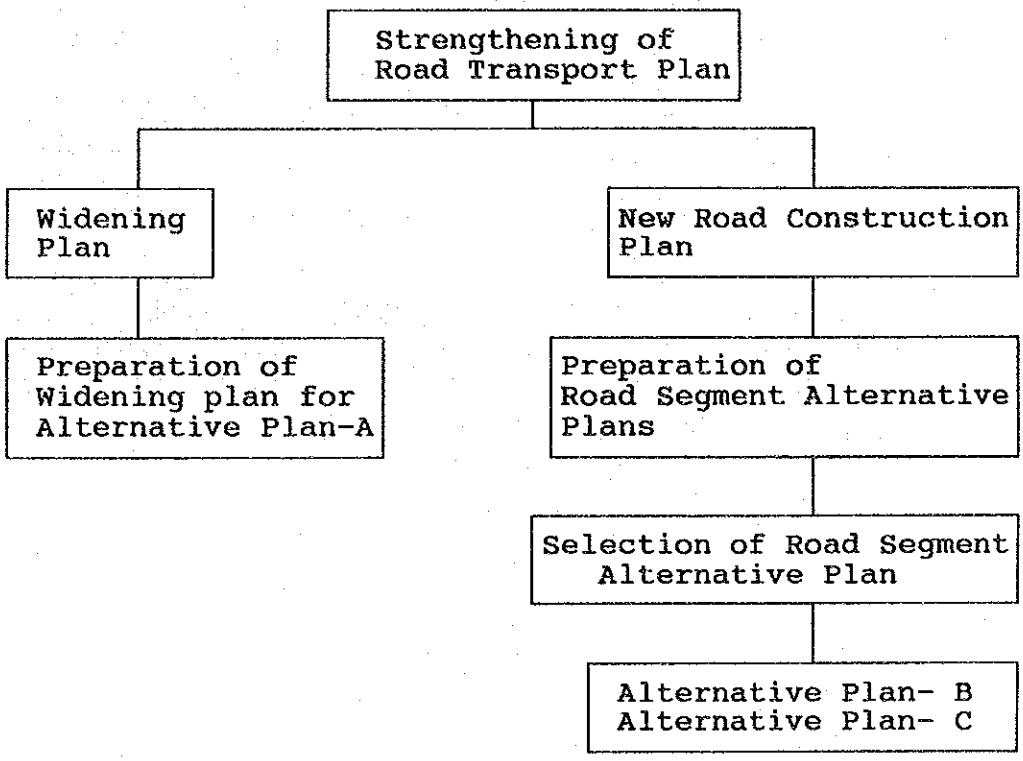


Figure 11.3.1. Procedure for Preparation of Alternative Plan

11.3.2 Characteristics of Traffic on Existing Road

(1) Future Traffic Volume

The traffic demand in the year 2010 in summarized in Figure 11.3.2.

1) The future traffic volume will be concentrated in the suburbs of the cities of Panama and Colon, For instance, the traffic volume from San Miguelito to San Isidro and Colon to Cativa are forecast as 204,000 and 137,000 passenger car unit par day (PCU/D), respectively.

2) However, the road segment between Alcalde Diaz and Buena Vista is forecast 37,000 to over 42,000 PCU/D.

3) The through traffic volume between the cities of Panama and Colon is estimated as 18,000 PCU/D.

4) Traffic flows can be classified arranges to this column as shown below:

a) The highest traffic volume is in the area between CBD of Panama City and San Isidro area with 235,000 PCU/D. This is mainly commuter traffic.
b) The second highest traffic volume is in the area be tween CBD in Colon City and Cativa a with 163,000 PCU/D. This is mainly commuter traffic.
c) The third highest traffic volume is in the area between the cities of Panama and Colon with 18,000 PCU/ D. This is through traffic.

(2) Relation of Traffic Volume to Required Road Space

Taking the traffic conditions and land use along the existing roads, in to account the traffic capacity of the road is about 9,000 PCU/ D per lane.

As the result of comparing the traffic demand in the year 2010 and capacity, the number of lanes required in the San Isidro Area, Buea Vista and Cativa areas is 12, 6 and 14 lanes, respectively.

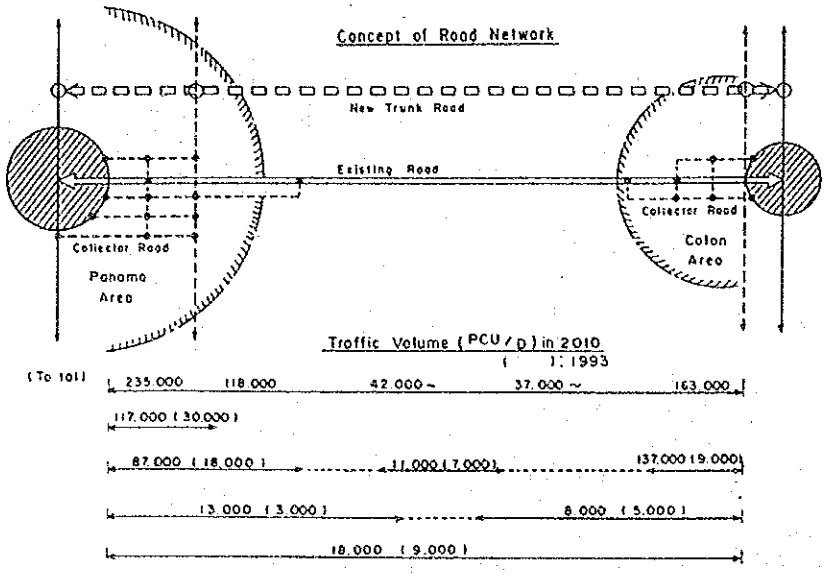


Figure 11.3.2 Future Traffic Volume

11.3.3 Proposed Alternative Plans

Prior to the preparation of the Alternative Plan for the new road construction, a route location analysis is carried out to verify the possibility of a new road through the area between the cities of Panama and Colon.

(1) Basic Considerations for Route Location

The route location analysis is conducted in consideration of following points.

1) Environmental Aspects

a) Avoid passing through the National Park so that a good natural environment can be maintained.
b) Avoid passing through existing and future housing development areas as much as possible in order to maintain a good social environment.
c) Regulate high cutting and embankment structure in order to maintain a good natural environment .

2) Technical Aspects

a) Satisfy geometric design elements adopted
b) Arrange suitable locations for interchange
c) Meet requirements of the existing and future road network

3) Economic Aspects

a) Avoid passing through steep mountainous areas as much as possible lower the construction costs
b) Identify areas which have high development potential to attract tourism, housing and other developments
c) Provide access to existing and future housing develop ment areas to increase traffic benefits

(2) Location of Route Alternatives

Based on the above points, actual controlling points for route location are summarized in Figure 11.3.3.

Considering the topographical conditions and land use characteristics, the route location area can be divided into four sections as shown below:

a) San Miguelito - Buenos Aires Section
b) Buenos Aires - Buena Vista Section
c) Buena Vista - Sabanitas Section
d) Sabanitas - Colon Section

1) San Miguelito - Buenas Aires Section

In this area, there are seven items to be considered by the location of the route alternatives as shown below.

a) Existing and future housing development areas in San Miguelito
b) Soberania National Park
c) Steep mountainous areas
d) Route of Corredor Norte
e) Route of Auto pista Arraijan - Panama
f) Electric power lines
g) Water pipe line

In consideration of the various developments and facilities, two alternative routes Segment A and B are defined as shown in Figure 11.3.3. The route in Segment A is located in consideration of the following points:

a) The route should be located so as to avoid passing through the Soberanian National Park Area.
b) The route should be located so as to avoid passing through the existing San Miguelito housing area as far as possible to make the construction of the road easier.
c) The route should be located so as to avoid passing through steep mountainous areas as far as possible.

The route is Segment B has been located consideration of the following points:

a) The route should be located so as to avoid passing through the existing housing areas in San Miguelito as far as possible.
b) The area of about 300 m in length of the existing housing area of Sito de Goytia is not avoided since the road in Segment B should be connected to the Corredor Norte.

2) Buenos Aires - Buena Vista Section

In locations the route in this section,the three facilities shown below should be considered.

a) Lago Alajuela
b) Madden Dam
c) Steep mountainous area

As shown in Figure 11.3.3, the above three features are located on the north side of the existing road but there is no obstruction to route location on the south side.

Taking these features into account, the route of segment C is located so as to avoid passing through the Lago Alajuera, Madden Dam and steep mountainous area as far as possible and on the south side of the existing road. As a result of the route location study, no other alternative route exists in this section.

3) Buena Vista - Sabanitas Section

In locating the route in this section, the three features below should be considered.

a) Lago Gatun
b) Cuenca area
c) Steep mountainous area

On the south side of the existing Panama-Colon Highway are Lago Gatun, Cuenca and comparatively steep mountainous areas. On its north side however, these are very steep mountainous areas. Segments D and E are considered as possible alternative routes for the construct of a new road. Shown in Figure 11.3.3.

4) Sabanitas - Colon Section

In this section, the five features below should be considered in locating the route.

a) Gatun National Park
b) Existing housing areas
c) Future housing development areas
d) Lago Gatun
e) Cuenca area

On the north side of the existing Panama-Colon Highway in this section, there are many houses and other buildings so it would be very difficult to build a new road in this area. Consideration of the above features the route is located on the south side of the existing Panama-Colon Highway. Therefore the route of Segment F is located so as to avoid passing through the Gatun National Park as well as the existing and future housing development areas and the Cuenca area as far as possible.

