2.3.2 Future Land Use

With regards to the regional land use plan of the Philippines, each municipality establishes current and future plans on the basis of socio-economic indices prepared by the Government. These plans were finalized on the municipal and provincial levels in each region.

The future population frame work indicated that the population of the provinces covered by this Study are expected to grow by factors of 1.1, 1.23 and 1.4 of that of 1998 by the years 2005, 2010 and 2020. The built-up areas are expected have a much larger population in 2020 and urbanization would further expand.

(1) Province

Bulacan province

Urbanization of this province, which is located in the neighborhood of Metro Manila is being rapidly made. The agricultural industry is also active due to the proximity of the huge Metro Manila consumption area. Palay production (278 thousand tons in 1997) is ranked ninth in the country, while hog production is ranked number one, and poultry production is ranked at the third in the country. The agriculture and agri-businesses are prosperous. Paddy fields have decreased in the course of urbanization, but the flatland is still occupied mostly by paddy fields. Paddy field areas in the neighborhood of NCR are expected to substantially decrease. The urbanization trend of the province in the future is as follows (see Figure 2.3-2):

For the eastern part of Bulacan Province, urban settlements are expected in the Norzagaray-San Jose del Monte Growth Corridor due to the expansion of Metro Manila. Urbanization is expected to proceed further in the future and paddy fields will be replaced by residential areas.

The southern part of Bulacan Province, which is in the neighborhood of Metro Manila and with the support of the North Luzon Expressway (NLE), will be further developed along the Malolos-Meycauyan Urban Core.

The northwest sides of the growth triangle of Bulacan Province are the municipalities of Baliuag and Plaridel. This growth corridor is the gateway of the Pan-Philippine Highway to connect Cabanatuan City and Region II. These two municipalities are expanding into neighboring municipalities such as San Rafael, San Miguel, Bustos, and parts of Angat.

San Miguel will be urbanized further as an urban service and distribution center for agricultural goods.

Nueva Ecija province

This Province has the largest production of palay in the country (930,000 tons in 1997). Poultry production is ranked fourth in the country. In this agricultural province, the flatland will be used for paddy fields even in the future. Urbanization trend of the province is expected in the following areas (see Figure 2.3-2):

- Cabanatuan City will have the full functions of a primary trade center and education center with higher education institutions. It will be urbanized rapidly as a sub-regional center. At present, 45% of the city area has already been urbanized.

- Strategic points for traffic are at Gapan in the south and San Jose in the north. Both will be further urbanized as major urban areas with sub-regional business and service centers and sub-regional educational and industrial facilities. San Jose City, a gateway to Cagayan Valley Region, will be urbanized as a trade center for neighboring areas.

- There is a plan to relocate the capital facilities of Nueva Ecija province to Palayan City. This will lead to the rapid growth of this city, which is also a gateway to Aurora Province. It is planned to be developed as a major processing center for agricultural goods.

The future land use map, Figure 2.3-3, is based on the plan prepared by Municipal and City Governments concerned.

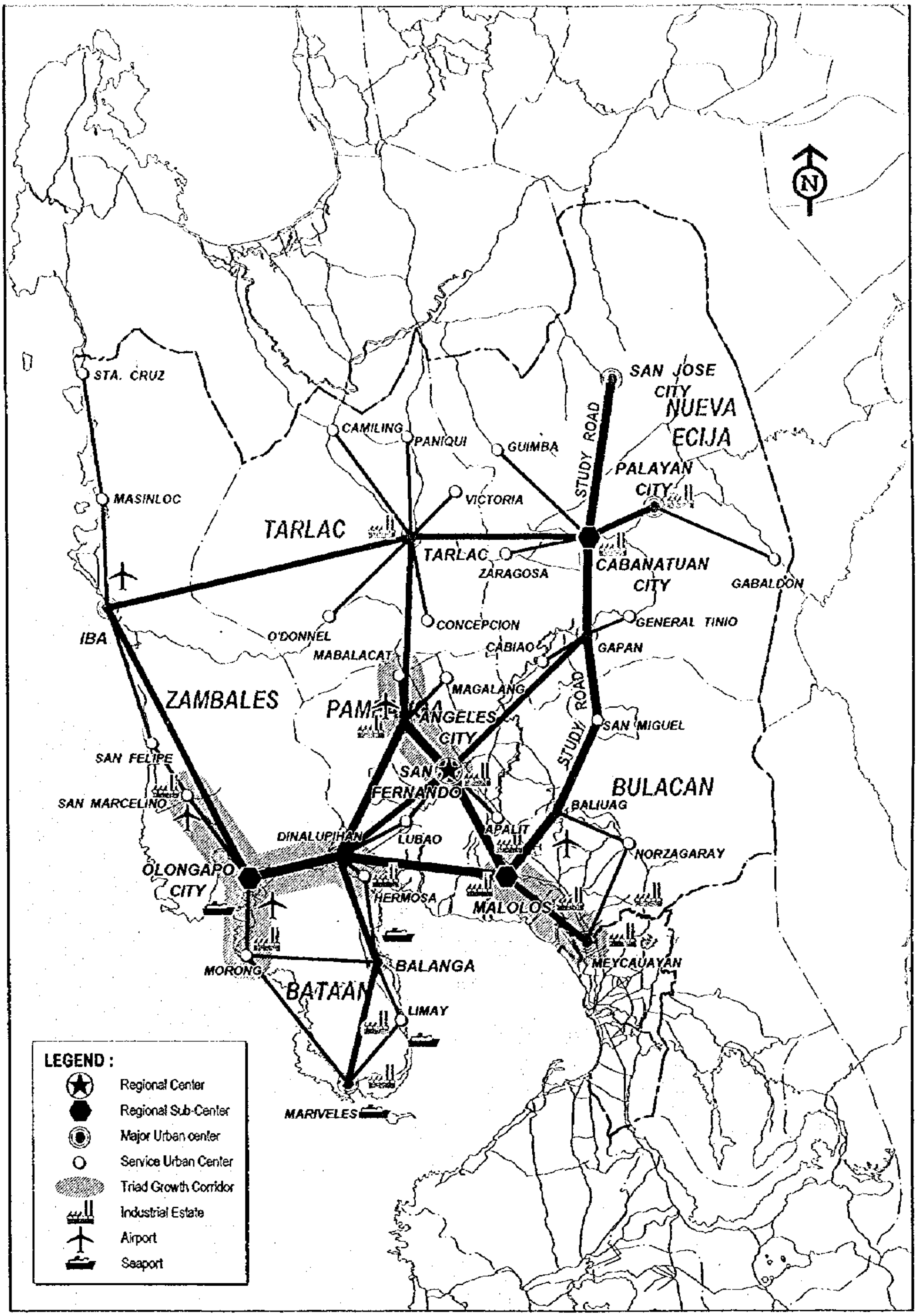


FIGURE 2.3 - 2 HIERARCHY OF URBAN CENTERS

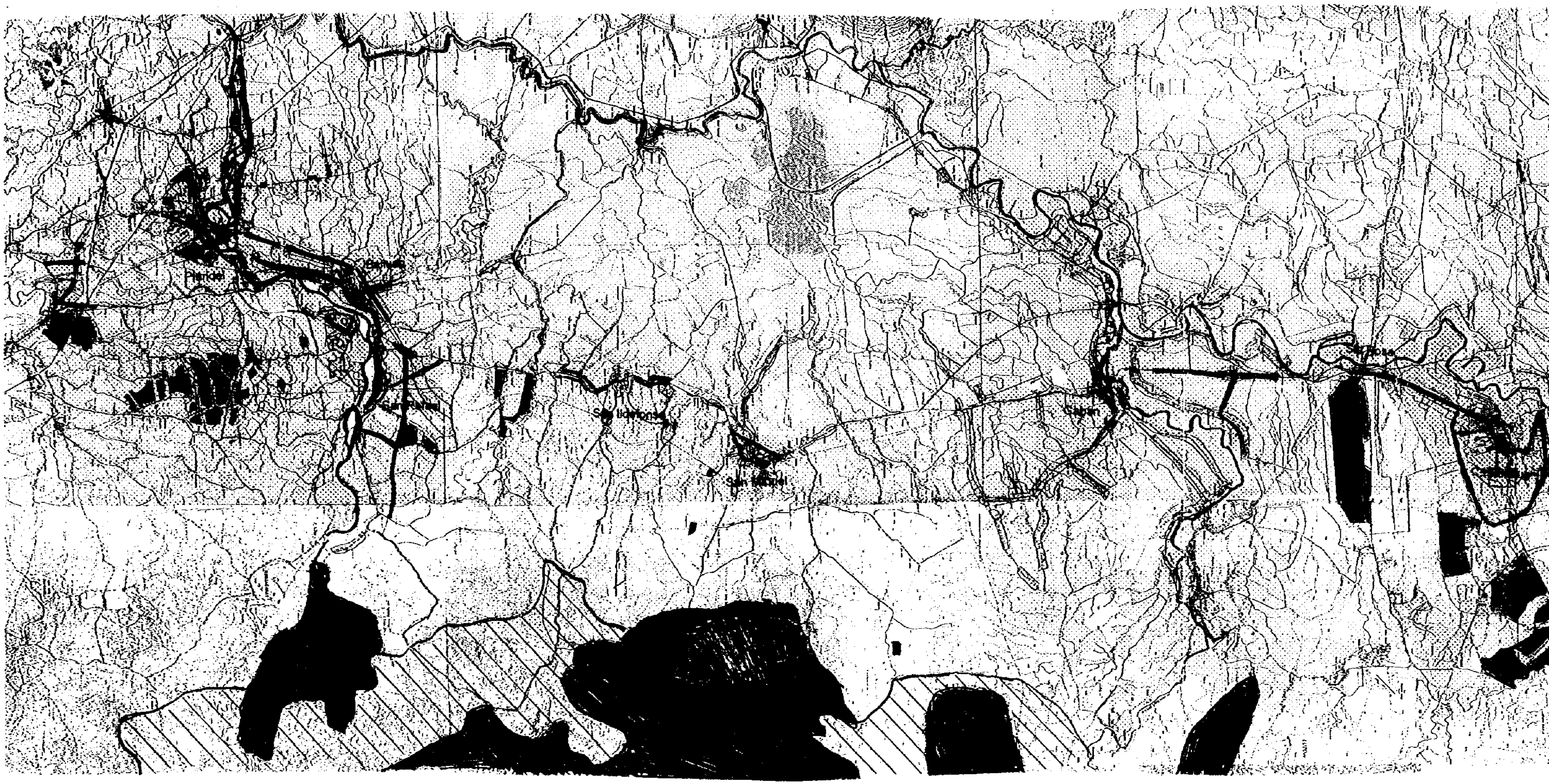


FIGURE 2.3-3 FUTURE LAND USE MAP

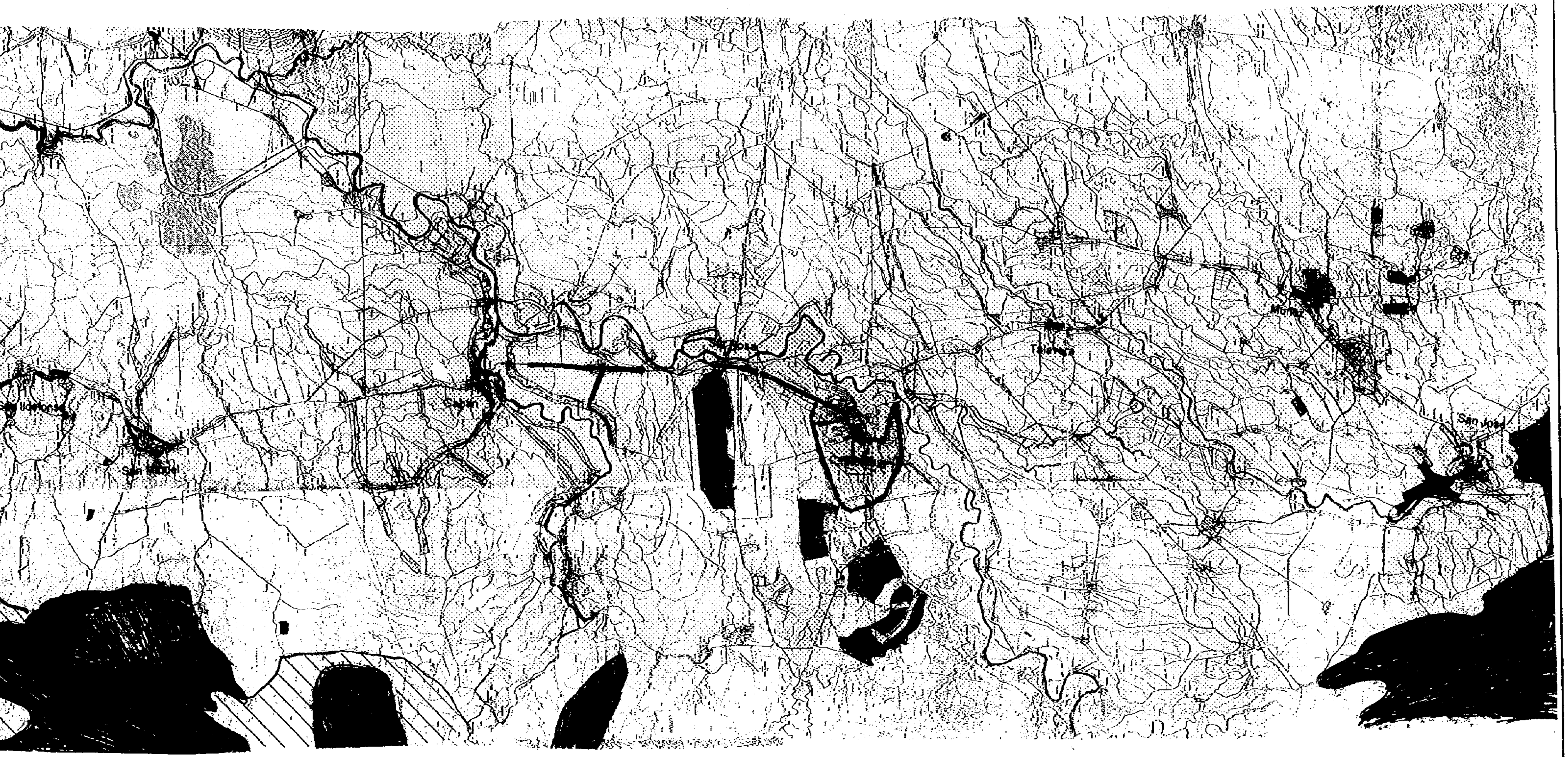


FIGURE 2.3-3 FUTURE LAND USE MAP

LEGEND :

- : Commercial Area
- : Residential Area
- : Industrial Area
- : Institutional Area
- : Rice Field
- : Reserved Forest
- : Productive Forest
- : National Park
- : Mining Area

(2) Urban Expansion Trends in the Main Municipalities along the Study Road

Urban Expansion of Plaridel

Plaridel is envisioned as the nucleus of a major growth corridor in the southern part of Bulacan province. This trend is projected based on the future land use plan of Plaridel and the Provincial Physical Framework Plan of Bulacan. As shown in Figure 2.3-4, settlements are expected to expand towards the proposed industrials estates and towards Guiguinto in the south, Malolos in the west, and Pulilan in the north. This expansion were seen as a result of a natural rural-urban migration triggered by economic growth rates in the urban centers and industrial estates. Pulilan for example, from being a secondary urban center is projected to become a major urban center by the year 2007. Malolos and Guiguinto on the other hand, are the sites of two (2) future major development projects namely the, *(i)* Bulacan Central Bulk Water Supply Project (BCBWSP) and *(ii)* Manila-Clark Rapid Railway Systems. These two projects will cause a rapid increase in population, not only in the municipality, but also towards other growth areas such as Plaridel. Malolos, as the seat of the provincial government, will always be a site for urban expansion.

