BOLIVIA NATIONAL TRANSPORT STUDY

FINAL REPORT VOLUME TWO

ANALYSES AND RECOMMENDATIONS

PREPARED FOR

GOVERNMENT OF THE REPUBLIC OF BOLIVIA
(MINISTRY OF TRANSPORT AND COMMUNICATIONS)
INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
UNITED NATIONS DEVELOPMENT PROGRAMME

PREPARED BY

WILBUR SMITH AND ASSOCIATES
IN ASSOCIATION WITH
CONSA SRL & ECOVIANA SRL

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July, 1981

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Minister of Transport and Communications
La Paz
Bolivia

Mr. James B. Newman
Ports, Railways and Aviation Division
Latin America and Caribbean Regional Office
The World Bank
Washington, D.C. U.S.A.

Gentlemen:

Wilbur Smith and Associates is pleased to submit this Final Report of Phase I of the Bolivia National Transport Study. The Report is in five volumes. Volumes I and II review the existing situation and present the main analyses, findings and recommendations. Volumes III and IV contain supplementary appendices and the fifth volume is a summary of the Report.

The Report represents the conclusion of over two years effort by a professional team made up of consultant's staff and Bolivian nationals. During the course of the Study, several interim reports and technical papers were produced, culminating in a draft Final Report in November, 1980. The first review period was concluded in December with the final meeting of the Study Steering Committee, when all initial comments on the draft report were presented by Bolivian entities and by the World Bank. A more lengthy review and discussion period followed in which additional valuable contributions were made to the Final Report.

The Report presents and supports a recommended National Transport Plan set in the context of the expected development of the Bolivian economy over the next ten years, and with consideration for possible developments in the following ten years. It is not intended that the recommendations be taken as a fixed plan; forecasting the future is a hazardous task, and it is impossible to foresee all possible developments. Therefore, it is strongly recommended that the Government set up a permanent transport planning group, utilizing the Bolivian counterpart team involved in this Study,to monitor developments and adapt the Plan to changing circumstances. The first steps have been taken in this direction by selecting a counterpart team for Phase II of this Study. Hopefully, this will form a solid basis for the continuing transport planning process, and for a permanent National Transport Center.

The cooperation and assistance we received throughout the Study from officers of the Government and others concerned with transport in Bolivia, is gratefully acknowledged. We also wish to recognize the contributions made by our colleagues on the national counterpart team, and by our local associate consultants, CONSA SRL and ECOVIANA SRL. We appreciate the opportunity to have participated in the study effort, and look forward to the implementation of the recommendations.

Respectfully submitted
WILBUR SMITH AND ASSOCIATES

Wilbur S. Smith
Chairman

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CHAPTER 11

IMPROVEMENT AND MAINTENANCE OF EXISTING HIGHWAYS

CHAPTER 11

IMPROVEMENT AND MAINTENANCE OF EXISTING HIGHWAYS

The importance of highway transport in Bolivia is hard to overstate. In 1977, 96 percent of domestic freight tons (excluding commodities carried in pipelines) and 96 percent of domestic passengers moved by road and these proportions are not expected to change much in the immediate future. Yet highway standards must be classified as poor. There are less than 1,300 km of paved interurban roads in the entire country and many of these have been allowed to deteriorate badly. The rest of the system is gravel and earth and the surfaces are also poor. In addition, the unpaved roads often lack drainage structures and bridges, so that travel is uncertain during the wet season from December to March.

Clearly, much can be done to improve the existing highway system. However, funds for investment are limited and existing commitments to highway projects will take up much of the available budget for the next two to three years. It is therefore of utmost importance to see that the remaining money is spent wisely and that priorities are established and observed. This will inevitably mean changes in the pattern of highway expenditure from the past. This chapter sets out the reasoning leading to the recommended changes.

Budget Restrictions

In preparing a highway program for the next ten years, it is necessary to take account of the sums likely to be available for new investment in transport during the period, and of their timing. This study made estimates of low, medium and high transport budgets, assuming that transport investment as a proportion of all public investment would be 20, 25 and 30 percent respectively. The high budget has only been exceeded once in the past few years (1978), and the transport budget for both 1979 and 1980 was between 20 and 25 percent of public investment. This subject is discussed in more detail in Chapter 8 and the allocation of funds amongst modes is discussed in Chapter 18.

Under the low budget, few funds beyond those already committed would be available in the next six years. This pessimistic possibility has been discounted and in the selection of projects for a highway program, it has been assumed that either the medium or the high budget will be available. Conclusions are presented in this chapter for both possibilities.

Analytical Tools

Besides the transport model, two important computer procedures were used in developing the highway program. One was the World Bank Highway Design and Maintenance Standards Model (HDM) which was used to analyze the benefits of alternative highway improvements and maintenance policies for both paved and unpaved roads. An analysis program using the HDM was designed in five stages, requiring a total of 28 major tests together with about 10 sub-tests (see Chapter 3).

The second important analytical tool was the budget allocation program, also described in Chapter 3. Many highway projects were found to be justified in the early part of the period 1981-1990, but funds are unlikely to be available then, under either the medium or the high budget assumptions. The budget allocation program was used to stage the main elements of the highway program -- major paved and unpaved road improvements and road maintenance -- in an optimum manner in accordance with likely budgets, using the criterion of maximizing total net present value.

Improvements to Existing Paved Roads

There are almost 1,300 km of interurban paved roads in the country of which many are now in poor condition. In some cases, patching and overlaying will be sufficient to restore the surface to good condition but in others, a more expensive reconstruction is required. This particularly applies to sections of the Cochabamba-Santa Cruz highway, which was the first paved highway built in Bolivia, but which has deteriorated badly. For this reason, this road is discussed separately from the other paved roads.

Before presenting specific improvement policies, the related subjects of pavement design and vehicle axle loads are discussed.

Pavement Design and Axle Loads - It has been policy to build comparatively weak pavements, except for roads near urban areas where traffic is denser. At the same time, the legal axle load is comparatively high at 11 tons per single axle (a standard for the Andean Pact) and this is frequently exceeded. It is estimated that one third of all trucks of more than 9 tons carrying capacity exceed the legal axle load.

The combination of high axle loads and weak pavements can lead to the rapid deterioration of pavements and to high maintenance costs. Therefore, analyses were made of the relationships between the key parameters -- pavement design, axle loadings and traffic volumes.

Combinations of six pavement designs, three vehicle mixes (each with a different axle load distribution) and four traffic levels were analyzed and the results are presented in Working Paper 119. The following conclusions were reached:

> Pavement Design - The weak pavements used in Bolivia are not necessarily bad at the low traffic volumes encountered, so long as a policy is followed of strengthening by overlaying when the traffic volumes increase. However, timely overlaying has not been a feature of pavement management over recent years.
>
> For new designs, a modified structural number ($\overline{SN}$) (1) in the region of 3 appears to be most economic. This is a conservative design since a weaker pavement could give better results, if overlayed at the correct time. A stronger design needs overlaying less frequently and is consequently less likely to suffer from neglect. A weaker design with an $\overline{SN}$ of 2.5 could be acceptable at volumes below 250 vehicles per day but a stronger design, with an $\overline{SN}$ of about 3.5, would be better for daily volumes above 700 vehicles. Details of the designs will vary depending upon local soil conditions, available materials and climatic and drainage characteristics. It was envisaged in the analysis that designs with $\overline{SN}$ equal to 3 or less would use surface treatment while stronger designs would use asphaltic concrete.
>
> Axle Loads - The analysis considered three alternative conditions of vehicle axle loading: first, that the present situation continues with a number of overloaded single-rear-axle trucks, secondly, that the current law is enforced and thirdly, that a lower axle loading is enforced. The results were not very conclusive in that total costs -- costs of vehicle operations, costs of pavement maintenance and costs of pavement provision -- did not vary greatly from one alternative to another, although they generally decreased with lower axle loads. However, costs of annual recurring maintenance provided by the National Road Service (SNC) were greatly reduced with lower axle loads, especially for the weaker pavements generally in place today. This is shown in Table 11-1. It is therefore recommended that the current law be enforced. The uncertainties of the relationships between axle loads and pavement deterioration did not permit a firm conclusion on a policy for reducing legal axle loads.