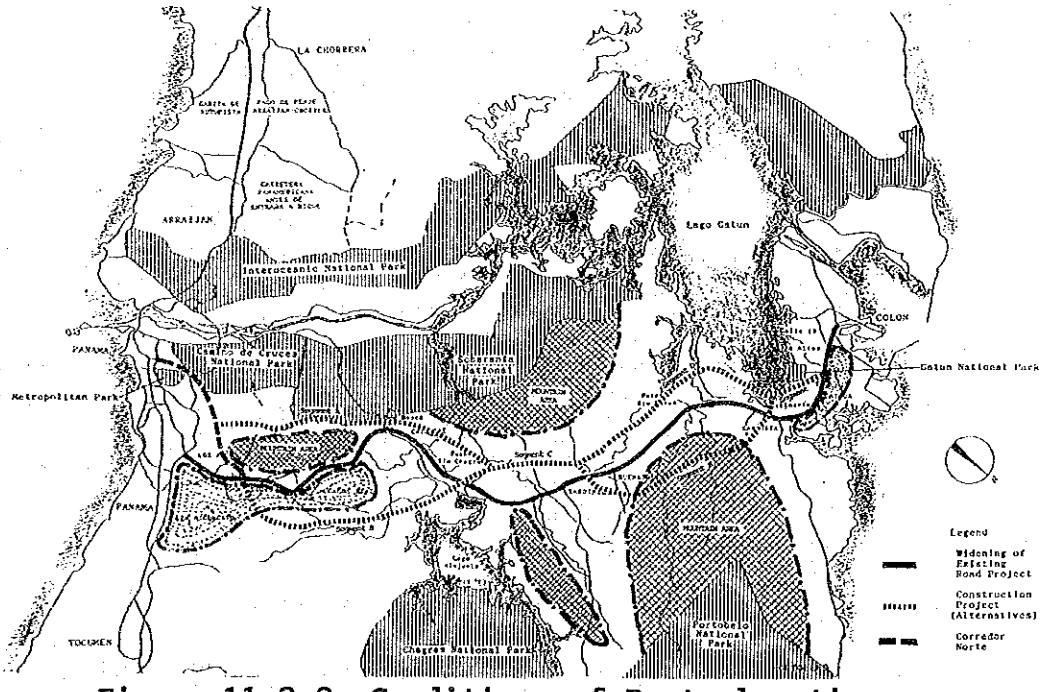


Figure 11.3.3 Conditions of Route location

(3) Initial Route Selection

In the previous section, six route Segments, Segments A to F are identified for the new road construction plan as shown in Figure 11.3.4. Segment A and B are proposed as alternatives for the San Miguelito - Buenas Aires Section. Segments D and E are proposed as alternative segments for the Buena Vista - Sabanitas Section.

Prior to the preparation of the Alternative Plans, an initial route selection study is conducted.

1) Comparison of Segments A and B

The advantages and disadvantages of the routes in Segments A and B are now examined based on technical, economic and environmental aspects.

(*) Advantages of Segment A;

a) Little compensation required(about 20 houses)
b) Easy land acquisition (few housing area)
c) No division of communities
d) Short distance from CBD to Alcarde Dias

(*) Disadvantages of Segment A;

a) High construction costs ($ 120 mill.)
b) Comparatively difficult construction
c) Large scale construction (tunnels, bridges)

(*) Advantages of Segment B;

a) Cheaper construction costs ($ 83 mill.)
b) Easy construction
c) Contribution of developments
d) Flexible road network

(*) Disadvantages of Segment B;

a) Larger compensation required(about 46 houses)
b) Division of communities
c) Difficulties in land acquisition

It is very difficult to select the optimum Segment for this section based only on construction costs and other technical evaluations. So the optimum Segment will be selected after examination of other factors such as economic analysis and environmental study.

2) Comparison of Segments D and E

Segment D is selected for the following reasons:

a) The construction costs of Segment D (93 mill.Balboas) are lower than for Segment E ($ 133 mill. Balboas)

b) The benefits of Segments D and E to road users are almost the same since the connections to the existing road are the same .
c) The land in Segments D and E is classified as forest so there is no difference for development possibilities.
d) The road lengths of Segments D and E are about 17,000 meters and 17,500 meters, respectively.

3) Results of Initial Route Selection

As mentioned in the previous section, further study is required to select either Segment A or B and Segment E is eliminated as a route in the road network of the Alternative Plan. The Segments proposed for the alternatives to the Master Plan for the road network between the cities of Panama-Colon are shown in Figure 11.3.4.

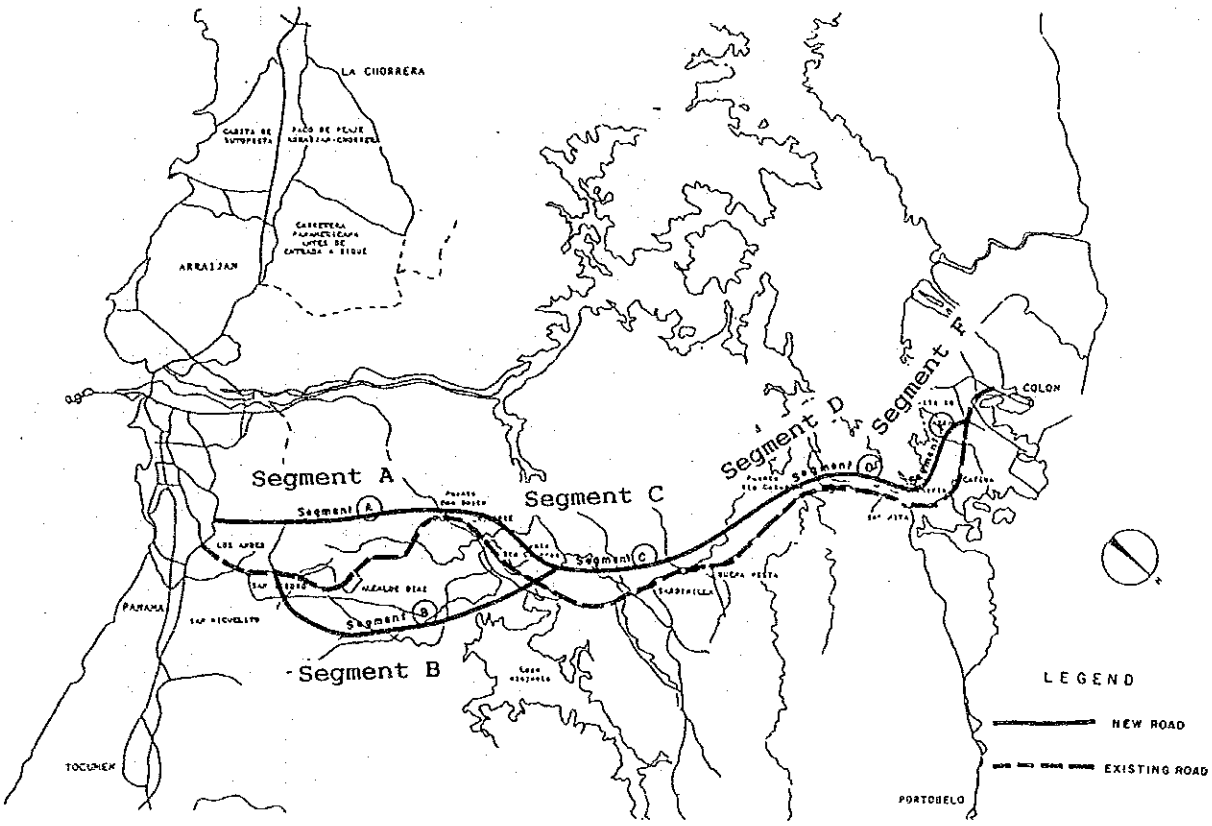


Figure 11.3.4 Location of Segment

(4) Proposed Alternatives to Master Plan

Alternative Plan A for the widening of the existing road and Alternative Plan B and Alternative Plan C for constructions the new road are proposed. These three plans are shown in Figure 11.3.5.

a) Alternative Plan A ; Widening of existing Panama-Colon Highway (Segment G, H, I, J, K)
b) Alternative Plan B; New road construction plan (Segment A, C, D, F)
c) Alternative Plan C; New road construction plan (segment B, C, D, F)

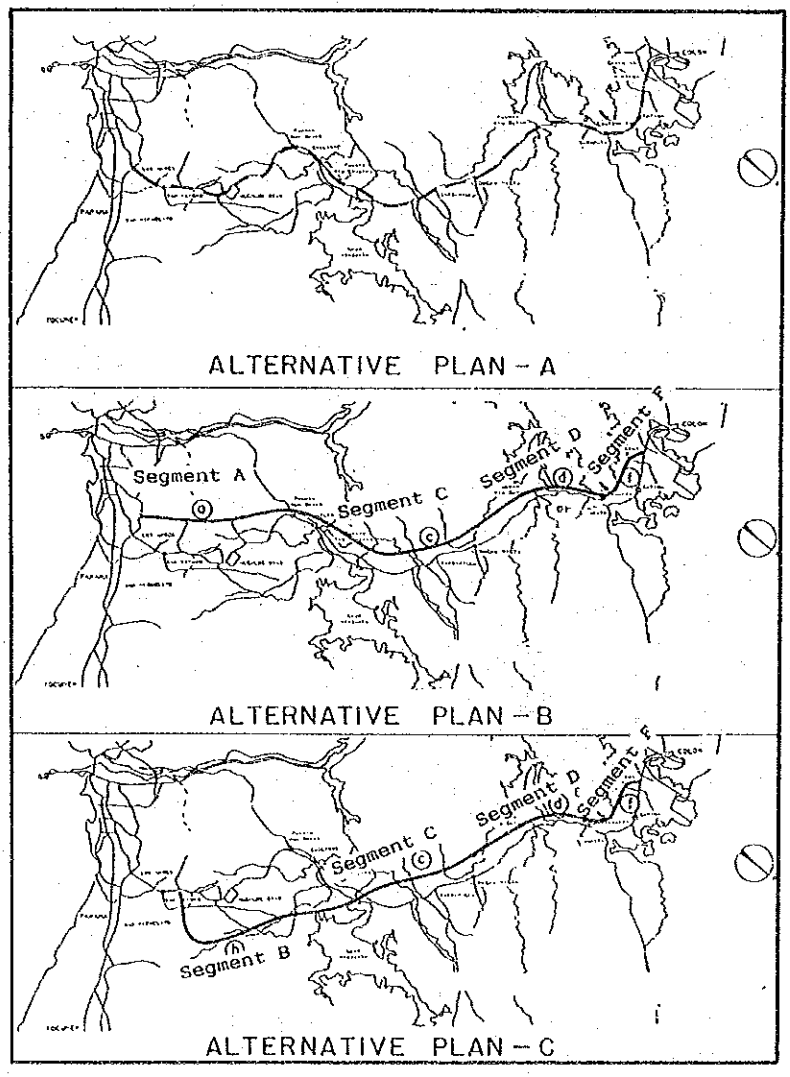


Figure 11.3.5 Proposed Alternative Plans

12 ENGINEERING EVALUATION AND COST ESTIMATE

The engineering evaluation is carried out based on the Alternative Plans A, B, and C in order to examine the technical feasibilities.