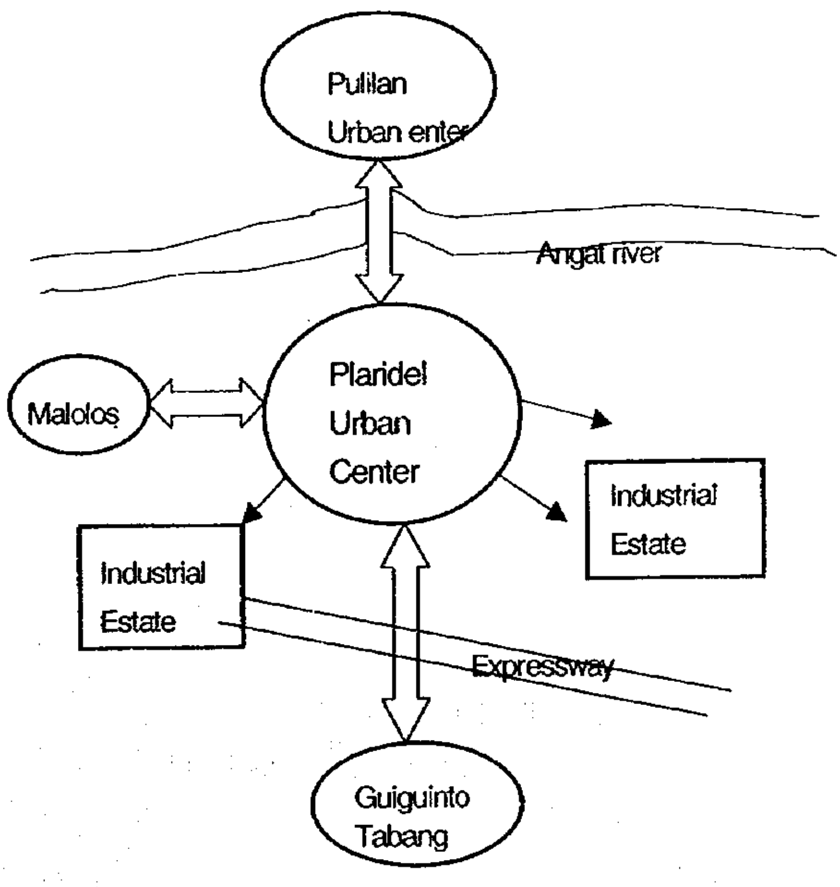


FIGURE 2.3-4 URBAN EXPANSION OF PLARIDEL

Urban Expansion of Baliuag

Baliuag in itself without the influence of other growth areas, has been considered as a rapid economic growth center, given its strategic location and extensive commercial development as shown in Figure 2.3-5. The expansion of settlement is therefore expected to be towards Pulilan, a candidate of becoming a major urban center and three other growth areas which are projected to develop from a medium town Non-Central Places (Bustos, San Rafael, and San Ildefonso) in 1995 to secondary urban center by 2007. As previously mentioned, Pulilan is classified in the Provincial Physical Framework Plan of Bulacan as a center with high development potential. The Cruz-na-Daan 100MVA-230KV Substation Project is proposed to be located in San Rafael. These two projects are included in the province's list of future major development projects.

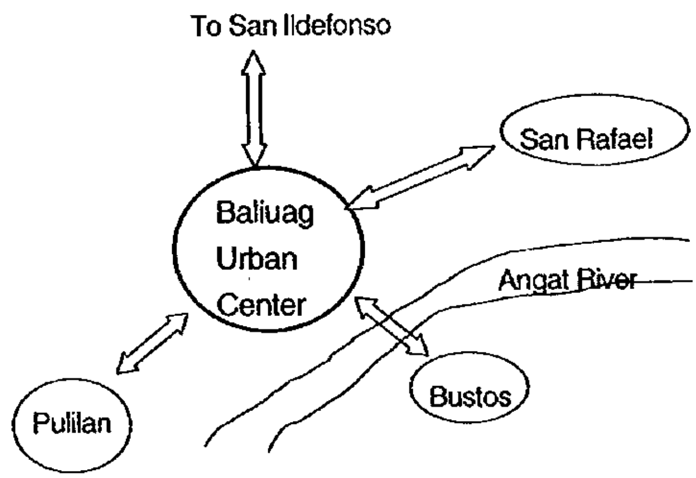


FIGURE 2.3-5 URBAN EXPANSION OF BALIUAG

Urban Expansion of Gapan

Gapan is presently classified as a Secondary urban Center in the Provincial Physical Framework Plan of Nueva Ecija since it provides secondary level of socio-economic facilities such as banks, shopping center, colleges and other related amenities as shown in Figure 2.3-6. The urbanization trend is expected to go towards the northeast to Peñaranda, westward to San Isidro, northward to Cabanatuan City, and southward to San Miguel, Bulacan. However, unlike Cabanatuan City and San Miguel which are already medium to highly urbanized, growth towards San Isidro and Peñaranda is not expected to be fast. At present, the area is classified as "highly restricted agricultural land", which means that these areas are not eligible for conversion to non-agricultural uses such as commercial or industrial use. Although San Miguel Bulacan is projected to become a major urban center by the year 2007, its physical distance from Gapan will slow growth along this corridor.

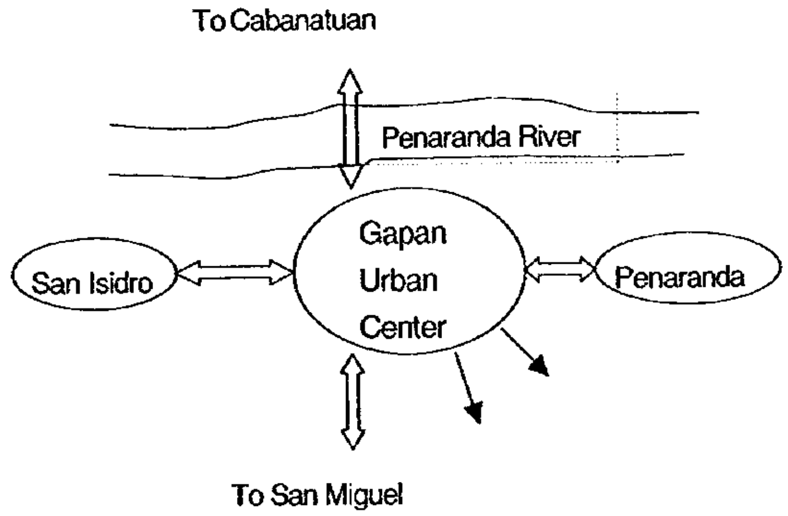


FIGURE 2.3-6 URBAN EXPANSION OF GAPAN

Urban Expansion of Cabanatuan City

Cabanatuan City is the only place in Nueva Ecija which is classified as a Primary Urban Center. As such, growth is expected to expand from this large town towards the proposed industrial estates in Bakod-Bayan, Cabu, Macatbong, and Bagong Buhay (all located within Cabanatuan City) and towards the northeast to Palayan City, northwest to Talavera, and southwest to Sta. Rosa, see Figure 2.3-7. The majority of future major development projects in Nueva Ecija are concentrated in Cabanatuan City. Some of these are the installation of the Level 3 Water Supply System, power lines by NAPOCOR, and Solid and Liquid Waste Management facilities. Palayan City is presently classified as a small town but is expected to catch up by its proximity to Cabanatuan City and as a result of the proposed transfer of the Provincial Capitol and other regional government and private offices from Cabanatuan City to this City. It is envisioned as the catchment for the north-eastward expansion of Cabanatuan City. Compared to Sta. Rosa, Talavera can be expected to have greater potential for rural-urban transformation as indicated in its share in its urban population change, which at 22%, is the largest among the municipalities and cities of Nueva Ecija, even greater than Cabanatuan City (16.9%).

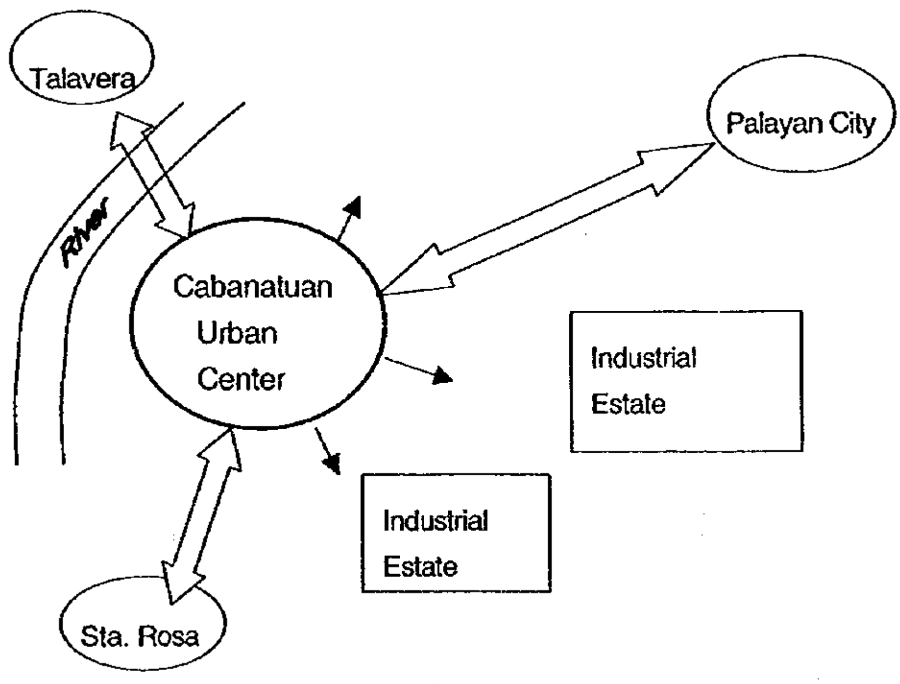


FIGURE 2.3-7 URBAN EXPANSION OF CABANATUAN CITY

Urban Expansion of San Jose City

San Jose City is categorized as a Secondary Urban Center, but is projected to have a greater share in urban population change than Cabanatuan City by the year 2002 according to Provincial Physical Framework Plan of Nueva Ecija, 1993. Growth expansion is expected to go eastward as a proposed agro-industrial estate and residential development areas, southward as an extension from the Cabanatuan City Urban Center, westward to Sto. Niño because of the proposed residential development plan, see Figure 2.3-8. In the northern most municipality of Nueva Ecija that is Carranglan, and other provinces in the Cagayan Valley, rural-urban transformation may be triggered by the construction of the proposed Dalton Pass Eastern Alternative Road in the near future.

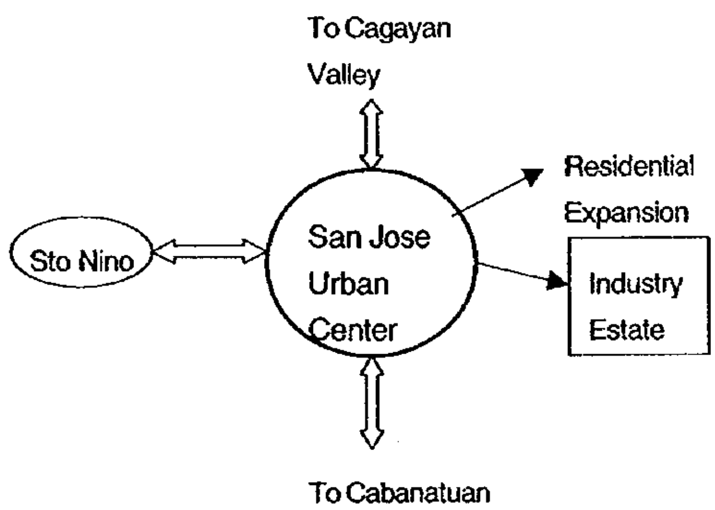


FIGURE 2.3-8 URBAN EXPANSION OF SAN JOSE CITY

2.3.3 Development Plans

BOI-DTI (Board of Investment of the Department of Trade and Industry) prepared the Central Luzon Development Plan in 1995 with the cooperation of JICA. The plan provides the conceptual framework for public investment in basic infrastructure improvements as well as effective development and implementation of measures for promotion of private investment. The development strategy, which is classified into agriculture, industry, tourism and trade, has been established for each sector on the basis of status analysis.

For the agricultural sector, five strategies were proposed, including those for enhancement of productivity, promotion of sustainable agriculture, effective utilization of primary products, livestock industry improvement, and agrarian reform.

In the industrial sector, a development strategy was proposed for three areas of development, international strategic alliances, inter-regional, and intra-regional. As a country and product specific strategy, it was considered necessary to promote agriculture and resource-based, consumer, and industrial products. Subic and Clark international airports and Subic Free Port are located in Region III, and are equipped with facilities sufficient to act as a service and distribution center not only for the Philippines, but also for the Southeast Asian region. Industrial and service areas will develop and expand around these facilities. The plan also proposes expansion of indigenous resources. This will include creation of domestic markets, specialization and subcontracting as well as building institutions to achieve these purposes.

Tourism and trade

Luzon has tourism, including sightseeing and vacation areas, in the Northern Luzon mountain circuit, the Manila Bay touring circuit, and the Western Luzon resort belt. The development strategy was established mainly on these elements. The strategy for trade and related services considered it important to generate producer and primary wholesaler (collector and intermediary), secondary wholesaler (distributor to retailer), and retailer and consumer systems and to establish tie-ups between trans-shipment between the North and Metro Manila and tourism.

In order to enhance the productivity of the land and to promote appropriate agriculture, improvement and development of the infrastructure is essential. It is necessary to strengthen the distribution system while establishing a tie-up with production activities. Productivity should be improved through a strengthening of tie-ups among industries, to create regional markets, to reduce production costs, and to decrease gradually the assignment of distribution functions to Manila.

In Bulacan province, plans for the future established by government or municipal units include the development of an industrial complex covering five municipalities: Balagtas, Pandi, Plaridel, Guiguinto, and San Rafael. In Nueva Ecija province the plans cover two cities, San Jose and Cabanatuan, and two municipalities, Santa Rosa and Muñoz.

2.4 ROAD NETWORK

2.4.1 The Pan-Philippine Highway

(1) Construction of the Highway

For the Philippines, being an archipelagic nation, the construction of a trunk road running through the major islands such as Luzon, Samar, Leyte and Mindanao was essential and long-cherished to attain the national targets, namely, regional development, industrial growth, preservation of peace and order, national unification, etc. The Pan-Philippine Highway was proposed as such a road functioning as an artery interconnecting Cagayan, Bicol, eastern Visayas and eastern Mindanao regions and linking them to the commercial and industrial areas in central Luzon with Metro Manila being a huge consuming area in order to promote the industrial development in the said regions and to secure peace and order in areas like northern Luzon and the eastern Mindanao.

The Pan-Philippine Highway construction plan was initially formulated in 1966. The original plan was for the construction of a 3,480 km. long road from Laoag City in northern Luzon to Zamboanga City in southwestern Mindanao, including improvement / upgrading of 2,503 km. of existing road, new construction of 488 km. of new road, construction / replacement of 450 bridges and construction of 2 ferry routes.

Of the planned road, the section from Aparri to Davao City with a length of about 2,100 km. was selected as Phase 1 of the Pan-Philippine Highway construction project and its construction was started in 1969 with financial assistance from Japan. The major components of the Phase 1 were pavement construction of road sections of 1,481 km. in total length (796 km. in Luzon Island, 246 km. in Samar Island, 159 km. in Leyte Island and 280 km. in Mindanao Island) and construction of 234 bridges and 2 ferry routes. The project was divided into many small contract segments with lengths varying from 2 km. to over 10 km. and the construction was undertaken by local, mainly small, contractors. The completion years by section are as follows:

Cagayan Valley Road	(Luzon section, north of Manila)	: 1979
Manila South Road	(Luzon section, south of Manila)	: 1978
Samar Leyte Road	(Samar and Leyte section)	: 1979
Surigao-Davao Road	(Mindanao section)	: 1978

The Pan-Philippine Highway is also known as the Philippines-Japan Friendship Highway because of Japan's participation in financing.

After the completion of Phase 1, the section from Laoag City to Allacapan with a length of about 210 km. was planned to be improved as Phase 2 of the Philippine-Japan Friendship Highway. This section branches off the Phase 1 road south of Aparri and is connected to the

Manila North Road at Laoag City. The construction of this section was started in 1982 and completed in 1994.

Table 2.4-1 shows the geometric standards of the Pan-Philippine Highway and Figure 2.4-1 shows typical cross-sections.