---

(1) A measure of pavement strength. Most existing pavements outside the urban areas have modified structural numbers of between 2 and 3.

Table 11-1

PERCENTAGE CHANGE IN TRANSPORT COSTS WITH LOWER AXLE LOADS

			LOW PAVEMENT			MEDIUM LOW PAVEMENT		
TRAFFIC LEVEL (1)	MAINTENANCE POLICY	ENFORCEMENT POLICY	Vehicle Operating Costs	Recurring Maintenance Costs	Total Costs	Vehicle Operating Costs	Recurring Maintenance Costs	Total Costs
Low	Low	a) Current Law (2)	+ 0	- 75	- 5	+ 1	- 24	0
		b) Lower Axle load limit (3)	- 2	- 17	- 1	- 1	- 8	- 1
	High	a) Current Law (2)	- 1	- 59	- 5	+ 1	- 62	- 3
		b) Lower Axle load limit (3)	- 2	- 18	- 2	- 1	- 8	- 1
High	Low	a) Current Law (2)	- 1	- 32	- 2	- 1	- 72	- 2
		b) Lower Axle load limit (3)	- 1	- 11	- 1	- 2	- 19	- 1
	High	a) Current Law (2)	- 3	- 54	- 7	0	- 18	- 1
		b) Lower Axle load limit (3)	+ 3	- 44	0	- 1	- 15	- 1
Very High	Low	a) Current Law (2)	- 1	- 41	- 3	+ 1	- 80	0
		b) Lower Axle load limit (3)	- 1	- 26	- 1	- 2	- 24	- 4
	High	a) Current Law (2)	+ 2	- 32	0	- 1	- 34	- 1
		b) Lower Axle load limit (3)	- 3	- 28	- 3	- 2	- 9	- 1

(1) Low = 270 - 430 vehicles per day (1980-1990)
High = 800 - 1,300
Very High = 1,300 - 2,100

(2) Percentage cost reductions are for enforcing the current law compared with the current situation with many vehicles overloaded.

(3) Percentage cost reductions are for an 8-ton axle load limit in comparison with enforcing the current law (11-ton axle load limit).

The enforcement of legal axle loads should involve the following:

(i) Restriction of imports to suitable vehicles. Many European vehicles currently imported by Bolivia are designed for 13 ton axle loads, above the legal maximum in Bolivia.

(ii) Control of the carrying capacity of vehicles, which is currently decided by the owner.

(iii) A vehicle taxation policy which encourages tandem rear axle vehicles.

(iv) A system of roadside checks, either at randomly chosen locations using portable scales, or at permanent locations such as at the transit stations on the outskirts of cities.

A vehicle taxation policy is discussed in Chapter 17 and a program of roadside vehicle weight checks is set out in Appendix 11A.

The Cochabamba-Santa Cruz Highway - This 495 km highway was built in the 1950s with paving completed in 1958, apart from a 35 km section with particularly severe climate in the region of Siberia, on the border of Santa Cruz and Cochabamba departments. Figure 11-1 shows the location of the route with the main towns and villages.

Apart from a surface dressing applied in about 1970, little maintenance has been done, and consequently the road has deteriorated badly. Pavement edges have eroded, potholes are frequent and in sections as long as several hundred meters, the surface has virtually reverted to gravel. The rate of deterioration has been accelerated by the number of overloaded trucks using this route.

Conditions are particularly bad in the part of the road in Santa Cruz department, and work has now started on rehabilitation by the National Road Service (Servicio Nacional de Caminos - SNC). A 46 km section from Santa Cruz to Jorochito was rehabilitated in 1979 and two further sections totalling 84 km, between Jorochito and Bermejo and between Abra del Quine and Comarapa, are currently being rehabilitated. In each case, the road is being constructed to a width of six meters (compared with the existing width of between 5.5 and 6.5 meters), a new 10 cm base is being laid on the existing surface and a new surface of 5 cm of asphaltic concrete is being laid. The sections currently being rehabilitated were reviewed, and projects for further rehabilitation and improvement were evaluated.

The evaluations took into account the likely opening of the Chimoré-Yapacaní highway in 1985, which will offer a more attractive paved route between Cochabamba and Santa Cruz. It was estimated that just over 400 vehicles per day would be diverted from the existing route in 1985, leaving volumes much reduced in the central section of the highway, and at about 1977 observed volumes nearer to Cochabamba and Santa Cruz.

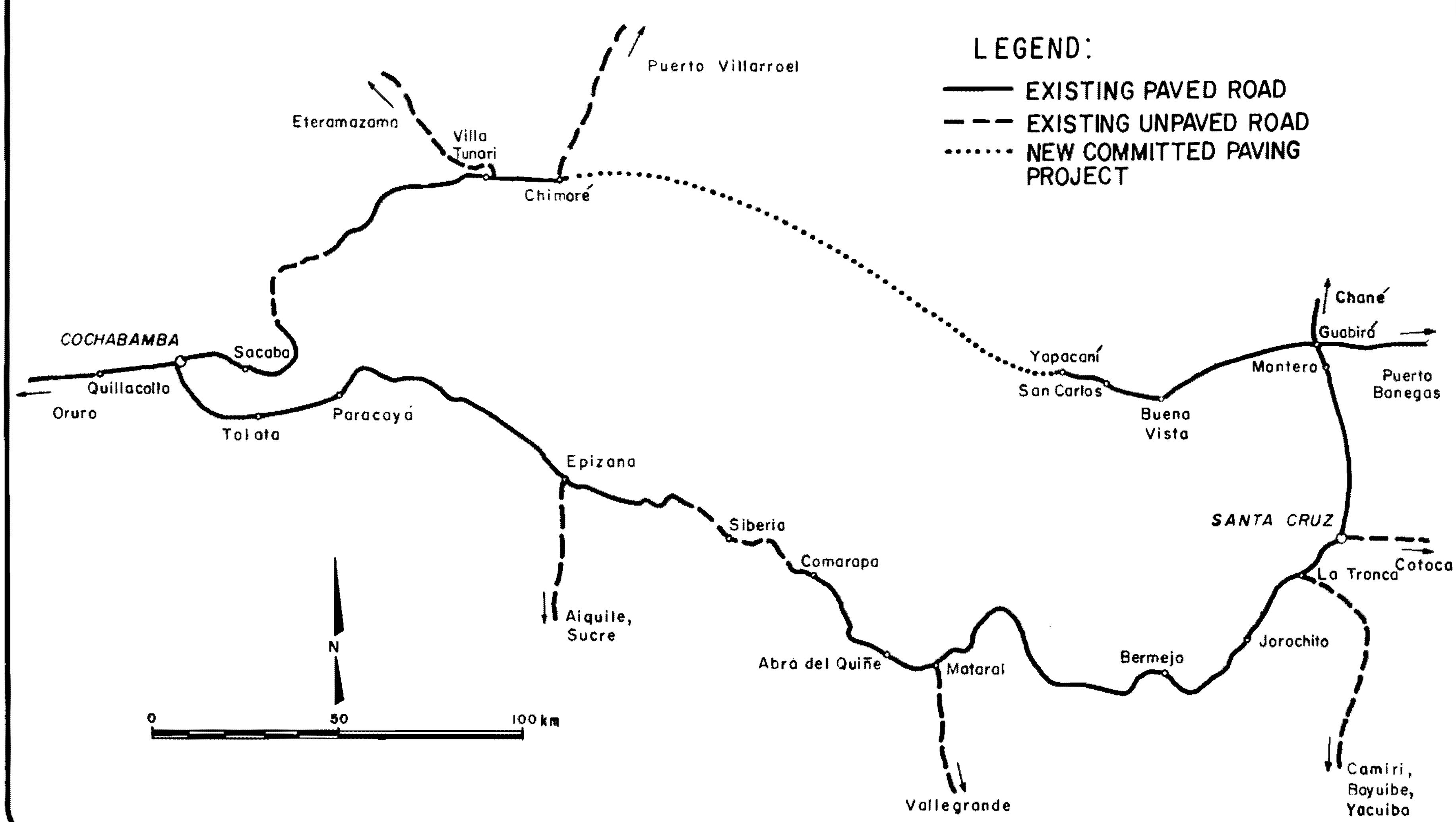
Table 11-2 presents the results of the evaluation. The optimum policies support the choice of the rehabilitation projects selected by SNC for immediate execution, and indicate that the remainder of the paved road between Santa Cruz and Siberia is also well worth rehabilitating. For the section between Siberia and Epizana, it was concluded that rehabilitation was worthwhile if done early, but if this project had to be delayed for budget reasons, rehabilitation would not be worthwhile with the very low volumes of traffic expected after the opening of the Chimoré-Yapacaní road. Between Cochabamba and Epizana, it was concluded that overlaying, if performed immediately, would be worthwhile but if this project has to be delayed, then rehabilitation would become necessary by 1985. The project for paving the 50 km section between Siberia and Comarapa is not worthwhile, because of the low volumes expected on this section after 1985. Based on the analysis of unpaved roads presented later in this chapter, it is recommended instead that a good gravel surface be provided for this section in the period 1984-1986 at a cost of $b 11 million.