12.1 Plan to Widen Existing Road

12.1.1 Design Policy

In view of the results of the reconnaissance survey, road inventory survey and future traffic demand, the following design policies are identified for the plan for Widening the Existing Road (Alternative Plan A).

a) To harmonize future traffic demand
b) To increase traffic capacity
c) To decrease traffic accidents
d) To maintain good environmental conditions
e) To utilize the existing road facilities

12.1.2 Design Concept and controls

(1) Design Concept

a) The road of widening project will be implemented while operating under existing traffic conditions as there is no alternative route.
b) Basically, the horizontal and vertical alignments follow the alignments of the existing Panama-Colon Highway in consideration of the topographical conditions.
c) An access control system has not been adopted due to the land use situation along the existing Panama-Colon Highway and the functions and characteristics of the road.

(2) Design Control

The proposed design controls are identified as shown below in consideration of the existing road facilities conditions and other road development plans.

a) A 60 km/h design speed has been adopted for this plan based on the results of an examination of the road structure the existing Panama-Colon Highway.
b) The American Road Design Standards (AASHTO) has been adopted as the design standard for this study
c) The full trailer vehicle has been adopted as the design vehicle.

12.1.3 Engineering Examination

(1) Horizontal Alignment Design

The horizontal alignment design is conducted along the existing Panama-Colon Highway. The small curvatures of 300 meters of less resulting from the horizontal alignment design, are shown in Table 12.1.1.

Table 12.1.1 Minimum Curvature

	Station No.	Curvature
a)	No. 6+000 - No. 7+000	R=275m
b)	No. 8+000 - No. 9+000	R=200m
c)	NO. 9+500 - No.10+000	R=300m
d)	No.18+500 - No.19+500	R=275m
e)	No.32+000 - No.34+000	R=200m
f)	do	R=250m
g)	do	R=300m
h)	No.46+500 - No.47+500	R=200m
i)	No.50+000 - No.51+000	R=180m
j)	No.52+000 - No.53+000	R=190m
k)	do	R=250m

(2) Vertical Alignment Design

The vertical alignment design is conducted on the basis of the existing road. The components of longitudinal gradient result from the vertical alignment design are shown in Table 12.1.2.

Table 12.1.2 Section Gradients and their Lengths

	Gradient(%)	Road Length(m)
a)	0.00 % - 3.00 %	36,747 m (54 %)
b)	3.00 % - 4.00 %	6,770 m (10 %)
c)	4.00 % - 5.00 %	12,569 m (18 %)
d)	5.00 % - 6.00 %	11,914 m (18 %)
	total	68,000 m (100 %)

About 46 percent of the total road length has a gradient of over 3.00 percent and about 18 percent of the total road length has a gradient of over 5.00 percent

(3) Cross-Section Design

1) Number of Lanes Required

The number of lanes required is decided by a comparison between

the future traffic demand and capacity per lane. The number of lanes to be required for all sections from the comparison are shown in Table 12.1.3.

Table 12.1.3 Number of Lanes for Each Section

Road Section			Traffic Volume	Capacity	Number of Lanes
San Miguelito	-	Pan de Azucar	87,000	9,000	10
Pan de Azucar	-	San Isidro	87,000	9,000	10
San Isidro	-	Las Cumbres	87,000	9,000	10
Las Cumbres	-	Alcalde Diaz	42,000	9,000	6
Alcalde Diaz	-	Don Bosco	42,000	9,000	6
Don Bosco	-	Buena Vista	37,000	9,000	4
Buena Vista	-	Sabanitas	37,000	9,000	4
Sabanitas	-	Cativa	137,000	9,000	14
Cativa	-	Colon	137,000	9,000	14

2) Capacity Calculation

The capacity is calculated by the following formula.

$$C = Bc * Cg * Cl * Cs * Cu * G$$

C ; Possible capacity per lane
Bc ; Basic capacity per lane (2,000 V/H)
Cg ; Adjustment factor for heavy vehicle (0.83)
Cl ; Adjustment factor for lane width (1.0)
Cs ; Adjustment factor for lateral clearance (1.0)
Cu ; Adjustment factor for land use (0.85)
G ; Signal phasing (0.65)

C= 2,000 * 0.83 * 0.85 * o.65 = 910 pcu /h /lane
=9,100 pcu /day /lane

3) Cross - Section Element Design

The elements of cross-section are identified as shown below consideration of the functions of the road and design standards.

a) A 3.65 meters (12') lane width is adopted in accordance with AASHTO
b) A 1.80 meters (6') shoulder width is adopted in accordance with AASHTO
c) A 5.00 meters median width is adopted considering additional lane width required for left turns or U-turns.
d) 5.00 meters sidewalk width on both side of the road in urban areas is adopted to ensure safety for pedestrians and traffic.
e) Plants are used on the median and sidewalks to maintain a good environment.

(4) Climbing Lane Design

Traffic congestion is occurring on certain road sections due to particularly slow vehicles, mainly fully loaded heavy trucks. The capacity of the road is decreased by these vehicles.

It is proposed that climbing lanes are planned on steep gradient road sections to maintain smooth traffic flows, to increase traffic capacity and also to reduce traffic accidents. Taking vehicle composition, road features and the critical length of grade, into account climbing lanes are planned for road sections where a grade of 5.00 percent or more continues over at least 500 meters.

As a result of the examination, climbing lanes are planned for the following road sections as shown in Table 12.1.4.

Table 12.1.4 Planned Climbing Lanes

Station No.	Length
a) No. 7+000 - No. 8+700	L=1,700 m (R)
b) No.10+725 - No.12+000	L=1,275 m (R)
c) No.12+000 - No.13+175	L=1,275 m (L)
d) No.26+700 - No.27+550	L= 850 m (R)
e) No.27+550 - No.28+400	L= 850 m (L)
f) No.30+700 - No.32+500	L=1,800 m (R)
g) No.33+300 - No.34+800	L=1,500 m (L)
h) No.35+700 - No.37+800	L=2,100 m (R)
i) No.48+100 - No.50+500	L=2,400 m (L)
j) No.52+000 - No.53+800	L=1,800 m (R)
k) No.53+800 - No.56+000	L=2,200 m (L)
Total	L=17,750 m

Notes : (R);right side for Colon City
(L);left side for Colon City

(5) Bridge Design

1) Design Concepts and Standards

There are 18 bridges on the existing Panama-Colon Highway. The carriageway width of the Don Bosco and Rio Chagres Bridges are 14.5 meters and 14.7 meters, respectively. These bridges are 2-lane. The carriageway width of the 4 bridges located in Colon City are about 2 * 7.8 meters for a 4-Lane dual carriageway. The carriageway widths of the remaining 12 bridges are about 7.8 meters.

The bridge design is conducted based on the following conditions;

a) Existing bridges with a 7.8 meters carriageway width are used for 2-lane traffic.

b) Existing bridges with a 14.8 meters carriageway width are also used for 2-lane traffic.
c) Existing bridge with 2 * 7.8 meters carriageway width are used for 4-lane dual carriageway.
d) New bridges with a 2-lane carriageway are planned to be beside the existing bridges.

2) Design Criteria

The following design criteria are drown up based on the results of collected data and its analyses, characteristics of bridge design in Panama, and other related matters.

a) The design standards to be adopted are AASHTO
b) The design loading to be adopted is HS 20-44
c) The influence value of earthquakes adopted is A=0.15
d) The vertical clearance to be adopted is 5.00 meters
e) The lane width adopted is 3.65 meters in accordance with the width of road cross-section elements .
f) The median width adopted is 5.00 meters in accordance with the width of road cross-section elements.
g) Shoulder width of 3.00 and 0.60 meters are adopted for shoulders of less than 50 meters in length and more than 50 meters in length, aspects consideration of economy.

3) Types of Bridge

Generally, the superstructures of bridge can be divided into three different types the RC type, PC type and Steel type. The RC type is adopted for short span bridges less than 20 m and the PC type is adopted for comparatively long span bridges. The followings points come to high from the bridge inventory survey.

a) Bridge Nos. 15 to 17 were constructed of steel in 1941 as 2-lane bridges and the PC type was used to make wider bridges in 1984. The lengths of the PC bridges are about 12 meters to 15 meters in accordance with AASHTO-PCI (Type- II).
b) There are three bridges under-construction in Panama City. These bridges are the PC type with a span of about 30 meters (AASHTO-PCI).
c) The concrete materials required can be produced in Panama.

Taking the above points into account, Those types of PC bridges; Types A, B and C, are adopted for the bridge superstructures in this study.

a) Type A is adopted for bridges with a span of less than 30 meters, (AASHTO-PCI)
b) Type B is a PC - BOX girder bridge adopted for bridges with spans of 30 to 50 meters.
c) Type C is a PC - BOX girder bridge adopted for bridges with a span of over 50 meters.

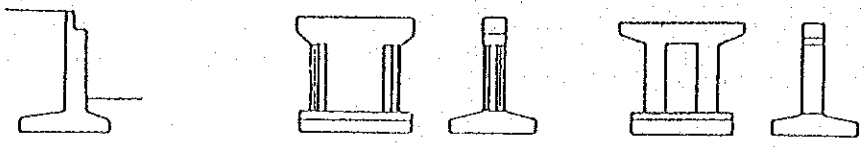


Figure 12.1.1 Types of Foundations

4) Proposed Bridges

The design of the proposed bridges are conducted based on the above mentioned points and their details are summarized in Table 12.2.2. As shown in the table, a total of 22 bridges is planned for the widening of the existing Panama-Colon Highway (Alternative Plan A).