TABLE 2.4-1 GEOMETRIC STANDARDS OF THE PAN-PHILIPPINE HIGHWAY

	Terrain		
	Flat	Rolling	Mountainous
Design Speed (km / h)	80 – 100	60 – 80	40 – 60
No. of Lanes	2	2	2
Carriageway Width (m)	6.7	6.7	6.7
Shoulder Width (m)	2.5	2.5	1.0
Minimum Radius (m)	220 – 350	120 – 220	50 – 120
Maximum Grade (%)	4 - 3	5 – 4	7 - 6

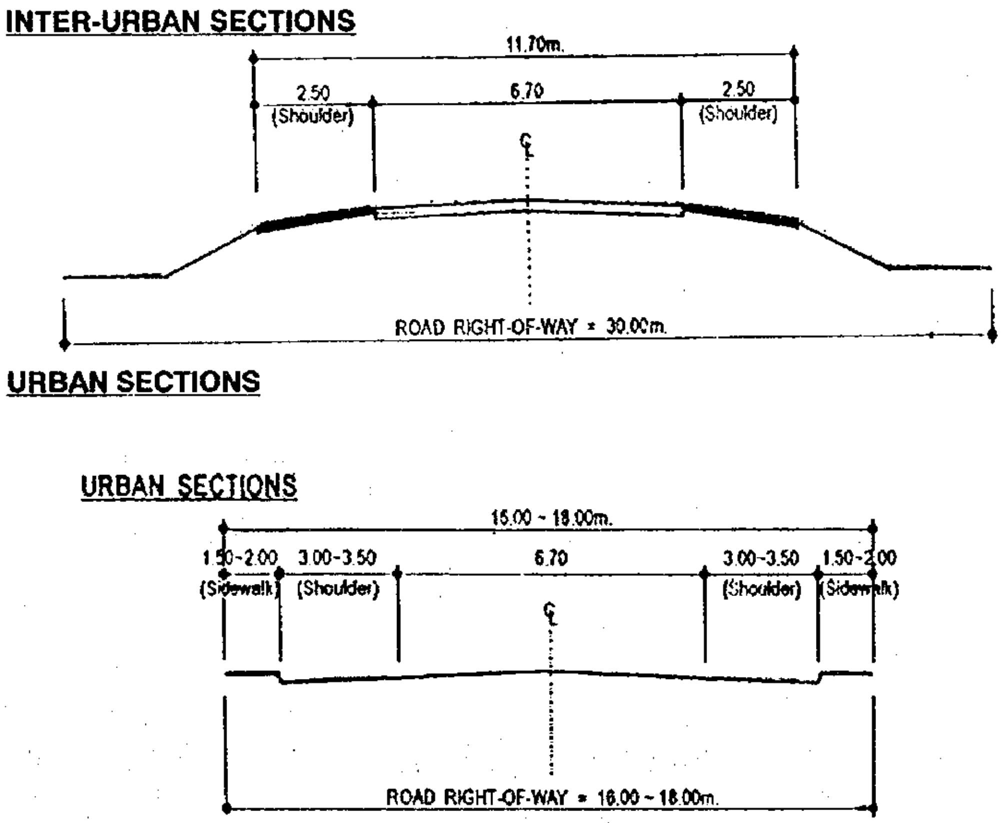


FIGURE 2.4-1 TYPICAL CROSS-SECTION OF THE PAN-PHILIPPINE HIGHWAY

(2) Rehabilitation of the Highway

After 10 to 15 years of its completion, the Highway has suffered from various structural problems such as progressive pavement deterioration, damage to bridges, slope failures in the mountainous sections as well as functional problems such as traffic congestion in the urban sections. This is due to the following factors:

- The pressing need at the time of construction was to complete the whole section as soon as possible within the limited budget appropriated under the then economic conditions, making no allowance for taking (adequate) slope protection measures, construction of bridges to withstand unstable rivers and the like.
- Rapid motorization after the completion of the Highway with the economic development resulted in remarkable traffic growth and passage of overloaded vehicles.
- Maintenance operation was insufficient and improper. Especially for pavement, it was often found that its service life passed without proper rehabilitation which would have effectively prolonged the life if carried out in a timely fashion.
- The Highway is situated in a severe natural environment such as steep topography, fragile geology, heavy rain, etc. and often hit by natural calamities like typhoons, earthquakes and volcanic eruptions.

In view of this situation, several feasibility studies on the rehabilitation of the Highway were conducted after the middle of the 1980s, and according to the findings of those studies, rehabilitation projects have been implemented since the early 1990's to the present.

(3) Upgrading of the Highway

Recently, the economic growth of the country has resulted in a sharp increase of road traffic demand in and around Metro Manila influenced areas and regional growth cities. Moreover, as the economy developed, road users have started to pay more attention to the functional serviceability of the facility rather than its physical condition. The acceptance level of congestion and service of the Highway has been raised as the economy developed. Therefore, the Highway is now required to be upgraded in terms of serviceability and functionality to a high standard.

Figure 2.4-2 shows the major cities along the Highway, and Table 2.4-2 shows the population and area of those cities. Judging from the present traffic condition and population, the sections of the Highway which may require upgrading are considered as follows:

- Sections under this Study
  - San Jose
  - Cabanatuan
- Section to be upgraded
  - San Pablo
  - Calbayog
  - Tagum
  - Davao
- Section where the Highway has been bypassed
  - Tuguegarao
  - Lucena
  - Naga
  - Legaspi
  - Tacloban

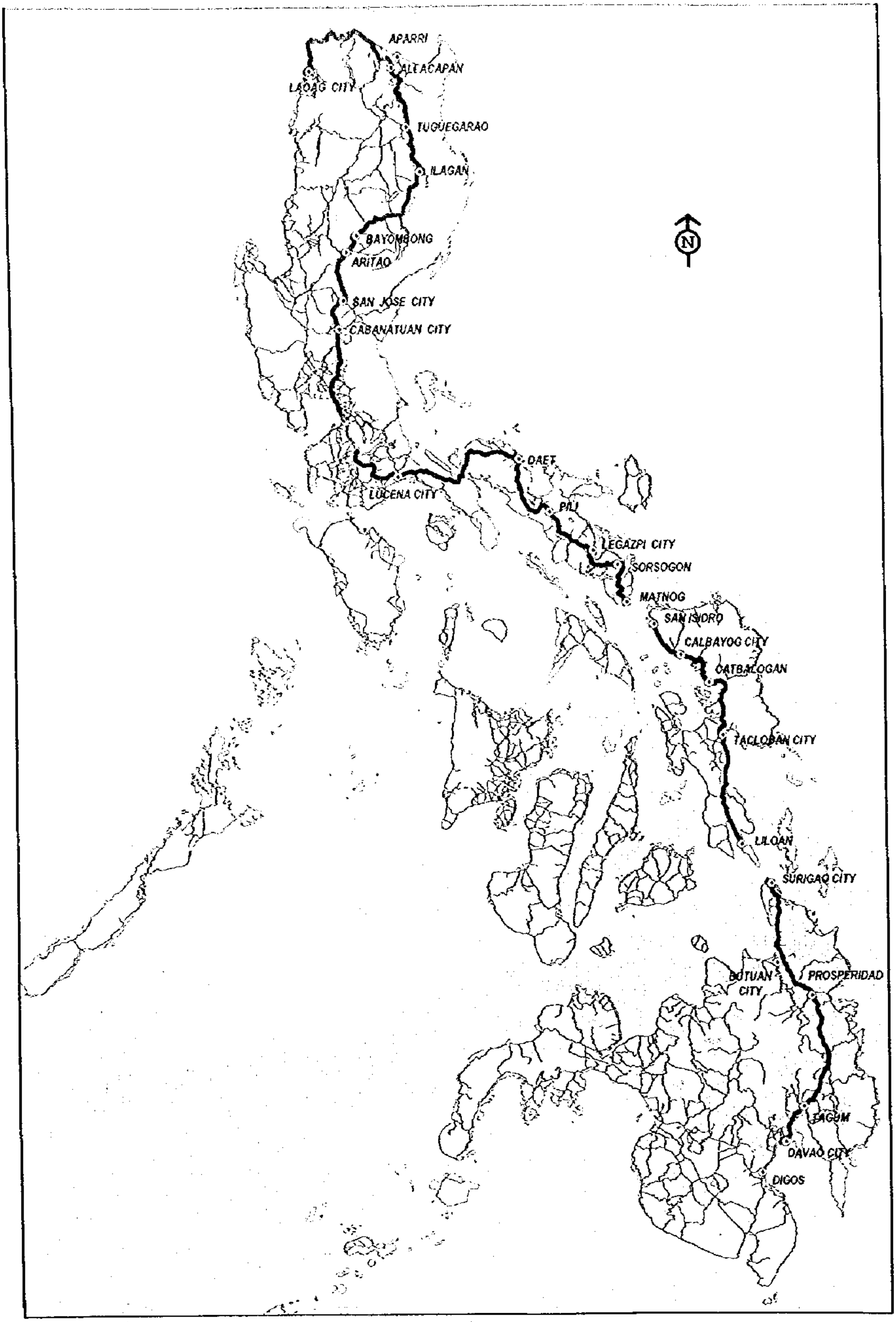


FIGURE 2.4 - 2 PROVINCIAL CAPITAL AND CITY ALONG THE PAN-PHILIPPINE HIGHWAY

TABLE 2.4-2 PROVINCIAL CAPITALS AND CITIES ALONG THE PAN-PHILIPPINE HIGHWAY

Province	Capital (City)	Province Capital/City	Population 1995	Population 1998	Area (km2)	Remarks
1. Cagayan	Tuguegarao	Cagayan	895,050	933,999	9002.7	
		Tuguegarao	107,725	115,275	144.8	
2. Isabela	Ilagan	Isabela	1,160,721	1,208,368	10664.6	
		Ilagan	106,912	111,564	1393.6	
3. Nueva Vizcaya	Bayombong	N. Vizcaya	334,965	355,572	3903.9	
		Bayombong	46,315	50,374	136.0	
4. Nueva Ecija	San Jose	N. Ecija	1,505,827	1,626,837	5284.3	Capital, Palayan
		San Jose	96,860	105,749	180.5	
5. Nueva Ecija	Cabanatuan	N. Ecija	1,505,827	1,626,837	5284.3	
		Cabanatuan	201,033	218,716	192.7	
6. Laguna	San Pablo	Laguna	1,631,082	1,798,991	1759.7	Capital, Sta. Cruz
		San Pablo	183,757	197,481	214.0	
7. Quezon	Lucena	Quezon	1,537,742	1,639,074	8706.6	
		Lucena	177,750	195,082	68.5	
8. Camarines Norte	Daet	Cam. Norte	439,151	468,777	2112.5	
		Daet	74,341	79,170	101.5	
9. Camarines Sur	Pili	Cam. Sur	1,432,598	1,509,133	5266.8	
		Pili	61,520	67,264	-	
10. Camarines Sur	Naga	Cam. Sur	1,432,598	1,509,133	5266.8	
		Naga	126,972	134,032	-	
11. Albay	Legaspi	Albay	1,005,315	1,067,162	2552.6	
		Legaspi	141,652	154,702	153.7	
12. Sorsogon	Sorsogon	Sorsogon	591,927	634,646	2141.4	
		Sorsogon	83,012	89,316	188.2	
13. Northern Samar	Calbayog	N. Samar	499,195	499,353	3498.0	Capital, Catarman
		Calbayog	129,216	137,690	903.0	
14. Samar	Catbalogan	Samar	589,373	632,242	5609.4	
		Catbalogan	76,324	79,834	119.8	
15. Leyte	Tacloban	Leyte	1,511,251	1,598,569	6268.3	
		Tacloban	167,310	187,280	100.9	
16. Southern Leyte		S. Leyte	317,565	327,440	1734.8	Capital, Maasin
17. Surigao del Norte	Surigao	S. del Norte	442,203	451,554	2739.0	
		Surigao	104,909	107,543	245.3	
18. Agusan del Sur	Prosperidad	A. del Sur	514,736	576,506	8965.5	
		Prosperidad	61,804	68,702	601.9	
19. Davao	Tagum	Davao	1,191,743	1,274,810	8129.8	
		Tagum	156,588	169,915	195.8	
20. Davao del Sur	Davao	D. del Sur	1,683,909	1,808,613	6377.6	
		Davao	1,006,840	1,107,266	2211.3	

2.4.2 EXISTING ROAD NETWORK

(1) Road classification

Roads in the Philippines are classified by two kinds of criteria; the *administrative classification* and the *functional classification*.

Under the administrative classification, roads are classified into the following five categories:

- National Road
- Provincial Road
- City Road
- Municipal Road
- Barangay Road

National roads are administered and maintained by the National Government and the rest by the respective Local Government Unit.

DPWH has established a functional classification as follows:

- National Roads (and Major Provincial Roads)
  - Arterial Road
    - North-South Backbone (Country's backbone roads)
    - East-West Lateral (Arterial roads which effectively inter-connect N-S backbone)
    - Other Roads of Strategic Importance (Arterial roads which strategically connect urban centers not covered by the above two roads)
  - National Secondary Road (all other national roads not classified as an arterial road)

In addition to the above, there are expressways which are operated by the private sector.

(2) Road Extension in Region III

The road extension by type of pavement and a road density in Region III are shown in Table 2.4-3.

There are 1,718 km of national roads of which 90% were paved in Region III. Bulacan Province has 263 km. of national roads with pavement ratio of 95%, whereas Nueva Ecija has 455 km. of national

TABLE 2.4-3 ROAD EXTENSION AND ROAD DENSITY IN REGION III

			Bulacan	N. Ecija	Bataan	Pampanga	Tarlac	Zambales	Region III
Population		(1,000)	1,784	1,506	491	1,636	946	569	6,932
Land Area		(sq.km.)	2,625	5,284	1,373	2,181	3,053	3,714	18,230
Road Extension (Km)	National Road	Concrete	107	252	179	162	111	30	841
		Asphalt	143	119	92	103	85	170	712
		Unpaved	13 (5%)	84 (18%)	17 (6%)	28 (10%)	15 (7%)	8 (4%)	165 (10%)
		Total	263	455	288	293	211	208	1,718
	Provincial Road	Concrete	180	35	12	113	240	44	624
		Asphalt	112	82	54	19	79	94	440
		Unpaved	61 (17%)	581 (83%)	160 (71%)	190 (59%)	233 (42%)	75 (35%)	1,300 (55%)
		Total	353	698	226	322	552	213	2,364
	Municipal / City Road	Concrete	128	50	1	99	106	34	418
		Asphalt	45	100	5	37	21	135	343
		Unpaved	66 (28%)	212 (59%)	448 (99%)	98 (42%)	58 (31%)	81 (32%)	963 (56%)
		Total	239	362	454	234	185	250	1,724
	Barangay Road	Concrete	83	49	1	-	76	31	240
		Asphalt	393	141	5	-	4	59	602
		Unpaved	1,695 (78%)	1,441 (88%)	449 (99%)	1,588 (100%)	1,706 (96%)	382 (81%)	7,261 (90%)
		Total	2,171	1,631	455	1,588	1,786	472	8,103
	Total	Concrete	498	386	193	374	533	139	2,123
		Asphalt	693	442	156	159	189	458	2,097
		Unpaved	1,835 (61%)	2,318 (74%)	1,074 (75%)	1,904 (78%)	2,012 (74%)	546 (48%)	9,689 (70%)
		Total	3,026	3,146	1,423	2,437	2,734	1,143	13,909
Road Density	National Road		0.12	0.16	0.35	0.16	0.12	0.14	0.15
	Provincial Road		0.16	0.25	0.28	0.17	0.32	0.15	0.21
	Municipal / City Road		0.11	0.13	0.55	0.12	0.11	0.17	0.15
	Barangay Road		1.00	0.58	0.55	0.84	1.05	0.32	0.72
	Total		1.40	1.12	1.73	1.29	1.61	0.79	1.24

Source: DPWH Region III

Note:
1/ National Road Extension in 1998, other roads in 1993 except Bulacan and Nueva Ecija in 1998.
2/ Population in 1995
3/ Road Density = L /√PA, where L = Road Length (km), P=Population in 1,000, A=Land Area: Sq.Km.

roads of which 82% were paved. The road density of national roads in Region III is 0.15, whereas that of Bulacan and Nueva Ecija Provinces is 0.12 and 0.16, respectively. The pavement ratio and road density of national roads of the country is 56% and 0.19, respectively, thus Region III as well as two provinces of Bulacan and Nueva Ecija has higher pavement ratio, but lower road density than the national average.

The pavement ratio of provincial roads is still very low, particularly in Nueva Ecija Province, compared with the national roads. Other classes of roads have also very low pavement ratio.