Budget restrictions require several modifications to the optimum program. Under the high budget, both the gravelling of Siberia-Comarapa and the rehabilitation of Comarapa-Jorochito would have to be postponed to the second period. Postponement also of the Epizana-Siberia rehabilitation project makes it no longer viable so it is abandoned. Both costs and NPV under the high budget reduce by nearly a quarter compared with optimum.

Under the medium budget, all projects are delayed until the last period, so that Epizana-Siberia is abandoned, as under the high budget, and also, rehabilitation is required for Cochabamba-Epizana instead of cheaper overlaying. Costs are consequently similar to the optimum but the NPV drops to only 35 percent of optimum.

Other Paved Roads - In addition to the Cochabamba-Santa Cruz highway, a further 574 km of paved highway were evaluated. There are other existing paved highways, either of recent construction or which have been the subject of recent improvements. It may well be that later in the 1980s, some work will be required on these more recent roads, but a program for this work should be considered nearer the time.

Three main groups of highways were identified by geographical region: Altiplano roads, the Cochabamba-Chimoré highway and Guabirá Area roads. The results of the evaluations of these roads are presented in Table 11-3.



EXISTING AND COMMITTED HIGHWAYS
BETWEEN COCHABAMBA SANTA CRUZ

Wilbur Smith and Associates

FIGURE 11–1

Table 11-2

EVALUATION OF THE COCHABAMBA-SANTA CRUZ HIGHWAY

SECTION	LENGTH (km)	FORECAST 1989 ADT (1)	$\overline{SN}$ (2)	OPTIMUM IMPROVEMENT Project	Start Date	Cost (millions of 1977 pesos)	NPV (3)	MEDIUM BUDGET Project	Start Date	Cost (millions of 1977 pesos)	NPV (3)	HIGH BUDGET Project	Start Date	Cost (millions of 1977 pesos)	NPV (3)
Cochabamba - Epizana	126	300/1115	2.1/2.7	Overlay	81-83	83	265	Rehab.	87-90	150	101	Overlay	81-83	83	265
Epizana - Siberia	73	64	2.0/2.6	Rehab.	81-83	69	15	None	-	-	-	None	-	-	-
Siberia - Comarapa (Gravel)	50	64	-	Regravel	81-83	11	30	Regravel	87-90	11	18	Regravel	84-86	11	22
Comarapa - Jorochito															
- being rehabilitated	84	137/392	2.3	Rehab.	1980	74	98	-	-	-	-	-	-	-	-
- others	120	137/392	2.3	Rehab.	81-83	135	92	Rehab.	87-90	135	23	Rehab.	84-86	135	9
	453					298 (4)	402 (4)			296	142			229	296

(1) From the 1989 Recommended Network Test.
(2) Modified Structural Number of the existing pavement.
(3) Net Present Value (NVP) calculated at 12 percent.
(4) Omitting the section of Comarapa - Jorochito already being rehabilitated.

Table 11-3

IMPROVEMENTS TO EXISTING PAVED HIGHWAYS
(Excluding Cochabamba-Santa Cruz)

SECTION	LENGTH (km)	FORECAST 1989 ADT (1)	$\overline{SN}$ (2)	OPTIMUM IMPROVEMENT				MEDIUM BUDGET				HIGH BUDGET			
				Project	Start Date	Cost (million of 1977 pesos)	NPV (3)	Project	Start Date	Cost (millions of 1977 pesos)	NPV (3)	Project	Start Date	Cost (millions of 1977 pesos)	NPV (3)
Altiplano Roads															
El Alto - Patacamaya	85	1298	2.2/2.6	Overlay	81-83	61	165	Overlay	87-90	61	98	Overlay	81-83	61	165
Patacamaya - Oruro	122	1200	2.2	Overlay	81-83	87	308	Overlay	87-90	87	183	Overlay	84-86	87	227
Oruro - Vinto	5	3622	-	Overlay	81-83	4	21	Overlay	87-90	4	12	Overlay	84-86	4	16
Vinto - Machacamarca	26	1510	-	Overlay	81-83	19	66	Overlay	87-90	19	40	Overlay	84-86	19	49
El Alto - Viacha	20	1358	3.7	Overlay	81-83	17	59	Overlay	87-90	17	35	Overlay	84-86	17	44
Cochabamba-Chimoré Highway															
Cochabamba - Sacaba	8	2130	2.9	Overlay	84-86	7	31	Overlay	87-90	7	25	Overlay	84-86	7	31
Sacaba - Villa Tunari (4)	116	900	2.7	Overlay	84-86	95	152	Overlay	87-90	95	131	Overlay	84-86	95	152
Villa Tunari - Chimoré	29	648	3.4	None	-	-	-	None	-	-	-	None	-	-	-
Guabirá Area Roads															
Guabirá - km 87	35	3110	2.4	Rehab.	81-83	106	60	Rehab.	87-90	106	47	Rehab.	87-90	106	47
km 87 - Puerto Banegas	19	1336	2.4	Rehab.	87-90	55	4	Rehab.	87-90	55	4	Rehab.	87-90	55	4
Guabirá - Chané	41	600	2.1	Rehab.	87-90	119	9	Rehab.	87-90	119	9	Rehab.	87-90	119	9
Guabirá - San Carlos	56	4174	1.7	Rehab.	81-83	162	124	Rehab.	87-90	162	90	Rehab.	84-86	162	105
San Carlos - Yapacaní	12	1900	1.8	Rehab.	81-83	35	26	Rehab.	87-90	35	19	Rehab.	84-86	35	22
						767	1,025			767	693			767	871

(1) From the 1989 Recommended Network Test.
(2) Modified Structural Number of the existing pavement.
(3) Net present value (NPV) calculated at 12 percent.
(4) In addition to the 116 km of paving recorded here, there are 29 km unpaved.

It was concluded that the Altiplano roads were relatively well constructed, although all those examined were in need of overlaying within the next three years. Some overlaying is currently being carried out on the El Alto-Patacamaya road in the region of San Antonio. It was concluded that for these roads, overlaying could be postponed for a few years without the pavements deteriorating to the point of requiring rehabilitation, although postponement of overlaying is not the optimum policy. Under the high budget, postponement would be required for all but one section (El Alto-Patacamaya) until 1984-1986, but under the medium budget, overlaying would have to be postponed on all sections until 1987-1990.