12.2 New Road Construction Plan (Alternative Plan B and C)

12.2.1 Design Policy and Concepts

The following design policies and concepts are identified from the results of the reconnaissance survey, functions and characteristics of the planned roads and a consideration of development conditions.

a) Ensure the functions of a trunk road
b) Contribution to economic development
c) Maintain a good social and natural environment

In order to achieve the above design policies, the following conditions are identified for the preliminary design of the new road.

a) A full access traffic control system introduced to ensure high traffic mobility and to maintain uninterrupted traffic flow.
b) The design speed adopted is 110 km/h in consideration of the design speed of related trunk roads in the Study Area such as the Autopista Arraijan-Panama (design speed 110 km /h) and Corridor Norte (design speed is 100 km /h to 80 km /h).
c) Structures such as bridges and tunnels are planned so as to maintain a good natural environment.

12.2.2 Engineering Evaluation of New Road Construction Plan

(1) Design Standards and Design Elements

In Panama, MOP has prepared two manuals of design standards for road planning and design:

a) Manual de normas y driterios para el diseno general de carreteras vecinales 1991
b) Manual de requisitos para aprobacion de planos

In general, when a road is planned and designed, the above two Manuals are used and, the American Design Standards (AASHTO) are also referred. In this study, the standards in the above mentioned are adopted for the road design.

(2) Horizontal and Vertical Alignment Design

The horizontal and vertical alignment design has been conducted using a geographical map with a scale of 1 to 25,000 based on the following conditions.

a) The minimum radius of curvature of the horizontal alignment is 460 meters.

b) The maximum gradient of the vertical alignment is 4.0 percent.

(3) Cross-Section Design

The proposed route passes through two different type of development area: urban areas and rural areas. The cross-section is different for each area in consideration of the traffic operation system and economic aspects.

In urban areas, the typical cross-section consists of traffic lanes and frontage roads on both side of the proposed road in consideration of the function of the proposed road, traffic operation system and urban development activities.

In rural areas, the typical cross-section consists of traffic lanes has no frontage roads. However,a full shoulder width (3.00 m) is adopted in consideration of traffic safety.

a) 3.65 meters lane width
b) 5.00 meters median width in consideration of traffic turning and U-turns.
c) 1.80 meters right side shoulder width
d) 3.00 meters right side shoulder width for rural areas.

(4) Pavement Type

The pavement can be divided into two different types; cement concrete and asphalt concrete pavement according to their construction materials. In this study, the cement concrete pavement type is adopted for the proposed road for the following reasons;

a) The initial construction costs for cement concrete pavement is cheeper than asphalt concrete pavement
b) Cement concrete pavement requires less maintenance than asphalt concrete pavement.

(5) Interchange Design

The design of interchanges is conducted on the basis of the road design policy and concepts. A full access control system is proposed in consideration of the functions and characteristics of the proposed road. The interchanges are planned based on the following conditions;

a) Intersections between the proposed road and the Auto pista are the Junction Type Interchange.
b) Intersections between the proposed road and 4-lane dual carriageway are Trumpet Type Interchanges.
c) Intersection between the proposed road and the main 2-lane carriageway are Diamond Type Interchanges.

(6) Bridge Design

Bridges are designed for Segments A to F in the new road construction plan. The design criteria and design standards adopted

are the same as for the plan to widen the existing road (Alternative Plan A).

Two types of bridge are considered, one is the viaduct and the other the river bridge. As shown in Table 12.2.1, these bridges have been divided into two or three types depending on their construction cost.

Table 12.2.1 Bridge Classification

Type of Bridge		Classification
Viaduct		Type A
River Bridge	L < 30 m	Type A
	30m < L < 50m	Type B
	50m < L	Type C

L; One Span Length

The design of bridges is conducted based on the following conditions;

a) Bridges are dual carriageway
b) Viaducts are the simple beam, continuous type (Type A) in view of economy.
c) Bridge pier are designed to be in shallow water.
d) Type C bridges are adopted for Rio Chagres and Rio Gatun in view of size constructions.
e) Type B or C is adopted for the other bridges.

The proposed types of bridge are summarized in Table 12.2.2.

Table 12.2.2 Proposed Bridge Type

SEGMENT	NO	Type of Bridge	Bridge Width	Carriage Width	Type	Bridge Type	Span arrengement (m)
A	No. 8+0	River	100	8.4*2	B	3 Span - Box	1*(30+40+30)m
A	No. 10+400	Viaduct	150	8.4*2	A	AASBTO - PCI TypeIV	5*30m
A	No. 13+0	River	100	8.4*2	B	3 Span - box	1*(30+40+30)m
A	No. 20+500	River	50	10.8*2	B	Simple Garden	1*50m
B	No. 2+200	Viaduct	200	8.4*2	A	AASBTO - PCI TypeIV	8*25m
B	No. 7+0	River	200	8.4*2	B	5 Span Box	1*(32.5+45+45+45+32.5)
C	No. 24+200	River	200	8.4*2	C	3 span - Box	1*(55+90+55)m
D	No. 35+600	Over pass	40	5.0	A	AASBTO - PCI TypeIII	2*20m
D	No. 40+100	Viaduct	400	8.4*2	A	AASBTO - PCI TypeII	16*25m
D	No. 42+0	River	20	10.8*2	A	AASBTO - PCI TypeIII	1*20m
D	No. 43+300	River	200	8.4*2	C	3 Span - box	1*(55+90+55)m
D	No. 44+700	Over pass	40	5.0	A	AASBTO - PCI TypeIII	2*20m
D	No. 46+800	Over pass	40	5.0	A	AASBTO - PCI TypeIII	2*20m
D	No. 48+100	River	100	8.4*2	B	3 Span - box	1*(30+40+30)m
D	No. 48+500	River	100	8.4*2	B	3 Span - box	1*(30+40+30)m
D	No. 48+900	River	100	8.4*2	B	3 Span - box	1*(30+40+30)m
D	No. 49+600	River	200	8.4*2	A	AASBTO - PCI TypeIV	8*25m
E	No. 38+400	River	300	8.4*2	B	7 Span - Box	1*(37.5+45+45+45+45+45 +37.5)m
E	No. 43+700	River	300	8.4*2	C	5 Span - Box	1*(45+70+70+70+45)m
E	No. 45+200	River	200	8.4*2	B	5 Span - Box	1*(32.5+45+45+45+32.5)
E	No. 48+500	River	200	8.4*2	B	5 Span - Box	1*(32.5+45+45+45+32.5)
F	No. 50+900	Viaduct	200	8.4*2	A	AASBTO - PCI TypeIV	8*25m

12.3 Construction Cost Estimate

The construction costs for road network Master Plan are estimated for each Segment (Segment A to F) as shown in Table 12.3.1 and based on the results of the engineering evaluation described in the previous section. The construction costs consist of the following items;

a) Labor costs
b) Equipment costs
c) Material costs
d) Contractor's profit
e) Land acquisition costs
f) Compensation

The construction costs are estimated based on the results of the engineering evolution and with reference to the construction costs estimated by MOP, as well as in the basis of discussions with Panamanian counterparts. The construction costs for the Segments are shown in Table 12.3.1.

Table 12.3.1 Total Construction Costs by Segments
(Unit; 1,000 Balboas)

Segment	Construction Cost	
Segment A	120,006	For new road cost. plan
Segment B	83,205	
Segment C	43,076	
Segment D	92,957	
Segment E	132,712	
Segment F	39,370	
Segment G	76,615	For widen plan to existing road
Segment H	22,129	
Segment I	51,167	
Segment J	17,405	

13 EVALUATION OF ALTERNATIVE PLANS

13.1 Future Traffic Assignment

13.1.1 Presuppositions

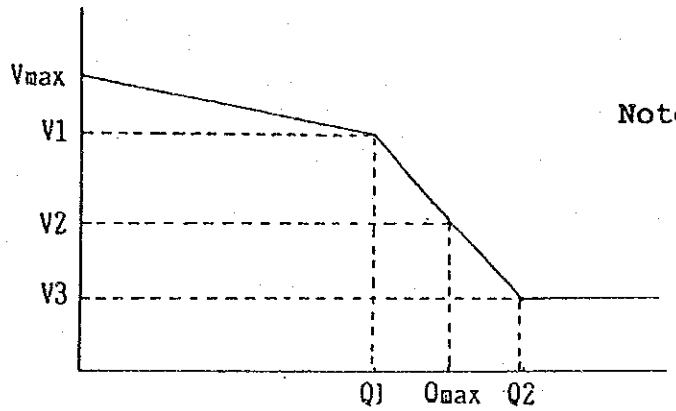
(1) Road NetWork

The future road network the traffic demand estimate consists of the Panama Metropolitan area, Master Plan network, Christobal Port Development Plan network, Colon City Development plan and principal roads in all of the Study Area.

The link lengths are taken from the road network inventory (Red vial) issued by MOP, and are measured from a map when not listed in the inventory.

(2) QV Equation

In the traffic assignment sub-model, the "QV Equation" function is used in order to calculate the travel speed on each link. The QV equation, which can be represented as a curve, as shown in figure 13.1.1, defines the relationship between road capacity and velocity. As shown in the figure, velocity is assumed to decrease up to a certain point as traffic volume increases up to a certain point. Beyond this point is constant.



Note:Qmax : Design capacity
Vmax : Design speed
Q1 = Q max x 0.8
Q2 = Q max x 1.2
V1 = V max x 0.8
V2 = V max x 0.5
V3 = 5 km/hr

Figure 13.1.1 Shape of QV Equation

Fifty nine (59) different parameters were set up for the QV equation as shown in the Table, in consideration of the following items.

a) Result of travel speed survey
b) Result of traffic count survey
c) Road inventory
d) Result of site observation

13.1.2 Future Traffic Assignment and Economic Benefits

(1) Traffic Assignment on Road Network Alternatives

The traffic assignment on the Master Plan alternatives is evaluated on the basis of PCU*hr in 2010. A "do nothing case" is first defined, in which all currently planned improvements are included with the exception of the alternatives considered in this Study. the PCU*km and PCU*hr for the "do nothing case" are calculated as a base for comparison with the alternatives considered in this Study. The PCU*km and PCU*hr for the "do nothing case" is important values represents the benefits for that alternative. Higher differences mean higher benefits. The result of the traffic assignment for the "do nothing case" are shown in Figure 13.1.2.