(3) Existing Road Network

The arterial road network together with other major transportation facilities in Region III is shown in Figure 2.4-3. Major road network consists of the following roads:

Expressway	:	North Luzon Expressway
North-South Backbone	:	Pan-Philippine Highway Manila North Road
East-West Lateral	:	Iba – Tarlac – Cabanatuan – Palayan Road
Other Road of Strategic Importance	:	Gapan – San Fernando – Olongapo Road Dinalupihan – Balanga - Mariveles Road Dinalupihan – Angeles Road Olongapo – Iba – Pangasinan Road Tarlac – Pangasinan Road San Jose – Pangasinan Road

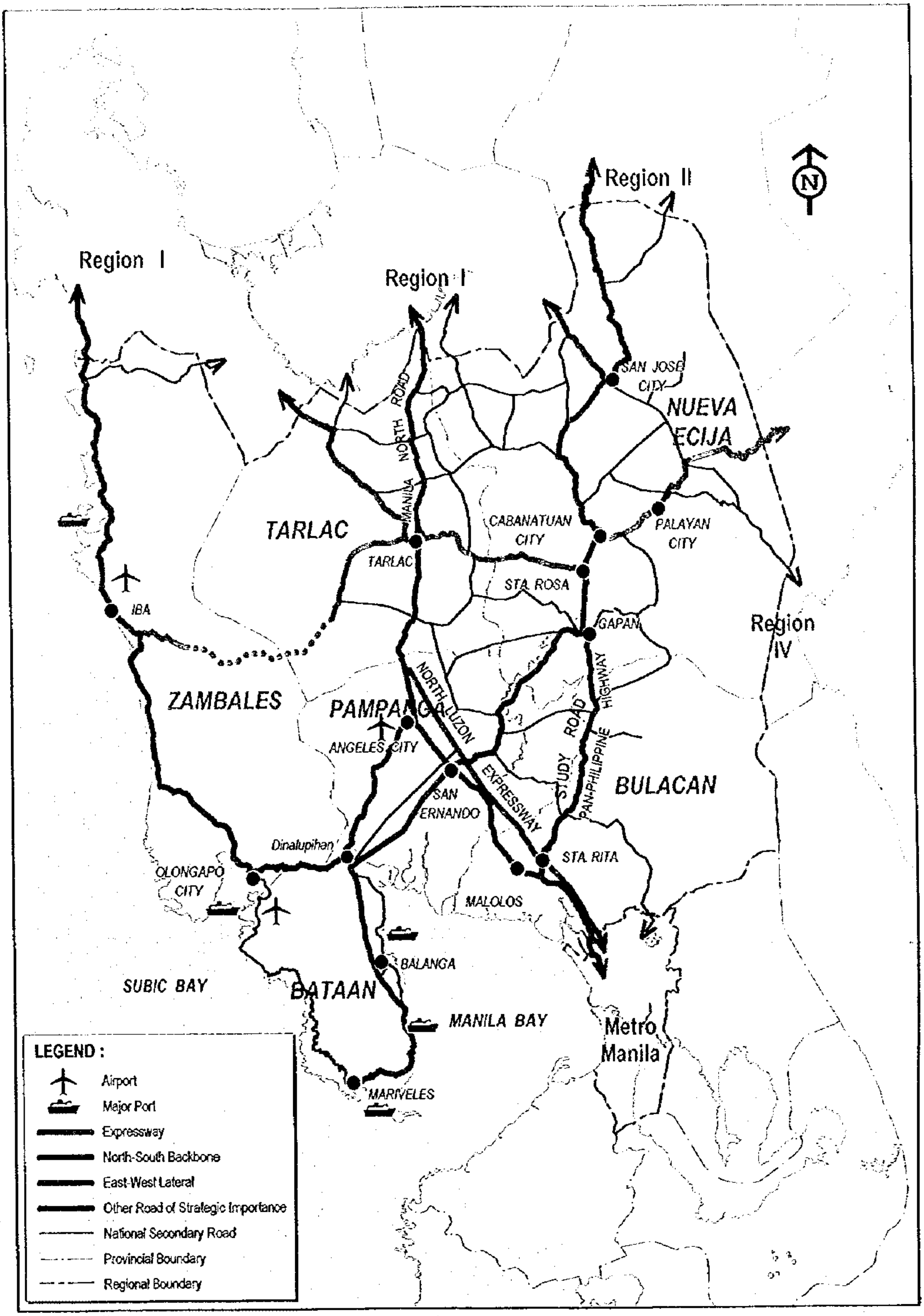


FIGURE 2.4 - 3 EXISTING ROAD NETWORK IN REGION III

2.4.3 Future Road Network

There are four proposed major road projects in Region III as follows (see Figure 2.4-4):

Sierra Madre Highway / North Luzon Expressway East

Sierra Madre Highway was proposed by the Master Plan Study for Central Luzon Development Program. The proposed alignment starts at C-5 in Metro Manila, goes towards north, running almost parallel to / and 10 to 20 km east of the Pan-Philippine Highway and ends at San Jose City. It traverses on the foot of the Sierra Madre Mountains.

It is also called as North Luzon Expressway East (NLEE) which is proposed to be further extended up to Bayombong in Region II.

Rainbow Highway

This highway was proposed as an Intra-Regional Artery Establishment by the Master Plan Study for Central Luzon Development Program. The highway is intended to strengthen links between key urban centers, and provide the shortest link between the Subic Free Port and the Clark International Aviation Complex and extend further to Cabanatuan City and Palayan City.

North Luzon Expressway Extension

Theexisting North Luzon Expressway was proposed to be extended in the north up to San Fernando, La Union and in the west up to Lingayen, Pangasinan in Region I in order to strengthen the transport linkage between Region I and Metro Manila.

Dalton Pass Road

The existing Pan-Philippine Highway passes through the natural disaster-prone area and is expected to be damaged to the extent of traffic interruption which would isolate Region II. In order to provide the alternative route for the Pan-Philippine Highway, this road was proposed. It starts at San Jose City and ends at Aritao in Region II.

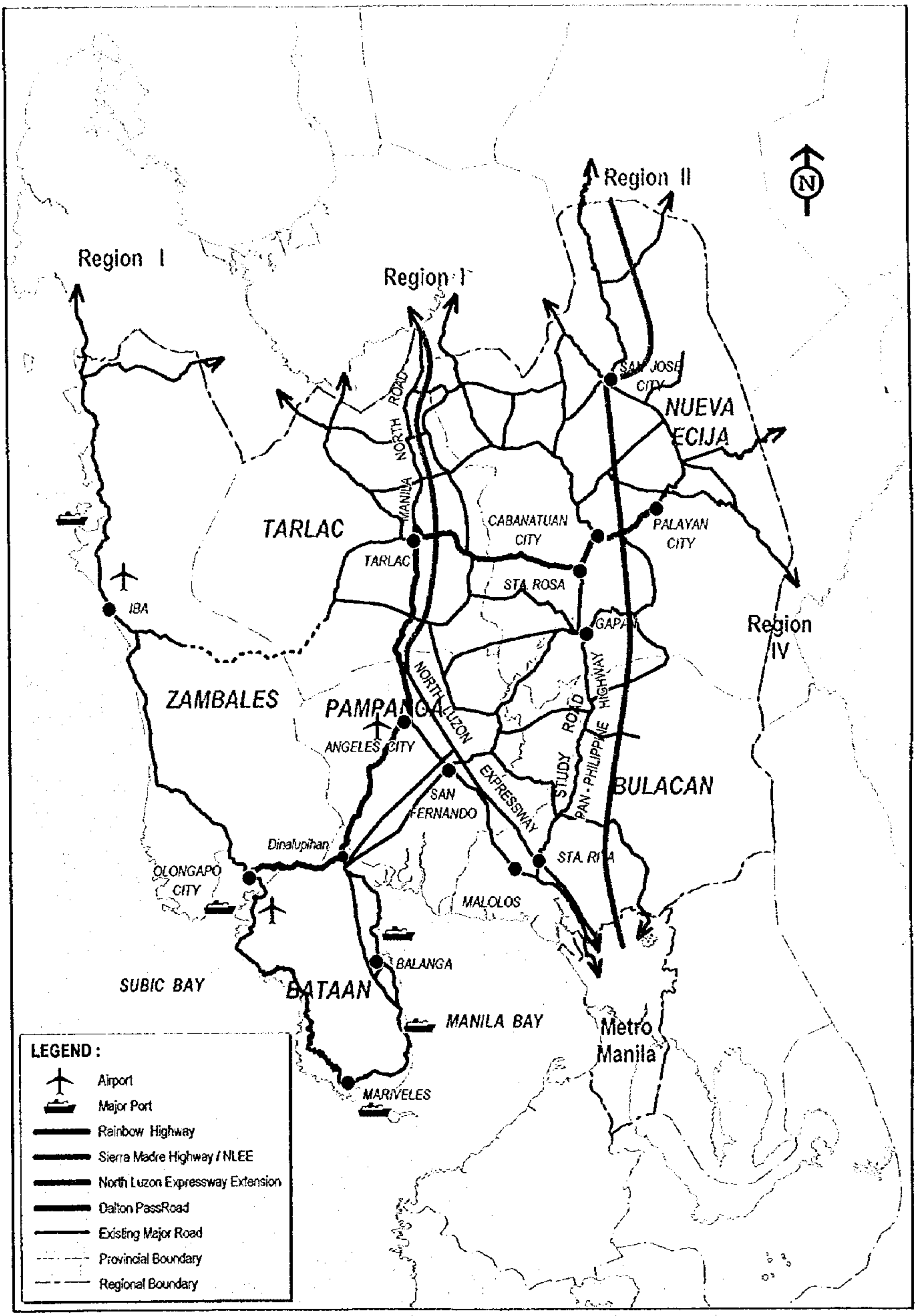


FIGURE 2.4 - 4 PROPOSED HIGHWAY PROJECTS

PART II

SURVEY AND ANALYSIS

CHAPTER 3

ROAD CONDITION SURVEY AND OBSERVATION

CHAPTER 3

ROAD CONDITION SURVEY AND OBSERVATION

3.1 ROAD CONDITION

The present condition of the Study Road, such as the geometric alignment, roadway cross-section, intersection geometry, pavement condition and roadside friction, were surveyed by the visual inspection to assess the serviceability of the Study Road as shown in Figure 3.5-1. The survey results are presented in Appendix 3.1-1 with the formats used for the road condition survey, and summarized hereunder.

3.1.1 Geometric Alignment

The geometric condition of the Study Road was inspected by visual observation referring the topographic maps prepared under the previous study, and found generally acceptable in accordance with the geometric design standard of the Philippines, except a few section mentioned below.

- Vertical Alignment

  A section between San Rafael and San Ildefonso carries a vertical grade of 6% which exceeds the allowable maximum grade of 4%.

  This grade was found to be one of the causes for reducing the running speed of vehicles on the road.

- Horizontal Alignment

  Several sections were observed to have below the allowable horizontal radius of 220m. These include sections from Plaridel to San Niguel, Talavera suburban area and sections after San Jose urban center.

  These small radius, below the standard, were assessed as a severe hazard in maintaining the smooth running speed, resulting in breaking the stable flow of vehicles fleet.

3.1.2 Roadway Cross Section

The cross sectional elements of the roadway, including the width of the carriageway, shoulder and sidewalk, were measured to obtain the data for traffic analysis and to examine the possibility of roadway widening.

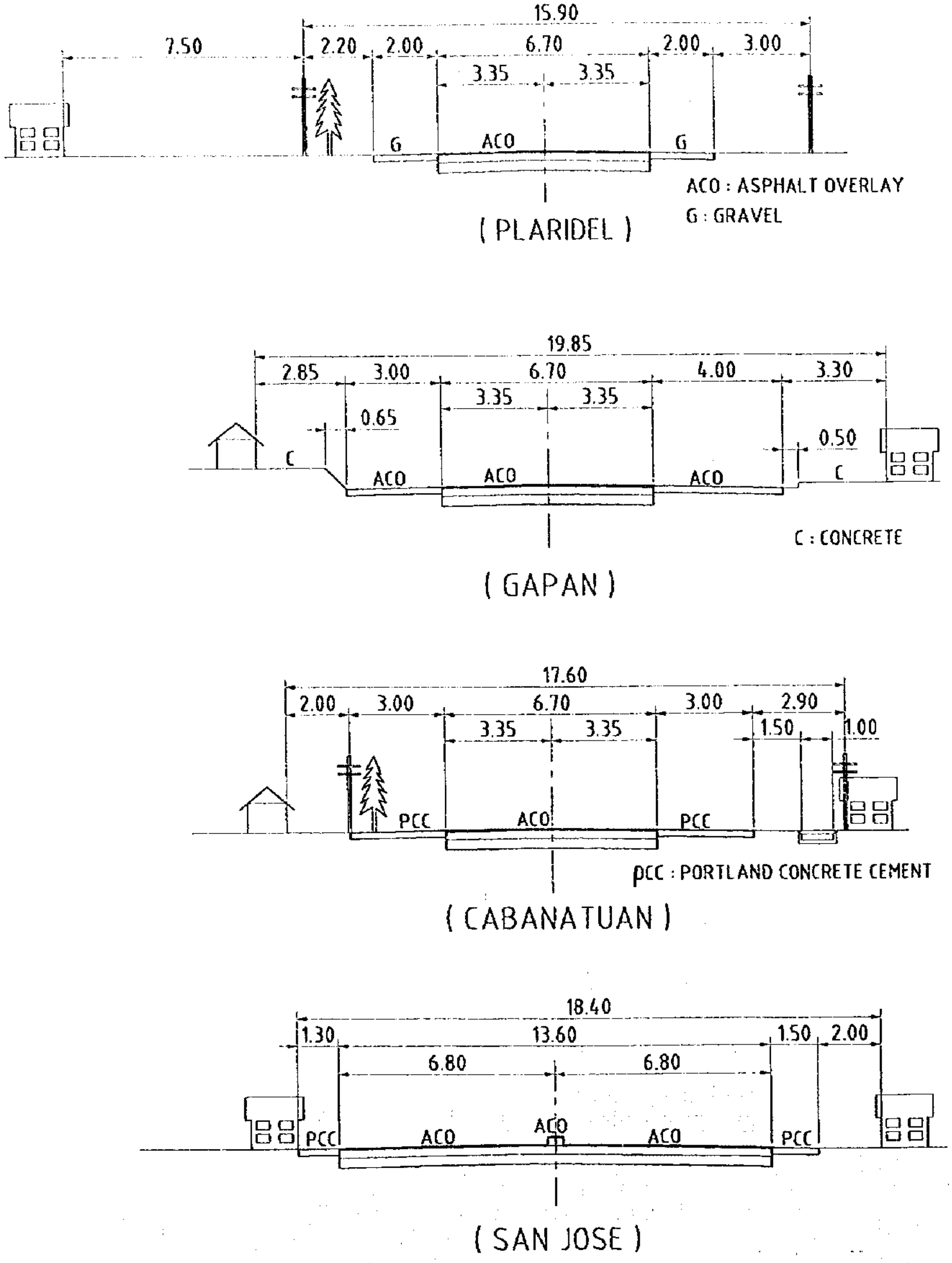


FIGURE 3.1-1 TYPICAL CROSS-SECTION OF URBAN SECTIONS

Figure 3.1-1 graphically shows the typical cross sections at Plaridel, Gapan, Cabanatuan and San Jose Cities where the present traffic congestion was assessed over an acceptable level of road users.

The survey results as mentioned revealed that the Study Road has the road standard only as a collector road in urban / suburban area, despite the initial objection that the Pan-Philippine Highway shall play a role as the principal arterial highway in the country.

- Carriageway

  At the most sections throughout the Study Road, the carriageway width is 6.7 m. (3.35m x 2) for both directions, except some urban sections such as San Jose urban center where the road has been widened.

- Shoulder

  Shoulder widths vary from 1.5m to 4.0m which are presently utilized for several purposes, such as parking areas, stopping areas for loading/unloading, travel ways for low-speed vehicles, spaces for residents daily activities, etc..

- Sidewalk

  No sidewalks were provided in the most sections, except a very few section in the urban centers such as Gapan and Cabanatuan.

3.1.3 Intersection Geometry

The geometry and configuration of intersections were surveyed to obtain data useful for traffic congestion analysis at the major 12 intersections selected among 35 intersections in a whole stretch of the Study Road. The survey results are presented in Appendix 3.1-1, and summarized in Table 3.1-1.

It was observed that intersections were a major cause of traffic congestion throughout the Study Road, due to heavy traffic volume not only on the Study Road but also on the intersecting road, and no provision of additional lanes such as exclusive lanes for turning movements.

3.1.4 Roadside Friction

A roadside friction was termed to express a condition of utilization of road shoulders in order to evaluate "obstruction degree" for through traffic, as follow.

High (H) : Almost all parts of shoulder are used as parking areas and loading/unloading areas, thus through traffic is severely affected.

Medium (M) : Jeepneys and tricycles stop on the shoulder for loading/unloading of the passengers, thus obstruct through traffic flow on spots.

Low (L) : Shoulder width is wide enough to provide a clearance for through traffic, thus through traffic can flow smoothly.

The observation were made for the intersection to evaluate the smoothness of through traffic flow. The result is presented in Figure 3.5-1.