The Cochabamba-Chimoré road is also relatively well constructed with both base and sub-base provided. A policy of overlaying proved to be optimal although not required until 1984/86. In this case, it may be convenient to overlay in the year before the opening of the Chimoré-Yapacaní road which is currently programmed for completion in 1985/86. The last section of this road from Villa Tunari to Chimoré does not need rehabilitation or overlaying in the next ten years, although a surface dressing could be required in this period. Under the high budget, overlaying in the optimum year is allowed, but the medium budget requires postponement until 1987. On the assumption that the high budget is available, it is also recommended that the 29 km of unpaved road in the Cochabamba-Villa Tunari road be paved in the period 1984-1986 at an estimated cost of 23 million pesos.

The three roads leading from Guabirá to Puerto Banegas, Chané and Yapacaní, are all of very weak construction, built without sub-base. It was concluded that an overlaying policy was not suitable and that complete reconstruction was required. For part of the road to Puerto Banegas, and for the two sections to Yapacaní, which will become part of the new Cochabamba-Santa Cruz highway via Chimoré, rehabilitation is desirable immediately. For the lower volume sections to Puerto Banegas and to Chané, rehabilitation can be delayed until the end of the decade.

Under the medium budget assumption, all the Guabirá projects are delayed to the 1987-1990 period. Under the high budget, the short section San Carlos-Yapacaní is advanced to 1984-1986. It is recommended that the entire section from Guabirá to Yapacaní is rehabilitated in 1984 before the opening of the Chimore-Yapacani highway. Improvements to the Guabirá-Puerto Banegas road should coincide with the construction of a road bridge at Puerto Banegas (see later in this Chapter).

Costs are identical under all three budget assumptions. The more serious postponements under the medium budget result in a drop in NPV of 32 percent and the postponements necessary under the high budget assumption reduce NPV by 15 percent.

Policies for Improving Unpaved Roads

The 1977 transport system coded for the computer transport model contains nearly 13,000 km of unpaved roads on routes between the 77 analysis zones defined for the Study. Some of these routes have now been, or are in the process of being, improved to better gravel or to paved standards leaving 5,780 km of gravel road and 5,560 km of earth roads as candidates for possible improvement projects. The total road system contains an additional 25,000 km of unpaved feeder roads which are discussed later in this chapter.

Several possibilities are available for improving unpaved roads, but the three projects selected below were chosen for detailed analysis:

(i) New construction - when a new road is built making little or no use of the existing alignment.

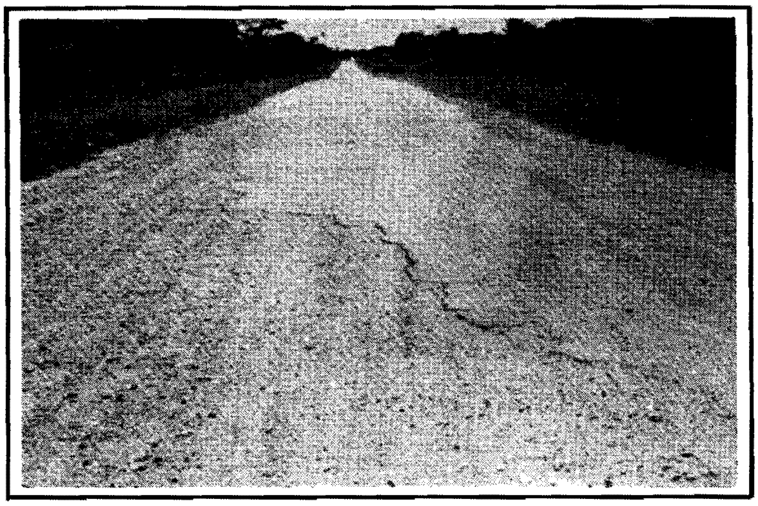
(ii) Betterment - when the existing alignment is improved by widening, provision of better drainage, correction of severe bends and provision of a better surface -- either gravel or paving.

(iii) Major gravelling - when adequate drainage and a good gravel surface are provided, but no improvements are made to width or to alignment.

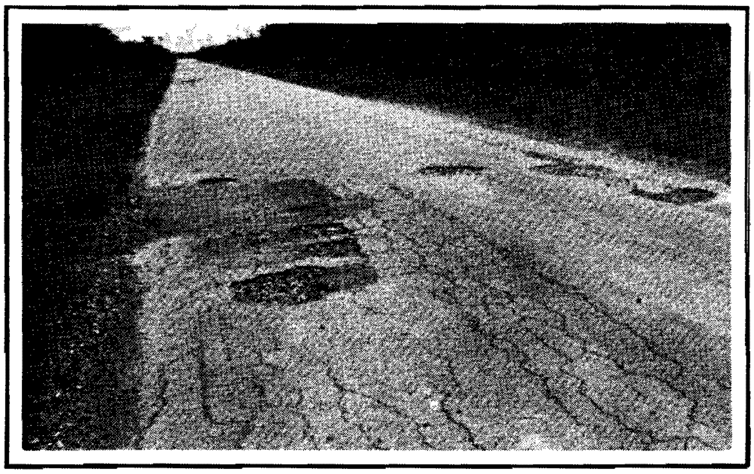
The feature common to all these improvements is the provision of a better road surface. Existing unpaved surfaces are poor, being either of earth or of poorly graded gravel. In the latter case, even frequent grading is insufficient to reduce road roughness to acceptable levels due to the coarse gravel currently in use. Better routine maintenance using selected materials can improve road surfaces, and this is discussed later in the chapter. However, it is considered that at least major gravelling, as described above, is required to make a significant and lasting improvement to unpaved surfaces.

In the rest of this chapter, poor gravel will refer to the existing gravel surfaces which feature oversized material, and good gravel to the surfaces after improvement using properly selected and graded materials. Where a good gravel surface is provided, improved routine maintenance standards are implied as discussed later.

The characteristics of existing roads and the assumptions made on improvement costs are presented below followed by the evaluation and selection of improvement policies. Recommended projects for unpaved road improvements are discussed in the section after.

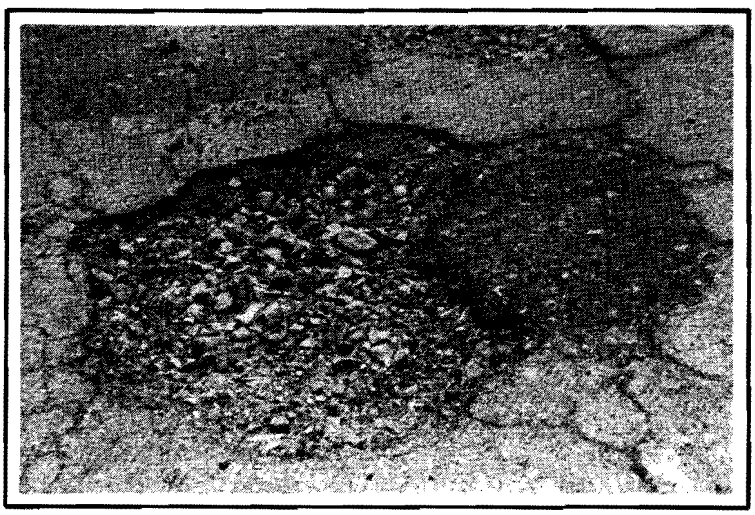


COMPLETE LOSS OF ASPHALT



BAD CRACKING
AND POTHOLES

FURTHER DAMAGE
AFTER PATCHING



PAVED ROAD DETERIORATION

GUABIRA-YAPACANI ROAD

Characteristics of Unpaved Roads - The basic characteristics of unpaved roads are shown in Table 11-4. For the most part, they are characterized by narrow widths, poor alignments (especially in undulating and mountainous terrain) and low traffic volumes. Over sixty percent of unpaved roads carry less than 50 vehicles per day, less than 5 percent (527 kms) carry more than 200 vehicles per day and none have more than 400 vehicles per day. On average, nearly two thirds of all vehicles are trucks, and on many roads the proportion of trucks is much higher.