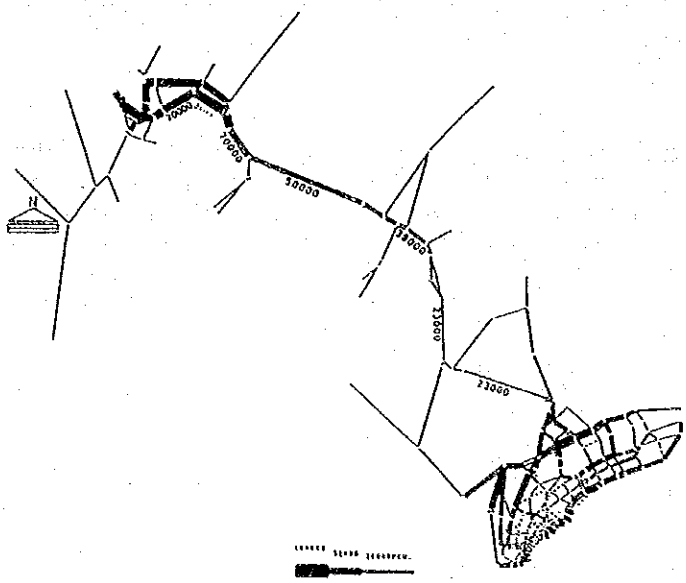


Figure 13.1.2 Assigned Traffic Volume in Do Nothing Case

(2) Speed Comparison

1) Alternative Plan A (Design speed 60 Km/h)

No construction of new highway, widen existing road into a dual carriageway road with 2 lanes in each direction. The assigned traffic volume in 2010 are shown in figure 13.1.3.

2) Alternative Plan C (1) (Design Speed 80 km/h)

Construct an 80 Km/h highway in Segments B, C, D and F, and existing roads remain as they are.

3) Alternative Plan C (2) (Design speed 110 Km/h)

Construct a 110 Km/h highway in Segments B, C, D and F, and existing roads remain as they are.The assigned traffic volume in 2010 are shown in Figure 13.1.3.

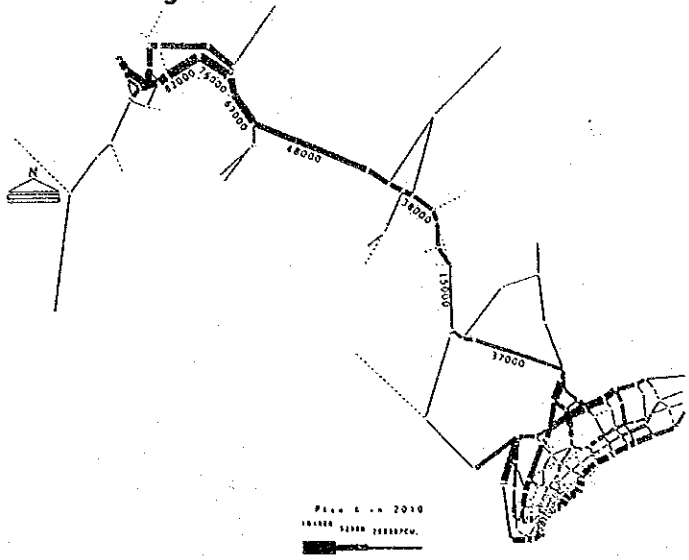


Figure 13.1.3 Assigned Traffic Volume in Alternative Plan A

(3) Route Comparison

A comparison is made in the basis of with following conditions:

1) Alternative Plan B (Design Speed 110 Km/h)

Construct a 110 km/h highway in Segments A, C, D and F and existing roads remain as they are.The assigned traffic volume in 2010 are shown in Figure 13.1.4.

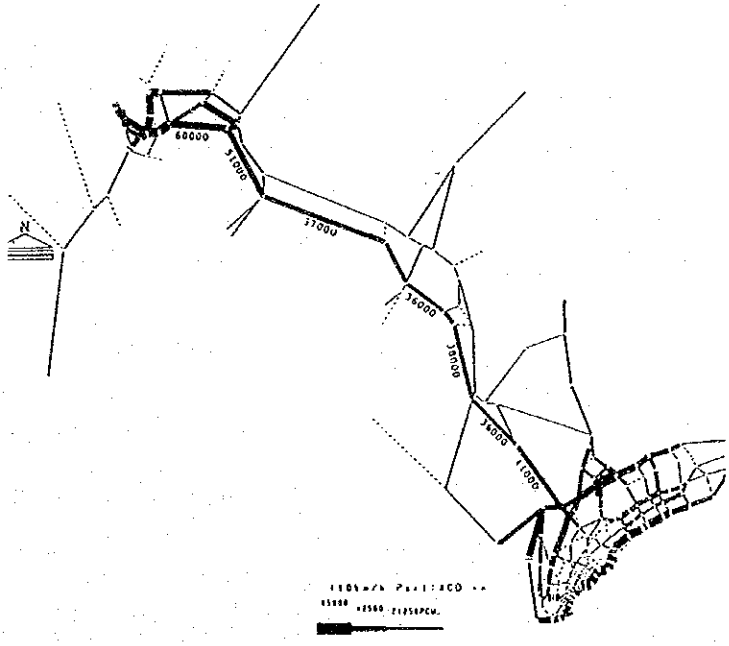


Figure 13.1.4 Assigned Traffic Volume Alternative Plan B

2) Alternative Plan C (2) (Design Speed 110 Km/h)

Construct a 110 Km/h highway in Segments B, C, D and F, and existing roads remain as they are.

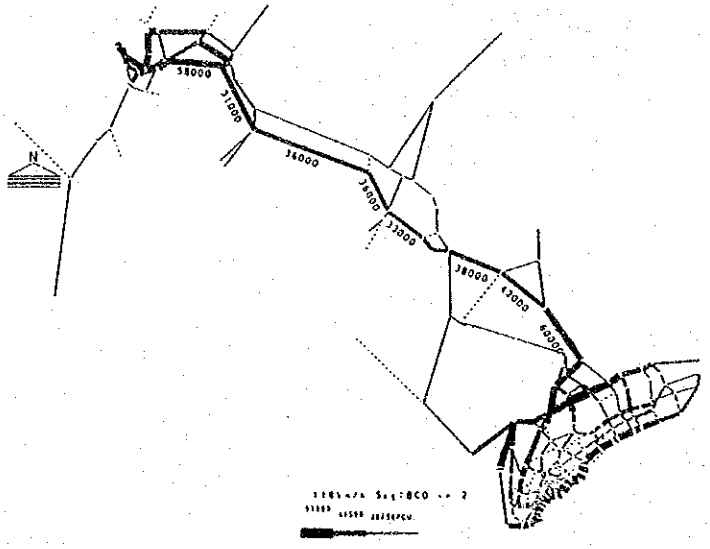


Figure 13.1.5 Assigned Traffic Volume Alternative Plan C

(4) Conclusion

The result of the comparison is shown in Table 13.1.1. From the comparison, Alternative Plan C (2) above has the highest value.

Table 13.1.1 Savings in Vehicle Operation and Times in 2010

Alternative	Factor	P.Car	Taxi	Bus	Truck	Total
Plan A	PCU*Km/Day	124,700	8,900	22,800	65,300	221,700
WIDENID	PCU*Hr/Day	137,900	14,100	22,600	85,400	260,200
Plan C (1)	PCU*Km/Day	39,400	-1,900	10,600	36,700	84,900
80Km/Hr	PCU*Hr/Day	232,500	27,100	41,600	122,200	423,400
Plan C (2)	PCU*Km/Day	110,900	5,800	20,200	79,700	216,600
110Km/Hr	PCU*Hr/Day	239,400	28,400	43,800	125,200	436,700

The result of the comparison is shown in Table 13.1.2. According to the comparison, there is no great difference between these two routes.

Table 13.1.2. Savings in Vehicle Operation and Times in 2010

Alternative	Factor	P.Car	Taxi	Bus	Truck	Total	Traffic Volume
Plan B	PCU*Km/Day	106,300	6,400	16,500	59,700	188,800	41,200
	PCU*Hr/Day	293,000	32,300	53,100	151,400	530,000	
Plan C (2)	PCU*Km/Day	110,900	5,800	20,200	79,700	216,600	44,100
	PCU*Hr/Day	239,400	28,400	43,800	125,200	436,700	

(5) Access Control

Figure 13.1.6 shows the assigned traffic volume for access control roads. Table 13.1.3 is a comparison between access control roads and non access control roads. From the comparison, the access control road has a higher value.

Table 13.1.3. Savings in Vehicle Operation and Times in 2010

Alternative	Factor	P. Car	Taxi	Bus	Truck	Total
Plan C (2)	PCU*Km/Day	110, 900	5, 800	20, 200	79, 700	216, 600
Free	PCU*Hr/Day	239, 400	28, 400	43, 800	125, 200	436, 800
Plan C (3)	PCU*Km/Day	137, 300	10, 900	25, 900	89, 700	263, 800
Access Control	PCU*Hr/Day	327, 600	39, 700	61, 200	165, 900	594, 400