TABLE 3.1-1 EXISTING GEOMETRY AND CONDITION OF MAJOR INTERSECTIONS

City/Municipality (Sta. No.)	Plaridel (Sta. 41+430)	Baliuag (Sta. 50+840)	San Rafael (Sta. 59+780)	San Ildefonso (Sta. 65+720)	San Miguel (Sta. 72+830)	Gapan (Sta. 93+480)
Geometry	• 4-leg intersection. • East leg: National road to Brgy with 6.0 m wide, AC overlaid. • West leg: National road to Malolos, with 5.2 m wide, PCC paved. • No channelization. • Temp. median fence provided at the west leg.	• 4-leg intersection • East leg: National road to town proper, with 6.0 m wide, AC overlaid. • West leg: National road to Canoaba, with 6.1 m wide, AC overlaid. • No channelization. • Provided AC pavement on both shoulders of main road.	• 4-leg intersection • East leg: National road to town proper. With 6.7 m wide, AC overlaid. • West leg: Provincial road with 5.0 m wide, PCC paved. • No channelization. • AC overlay provided on both shoulders of main road.	• 4-leg intersection • East leg: National road to Brgy.Pinaod. With 5.1 m wide, AC overlaid • West leg: Municipal road to town proper with 4.6 m wide, AC overlaid. • No channelization. • AC overlay provided on both shoulders of main road.	• Y (3) leg - intersection • East-leg: National road to Brgy with 6.7 m wide, PCC paved. • No channelization. • No AC overlay provided on both shoulders of main road.	• 5-leg intersection • East-leg: National road to Penaranda with 8.4 m wide, AC overlaid. • West-leg: National road to San Isidro with 9.0 m wide, AC overlaid. • Right turn lane with traffic island provided on the east side
Traffic Condition	• Congested due to both thru and local traffic. • Especially tricycle and jeepney crossing. • No traffic signal, policeman controls traffic.	• Congested due to mainly local traffic. • Especially tricycle and jeepney crossing. • Traffic signal provided but not working, policeman controls traffic.	• Congested due to local traffic, especially tricycle. • No traffic signal provided.	• Slightly congested due to local traffic especially tricycle at the east leg. • No traffic signal provided, policeman controls traffic.	• Not congested.	• Highly congested due to thru and local traffic. • No traffic signal, policeman controls traffic. • New traffic code will be enforced.
Remarks	• Refer to Appendix 3.1-1. • Traffic survey point.	• Refer to Appendix 3.1-1. • Traffic survey point.			• Traffic survey point.	• Refer to Appendix 3.1-1. • Traffic survey point

City/Municipality (Sta. No.)	Sta. Rosa (Sta. 107+050)	Cabanatuan (1) (Sta. 113+750)	Cabanatuan (2) (Sta. 116+100)	Talavera (Sta. 129+700)	Munoz (Sta. 146+410)	San Jose (Sta. 159+089)
Geometry	• 4-leg intersection • East leg: Provincial road to Brgy. with 5.0 m wide, PCC paved. • West leg: National road to Tarlac, with 6.0 m wide, AC overlaid. • No channelization. • PCC pavement provided on both shoulders of main road.	• Y (3)-leg intersection. • North-leg: Provincial road to City Proper with 6.1 m wide, PCC paved. • No channelization. • PCC pavement provided on both shoulders of main road.	• 4-leg intersection. • East leg: National road to Palayan with 6.1 m wide, AC overlaid. • West leg: National road to City Proper with 6.1 m wide, PCC paved. • No channelization. • AC overlay provided on both shoulders of main road.	• T (3)-leg intersection. • West leg: Municipal road to Town Proper with 6.7 m wide, PCC paved. • No channelization. • AC overlay provided on both shoulders of main road.	• Y (3)-leg intersection. • West leg: Municipal road to Town Proper with 6.0 m wide, AC overlaid. • No channelization. • No AC overlay provided on both shoulders of main road.	• 5-leg intersection. • South-leg. National road to Rizal with 7.7 m wide, AC overlaid. • East-leg: Municipal road to Town Proper with 7.3 m wide, PCC paved. • North-leg National road to Lupao with 6.2 m wide, AC overlaid • No channelization. • AC overlay provided on shoulders of main road.
Traffic Condition	• Congested due to both thru and local traffic. • Especially tricycle moving to roadside public market. • No traffic signal, policeman controls traffic.	• Slightly congested due to both thru and local traffic. • No traffic signal.	• Highly congested due to both thru and local traffic. • Traffic signal provided, but not working, policeman controls traffic. • West-leg used as one lane extending from the intersection.	• Slightly congested due to local traffic • No traffic signal.	• Not congested.	• Highly congested due to thru and local traffic. • East-leg used as one way towards thet intersection.
Remarks	• Traffic survey point	• Traffic survey point	• Refer to Appendix 3.1-1 • Traffic survey point			• Refer to Appendix 3.1-1 • Traffic survey point

3.2 BRIDGE CONDITION

Fifty (50) bridges along the Study Road were inspected to assess the present structural condition which were rated to the following three(3) categories:

Class A :	Main structural components of a bridge are seriously deteriorated or substructures are observed unstable, thus urgent replacement or major structural repairs are judged needed.
Class B :	Deterioration of structural members are not so serious that minor repair can be applied, thus timely repairs are judged necessary.
Class C :	Structural condition of a bridge is fair, thus proper maintenance is recommended.

The result of inspection including rating and recommended repair works, are presented in Appendix 3.2-1.

The number of bridges under each class are:

Rating	Numbers of Bridges
Class A	6
Class B	37
Class C	7
	Total 50 Bridges

Table 3.2-1 shows six(6) bridges classified as Class A with the recommended countermeasure works.

TABLE 3.2-1 LIST OF BRIDGES WITH RATING A
(Sta. Rita, Plaridel - San Jose Section)

Item \ Bridge Name / Station	MAASIM 1 Km 59+150	MAASIM 2 Km 61+300	ANYATAM 2 Km 68+000	MARUGAY-RUGAY Km 69+050	BALUARTE 2 Km 85+762	DOÑA JOSEFA Km 94+060
BASIC CONDITION	BRIDGE TYPE - RCDG NO. OF SPAN - 2 SPAN LENGTH - 2@12.00 BRIDGE LENGTH (m) - 24.00 NO. OF LANE - 2 CAPACITY (TONS) - 15 SKEW - 0 YEAR BUILT - 1975 ROADWAY WIDTH (m) - 7.30 SIDEWALK (m) - 0.80 NO. OF GIRDERS - 4 TYPE OF DECKSLAB - Conc. w/ Asphalt Overlay TYPE OF ABUTMENT - Pile Bent TYPE OF PIER - Pile Bent	BRIDGE TYPE - RCDG NO. OF SPAN - 7 SPAN LENGTH - 7@12.00 BRIDGE LENGTH (m) - 84.00 NO. OF LANE - 2 CAPACITY (TONS) - 10 SKEW - 0 YEAR BUILT - 1951 ROADWAY WIDTH (m) - 7.35 SIDEWALK (m) - 0.80 NO. OF GIRDERS - 4 TYPE OF DECKSLAB - Conc. w/ Asphalt Overlay TYPE OF ABUTMENT - Gravity Type TYPE OF PIER - Wall Type	BRIDGE TYPE - RCCB / RCD NO. OF SPAN - 3 SPAN LENGTH - 2@6.00+1@12.00 BRIDGE LENGTH (m) - 24.00 NO. OF LANE - 2 CAPACITY (TONS) - 10 SKEW - 0 YEAR BUILT - 1975 ROADWAY WIDTH (m) - 7.40 SIDEWALK (m) - 0.70 NO. OF GIRDERS - 10 / 4 TYPE OF DECKSLAB - Conc. w/ Asphalt Overlay TYPE OF ABUTMENT - Pile Bent TYPE OF PIER - Pile Bent	BRIDGE TYPE - RCCB / RCD NO. OF SPAN - 3 SPAN LENGTH - 1@7.00+2@12.00 BRIDGE LENGTH (m) - 31.00 NO. OF LANE - 2 CAPACITY (TONS) - 10 SKEW - 0 YEAR BUILT - 1960 ROADWAY WIDTH (m) - 7.50 SIDEWALK (m) - 0.75 NO. OF GIRDERS - 10 / 4 TYPE OF DECKSLAB - Conc. w/ Asphalt Overlay TYPE OF ABUTMENT - Pile Bent TYPE OF PIER - Pile Bent	BRIDGE TYPE - RCDG NO. OF SPAN - 1 SPAN LENGTH - 1@9.80 BRIDGE LENGTH (m) - 9.80 NO. OF LANE - 2 CAPACITY (TONS) - 15 SKEW - 45° YEAR BUILT - 1970 ROADWAY WIDTH (m) - 7.40 SIDEWALK (m) - 0.45 NO. OF GIRDERS - 4 TYPE OF DECKSLAB - Conc. w/ Asphalt Overlay TYPE OF ABUTMENT - Gravity Type TYPE OF PIER - None	BRIDGE TYPE - PCDG NO. OF SPAN - 6 SPAN LENGTH - 6@46.70 BRIDGE LENGTH (m) - 280.20 NO. OF LANE - 2 CAPACITY (TONS) - 15 SKEW - 0 YEAR BUILT - 1980 ROADWAY WIDTH (m) - 7.40 SIDEWALK (m) - 0.80 NO. OF GIRDERS - 4 TYPE OF DECKSLAB - Conc. w/ Asphalt Overlay TYPE OF ABUTMENT - Gravity Type TYPE OF PIER - Wall Type
RESULT OF THE OBSERVATION	GIRDER - Fair DECKSLAB - Fair CURB STONE AND GUARDRAIL - Fair ABUTMENT - 1 w/crack L=15cm PIER - Fair FOUNDATION - Fair CONDITION OF RIVER STREAM- Upstream/Downstream Ricefield FLOODING & BRIDGE OPENING - Fair	GIRDER - Fair DECKSLAB - Fair CURB STONE AND GUARDRAIL - Fair ABUTMENT - Fair PIER - Bad condition; Pier 4 & 5 with steel support and are sinking FOUNDATION - Bad condition; foundation of P4 & P5 are sinking CONDITION OF RIVER STREAM- River is meandering both upstream and downstream. FLOODING & BRIDGE OPENING - With high water level as of survey time.	GIRDER - Fair; spalling of concrete (RCCB) at channel; minor problem DECKSLAB - Fair CURB STONE AND GUARDRAIL - Fair ABUTMENT - Fair PIER - Fair condition FOUNDATION - Fair CONDITION OF RIVER STREAM- Meandering upstream and swamps at downstream. FLOODING & BRIDGE OPENING - No flooding	GIRDER - Fair; spalling of concrete (RCCB) at channel; minor problem DECKSLAB - Fair CURB STONE AND GUARDRAIL - Fair ABUTMENT - Fair PIER - Fair FOUNDATION - Fair CONDITION OF RIVER STREAM- Upstream river at upstream. FLOODING & BRIDGE OPENING - Flooding level is at 1/2 of the girder. Flooded approaches.	GIRDER - Fair; water level is below the girder. DECKSLAB - Fair CURB STONE AND GUARDRAIL - Fair ABUTMENT - Fair PIER - None FOUNDATION - Fair CONDITION OF RIVER STREAM- Heavily silted and with vegetation. Creek is meandering at both upstream and downstream. FLOODING & BRIDGE OPENING - Overtopping of the bridge.	GIRDER - Fair DECKSLAB - Fair CURB STONE AND GUARDRAIL - Fair ABUTMENT - Fair; riprapings in fair condition. PIER - Foundation of P4 & P5 which are in the main river channel were scoured and exposed about 1.5m above the water level FOUNDATION - See above CONDITION OF RIVER STREAM- Meandering upstream and downstream. FLOODING & BRIDGE OPENING - No overtopping of the bridge
REMARKS / RECOMMENDATION	Continuous - 2 span girder with steel plate support (stiffener) Protection of Earthquake Steel Plate Support of Girder is DPWH project. No cracks seen in girders. Maintenance of abutment.	Trees and vegetation at river banks including Abutment 1 & 2 Need thorough investigation of Pier 4 & 5. (For replacement) According to our observation this bridge must be replaced with a new one	Asphalt overlay of the deckslab is in fair condition. To increase the bridge capacity, replace the existing with a new one or strengthen it. (Basis-posted capacity). Few hair cracks have seen in girders and the channel beam.	With a newly constructed dike about 50m (on both sides of the river) downstream. Riprapings/ slope protection at Abutment 1 is under repair while at Abutment 2 there is a big hole. To increase the bridge capacity, strengthen the existing or replace it with a new one. (Basis-posted capacity) Hair cracks have seen in girders and the channel beam	Bridge opening is in adequate for flood run-off. For replacement Need Hydrological study to estimate the amount run-off. Need riprapings about 50m upstream and downstrea	Seal at the expansion joint over Pier 4 are totally gone while over Pier 2 is beginning to deteriorate (30cm long hole). The expansion joint (gap) is about 10cm. Wide Provide sealant at the expansion joint over Pier 2 and Pier 4

3.3 EXISTING ROAD RIGHT-OF-WAY

Cadastral maps which define the extent of road right of way were obtained from respective cities and municipalities and summarized as shown in Table 3.5-1.

TABLE 3.5-1 ROAD RIGHT-OF-WAY

	Cities / Municipalities	R.O.W (m)
(1)	Plaridel	15.0
(2)	Baliuag	15.0
(3)	San Rafael	15.0 – 20.0
(4)	San Ildefonso	20.0
(5)	San Miguel	15.0
(6)	Gapan	15.0 – 20.0
(7)	Sta. Rosa	15.0 – 25.0
(8)	Cabanatuan	20.0
(9)	Talavera	15.0
(10)	Munoz	15.0 – 20.0
(11)	San Jose	15.0 – 30.0

Source : Cadastral Maps

In sections where no cadastral maps were provided, the width of road right-of-way was judged from the road shoulders as presented in Figure 3.5-1.

3.4 OBSERVATIONS ON FACTORS AFFECTING TRAFFIC FLOW

Followings are the observations on primary factors affecting traffic flow:

(1) Mixture of low speed vehicles
- jeepneys (frequent stopping)
- tricycles (slow moving and stops at anywhere)
- unorderly movements of these vehicles

(2) Side friction
- narrow shoulders
- too many crossing/access roads
- irregular parking of vehicles
- illegal establishments or vendors within shoulders or R.O.W.
- no sidewalks

(3) Intersections
- no traffic signal
- no exclusive lanes for turning vehicles

(4) Access Roads
- many access roads at short interval
- no access control

(5) Geometry of road alignment
- substandard vertical and horizontal alignment (only limited sections)
- narrow and irregular shoulder width

(6) Natural Hazard
- flooding

Among these factors observed, the most serious problem is low speed vehicles mixed with ordinary vehicles in a group of platoon. These low speed vehicles such as jeepneys and tricycles can run with a speed of 20 to 30 km/h only. Moreover, they stop frequently and anywhere for loading/unloading of passengers. From the observations, the followings are considered to be studied to remedy the situations.

- Provision of an exclusive lane to segregate low speeds vehicles from a carriageway of the of the Highway.
- Enforcement that tricycles shall not allow to run on the Highway. (instead, roads parallel to the Highway for tricycles are needed)
- Enforcement that jeepneys and tricycles shall stop only at designated spots for loading/unloading of passengers.

The side friction along the Highway is also a serious hazard for traffic flow, particularly in urbanized areas. As mentioned above, several causes were observed. From the observations, the followings are considered to be studied to remedy the situations:

- Provision of wide shoulders and sidewalks
- Enforcement that illegal establishments and vendors within ROW shall be removed
- Enforcement that parking on shoulders shall be prohibited.

Frequent flooding also affected the traffic flow on the Study Road. The causes of flood are listed as follows:

- Overflowing of river or canal caused by heavy rain
- Poor drainage system

The flood survey was done along the Study Road and along the expected bypass routes by interviewing nearby residents. Results of the flood survey are summarized as follows:

- Floodings, particularly in the years 1975, 1978, and 1998 were caused by overflow of the Pampanga River and Angat River.
- Areas between Sta. Rita and San Miguel has never been flooded since 1975 because of Bustos Dam.

- In the area around the San Miguel Bypass, small flooding occurs because of the lowest land and the poor irrigation.
- The area around Sta. Rosa experienced flooding in 1998 due to the overflowing of Pampanga River.

It was observed that bypass routes may be more advisable in the east side in the above areas because the east areas are higher in elevation than those on the side.

3.5 SUMMARY OF ROAD CONDITIONS OF STUDY ROAD

The existing conditions of the Study Road and the results of traffic analysis (see Chapter 4) are summarized and presented in Figure 3.5-1.

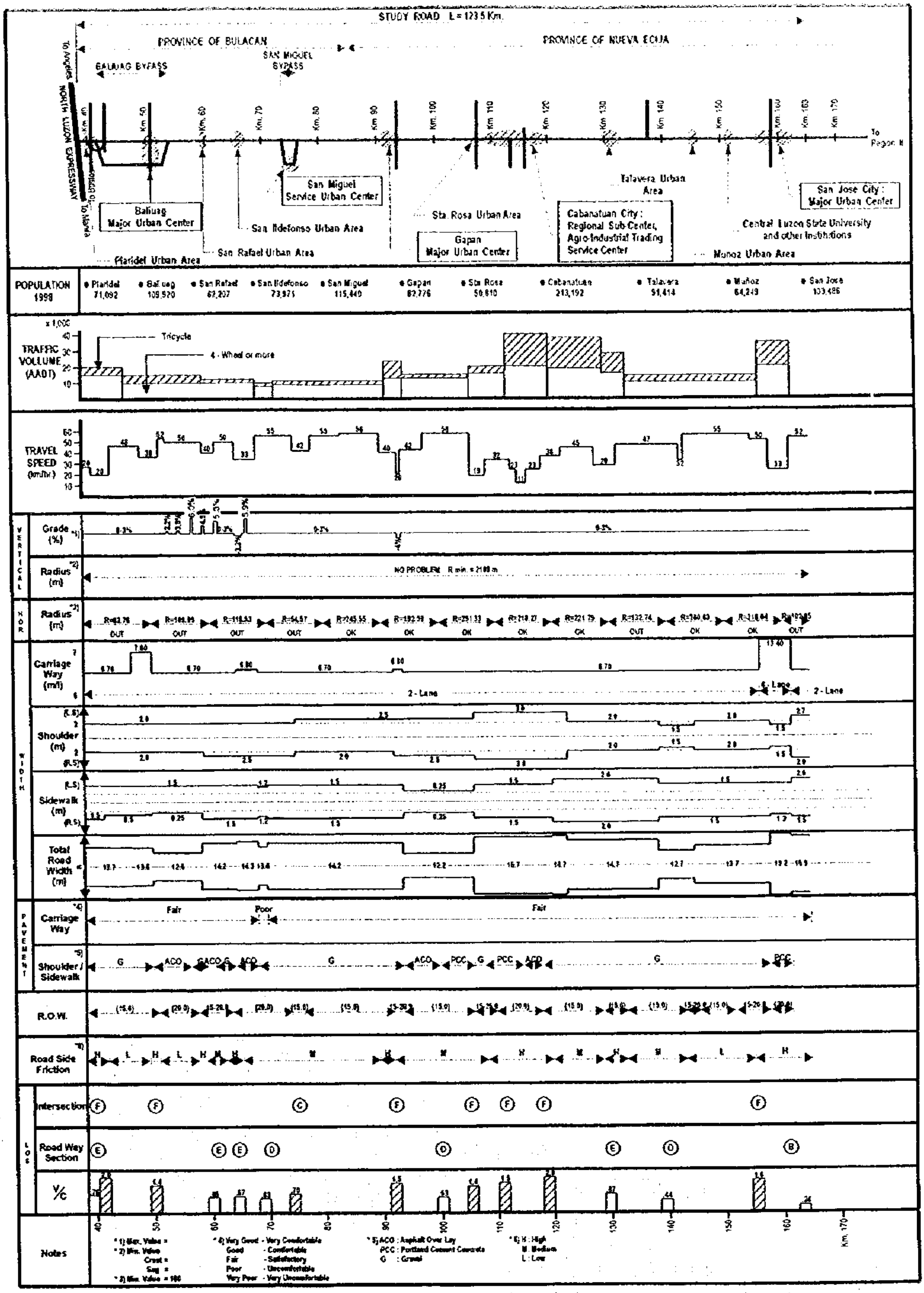


FIGURE 3.5-1 SUMMARY OF EXISTING ROAD CONDITIONS AND TRAFFIC ANALYSIS

CHAPTER 4

PRESENT TRAFFIC CONDITION SURVEY AND ANALYSIS

CHAPTER 4

PRESENT TRAFFIC CONDITION SURVEY AND ANALYSIS

4.1 TRAFFIC SURVEYS CONDUCTED

The following five kinds of traffic surveys were undertaken:

Type of Traffic Survey	No. of Stations	Survey Duration
Roadside Traffic Count Survey	8	12 hours from 6:00 AM to 6:00 PM for 2 consecutive days.
Intersection Traffic Count Survey	8	12 hours from 6:00 AM to 6:00 PM for 2 consecutive days.
Roadside OD Survey	5	12 hours from 6:00 AM to 6:00 PM for 2 consecutive days.
Axle Load Survey	2	12 hours from 6:00 AM to 6:00 PM for 2 consecutive days.
Travel Time Survey	3 Routes	3 times a day (morning, noon & evening) for 2 consecutive days.