New Construction - The standards currently guiding the design of new roads are shown in Table 11-5. Five design levels are shown with different standards for each of three terrains. These design levels were taken as the basis for analysis although in reality, designs depart from these standards quite frequently. The traffic volumes assigned to each design level in this table were disregarded, since it was the basic objective of the analysis reported here to assess the traffic volumes appropriate for each design.

The alignment characteristics and estimated costs of construction for each combination of design level and terrain are shown in Table 11-6. Costs are in 1977 pesos but at 1985 price levels, the average for the ten years of the investment program under consideration. Construction costs were derived from a detailed analysis of recent and current construction projects and this analysis is presented in Working Paper 38a.

Costs were initially calculated assuming roadway and shoulder widths based on those given in Table 11-5. Later analysis showed that few paved roads could be justified unless design standards were reduced, and so alternative costs were calculated for both a seven meter gravel road and for a six meter paved road with half meter gravel shoulders. This is commented on in more detail later in the Chapter.

The original designs assume an asphaltic concrete pavement for design level I and surface treatment for design levels II to V. The reduced six meter pavement designs assume surface treatment for opening volumes up to 700 vehicles per day and asphaltic concrete for higher volumes.

Betterment and Major Gravelling - Betterment is defined as improvement of the existing road alignment, and comprises the following:

- Widening to seven meters
- Additional drainage
- Enlargement of sharp bends
- Additional retaining walls
- Improved surface -- either good gravel or a six meter pavement.

Table 11-4

CHARACTERISTICS OF EXISTING UNPAVED ROADS

ROAD CATEGORY					AVERAGE	AVERAGE	AVERAGE ALIGNMENT		1977 TRAFFIC	
No.	Terrain	Surface	Volume (Veh/day)	LENGTH (km)	WIDTH (meters)	ALTITUDE (meters)	Horizontal (degrees/km)	Vertical (meters/km)	Total (Veh/day)	% Trucks
1	Flat	Gravel	0-49	421	7.5	1,417	149	25	20	58
2			50-99	183	6.1	2,128	212	51	79	56
3			100-199	305	6.5	2,262	183	42	128	64
4			200-399	189	8.1	2,972	51	15	270	47
5		Earth	0-49	3,222	4.4	1,964	269	27	10	70
6			50-99	97	5.8	4,079	249	37	66	94
7			100-199	255	5.2	1,227	264	43	134	64
8			200-399	52	8.3	383	68	15	259	37
9	Undulating	Gravel	0-49	389	5.5	2,395	219	53	30	63
10			50-99	548	5.7	2,724	144	54	72	70
11			100-199	326	6.0	2,814	160	49	125	69
12			200-399	172	6.9	3,407	136	46	262	57
13		Earth	0-49	653	4.5	3,444	251	40	12	78
14			50-99	185	6.7	3,782	217	25	61	78
15			100-199	108	5.7	750	300	15	122	46
16	Mountainous	Gravel	0-49	1,573	4.7	2,586	223	62	29	72
17			50-99	600	5.0	2,322	152	56	73	69
18			100-199	962	5.7	3,050	176	59	130	66
19			200-399	114	7.3	2,064	205	61	279	73
20		Earth	0-49	718	4.6	3,356	205	60	19	74
21			50-99	271	4.9	3,338	300	78	67	69
		Total		11,343	5.2	2,483	217	45	57	64

NOTE: Excludes feeder roads and roads improved since 1977 or committed to be improved.

SOURCES: SNC road inventory and traffic counts.

Table 11-5

CURRENT HIGHWAY DESIGN STANDARDS

CATEGORY AND FUTURE TRAFFIC VOLUME (ADT)	TERRAIN	DESIGN SPEED (KPH)	MINIMUM RADIUS (m)	MAX. GRADIENT ON TANGENTS UNTIL 1000m ABOVE SEA LEVEL (%)		MINIMUM SIGHT DISTANCE (M)		MINIMUM SHOULDER WIDTH (m)	ROAD PAVEMENT WIDTH (m)	PAVEMENT TYPE
				DESIRABLE	MAX.	STOPPING	PASSING			
Category I 1500-3000 (ADT)	Flat	100	450	3	4	180	800	3.00	7.30	Asphalt concrete or better
	Undulating	90	350	4	5	150	600	2.50	7.30	
	Mountainous	60	120	5	6	80	370	1.50	7.30	
Category II 500-1500 (ADT)	Flat	100	450	3	4	180	800	2.00	7.30	Asphalt treated surface or better
	Undulating	80	250	4	5	120	540	1.50	7.30	
	Mountainous	45	60	6	7	55	230	1.50	7.00	
Category III 200-500 (ADT)	Flat	90	350	4	5	150	600	1.50	7.00	Asphalt treated surface
	Undulating	70	170	5	6	100	460	1.15	6.70	
	Mountainous	40	50	7	8	45	160	1.15	6.70	
Category IV 50-200 (ADT)	Flat	80	170	4	5	120	540	-.-	7.00	Stabilized gravel
	Undulating	60	100	5	6	80	370	-.-	6.70	
	Mountainous	40	40	7	8	40	160	-.-	6.70	
Category V 10 - 50 (ADT)	Flat	50	80	5	6	60	270	-.-	6.00	Stabilized earth
	Undulating	40	50	6	8	40	160	-.-	6.00	
	Mountainous	30	25	7	9	25	150	-.-	6.00	

Notes

1. The traffic volumes indicated are future projected traffic.
2. For volumes more than 3000 vehicles per day, the standards are established based on a capacity calculation.
3. For volumes less than 10 vehicles per day, a minimum platform width of 4.5 m is required, specific standards will vary according to each specific case.
4. Maximum gradients are reduced by 0.5 percent between 1000 and 3000 m above sea level, and by 1.0 percent for higher altitudes.
5. The maximum length with constant gradient is determined based on the criterium of not decreasing operating speed by more than 25 kph, especially for heavy vehicles.
6. The maximum super elevation is 10 percent, based on the design speed and the adopted curvature.
7. Widening of curves should be considered based on traffic composition.

SOURCE: National Road Service (SNC).

Table 11-6

ALIGNMENT CHARACTERISTICS AND ESTIMATED CONSTRUCTION COSTS PER KM

FOR NEW ROADS FOR ALTERNATIVE DESIGN LEVELS

TERRAIN	DESIGN LEVEL	ALIGNMENT Horizontal	ALIGNMENT Vertical	LENGTH REDUCTION FACTOR(1)	ORIGINAL PAVED DESIGN Roadway Width	ORIGINAL PAVED DESIGN Shoulder Width	ORIGINAL PAVED DESIGN Cost	ORIGINAL GRAVEL DESIGN Road Width	ORIGINAL GRAVEL DESIGN Cost	MODIFIED DESIGN COSTS Paved(2)	MODIFIED DESIGN COSTS Gravel(3)
		(degrees/km)	(meters/km)		(m)	(m)	(thousands of 1977 $b)	(m)	(thousands of 1977 $b)	(thousands of 1977 $b)	
Flat	I	10	7	.96	7.3	3.0	4,120	-	-	1,840	-
	II	15	10	.97	7.3	2.0	3,750	11.3	2,210	1,820	1,340
	III	20	15	.97	7.0	1.50	2,830	10.0	2,020	1,770	1,320
	IV	30	20	.98	6.7	1.15	2,620	9.0	1,850	1,720	1,270
	V	40	25	.98	6.0	1.0	2,160	8.0	1,420	1,700	1,250
Undulating	I	50	15	.92	7.3	2.5	7,800	-	-	5,200	-
	II	90	20	.93	7.3	1.5	7,080	10.3	5,710	4,830	4,510
	III	130	25	.94	6.7	1.15	5,910	9.0	5,300	4,510	4,180
	IV	170	30	.95	6.0	1.0	4,760	8.0	4,180	4,210	3,840
	V	200	35	.96	6.0	1.0	4,000	6.0	3,480	3,910	3,550
Mountainous	I	100	30	.85	7.3	1.5	12,400	-	-	9,130	-
	II	150	35	.87	7.0	1.5	12,190	10.0	10,560	8,100	7,560
	III	200	40	.89	6.7	1.15	10,950	9.0	10,030	7,220	6,650
	IV	300	45	.91	6.0	1.0	7,480	8.0	6,580	6,440	5,830
	V	400	50	.93	6.0	1.0	6,420	6.0	5,000	5,800	5,160

(1) Reduction from existing route length achieved by new road
(2) Assumes a 6.0 meter pavement and 0.5 meter shoulder. Costs are for volumes up to 250 vehicles per day (vpd), add 390 for volumes above 250 vpd, add 800 for volumes above 700 vpd for stronger pavements.
(3) Assumes 7.0 meter roadway.