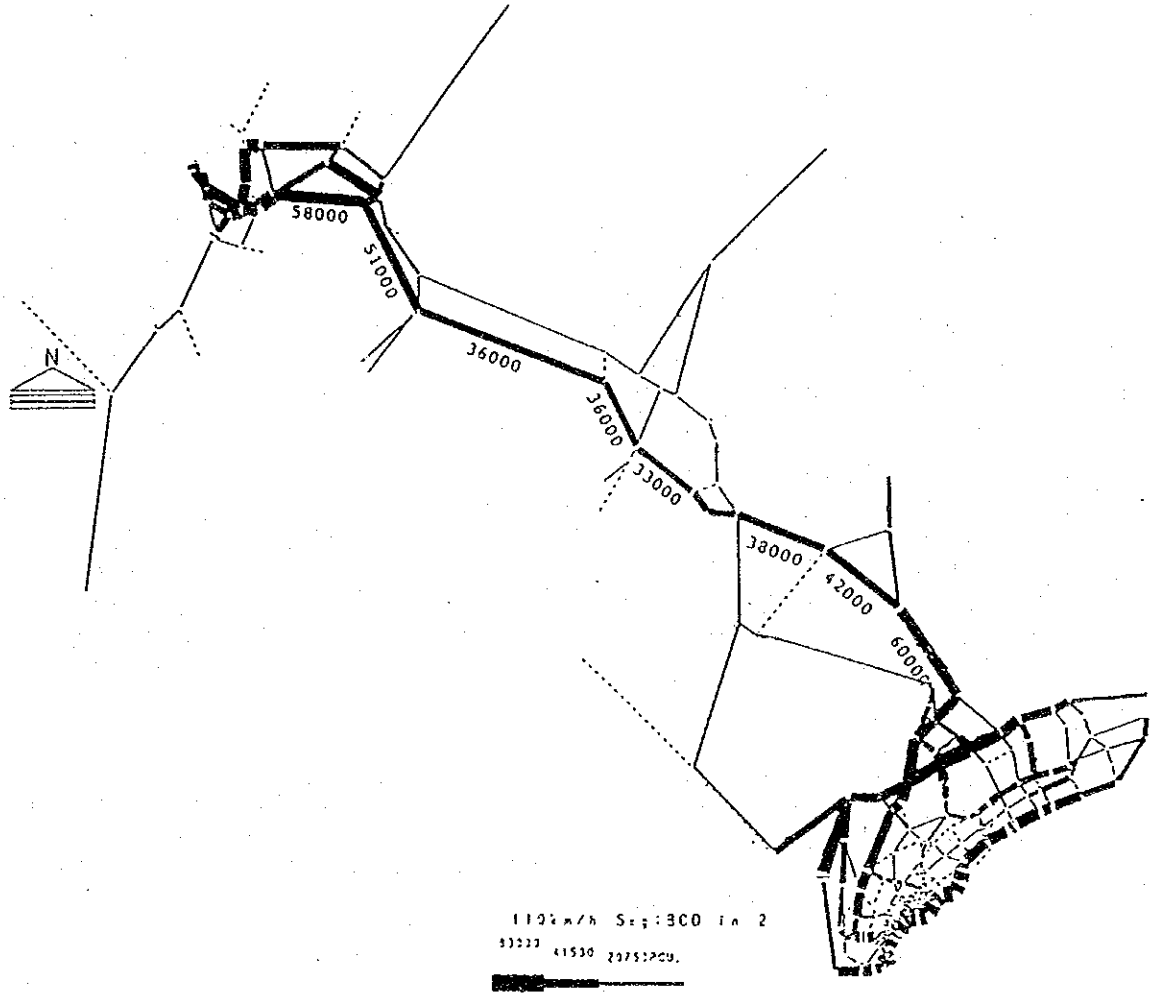


Figure 13.1.6 Assigned Traffic Volume with Access Control

13.2 Cost/Benefit Analysis

13.2.1 Objective of Analysis

The objective of the cost/benefit analysis in the Master Plan Stage is to undertake a comparative examination of the economic feasibility of the alternative plans for the Study. Six (6) alternative plans are set up for comparison in terms of economic cost and benefits. Not having a construction scheme for the project makes a detailed analysis difficult because it determines the time when the new road will be available.

13.2.2 Alternatives

(1) Do Nothing Case

No improvement of the existing road, or construction of new road.

(2) Alternative Plan - A

This is a rehabilitation plan to widen the existing road. The completion of this plan will allow people to drive at a maximum speed of 60 km per hour. The plan has the lowest construction costs and maintenance, but has the lowest economic benefits of all the alternative plans.

(3) Alternative Plan - B

This is a plan for new road construction: Segment A. Carrying it out will allow people to drive at a maximum speed of 110 km per hour. No toll is charged. Although it is the most expensive improvement plan, it is expected to produce a large amount of economic benefits

(4) Alternative Plan C - (1)

This is a plan for new road construction: Segment B. Carrying it out will allow people to drive at a maximum speed of 80 km per hour. The plan requires a medium level of construction and maintenance costs, so, the level of expected economic benefits is also Medium.scale

(5) Alternative Plan C - (2)

This is a variation of Alternative Plan C. Implementing this plan will allow people to drive at a maximum speed of 110 km per hour.

(6) Alternative Plan C - (3)

This is another variation of Alternative Plan C. Implementing

this plan will allow people to drive at a maximum speed of 110 km per hour and a charge of B/.2.00 per PCU.

13.2.3 Economic Cost

Raw data for the estimation of construction and maintenance costs are used for the analysis. These data need to be covered into economic costs at a later stage of the study. They will cause distortion because various tax levies and unskilled labor are used. The distortion will be corrected at a later stage of the Study.

It is assumed that the duration of the depreciation of road asset is 25 years and the assets depreciate by an equal amount every year. If the project life is shorter than 25 years, the remaining portion of the road assets, which is not depreciable, will be accounted for in the residual value of the project.

Table 13.2.1 Construction and Maintenance Costs
(Unit; 1,000 Balboas)

Alternative Plan	Construction Cost	Maintenance Cost
Do Nothing Case	0	0
Alternative Plan A	167,316	100,390
Alternative Plan B	295,409	155,165
Alternative Plan C (1)	193,498	116,099
Alternative Plan C (2)	258,604	155,162
Alternative Plan C (3)	258,604	155,162

13.2.4 Construction Period

Since the purpose of the preliminary cost/benefit analysis is to compare the economic priority of the alternative plans, the same conditions to the construction period are applied on the analysis for all the alternatives. It is assumed that the construction work will start in 1993 and end in 1997 (5 year-construction - period).

13.2.5 Project Life

It is expected that the project will be completed in the year 2010, by which time the project costs will have been amortized. The economic benefits are assumed to continue after the completion of the construction work and to be realized gradually over the years until 2010.

13.2.6 Cost Benefit Analysis

First, the three (3) alternatives; Alternative Plan A, Alternative Plan B and Alternative Plan C are compared. The most economical alternative plan will be selected from those basic variations of the alternatives. The criteria for the selection is a benefit/cost ratio which is assumed to be 8 percent of a social discount rate. The benefit/cost ratio, Economic Internal Rate of Return (EIRR), and net present value for each alternative are shown in Table 13.2.2.

Table 13.2.2 Results of Cost - Benefit Analysis

Alternative Plans	B/C Ratio	EIRR (%)	NPV (1,000 Balboas)
Alternative Plan A	2.15	17.32	203,114
Alternative Plan B	2.36	18.54	422,378
Alternative Plan C (1)	2.86	21.21	378,580
Alternative Plan C (2)	2.40	18.76	380,283
Alternative Plan C (3)	2.96	21.68	531,847

The above table shows that Alternative Plan C (3) (Segment B 110km/hour maximum speed, US$2.00 toll charge), has not only the highest B/C ratio and EIRR but also the highest net present value.

Alternative Plan B (Segment A, 110 km/hour maximum speed.no toll) requires the highest cost for construction and maintenance but, a large amount of NPV can be expected. As a result, all cases of Alternative plan C (3) have highway B/C ratio and EIRR than other cases.

13.3 Environmental Evaluation

13.3.1 Environmental Impact

The possible environmental impacts of the plan alternatives are examined on the basis of a study of the present environmental conditions and the location of the alternatives plans. The environmental impact is seen to be as follows.

(1) Topography and Geology

In the Study Area, no topographical or geological features of scientific importance are identified. The possibility of landslides is assumed to be small, from the results of the field survey. However, a subsurface investigation will be carried out as part of a feasibility study to obtain accurate data for evaluating the possibilities of landslides.

(2) Vegetation

The natural vegetation in the Study Area is in mostly forest, most of which is now secondary or artificial vegetation such as pasture ground and abandoned grassland. In this study there will be a direct impact on the vegetation due to following and cutting during the road construction, and it may cause a secondary impact in the form of new species coming into the area, etc. Because of its ecological importance and biological sensitivity, more attention must be paid to the forest vegetation than other types of vegetation. That are forests areas in Segments D,E and F of the alternative plans and small, sporadic patches of forest in Segment A.

(3) Fauna

As most of the wildlife in the Study Area base their lives in forests, the impact on fauna will be great here. The direct impact will be the destruction of their habitat caused by removing vegetation. It should also be considered that the new road will divide their habitat into small areas, disturbing their migration as well as destroying it. in addition, traffic noise may confine the wildlife far away from the road. This type of impact is predicted in Segments D,E and F where the road divides the forest habitat for several kilometers. In Segment A, the road divides forest only on a small scale but the passes close to the Soberania National Park so where traffic noise may disturb the wildlife in it.

(4) Soil Erosion

Areas sensitive to soil erosion are those where the terrain is steep and rainfall large. Such areas are found in the northern part of the Study Area (in Segment D,E,F,H,I, J). The southern part has lower rainfall so the possibility of erosion is comparatively low.

(5) Hydrological Situation

The routes in the alternatives places cross many rivers and some sections follow the shore of Gatun Lake. But it is not likely that they will have a serious impact on the hydrological situation in terms of water depth, volume and speed of flow attacks although there may be water pollution, because there is no part of the project which is likely to severely alter the hydrological situation.

(6) Landscape

There is no area of cultural or religions importance along the routes of Alternative plans. So, the impact on the landscape will be negligible. But more general consideration is required because there are many recreational spots along the existing highway although the landscape itself is not an attraction for them.

(7) Resettlement

An impact on resettlement is predicted on the basis of their distribution. There are many settlements along the existing highway, so resettlement cannot be avoided if the road is widened. The same problem will occur in some parts of the new road where the route lies close to or across the existing highway. In another areas of the alternative plans villages are sporadic, so resettlement should not a critical issue here.

(8) Economic Activities

The impact on economic activities is evaluated as a direct impact in the form of people having to move and losing that land. There are many local businesses along the existing highway which must be removed if the highway is widened. The number of such local businesses in other parts of the Alternative plans were not clarified in the study. The project will have no serious impact on farming.

(9) Public Facilities

The extent of the impact on public facilities is unsure because data on such facilities in individual locations is not available in this study.

(10) Splitter, Communities and Community Safety

The Alternatives plans split local communities in some parts. The widening of the existing highway and expected increases in traffic will make communication between both sides of the highway rather difficult. The routes cut across some roads as serving as communication links between isolated communities and the existing highway in some parts (in Segments B,C and D). The safety of residents will be affected by new traffic. This impact could be serious in some densely populated areas.