Location of survey stations is shown in Figure 4.1-1. The field survey formats used are presented in Appendix 4.1-1.

4.2 AADT ALONG THE STUDY ROAD

Results of the roadside traffic count survey and the intersection traffic count survey were converted to AADT utilizing expansion factors developed by DPWH. Survey results are attached in Appendix 4.2-1.

AADT along the Study Road is summarized in Table 4.2-1 and graphically presented in Figure 3.5-1 in Chapter 3. Peak hour ratio and directional distribution of traffic are also shown in Table 4.2-1.

AADT of 4-wheel vehicles or more varies from 8,300 (San Miguel Bypass) to 26,100 (Cabanatuan Urban Section), except outside San Jose Urban Center where traffic volume drastically reduced to about 3,750.

Tricycle traffic is very heavy in Gapan Urban Section (9,200 to 15,400 per day), Cabanatuan Urban Section (15,400 to 24,200 per day), San Jose Urban Section (25,200 to 27,500 per day) and Talavera Urban Section (12,300 per day).

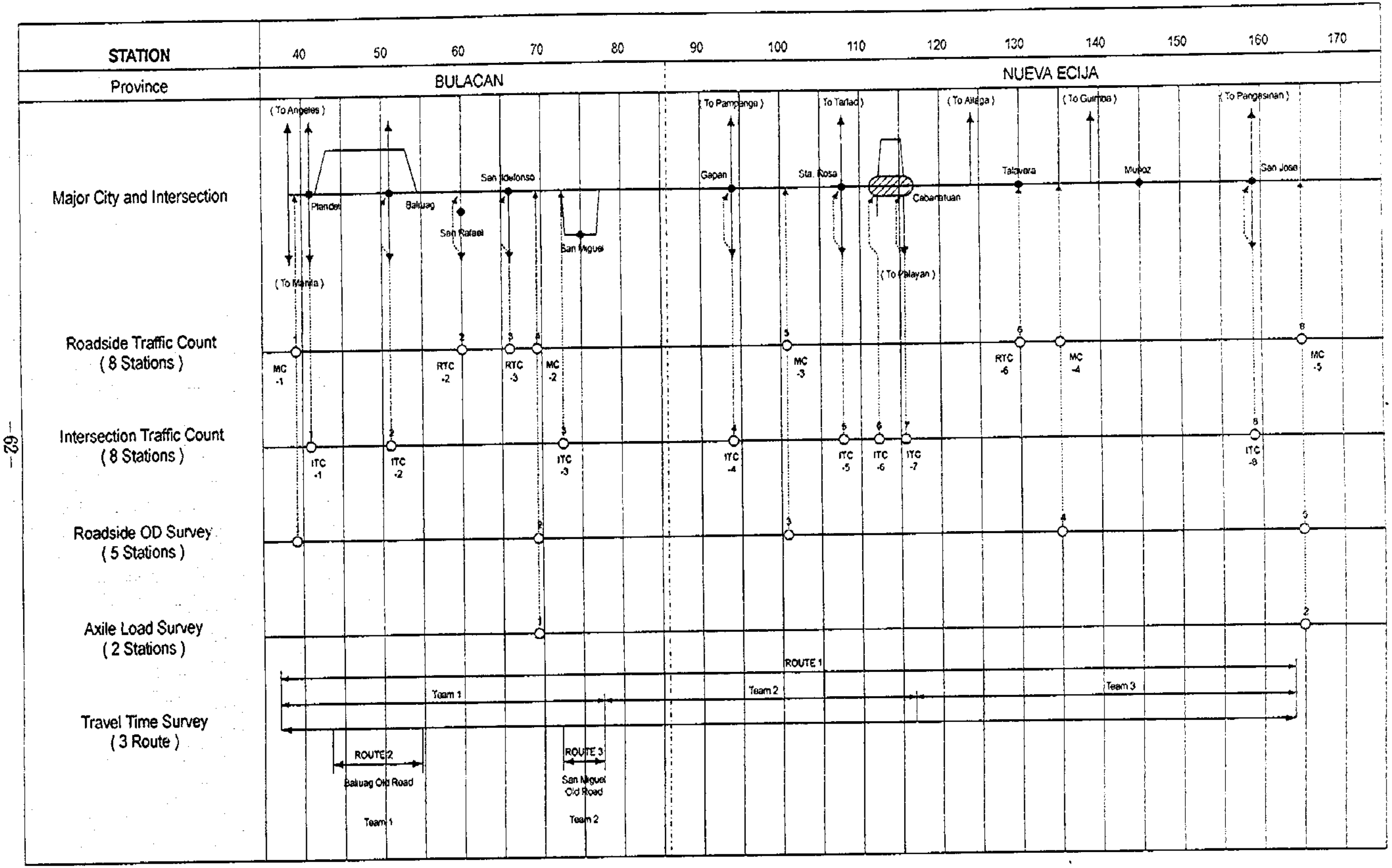


FIGURE 4.1-1 LOCATION OF SURVEY STATION

TABLE 4.2-1 AADT ALONG THE STUDY ROAD

Survey Station No.	Location	Km.	AADT By Vehicle Type										Peak Hour Ratio (%)	Directional Distribution (%)
			Car/Taxi/ Jeep	Pick-up / Van	Jeepney	Bus	Truck	Sub-Total	Tricycle	Motorcycle	Special	Total		
MC-1	Sta. Rita, Plaridel	Km 39	6,122	4,200	2,383	1,128	2,978	16,811	1,616	570	27	19,024	8.0	53
ITC-1	Plaridel Intersection (Manila Side)	Km 41+400	5,443	6,003	184	772	3,196	15,598	2,083	398	3	18,082	7.8	52
	Plaridel Intersection (Region II Side)	Km 41+450	5,836	6,341	350	773	3,218	16,518	7,088	1,694	10	25,310	7.4	55
ITC-2	Baliuag Intersection (Manila Side)	Km 50+810	3,402	3,465	2,591	1,111	776	11,345	5,197	1,095	20	17,657	8.2	53
	Baliuag Intersection (Region II Side)	Km 50+860	2,646	2,971	3,688	1,112	1,243	11,660	4,274	842	8	16,784	8.3	52
RTC-2	San Rafael	Km 60	3,786	3,370	1,345	765	2,190	11,456	2,247	653	20	14,376	7.6	55
RTC-3	San Ildefonso	Km 66	4,485	3,399	1,811	898	1,881	12,474	2,295	776	8	15,553	8.3	51
MC-2	San Ildefonso - San Miguel	Km 68	2,783	2,906	461	844	1,594	8,588	2,273	431	12	11,304	10.5	58
ITC-3	San Miguel Intersection (Manila Side)	Km 72+800	3,245	3,096	479	874	1,569	9,263	2,795	309	4	12,371	9.8	54
	San Miguel Intersection (Region II Side)	Km 72+850	2,875	2,814	311	876	1,423	8,299	1,184	235	3	9,721	10.1	56
ITC-4	Gapan Intersection (Manila Side)	Km 93+450	4,000	3,472	847	827	1,941	11,087	15,358	463	17	26,925	7.3	52
	Gapan Intersection (Region II Side)	Km 93+500	3,673	3,156	1,602	928	1,661	11,020	9,179	346	10	20,555	7.4	51
MC-3	Gapan - Sta. Rosa	Km 104	4,307	3,311	1,704	772	1,876	11,970	664	368	22	13,024	7.6	51
ITC-5	Sta. Rosa Intersection (Manila Side)	Km 107+020	4,709	3,705	3,162	877	2,067	14,520	5,010	522	27	20,079	8.0	53
	Sta. Rosa Intersection (Region II Side)	Km 107+070	5,736	4,275	3,647	948	2,214	16,820	6,288	696	27	23,831	7.8	53
ITC-6	Cabanatuan 1 Intersect. (Manila Side)	Km 113+700	11,018	7,948	4,479	504	2,188	26,137	20,212	1,980	13	48,342	7.0	52
	Cabanatuan 1 Intersect. (Region II Side)	Km 113+800	7,836	5,573	520	432	1,832	16,193	15,388	1,468	15	33,064	7.5	53
ITC-7	Cabanatuan 2 Intersect. (Manila Side)	Km 115+950	5,554	4,324	3,298	666	2,169	16,011	18,411	1,303	44	35,769	7.8	53
	Cabanatuan 2 Intersect. (Region II Side)	Km 116+000	7,077	5,303	5,488	652	2,210	20,730	24,230	1,730	56	46,746	7.2	51
RTC-6	Talavera	Km 130	5,385	4,685	3,460	344	2,629	16,503	12,332	1,152	146	30,133	6.4	52
MC-4	Talavera - Munoz	Km 102	2,699	2,721	2,600	265	2,223	10,508	1,854	545	170	13,077	6.5	51
ITC-8	San Jose Intersection (Manila Side)	Km 159+050	3,358	2,743	1,651	214	2,229	10,195	25,187	1,348	80	36,810	7.4	54
	San Jose Intersection (Region II Side)	Km 159+100	3,633	2,810	779	253	2,374	9,849	27,534	1,619	141	39,143	7.3	53
MC-5	San Jose (Outside Urban Center)	Km 161	846	1,218	278	244	1,168	3,754	3,405	438	108	7,705	6.8	57

The heaviest AADT was observed at Cabanatuan Urban Section (48,300 per day), followed by San Jose Urban Section (39,100 per day).

The peak hour ration (maximum hourly traffic volume / AADT x 100) ranges from 6.4% to 10.5%. The directional distribution of traffic (heavy traffic direction) is almost the same throughout the Study Road and ranges from 51% to 58%.

4.3 INTERSECTION TRAFFIC

Directional traffic movements at the peak hour are attached to Appendix 4.3-1.

4.4 PRESENT OD MATRICES

Present OD Matrices were developed based on the roadside OD survey results and AADT along the Study Road.

Zoning

The study area for traffic demand forecast includes the whole area of provinces of Bulacan and Nueva Ecija and the part of Pampanga Province. Surrounding areas of the study area were included as outside of study area. The study area was divided into traffic zones on the basis of boundary of municipality. Municipalities along the Study Road and the proposed bypass routes were divided into smaller traffic zones on the basis of Barangay boundaries. Finally the study area and surrounding area were divided into 138 traffic zones (refer to Appendix 4.4-1).

Link Network

The link network was prepared on the basis of the existing road network and traffic zones. The link network is composed of 204 nodes of which 138 are the ones as zone center and 66 are the dummy nodes and 274 links of which 8 are dummy links (refer to Appendix 4.4-2).

Kinds of OD Matrix

The following OD matrices were prepared:

i) Vehicle OD Matrices

- Car/taxi/jeep/pick-up/van
- Jeepney
- Bus
- Truck
- Tricycle

ii) Passenger OD Matrix

- Car/taxi/jeep/pick-up/van
- Jeepney
- Bus
- Tricycle

iii) Commodity OD Matrices

The following four categories of commodity OD matrices were estimated:

- Agricultural Products
- Manufactured Products
- Mineral Products
- Construction Materials

Procedure of Preparation of OD Matrices

(1) Vehicle OD Matrices

The procedure for preparation of present OD matrices for type of vehicle is shown in Figure 4.4-1.

OD volumes of the OD pairs passing the survey stations (KNOWN OD) are obtained from the survey data, while those not passing any survey station (UNKNOWN OD) are estimated by the following methods:

(i) KNOWN OD is obtained from the roadside OD survey data.
(ii) The OD Trip Model of gravity type was developed by multiple regression analysis using KNOWN OD as objective variable and population of origin and destination zones and travel time as explanatory variables.
(iii) Initial volumes of UNKNOWN ODs were calculated applying the above model.
(iv) OD volume was assigned to the road network to get the traffic volume on each link.
(v) Traffic volume data on as many links of the network as possible were obtained from various sources. These volumes were used as CONTROL VOLUME.
(vi) The assigned volume calculated in (iv) above were compared CONTROL VOLUME. If different, UNKNOWN ODs was adjusted and link volumes based on the adjusted OD were re-calculated (feedback to (iv) above). This (iv) and (v) step was iterated until the assigned volume coincides with CONTROL VOLUME.

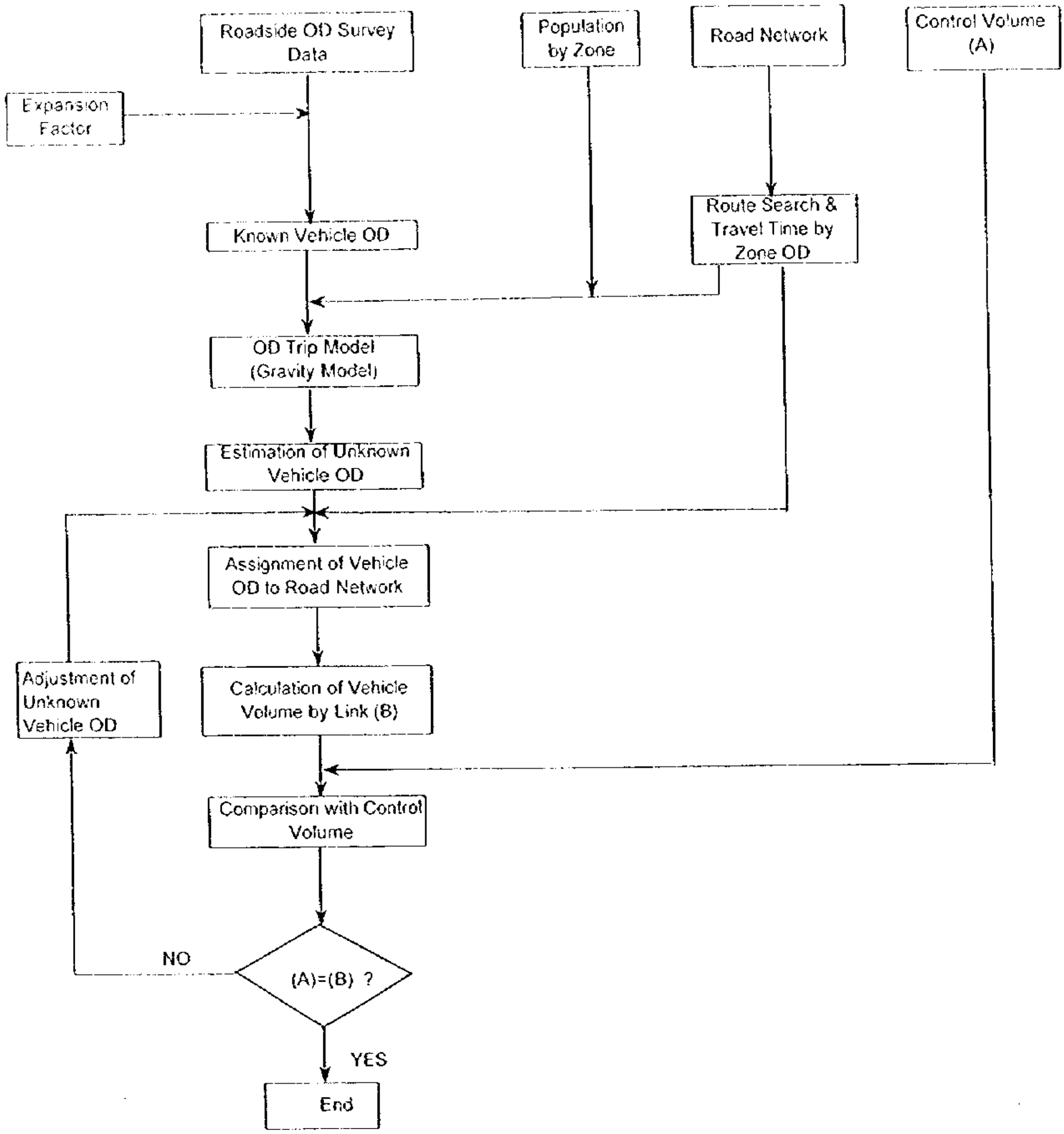


FIGURE 4.4-1 PROCEDURE FOR PREPARATION OF VEHICLE OD MATRICES

(2) Private Vehicle Passenger OD Matrices

(i) KNOWN OD was obtained from the roadside OD survey results.
(ii) Based on the KNOWN OD, average number of passengers was obtained for each origin/destination
(i) Unknown OD was estimated by multiplying the average number of vehicle OD by the average number of passengers of corresponding origin/destination.