NOTE: Costs in eastern Bolivia - essentially the region of Santa Cruz and the corridor from Santa Cruz to Yacuiba - are estimated to be about 40 percent higher than the costs given here which apply to the Valleys and the Altiplano.

The costs of betterment are presented in detail in Appendix 11B. The crucial factors affecting costs are the terrain, the existing road width and the surface provided.

For major gravelling, it is considered that a new gravel surface on its own would not be sufficient to improve the quality of the road and that improvements would also be needed to the drainage. It was assumed that 2, 2.5 and 3 drains per km would be needed in flat, rolling and mountainous terrain respectively.

Costs of betterment and major gravelling are summarized in Table 11-7.

The geometric standards for major gravelling are, of course, the same as for the original road. The standards for betterment were assumed to be half way between those of the existing roads and those of design Level V (see Table 11-6).

Road Construction in Special Areas - Some parts of the country feature quite exceptional terrain which requires special construction techniques at higher costs. In particular, the Yungas valleys to the east of La Paz are steep and new road construction is extremely costly. For example, the cost per km on the La Paz-Cotapata road now under construction in the Yungas is at least double that of the Quillacollo-Confital road which also runs through mountainous terrain.

Another region requiring special construction techniques is the Beni. Flooding is the problem here so that roads have to be built on embankments and many bridges and drainage structures are required. Most of the roads in these regions, including the extension of the La Paz-Cotapata route to the northern La Paz and Trinidad, are dealt with separately in Chapter 12. The construction costs for these roads are not considered in this Chapter.

Evaluation of Road Improvements - The HDM model was used to evaluate road improvements in each type of terrain, for different traffic volumes. For each type of improvement, benefits, in terms of reduced vehicle operating costs and time savings compared with doing nothing, were estimated and they are reported in Table 11-8.

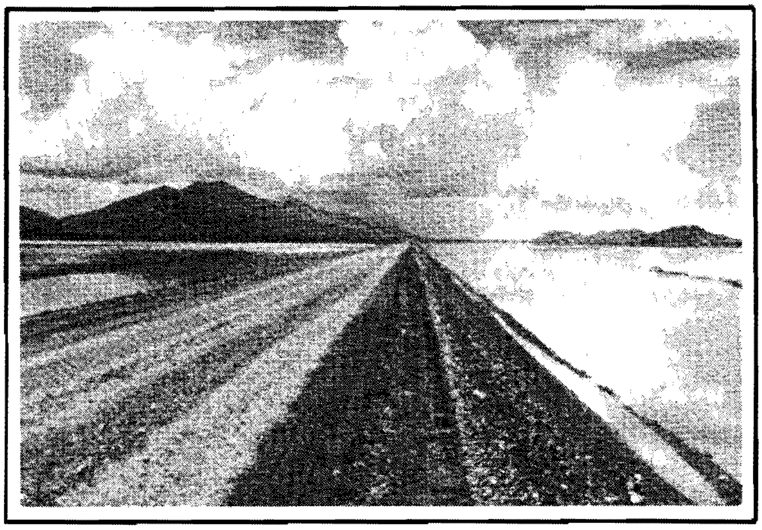
From these results, it is concluded that almost any new design can be justified at quite low traffic volumes, when compared with leaving the road completely alone. The qualification is important and will be returned to in a moment. If it is assumed that benefits to traffic in the year of opening must equal or exceed 12 percent of the construction costs, all designs in flat terrain can be justified at less than 300 vehicles per day. The volume required in the year of opening tends to go up as terrain becomes more severe. In general, new paved designs can be justified at a lower traffic volume than new gravel designs, despite the additional construction cost required, because of the much higher benefits associated with a better surface.

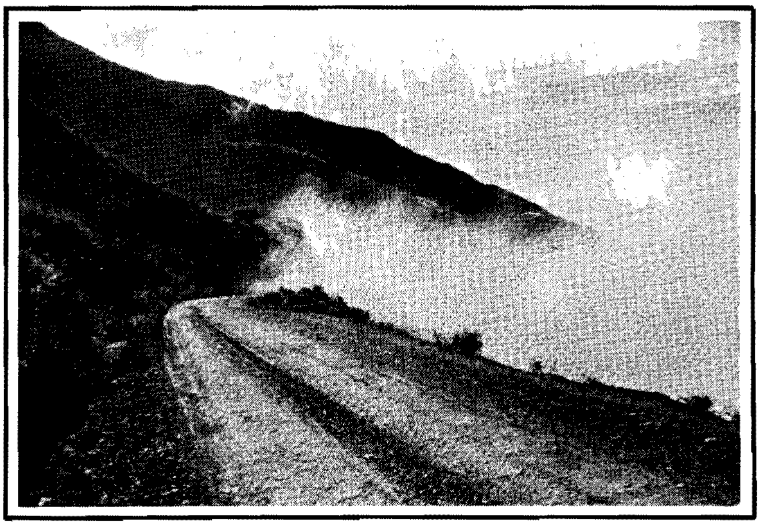
Table 11-7

ESTIMATED COSTS OF BETTERMENT AND MAJOR GRAVELLING

TYPE OF IMPROVEMENT	TERRAIN	CONSTRUCTION COSTS RELATED TO EXISTING ROAD WIDTHS Under 5 meters	5 meters to 7 meters	Over 7 meters
		(Costs in thousands of 1977 pesos per km)		
Betterment with Paved Surface	Flat	1,160	1,116	1,074
	Undulating	1,784	1,518	1,385
	Mountainous	3,461	2,414	1,370
Betterment with Gravel Surface	Flat	446	402	360
	Undulating	1,070	804	538
	Mountainous	2,747	1,700	656
Major Gravelling	Flat	265	320	360
	Undulating	285	369	427
	Mountainous	305	393	454