(11) Cultural property

No cultural properties were found along the routes in the alternatives plans. But further analysis of archaeological and historical data is required in the feasibility study since the Study Area lies along the historic route across the isthmus during the pre-hispanic and colonial periods.

(12) Air Pollution, Noise, Vibration

The impact of air pollution,noise and vibration must be considered in densely populated areas. These areas are located along the existing Panama-Colon Highway and in the southern part of Segment B.

(13) Water Pollution

Water pollution due to this project, may affect some aquatic fauna and flora, fisheries and sources of water supply. The critical places are where the large rivers Gatun and Chagres are crossed. Carried by the strong current of these rivers, eroded soil from the river banks will cause pollution and sedimentation at points downstream. Another critical section is along Gatun Lake; eroded soil may flow directly into the lake.

13.3.2 Evaluation of Alternative Plans by Segment

An evaluation of the Alternatives by segment to assess their environmental impact is described below and in the tables on the following pages.

(1) Segment A

In this segment little impact is extended on vegetation and fauna and there is little chance of residents having to be removed. As most of this segment is pasture ground, the impact on vegetation will be limited to some small sections of forest. Fauna will be slightly affected in the southern part where the segment is close to the national park. This segment does not cross large residential areas except for one section near Agua Buena that lies close to the existing Panam-Colon Highway. Therefore, the effect of pollution and the impact on the social environment will be comparatively slight.

(2) Segment B

Little impact is expected on the natural environment because the segment is pasture ground for the most part. But there will have to be resettlement in the southern part of the segment where a middle class residential area is located. The other populated area is in the northern part which crosses a section of the existing Panama-Colon Highway. There may be pollution and other impact on the social environment in the

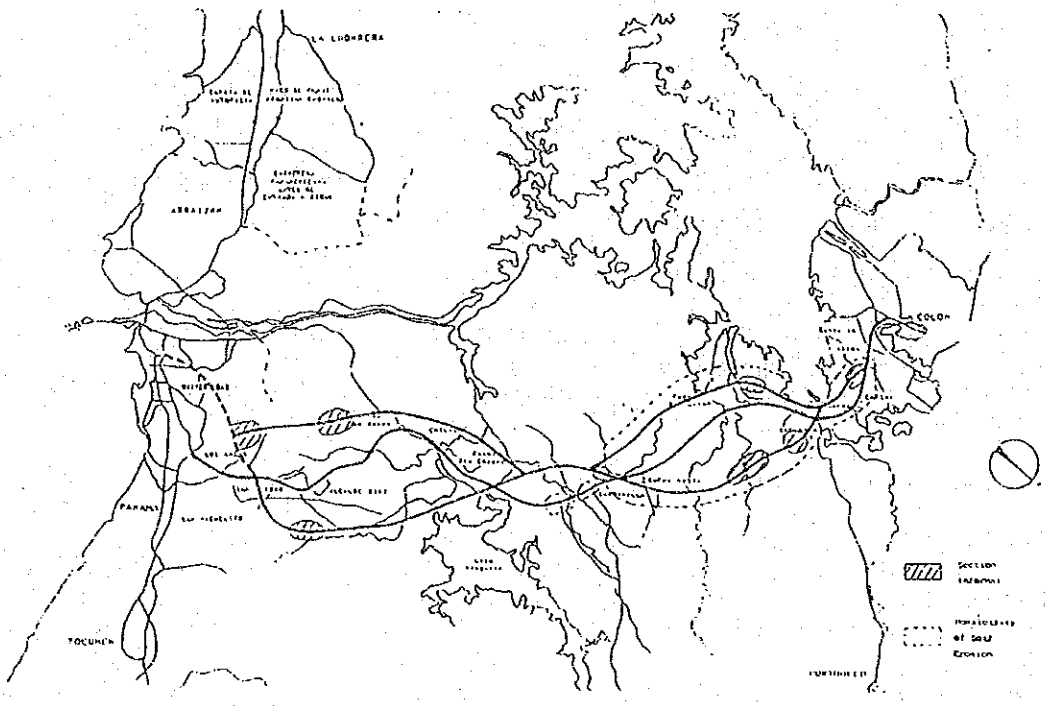


Figure 13.3.1 Environmental Conditions (1)

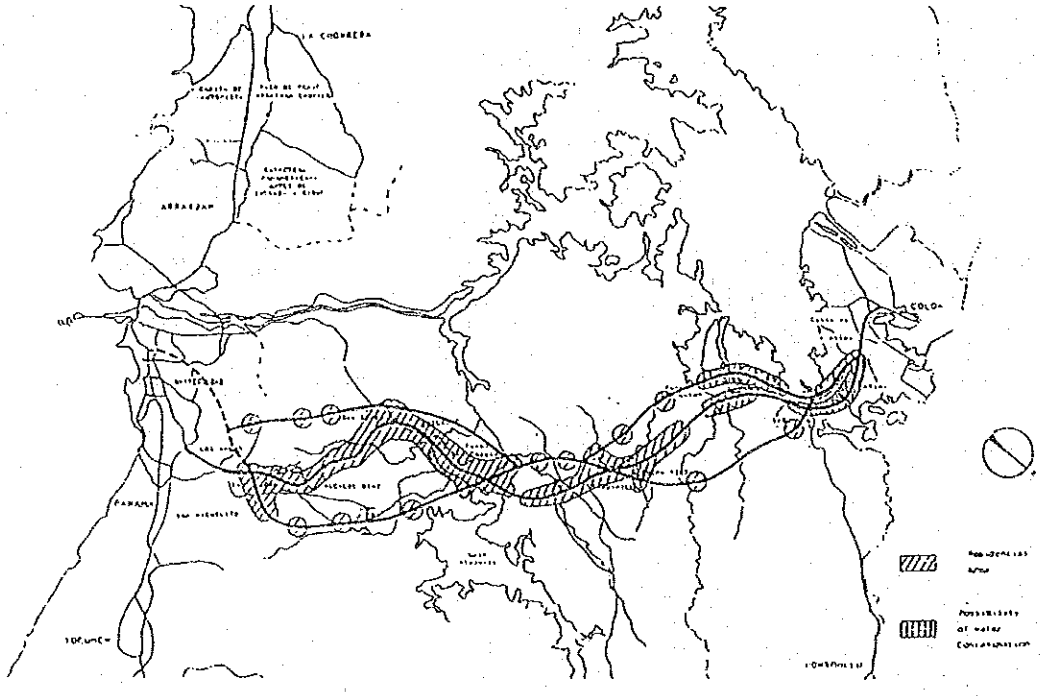


Figure 13.3.2 Environmental Conditions (2)

same sections. The segment may isolate some remote settlements because the road in it cuts across certain local roads which connect these settlement to the existing Panama-Colon Highway.

(3) Segment C

In this segment very little impact is expected on the natural environment as for Segment B. There will have to be a little resettlement but there will be same impact on the social environment mainly where the segment crosses the existing Panama-Colon Highway at Buenos Aires. There is the possibility of water pollution at the banks of the Chagres. The segment may isolate some remote settlements, as in Segment B.

(4) Segment D

In this segment, an impact on vegetation and fauna is predicted. The segment passes through a rather extensive forest between Gatun River and Sabanitas, which is an important habitat for local fauna. There is the Possibility of soil erosion because of the rugged terrain and high precipitation. Water pollution will occur at banks of the Gatun River and the shore of Lake Gatun if soil erosion is not kept in check. It should also be considered that the segment could pamper communications for some settlements on the lake shore.

(5) Segment E

In this segment, an impact on vegetation and fauna is predicted at some small sections of forest. Attention should be paid to the possibility of water pollution at the banks of the Gatun River and soil erosion in the whole of the segment, as in Segment D.

(6) Segment F

In this segment, an impact on vegetation and fauna is predicted in the northern part beside the Gatun Recreation Park. There is the possibility of water pollution along the lake shore. Resettlement will be required at Sabanitas and at the northern border of the segment. Some settlements on the lake shore may be isolated by this segment.

(7) Segment G

Because the segment passes through populated areas, an impact on social environment and pollution is predicted in most parts of the segment. However, there is no need to consider the natural environment in this segment.

(8) Segment H

In this segment an impact on the social environment and pollution is predicted for the same reasons as for Segment G. There is the possibility of soil erosion with water pollution at

the banks of the Chagres River.

(9) Segment I

Because this segment is in a less populated area than Segments G and H, the impact on the social environment and pollution are expected to be less. Soil erosion is expected in all parts. There is a possibility of water pollution at the banks of the Gatun River.

(10) Segment J

As for Segment G, an impact on the social environment and pollution in predicted. There is the possibility of soil erosion because of the rugged terrain and high precipitation.

An evaluation of the environmental impact in all segments has been compiled into Table 13.3.1. Impact on the natural environment is expected to occur in Segments A to F (new route) while an impact on the social environment is expected to occur in Segments G to J (the existing Panama-Colon Highway).

The environmental impact expected from this study is not serious enough to cause fundamental changes in this study. When a route is selected from among the alternative plans for the feasibility study, following environmental issues should be considered:

a) Impact on rather extensive forest area along Gatun Lake and fauna in it (Segment D)
b) Impact on fauna in the national parks where the segments are situated close to them (Segments A and F)
c) Impact of social environment and effect of pollution on local residents in some densely populated areas (Segment B and Segments G to F)
d) Impact on Gatun Lake in form of water pollution (Segments D and F)

Table 13.3.1 Environmental Impact by Segment

Item / Segment	A	B	C	D	E	F	G	H	I	J
Topography & Geology	—	—	—	—	—	—	—	—	—	—
Vegetation	○	—	—	◎	○	○	—	—	—	—
Fauna	○	—	—	○	○	○	—	—	—	—
Soil Erosion	—	—	—	○	○	○	—	○	○	○
Hydrological Situation	—	—	—	—	—	—	—	—	—	—
Landscape	—	—	—	—	—	—	—	—	—	—
Resettlement	○	◎	○	—	—	○	◎	◎	○	◎
Economic Activities	△	△	△	—	—	△	○	○	○	○
Public Facilities	—	△	—	—	—	—	△	△	△	△
Safety & Split of Community	—	○	○	○	—	○	○	○	○	○
Cultural Property	△	△	△	△	△	△	△	△	△	△
Air Pollution, Noise, Vibration	—	○	—	—	—	—	○	○	○	○
Water Pollution	—	—	○	◎	○	◎	—	○	○	—

◎ : Large or Moderate
○ : Slightly
△ : Uncertain
— : Nil or Negligible

13.4 Overall Evaluation

13.4.1 Tangible Evaluation

As mentioned in the previous section, the economic evaluation is conducted among three alternatives; Alternative Plan A, Alternative Plan B and Alternative Plan C. The results of the economic evaluation is shown in Table 13.4.1.