(3) Jeepney/Bus Passenger OD Matrices

The method for preparing the jeepney/bus passenger OD matrices was basically same as the one of the vehicle OD matrices.

(4) Commodity OD Matrices

The same method as the one of the private vehicle OD passenger was applied. The average load was used for preparation for Commodity OD Matrices instead of the average number of passengers.

Analysis of Roadside OD Survey Data

The survey data were expanded to get the annual average daily volume. The expansion includes (i) sample data to 12 hours total volume, (ii) 12 hours volume to 24 hours volume, (iii) 24 hours volume on the specific day to annual average daily volume Item. (i) Was done based on the Traffic Count Survey results carried out simultaneously with the Roadside OD Survey Items. (ii) and (iii) depends on the hourly variation and daily and Nationwide Traffic Counting Program (NTCP) data.

OD Trip Model

The following form expresses OD trip model;

$$X_{ij} = (P_i\, P_j)^{\alpha}\, t_{ij}^{-\gamma}$$

Where, X_{ij} = *OD volume from zone I to zone j*
$P_i\, P_j$ = *population of zone I to zone j*
t_{ij} = *travel time from zone I to zone j*
α, γ = *parameters derived from the multiple regression analysis based on the KNOWN OD*

The parameter α and γ were calculated individually by kind of OD.

Results of Analysis

The vehicle desire line of OD traffic volume for all vehicle types is shown in Figure 6.3-1 in Chapter 6. The integrated OD matrix between 68 zones is reported in Appendix 4.4-3.The average trip distance is shown in Table 4.4-1. The vehicle type of longest trip is bus by 32.12km followed by car of 20.54km and jeepney of 19.45km.

As shown in Table 4.4-2, passenger cars and tricycles mostly occupy the traffic volume of vehicle. The share of these two types of vehicle is more than 80%. But with regard to number of passengers, jeepney is the highest share of 42.1% followed by car of 28.5%. The average number of passenger is 27.4 persons of bus were followed by jeepney. The average load of commodity is 3.7ton.

As shown in Table 4.4-3. The most of commodities were transported by truck. The biggist share of commodity category transported by truck is agricultural products of 74,776 ton (35.6%) followed by manufactured products, construction materials, 55,602 ton (26.5%) and 47,885 ton (22.8%).

4.5 TRAVEL SPEED

The travel time survey results are summarized in Table 4.5-1 and graphically shown in Figure 4.5-1.

The average travel time for the 125.9 km section along the Study Road was 3.26 hours (or an average travel speed of 38.6 km/hr.), while the longest was 3.43 hours (36.7 km/hr.) on the north-bound during 4:00 to 6:00 P.M., and the shortest was 3.12 hours (40.3 km/hr.) on the south bound during 11:00 A.M. to 1:00 P.M.

The travel speed is drastically reduced in the urban sections, particularly in Cabanatuan Urban Section, Plaridel Urban Section and Gapan Urban Section, where the slowest travel speed was 10.2 km/hr., 13.3 km/hr. and 11.9 km/hr., respectively.

The inter-urban sections still enjoy relatively high travel speeds ranging from 40 to 60 km/hr.

4.6 AXLE LOAD

The purpose of the Axle Load survey is to obtain data to calculate Equivalent Single Axle Load (ESAL) factors to be used in the design of 18-kip pavements. The AASHTO method was applied to calculate the ESAL factors.

Procedure to determine ESAL per vehicle type is shown in Figure 4.6-1.

TABLE 4.4-1 AVERAGE TRIP DISTANCE

Vehicle Type	No. of Vehicle	Trip Distance (km.)	Average Trip Distance (km./Vehicle)
Car/taxi/jeep/pick-up/van	243,462	5,001,536	20.54
Jeepney	83,076	1,615,577	19.45
Bus	12,520	402,201	32.12
Tricycle	263,458	901,468	3.42
Truck	55,984	1,457,285	26.03
Total	658,500	9,378,067	14.24

TABLE 4.4-2 TRAFFIC VOLUME BY VEHICLE TYPE(1998)

Vehicle Type	No. of Vehicle	Share(%)	No. of Passenger (Tonnage)	Share(%)	Average Passenger (Load) /Vehicle
Car/taxi/jeep/pick-up/van	243,462	40.4	585,570	28.5	2.4
Jeepney	83,076	13.8	866,189	42.1	10.4
Bus	12,520	2.1	342,703	16.7	27.4
Tricycle	263,458	43.7	263,458	12.8	1.0
Total	602,516	100.0	2,057,920	100.0	3.4
Truck	55,984	-	209,787	-	3.7

TABLE 4.4-3 COMMODITY TRAFFIC VOLUME(1998)

Vehicle Type	Commodity Category	No. of Tonnages	Share(%)
Car/taxi/jeep/pick-up/van	Agricultural Products	2,073	24.2
	Manufactured Products	5,953	69.5
	Mineral Products	166	1.9
	Construction Materials	375	4.4
	Sub-Total	8,567	100.0
Truck	Agricultural Products	74,776	35.6
	Manufactured Products	47,885	22.8
	Mineral Products	31,524	15.0
	Construction Materials	55,602	26.5
	Sub-Total	209,787	100.0
Total	Agricultural Products	76,849	35.2
	Manufactured Products	53,838	24.7
	Mineral Products	31,690	14.5
	Construction Materials	55,977	25.6
	Total	218,354	100.0

TABLE 4.5.1 TRAVEL SPEED BY ROAD SECTION

Number	Section	Location	Distance (km)	Travel Speed (Km/Hour) 7:00AM-9:00AM North Bound	South Bound	11:00AM-1:00PM North Bound	South Bound	4:00PM-6:00PM North Bound	South Bound	Average Travel Speed (km/hr)	Traffic Volume (AADT)
1	39.00 ~ 40.80	- Bypass (Plandel)	1.80	22.5	19.5	34.7	23.8	32.7	26.2	26.58	18,426
2	40.80 ~ 42.10	Bypass (Plandel) - Jct Old CVR	1.30	21.9	13.3	24.6	15.0	24.6	21.4	20.12	15,934
3	42.10 ~ 43.10	Jct Old CVR - Jct Pulilan/ Baliuag	1.00	25.5	41.4	42.4	13.7	25.5	19.6	28.02	—
4	43.10 ~ 49.00	Jct Pulilan/ Baliuag -	5.90	45.5	51.6	59.7	54.7	47.7	38.4	49.60	17,681
5	49.00 ~ 52.00	- Bypass	3.00	34.6	39.9	37.2	48.2	39.3	49.5	41.46	23,606
6	52.00 ~ 54.45	Bypass - Jct Old CVR /San Rafael	2.45	58.8	50.7	56.5	59.6	51.9	47.9	54.24	
7	54.45 ~ 58.00	Jct Old CVR /San Rafael -	3.55	50.3	46.3	49.0	52.2	49.7	38.0	47.59	
8	58.00 ~ 61.00	- San rafael	3.00	40.6	43.9	45.6	42.2	32.5	35.9	40.11	13,703
9	61.00 ~ 64.00	-	3.00	44.4	47.6	51.9	56.0	36.5	43.4	46.63	
10	64.00 ~ 67.00	San Ildrefonso -	3.00	34.3	32.0	32.8	36.6	30.4	29.2	32.55	14,732
11	67.00 ~ 72.90	- Jct San Miguel	5.90	48.6	55.6	57.9	53.5	50.0	47.9	52.25	11,460
12	72.90 ~ 76.08	Jct San Miguel - Jct San Miguel	3.18	35.6	34.9	48.5	53.0	41.6	43.2	42.80	9,483
13	76.08 ~ 84.24	Jct San Miguel - NE/Bulacan BDR	8.16	47.8	51.9	50.3	53.2	46.9	50.6	50.11	
14	84.24 ~ 91.00	NE/Bulacan BDR -	6.76	55.3	53.3	56.2	38.6	50.2	54.1	51.27	
15	91.00 ~ 93.00	- Gapan	2.00	41.6	36.7	41.4	48.3	30.6	42.1	40.13	
16	93.00 ~ 93.55	Gapan -	0.55	24.7	20.4	27.5	26.8	11.9	26.8	23.02	26,445
17	93.55 ~ 97.00	-	3.45	47.0	33.7	45.5	39.8	47.0	34.0	41.18	
18	97.00 ~ 106.00	-	9.00	59.4	56.3	63.9	58.1	50.4	47.9	56.00	12,633
19	106.00 ~ 107.95	- Sta Rosa	1.95	18.0	21.5	25.0	17.7	14.6	18.2	19.17	42,638
20	107.95 ~ 111.93	Sta Rosa -	3.98	48.2	38.2	33.6	31.8	27.2	25.2	34.05	
21	111.93 ~ 113.76	- Jct Cabanatuan City Proper	1.83	27.5	31.2	29.7	21.5	19.2	23.9	25.48	46,349
22	113.76 ~ 116.10	Jct Cabanatuan City Proper - Jct to Palayan City	2.34	10.2	14.8	4.4	10.9	11.8	25.0	12.85	31,581
23	116.10 ~ 119.00	Jct to Palayan City -	2.90	30.8	25.1	31.8	24.8	22.8	13.7	24.84	39,141
24	119.00 ~ 122.00	- Jct Aliaga	3.00	37.4	41.9	33.0	60.0	42.5	34.5	41.55	
25	122.00 ~ 127.90	Jct Aliaga -	5.90	47.8	34.7	53.5	42.7	44.0	48.1	45.14	
26	127.90 ~ 130.90	-	3.00	30.3	25.1	30.2	30.8	26.1	18.0	26.74	
27	130.90 ~ 145.90	Talavera - Jct Town Proper	15.00	44.7	50.8	51.6	51.8	44.4	53.8	49.50	28,835
28	145.90 ~ 146.40	Jct Town Proper - Jct Munoz Town Proper	0.50	34.0	32.1	30.5	33.3	25.0	31.0	31.00	12,361
29	145.40 ~ 154.90	Jct Munoz Town Proper -	8.50	51.3	51.7	56.6	57.8	63.6	51.4	55.40	
30	154.90 ~ 157.90	- San Jose City	3.00	42.4	53.5	58.4	55.7	48.0	53.5	51.89	
31	157.90 ~ 160.83	San Jose City - Malasin Br	2.93	26.7	24.0	29.8	33.3	19.8	21.9	25.93	36,383
32	160.83 ~ 164.90	Malasin Br -	4.07	53.9	53.1	58.4	60.0	40.9	50.5	52.80	7,159
Total			125.9	39.5	39.4	39.0	40.3	36.7	37.2	38.6	

Source : Survey Result by JICA
Note: Traffic volume includes vehicles more than 4 wheels and tricycle.

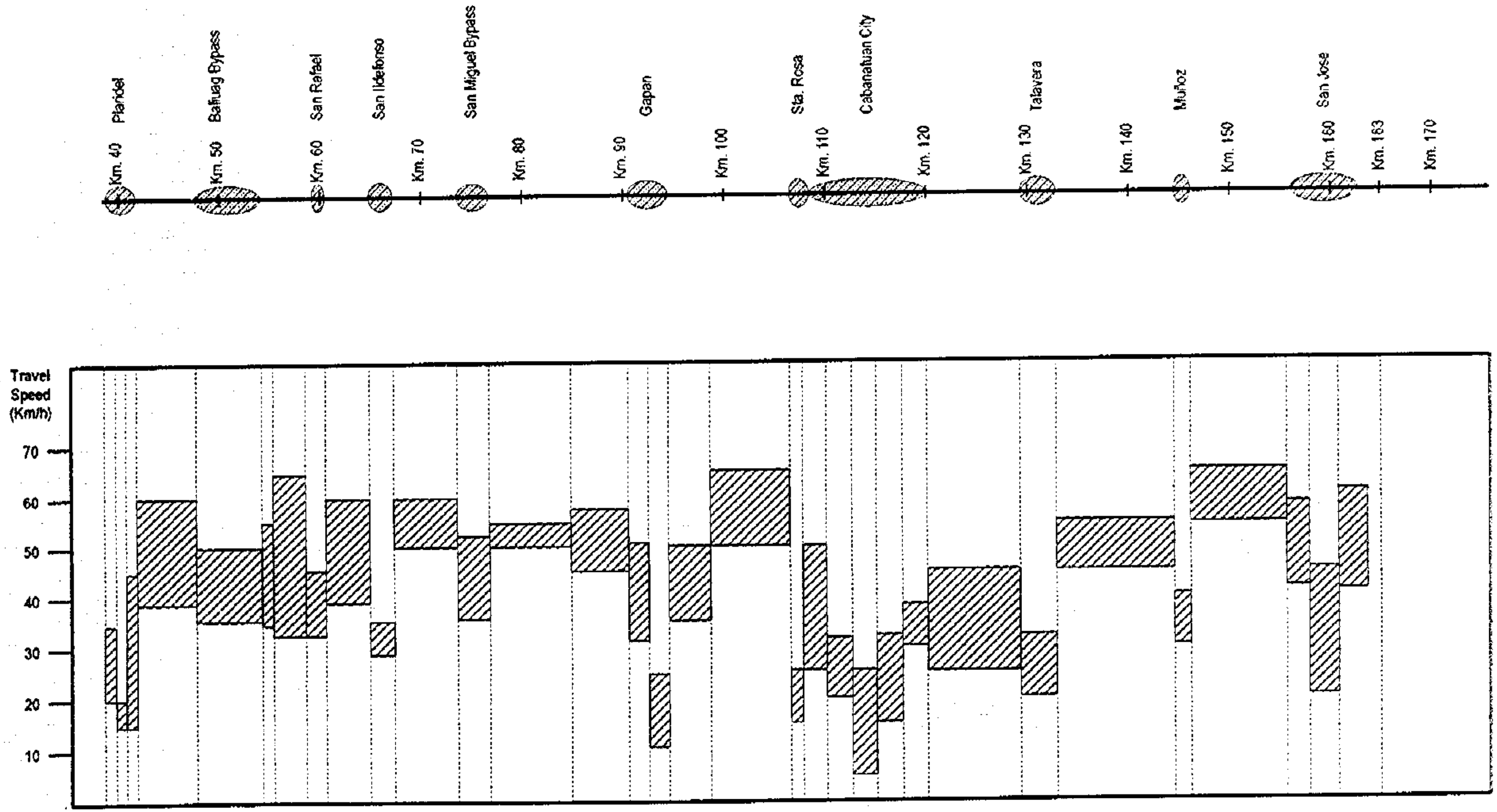


FIGURE 4.5-1 TRAVEL SPEED ALONG THE STUDY ROAD

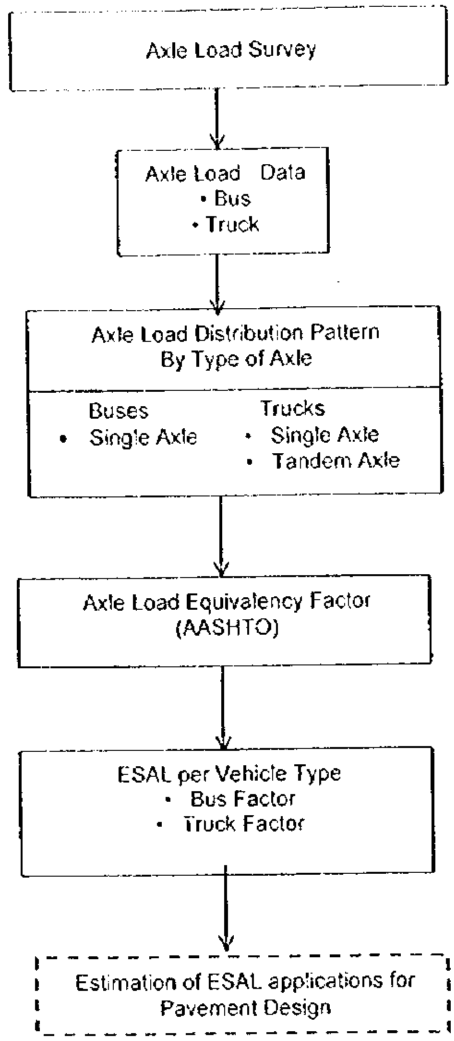


FIGURE 4.6-1 PROCEDURE TO DETERMINE AXLE LOAD DISTRIBUTION PATTERN

The axle load distribution patterns and ESAL of weighed vehicles are presented in Appendix 4.6-1. The bus and truck factors were developed as shown in Table 4.6-1.