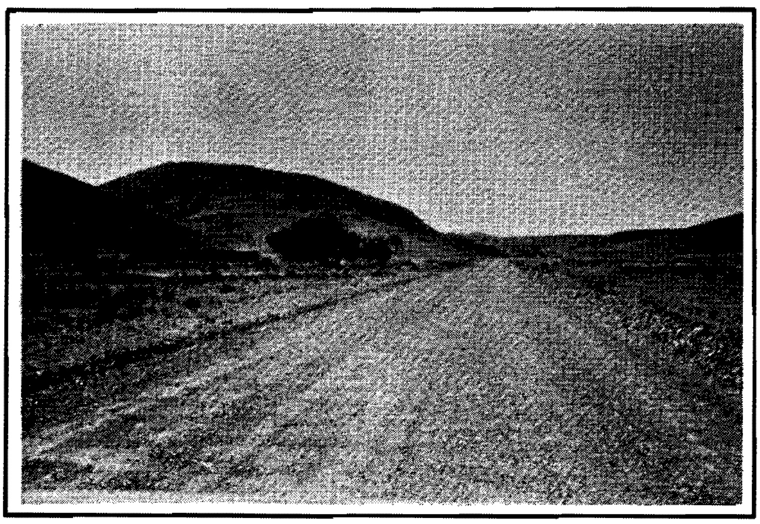
ORURO - POTOSI





AIQUILE - EPIZANA

POTOSI - TARIJA



GRAVEL ROADS

Table 11-8

UNPAVED ROAD IMPROVEMENT BENEFITS BY
TRAFFIC VOLUME AND TERRAIN

TERRAIN	DESIGN LEVEL	CAPITAL COST	BENEFITS AT DIFFERENT TRAFFIC VOLUMES (VEH.PER DAY) 100	200	300	400	500	600	700	800	900	1000
			(millions of 1977 pesos per 100 km)									
Flat	Major Regravelling (1)	29	6	11	15	20	24	29	33	38	42	47
	Betterment with Gravel Surface (1)	49	6	11	16	22	27	32	37	43	48	53
	Design Level V Gravel (2)	125	7	13	20	26	32	39	45	51	58	64
	IV Gravel	127	7	14	20	27	33	40	47	53	60	67
	III Gravel	132	8	15	22	29	37	44	51	58	65	72
	II Gravel	134	8	16	23	30	37	45	52	59	67	74
	Betterment with Paved Surface	98	13	24	36	47	59	70	82	94	105	117
	Design Level V Paving (3)	170	13	26	38	51	63	76	88	100	113	125
	IV Paving	172	14	27	39	52	65	78	91	103	116	129
	III Paving	177	14	28	41	54	68	81	94	107	121	134
	II Paving	182	14	28	42	55	69	83	96	110	124	137
	I Paving	184	15	29	43	57	71	85	99	113	127	141
Undulating	Major Regravelling (1)	31	6	11	16	21	26	31	36	41	46	51
	Betterment with Gravel Surface (1)	93	7	13	19	24	30	36	42	48	54	60
	Design Level V Gravel (2)	355	9	17	25	33	41	49	57	65	73	81
	IV Gravel	384	10	19	28	38	47	56	65	74	83	92
	III Gravel	418	11	21	31	42	52	62	72	82	92	103
	II Gravel	451	12	23	34	45	56	67	78	89	100	111
	Betterment with Paved Surface	140	14	27	40	52	65	78	91	103	116	129
	Design Level V Paving (3)	391	16	30	45	59	73	88	102	117	131	145
	IV Paving	421	17	32	47	63	78	94	109	124	140	155
	III Paving	451	18	34	50	66	83	99	115	131	148	164
	II Paving	483	19	35	52	69	86	103	120	137	154	171
	I Paving	520	19	37	54	72	89	107	125	142	160	178
Mountainous	Major Regravelling (1)	52	6	11	15	19	23	28	32	36	40	44
	Betterment with Gravel Surface (1)	351	7	12	16	21	26	30	35	40	44	49
	Design Level V Gravel (2)	516	10	18	25	33	41	48	56	64	71	79
	IV Gravel	583	12	23	34	45	57	68	79	90	101	112
	III Gravel	665	17	32	47	62	76	91	106	120	135	150
	II Gravel	756	19	36	52	69	85	101	118	134	151	169
	Betterment with Paved Surface	423	13	24	34	45	55	65	76	86	97	107
	Design Level V Paving (3)	580	17	31	45	59	73	87	101	115	129	143
	IV Paving	644	21	39	57	76	94	112	130	148	166	184
	III Paving	722	24	45	66	87	107	128	149	170	191	212
	II Paving	810	25	47	70	92	114	136	159	181	203	226
	I Paving	913	26	50	73	97	120	143	167	190	213	237

(1) Assumes five meter wide existing road.
(2) New construction of a seven meter road.
(3) New construction of a seven meter road with six meter pavement.

The question of the basis for comparison of a road improvement is now returned to. It is emphasized most strongly that a simple comparison with existing conditions is not a sufficient basis for justifying a new road. For example, an existing unpaved road in poor condition can be improved quite cheaply by placing a properly graded and compacted gravel surface, together with sufficient drainage. This should result in a significant reduction in road maintenance and vehicle operating costs. A better design is only worthwhile if it can produce sufficient additional benefits to justify the additional construction costs.

In general, the optimum improvements to an unpaved road are major gravelling at low volumes, betterment with paving at intermediate volumes and the construction of a new paved road to a higher geometric alignment than can be achieved by betterment for higher volumes. New gravel roads on new alignments, to replace existing unpaved roads, are never justified. The exact volume at which a higher level of project becomes justified depends much upon the type of terrain and the condition of the road in question, particularly its width. Therefore, it is not possible to specify a general table of optimum design levels.

Selection of Improvement Policies - The general evaluation of road improvements reported above was the basis of a more detailed investigation of unpaved roads. For each road category reported in Table 11-4, a set of alternative projects was specified, including major gravelling, betterment and new road construction, each with alternative construction start dates of 1981, 1984 and 1987. Thus, at least nine projects were specified for each category. In some cases, more than one design level was investigated for new road construction so that up to 15 alternative projects were specified for some road categories.

Traffic volumes were derived from an analysis of the transport model forecasts considering normal traffic, traffic generated by a gravelling project and traffic generated by a paving project. Thus, for each project in each road category, a distinct traffic forecast was derived, reflecting the type and timing of the improvement project.

Each project was evaluated using the HDM model, and the alternatives within a category were then compared. The optimum improvement, that is the one with the highest net present value, is shown in Table 11-9 for each category (omitting some low volume categories where no improvements of this nature could be justified).

Optimum improvement policies imply many more projects in the next few years than funds can possible permit. Therefore, the budget allocation program described in Chapter 3 was used to select improvement policies for each road category. Competing for the same funds were projects for road maintenance, paved road improvements, bridges, penetration roads and feeder roads. The final set of unpaved road improvements selected for each category under assumptions of the medium and the high budget is also shown in Table 11-9.

Table 11-9

MAJOR IMPROVEMENTS TO UNPAVED ROADS - OPTIMUM AND BUDGET RESTRAINED

ROAD CATEGORY					OPTIMAL IMPROVEMENTS				IMPROVEMENT UNDER BUDGET RESTRAINT: Medium Budget				IMPROVEMENT UNDER BUDGET RESTRAINT: High Budget			
Number[1]	Terrain	Surface	1977 Av. Volume (vpd)	Length (km)	Type[2]	Cost (millions of 1977 pesos)	NPV[3] (millions of 1977 pesos)	Construction Start Period	Type[2]	Cost (millions of 1977 pesos)	NPV[3] (millions of 1977 pesos)	Construction Start Period	Type(2)	Cost (millions of 1977 pesos)	NPV(3) (millions of 1977 pesos)	Construction Start Period
1	Flat	Gravel	20	421	Major Grav.[4]	34	2	87-90	Major grav.	34[4]	2	87-90	Major grav.	34[4]	2	87-90
2		Gravel	79	183	Betterment	198	17	84-86	Betterment	198	5	87-90	Major grav.	63	10	84-86
3A(5)		Gravel	128	122	Major Grav.	35	110	81-83	Major grav.	35	62	87-90	Major grav.	35	110	81-83
3B(6)		Gravel	128	183	Betterment	189	180	81-83	Betterment	189	107	87-90	Betterment	189	143	84-86
4		Gravel	270	189	Betterment	244	462	81-83	Betterment	244	289	87-90	Betterment	244	462	81-83
6		Earth	66	97	Major grav.	30	9	81-83	Major grav.	30	6	87-90	Major grav.	30	9	81-83
7		Earth	134	255	Betterment	336	194	81-83	Betterment	336	126	87-90	Major grav.	74	172	81-83
8		Earth	259	52	Betterment	83	48	81-83	Betterment	83	25	87-90	Major grav.	20	44	81-83
9	Undulating	Gravel	30	389	Major grav.[7]	75	14	87-90	Major grav.	75[7]	14	87-90	Major grav.	75[7]	14	87-90
10		Gravel	72	548	Major grav.	187	90	84-86	Major grav.	187	46	87-90	Major grav.	187	90	84-86
11A(5)		Gravel	125	254	Major grav.	86	153	81-83	Major grav.	86	86	87-90	Major grav.	86	129	84-86
11B(6)		Gravel	125	72	Betterment	74	44	81-83	Betterment	74	27	87-90	Major grav.	31	32	84-86
12		Gravel	262	172	Betterment	278	302	81-83	Betterment	278	178	87-90	Betterment	278	224	84-86
14		Earth	61	185	Major grav.	71	5	87-90	Major grav.	71	5	87-90	Major grav.	71	5	87-90
15		Earth	122	108	Major grav.	43	37	81-83	Major grav.	43	21	87-90	Major grav.	43	21	87-90
16	Mountainous	Gravel	29	1,573	Major grav.[8]	311	31	87-90	Major grav.	311[8]	31	87-90	Major grav.	311[8]	31	87-90
17		Gravel	73	600	Major grav.	291	97	84-86	Major grav.	291	56	87-90	Major grav.	291	97	84-86
18		Gravel	130	962	Major grav.	582	82	84-86	None	-	-	-	Major grav.	582	11	87-90
19		Gravel	279	114	Major grav.	86	177	81-83	Major grav.	86	107	87-90	Major grav.	86	177	81-83
21		Earth	67	271	Major grav.	137	10	87-90	Major grav.	137	10	87-90	Major grav.	137	10	87-90
				6,750		3,370	2,064			2,788	1,203			2,867	1,793	