Table 13.4.1 Results of Economic Evaluation

Alternatives	B/C Ratio	EIRR (%)	NPV (1,000 Balboas)
Alternative Plan A	2.15	17.3	203,114
Alternative Plan B	2.36	18.5	422.378
Alternative Plan C (3)	2.96	21.7	531,847

Judging from a results of economic evaluation, the implementation of the three alternative plans; Alternative Plan A, Alternative Plan B and C (3) are indicated as economically feasible. The indicators of economic evaluation; B/C, EIRR and NPV of Alternative Plan C (3) is indicated as the highest value among the three alternatives.

Therefore, Alternative Plan C (3) is recommended for the road network Master Plan in 2010 based on the economic evaluation.

13.4.2 Intangible Evaluation

(1) Road Function

The functions and characteristics of traffic on the Alternative Plan A will be maintained for the traffic of long and short distance trips as well as commuter traffic as the mixed traffic flows, due to there is no diversion road between the cities of Panama and Colon. However, the functions and characteristics of traffic on the Alternative Plan B and C can be separated into two functions, that is, the new road will be maintained for the long distance trips traffics and the existing road will be maintained for the short distance trips traffic.

According to the road functions, Alternative B and C is obviously desired than the Alternative plan A.

(2) Environmental Impact

As mentioned in the previous section, the flora, fauna, water contamination, soil erosion and others environmental aspects

are identified as to be considered in the Study. Based on the results of the environmental impacts study, there is no serious environmental impacts among three alternative plans.

(3) Land Acquisition and Compensation

The number of houses and buildings to be demolished for the implementation of the Alternative Plan A, Alternative Plan B and Alternative Plan C are about 171, 44 and 70 houses respectively. It is very difficult to acquired the land space for implementation of the Alternative Plan A and the Alternative Plan B and C also seem to comparatively difficult to the land acquisition.

(4) Construction Difficulty

The implementation of Alternative Plan A should be constructed under the existing traffic operation on the Panama-Colon Highway. Considering the traffic safety, diversion of traffic flows and construction scale, it is very difficult to construct the Alternative Plan A.

The road Segment A of Alternative Plan B passes through comparatively steep mountainous areas, therefore, many large size structures such as tunnels and bridges are required. In addition, there is no pilot road for construction of new road. Considering these conditions, implementation of Alternative Plan B is slightly difficult.

The road Segment B of Alternative Plan C passes through comparatively flat terrain areas. The implementation of the Alternative Plan C is easy, however, it is required to establish some environmental measurement during the construction period due to the route passes through a part of the existing residential area.

(5)Traffic Congestion

As the results of the future traffic demand forecasted, traffic congestion ratio in 2010 of the Alcalde Diaz and Sabanitas Sections on the existing Panama-Colon Highway by Alternative Plan A is indicated still over the 1.0. This means; it is required that a new roads should be constructed on these road sections.

(6) Effective Use of Corredor Norte

Considering the trunk road network configurations in Panama City area, and to mitigate the traffic congestion on San Miguerito area, it is very important to construct the Corredor Norte. Taking into account of the road network formation , Alternative Plan C is the most optimum route for effective use of the Corredor Norte.

(7) Promotion of Developments

The road Segment A of Alternative Plan B is passes through comparatively steep mountainous area and also passing in parallel with the national parks; Camino de Crruces and Soberanias.

Along the existing Panama-Colon Highway, the housing and some industrial developments are already developed. Therefore, The promotion of developments along the Alternative Plan A and a part of Alternative Plan B has not be anticipated largely.

However, road Segment B of Alternative Plan C is located in the flat terrain area and housing developments are development gradually. The promotion of developments along the Alternative Plan C can be anticipated considering developments potentiality along the route. The above mentioned matter is summarized in Table 13.4.2.

Table 13.4.2 Comparison of Alternative Plan

Items/Alt. Plan	Alt.Plan A	Alt,Plan B	Alt.Plan C
1) Road Function	B	G	F
2) Environmental	F	B	F
3) Land Problems	B	G	F
4) Construction	B	B	F
5) Traffic Control	B	G	G
6) Road Network	B	F	G
7) Development	B	F	G

Note;
G ; Good
F : Fairly Good
B : Bad

13.4.3 Conclusion

Taking into accounts the economic evaluation, technical evaluation, environmental impacts study and the other traffic examinations, Alternative Plan C is recommended as the road network Master Plan in 2010 between the cities of Panama and Colon.

The route of Alternative Plan C is passes through a parts of the existing residential area of Alcald Diaz. The housing developments in this area are gradually spreading to the suburbs of Alcalde Diaz. Therefore, it is required to acquire the land as soon as possible for earlier implementation of the Alternative Plan C.

14 PRIORITY ROAD SECTION

14.1 Identification of Road Section

In the previous Chapter, the Alternative Plan C (New Road Construction Plan) is selected based on the results of the technical and economic evaluations as well as initial environmental examination as the most optimum road network Master Plan in 2010 on the Panama-Colon Highway.

The route of Alternative C is illustrated in Figure 14.1.1. The total road length of the Alternative Plan C is about 58 kilometers for new road construction and it is recommended that the proposed road should be constructed before the year 2010.

To identify the most effective implement schedule of the Alternative Plan C, the stage construction plan should be considered taking into account the technical and economic conditions and environmental aspects as well as the future traffic demands on certain road sections. The Feasibility Study is conducted based on the selected routes in the Master Plan for Short and Mid Term Plans with target year in 2000. As illustrated in Figure 14.1.1, the proposed road can be divided into three sections; Alcalde Diaz, Chagres and Sabanitas Section.

(1) Alcalde Diaz Section

The total length of Alcalde Diaz Section is about 22 kilometers, and the route is located at the area between San Isidro and Buenos Aires and passes through on the east side of the existing Panama-Colon Highway. The Alcalde Diaz Section is the same as the Segment B mentioned previously.

(2) Chagres Section

The total length of Chagres Section is about 12 kilometers, and the route is located at the area between Buenos Aires and Buena Vista and passes through on the west side of the existing Panama-Colon Highway. The Chagres Section is the same as the Segment C mentioned previously.

(3) Sabanitas Section

The total length of Sabanitas Section is about 26 kilometers, and the route is located at the area between Buena Vista and Coco Solo in Colon city and passes though on the west side of the existing Panama-Colon Highway. The Sabanitas Section consists of the Segment D and F mentioned previously.

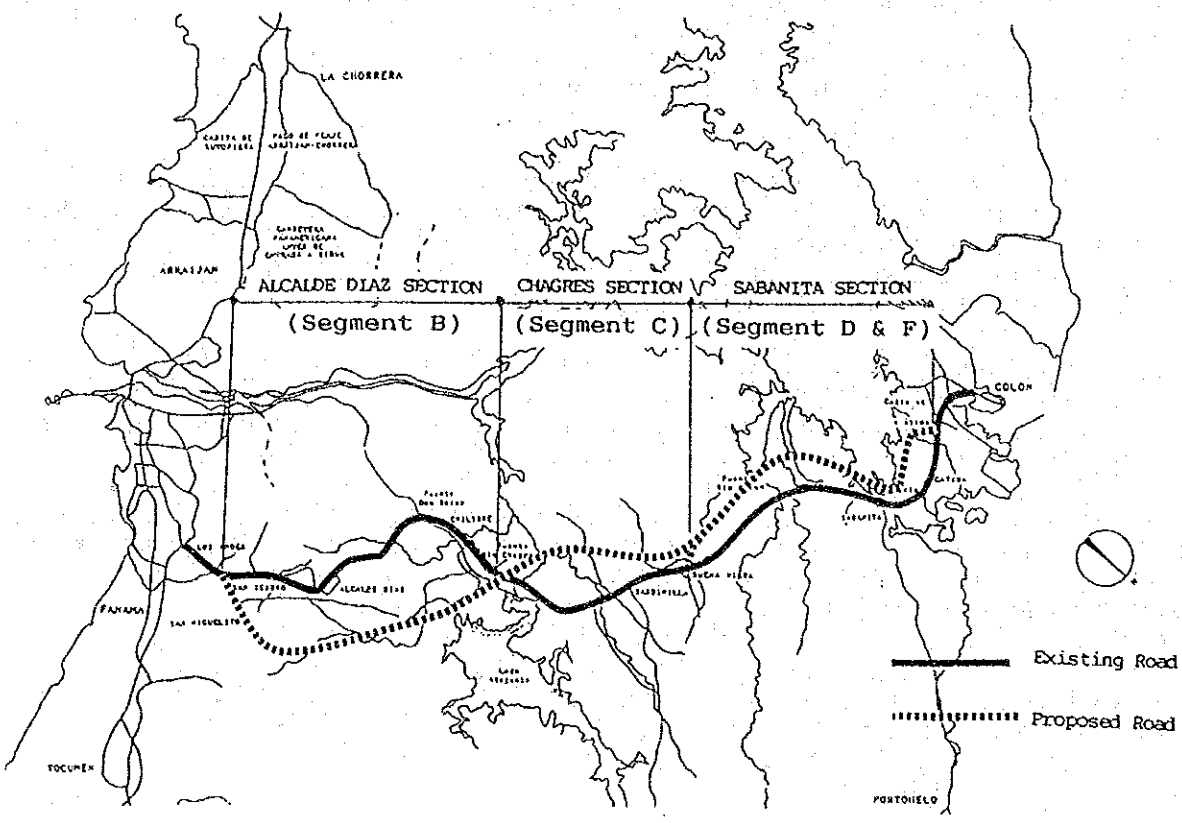


Figure 14.1.1 Location of Alternative Plan C