TABLE 4.6-1 BUS AND TRUCK FACTORS BASED ON AXLE LOAD SURVEY

Survey Station	Direction	Bus Factor	Truck Factor		
			2-Axle Truck	3-Axle Truck	Trailer
No. 2	1	1.43	0.70	6.76	11.52
	2	1.53	1.42	7.55	12.41
No. 5	1	0.99	0.51	7.18	17.76
	2	1.68	0.91	10.73	10.61

Notes: Bus Factor = Number of 18-kip Equivalent Single Axle Load (ESAL) / Number of Buses
Truck Factor = Number of 18-kip Equivalent Single Axle Load (ESAL) / Number of Trucks
No. 2 : San Ildefonso – San Miguel
No. 5 : San Jose City - Aritao

4.7 ANALYSIS ON LEVEL OF SERVICE

Level of service (LOS) analysis was made adopting Highway Capacity Manual (HCM), 1994 with modifications/adjustments to suit the road and traffic conditions along the Study Road.

The level of service of the following two kinds of facilities were evaluated:

- Two-lane Highway
- At-grade Intersection (assumed as signalized intersection in analysis)

Results of LOS analysis are presented also in Figure 3.5-1 in Chapter 3.

4.7.1 Road Sections (Two-Lane)

(1) Methodology

Measures for evaluation of level of service of 2-lane highways are defined as follows:

- Percent time delay (%) . . . . . .the average percent of time that all vehicles are delayed while travelling in platoons due to inability to pass.
- Average travel speed (km/h).
- Ratio of the demand flow rate to the capacity of the facility.

General terrain segment and specific grade segment are analyzed in separate procedures. The general terrain methodology estimates average traffic operational measures along a section of highway based on average terrain, geometric, and traffic conditions. This procedure is usually applied to highway sections of at least 3 km. in length. The procedure for specific guide is usually applied to extended specific grade segment, usually with grade of not less than 3% and longer than 400 meters in length.

The level of service is determined by comparing the actual flow rate with the service flow rate which is obtained through the following equation:

$$SF_i = 2{,}800 \times (v/c)_i \times f_d \times f_w \times f_{hv}$$

where:

SF_i = total service flow rate in both directions for prevailing roadway and traffic conditions, for level of service I, in vph;

$(v/c)_i$ = ratio of flow rate to ideal capacity for level of service I,

f_d = adjustment factor for directional distribution of traffic,

f_w = adjustment factor for narrow lanes and restricted shoulder width,

F_{hv} = adjustment factor for the presence of heavy vehicles, jeepneys and tricycles in the traffic stream, computed as:

F_{hv} = 1/(Pcar + Pjny + Pmcy Emcy + Pmtr Emtr + Ptrk Etrk + Pbus Ebus)

where:

Pcar, Pjny, Pmcy, Pmtr, Ptrk and Pbus

= proportion of cars, jeepneys, motorcycles, motorcycles, tricycles, trucks and buses, respectively in the traffic stream, expressed as a decimal;

Ejny, Emcy, Emtr, Etrk and Ebus

= passenger-car equivalent for jeepneys, motorcycles, tricycles, trucks and buses, respectively

Table and worksheet for the level of service analysis for the general terrain segment are attached in Appendix 4.7-1.

(2) Analysis on Level of Service on Road Sections

The level of service (LOS) and corresponding traffic volume/capacity ratio (v/c ratio) in the HCM are as follows:

Level A : Free flow traffic, v/c less than 0.15
Level B : Free flow traffic, v/c 0.16 - 0.27
Level C : Moderate traffic, v/c 0.28 - 0.43
Level D : Moderate / heavy traffic, v/c 0.44 - 0.64

Level E : Heavy traffic, v/c 0.65-1.00
Level F : Saturation volume, stop and go

Results of analysis on LOS are shown in the Table 4.7-1. From the Table 4.7-1, the following features are indicated:

- The LOS at Plaridel, San Rafael, San Ildefonso, and Talavera are E.
- LOS of Inter-urban roads such as San Ildefonso–San Miguel, Gapan-Sta. Rosa and Talavera-Munoz are classified under D. The v/c of these portions are between 0.44 and 0.53, which means half of traffic volume capacity.
- It should be noted that LOS at San Jose was analyzed as B. Where a survey station was selected at the suburban area (not at the center of city), and it carries small number of traffic.

TABLE 4.7-1 SUMMARY OF LEVEL OF SERVICE ON ROAD SECTION ANALYSIS

		Plaridel (039+500)	San Rafael (061+630)	San Ildefonso (065+740)	Ildefonso-San Miguel (068+100)	Gapan-Sta. Rosa (100+270)	Talavera (129+100)	Talavera-Munoz (138+130)	San Jose (163+000)
dR (m)		2.0	1.5	1.5	2.0	2.75	2.0	2.0	2.0
H (m)		6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
dL (m)		2.0	1.5	1.5	2.0	2.75	2.0	2.0	2.0
Travel Speed (km/h)		28.0	40.0	33.0	55.0	56.0	28.0	47.0	55.0
Total Traffic Volume (AADT)		4-wheel or 16,810 1,616 Tricycle	12,456 2,247	12,473 2,295	8,589 2,273	11,969 664	16,503 12,332	10,507 1,854	3,754 3,405
Flow Rate (VPH)		1463	1205	1246	1188	976	1998	889	538
PHF		0.94	0.94	0.94	0.94	0.93	0.95	0.93	0.93
LOS		E	E	E	D	D	E	D	B
V/C		0.76	0.65	0.67	0.53	0.53	0.87	0.44	0.24
Traffic Composition	Car	32.0%	30.3	24.4	23.5	36.0	12.5	16.6	13.6
	Jny	40.0%	35.7	29.4	26.9	39.0	23.4	34.6	15.2
	Mcy	1.9%	4.8	3.9	3.3	3.5	3.9	6.1	2.5
	Mtr	7.6%	14.4	22.8	18.0	4.5	55.0	28.8	59.0
	Trk	13.6%	9.6	15.8	22.5	12.5	4.3	12.1	9.0
	Bus	5.10%	5.2	3.8	5.9	4.5	0.9	1.9	0.7

4.7.2 At-grade Intersections

(1) Level of Service for At-grade Intersection

At-grade intersections were assumed as signalized intersection for the purpose of analysis.

Level of service for signalized intersections is defined in terms of stopped delay. Level of service criteria are given in Table 4.7-2.

TABLE 4.7-2 LEVEL OF SERVICE CRITERIA FOR SIGNALIZED INTERSECTION

Level of Service	Stopped Delay Per Vehicle (Sec.)
A	< 5.0
B	5.1 to 15.0
C	15.1 to 25.0
D	25.1 to 40.0
E	40.1 to 60.0
F	> 60.0

(2) Methodology

The analysis of signalized intersections is divided into five distinct modules, as follows:

1) *Input module* - This analysis module focuses on the definition of all required information on which subsequent computations are based. It includes all necessary data on intersection geometry, traffic volumes and conditions, and signalization. It is used to provide a convenient summary for the remainder of the analysis.

2) *Volume adjustment module* - Demand volumes are generally stated in terms of vehicles per hour a peak hour. The volume adjustment module converts these to flow rates for a peak 15-min. analysis period, and accounts for the effects of lane distribution. The definition of lane groups for analysis also takes place in this module.

3) *Saturation flow rate module* - This module is used to compute the saturation flow rate for each of the lane groups established for analysis. It is based on the adjustment of an "ideal" saturation flow rate to reflect a variety of prevailing conditions.

4) *Capacity analysis module* - In this module, volumes and saturation flow rates are manipulated to compute the capacity and v/c ratios for each lane group and the critical v/c ratio for the intersection.

5) *Level -- of -- service module* - Delay is estimated for each lane group established for analysis. Delay measures are aggregated for approaches and for the intersection as a whole, and levels of service are determined.

Saturation Flow Rate

The saturation flow rate is the flow in vehicles per hour which could be accommodated by the lane group assuming that the green phase was always available to the approach -- i.e., that the green ratio, g/c, was 1.00. Computations begin with the selection of an "ideal" saturation flow rate, usually 1,800 passenger cars per hour of green time per lane (pcphgp1), and adjustment of this value for a variety of prevailing conditions that are not ideal.

$$S = S_o N f_w f_{HV} f_g f_p f_{bb} f_a f_{RT} f_{LT}$$

where:

S	=	saturation flow rate for the subject lane group, expressed as a total for all lanes in the lane group under prevailing conditions, in vphg;
S_o	=	ideal saturation flow rate per lane, usually 1,800 pcphgpl;
N	=	number of lanes in the lane group;
f_w	=	adjustment factor for lane width; 3.65m lanes are standard;
f_{HV}	=	adjustment factor for heavy vehicles in the traffic stream;
f_g	=	adjustment factor for approach;
f_p	=	adjustment factor for the existence of a parking lane adjacent to the lane group and the parking activity in that lane;
f_{bb}	=	adjustment factor for the blocking effect of local buses stopping within the intersection area;
f_a	=	adjustment factor for area type;
f_{RT}	=	adjustment factor for right turns in the lane group; and
f_{LT}	=	adjustment factor for left turns in the lane group, or computed as described in the following sections:

Capacity

The capacity of each lane group is computed from Eq. (2):

$$C_1 \quad = \quad s_1 \, X \, (g/c)_1$$

If the signal timing is not known, a timing plan will have to be estimated or assumed to make these computations.

where:

C_i = capacity of lane group or approach I, in vph;

S_i = saturation flow rate for lane group or approach i, in vphg; and

$(g/C)_I$ = green ratio for lane group or approach i.

The v/c ratio for each lane group is computed directly, by dividing the adjusted flows by the capacities computed above, as in Eq. (3):

$$X_i \quad = \quad v_i / c_I$$

The final capacity parameter of interest is the critical v/c ratio, X_{CD} for the intersection. It is computed from Eq. (4), as follows:

$$X c \quad = \quad \sum_i (v/S)_{ci} \times [C/(C-L)]$$

where:

Xc = critical v/c ratio for the intersection;

$\sum_i (v/S)ci \;)_{ci}$ = the summation of flow ratios for all critical lane groups or approaches, I;

C = cycle length, in sec; and

L = total lost time per cycle; computed as the sum of "start-up" and change interval lost

Level-of-service determination

Delay assuming random arrivals - The delay for each lane group is found using the following relationship.

$$d = 0.38C \frac{[1 - g/C]^2}{[1 - (g/C)(X)]} \; x^2 \left[(X - 1) + \sqrt{(X - 1)^2 + (16X/c)} \right] \qquad (5)$$

where:

d = average stopped delay vehicle for the lane group, in sec/veh;

C = cycle length, in sec;

g/C = green ratio for the lane group; the ratio of effective green time to cycle length;

X = v/c ratio for the lane group; and

C = capacity of the lane group.

(3) Analysis on Level of Service on Intersections

Table 4.7-3 shows summary of intersection analysis on the level of service and Figure 4.7-1 graphically shows the time delay.

All major intersections along the Study Road have an LOS of F, except San Miguel Intersection which is C. The road section in San Jose City area is already four-lane but the LOS has already reached to F. It is quite clear that major intersections in urban sections are serious traffic bottlenecks.

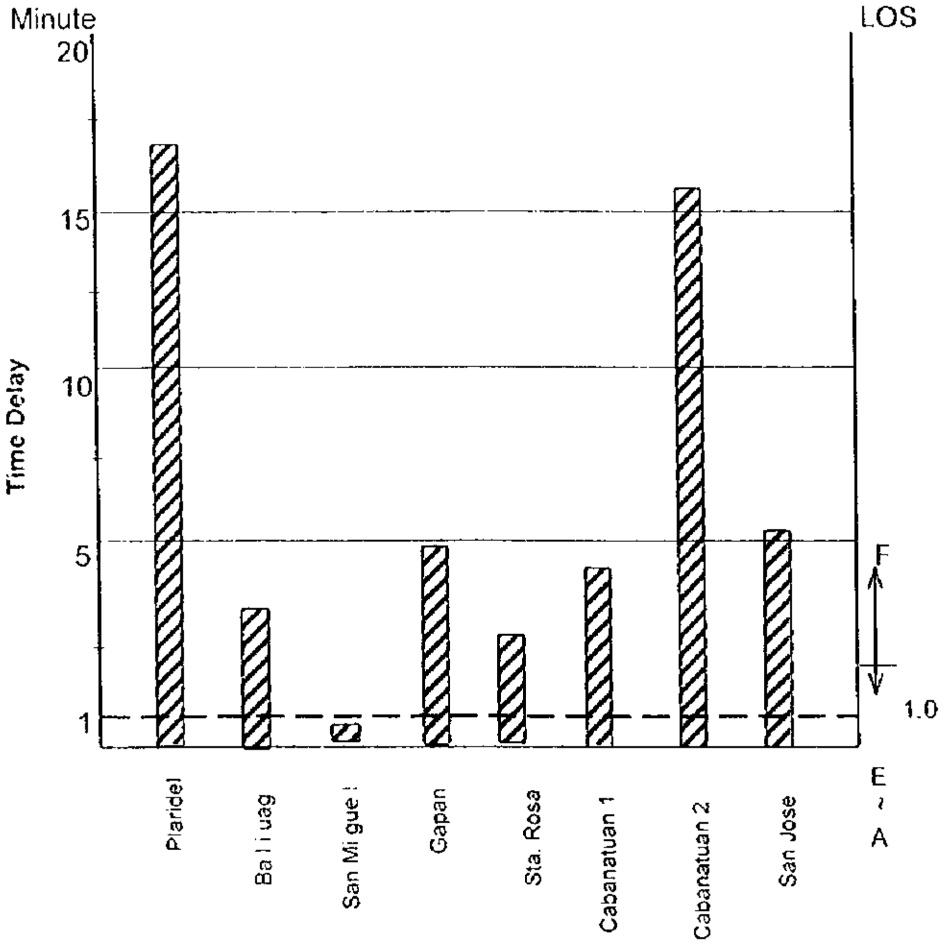
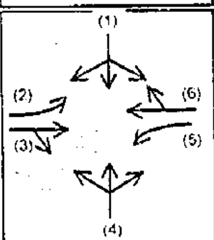
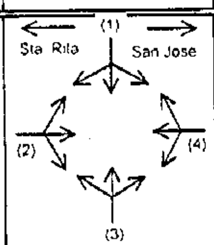
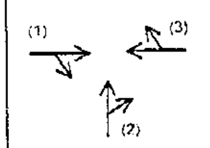
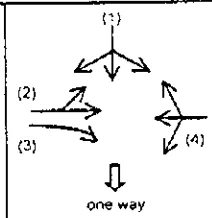
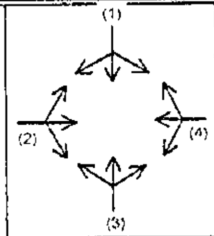
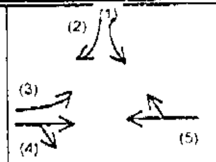
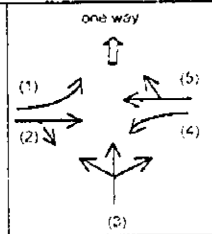
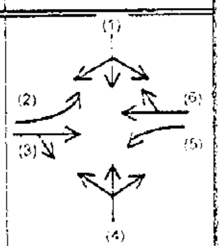


FIGURE 4.7-1 DELAY TIME AND LOS AT MAJOR INTERSECTIONS

TABLE 4.7-3 SUMMARY OF LEVEL OF SERVICE ON INTERSECTION

	Plaridel	Baliuag	San Miguel	Gapan	Sta. Rosa	Cabanatuan 1	Cabanatuan 2	San Jose
Patterns of Traffic Flow at Intersections								
Traffic Volume (AADT)	4-wheel or more 15,598 16,518 2,083 7,088 Tricycle (2)+(3) (5)+(6)	11,345 11,660 5,197 4,274 (2) (4)	8,229 9,263 1,184 2,795 (1) (3)	11,087 11,020 15,358 9,179 (2)+(3) (4)	14,520 16,820 5,010 6,288 (2) (4)	26,137 16,193 20,212 15,389 (3)+(4) (5)	16,011 20,730 18,411 24,230 (1)+(2) (4)+(5)	10,195 9,849 25,187 27,534 (2)+(3) (5)+(6)
Travel Speed (km/h)	20	38	43	20	19	23	11	23
LOS	F	F	C	F	F	F	F	F
V/C	2.0	1.4	0.7	1.5	1.4	1.5	2.0	1.6
Delay Time (minute)	19	4	0.3	6	4	5	18	7