(1) For category definitions, see Table 11-4.
(2) In all cases, betterment is with paving.
(3) Net Present Value (NPV) calculated with 12 percent discount rate.
(4) Only 95 km out of 421 km total.
(5) Links less than 6.5 meters width.
(6) Links of 6.5 meters width or wider.
(7) Only 238 km out of 389 km total.
(8) Only 597 km out of 1,573 km total.

In all cases, the optimum improvements are either major gravelling or betterment with paving. No projects for completely new roads were selected as worthwhile compared with betterment, and this is really a reflection of the very low traffic volumes on existing roads. In total, 1,106 km of betterment with paving and 4,191 km of major gravelling could be justified with no budget restriction.

All but 172 km of betterment is in flat terrain, where this type of improvement can be justified at quite low traffic volumes. In undulating terrain, the highest volume category also merits betterment, but none of the mountainous roads had sufficient volumes to do so.

The effects of budget restraint are summarized below:

IMPROVEMENT	BUDGET	1981-1983	1984-1986	1987-1990	TOTAL
			(kilometers)		
Betterment	Optimum	923	183	-	1,106
	Medium	-	-	1,106	1,106
	High	189	355	-	544
Major Gravelling	Optimum	695	2,110	1,386	4,191
	Medium	-	-	3,229	3,229
	High	640	1,657	2,456	4,753

The main effect of budget restraint is to postpone projects until later in the decade. The postponement is most severe under the medium budget, which does not permit any expenditure on new projects for the first six years. In this case also, it is not possible to justify gravelling of category 18 roads.

Under the high budget, investment is permitted in some road categories at an earlier date than under the medium budget, but at a lower level -- major gravelling instead of paving. In total, the quantity of major gravelling in each period is very similar to the optimum (except in the last period), but the quantity of betterment is reduced.

Total expenditures compared with the optimum are reduced by 15 percent under the high budget and by 17 percent under the medium budget. NPVs are reduced by 15 percent under the high budget (similar to the expenditure reductions) but by 42 percent under the medium budget.

The analysis reported above was completed considering 21 road categories, each category made up of as much as 20 individual links in different parts of the country, but all having the same characteristics of surface, terrain and traffic volume. In interpreting these results, other factors had to be taken into account, In particular, it was desirable to have continuity along reasonable route lengths. A mixture of recommendations for betterment, major gravelling or even for doing nothing, all for different years, within, say, less than 50 km, would be confusing and difficult to implement. Also, there were cases when the particular characteristics of a link differed sufficiently from the overall category characteristics, that it warranted a different type of improvement. Hence, each link was evaluated, either separately, or as part of a group, and the results are presented in Appendix 11E. A description of the improvements recommended by region is given in the next section of this Chapter.

It can be noted also that other changes occurred in the final stages of preparing the investment program. In particular, it became evident that more construction remained to be completed on committed projects at the end of 1980 than previously expected. Consequently, new projects had to be postponed until later in the decade or, in a few cases, abandoned. The final program can be summarized as follows:

IMPROVEMENT	BUDGET	1981-1983	1984-1986	1987-1998	TOTAL
			(kilometers)		
Betterment	Optimum	923	183	0	1,106
	High	189	355	0	544
	Final	48	308	313	669
Major Gravelling	Optimum	695	2,110	1,386	4,191
	High	640	1,657	2,456	4,753
	Final	339	851	2,453	3,643

Conclusions on Unpaved Road Improvement Policies - It was concluded on the basis of this analysis, that for traffic volumes forecast for the next ten years, no completely new roads could be justified economically to replace roads already in existance (2). Rather, it is recommended that improvements are made on the existing alignments with either major gravelling or betterment. Major gravelling includes

(2) One exception is Machacamarca-Challapata -- see next section of this Chapter.

construction of all necessary minor drainage structures, together with placing and compacting a 15 cm surface of good gravel. Betterment includes, in addition to major gravelling, widening to 7 meters, minor improvements to alignment and the construction of a 6 meter pavement.

These recommendations are based on the finding that improvements to surface are more important than improvements to alignment. A six meter pavement is considered sufficient for betterment for low volumes of traffic. Even 1,000 vehicles per day, a volume greater than forecast on any currently unpaved road for the next ten years, represents at the most two vehicles per minute. This is discussed further in Appendices 11C and 11D, and a case study of the Rio Seco-Desaquadero highway is presented in more detail in Appendix 3G.

Both major gravelling and betterment can be regarded as interim improvements until such time as new roads can be economically justified. This will be when volumes reach between 1,000 and 1,500 vehicles per day. The advantage of both types of improvement is that they are cheap compared with new construction, so that improvements can be made to a greater length of road than would be possible if only new construction to ambitious design standards is considered. A further advantage is that works can be broken down into comparatively small contracts which will not require international bidding, which has resulted in high construction costs in the past.

It is accepted that the concept of betterment is new and that the estimates of quantities and costs as set out in Appendix 11B could be in error. It is therefore recommended that the first one or two betterment projects be regarded as pilot studies, to investigate further the desirable design and construction requirements, and also in more detail the benefits. They could be a combination of engineering investigations and theoretical analysis using the World Bank HDM model (see earlier).

The design standards currently in use (see Table 11-5) were reviewed and, although no new roads are recommended to replace existing highways, a revised set of design standards are suggested in Appendix 11C.

Both major gravelling and betterment have high benefits and many improvements of this type could be economically justified immediately. However, the Study had to take account of the likely limits on funds in the next ten years, and especially in the next few years. To a great degree, these limits are due to the large number of committed projects, of which many are in the highway sector. Also competing for the remaining non-committed funds are (in the highway sector) projects for bridges, for better maintenance and for overlaying and reconstructing existing paved highways. Both these latter projects tend to have priority, so that much of the program for improving unpaved roads has been postponed to later in the decade.

The specific recommendations by region are discussed in the following sections.

Recommended Improvements to Unpaved Roads

In the previous section, the evaluation of improvement policies for existing unpaved roads was discussed by road category. In this section, individual projects are discussed within the overall context of the evaluation. Details of the evaluation of each road are given in Appendix 11E. It should be noted that all recommendations presented here are subject to the findings of detailed feasibility studies which should reconsider, where appropriate, the question of intermodal competition.

Projects are discussed for seven areas of the country as follows:

- Western Bolivia
- South Yungas
- Southern Bolivia
- Cochabamba Region
- Oruro-Sucre-Boyuibe Corridor
- Central Bolivia
- Santa Cruz Region

Many of the road improvements in the border regions are best discussed in the context of a strategy for moving external trade. Therefore, detailed discussion of these links is found in Chapter 15. This is noted where appropriate in the discussion below. Whenever betterment is recommended, it includes a six meter pavement, as discussed above.

Recommended Projects in Western Bolivia - Recommended projects are shown in Figure 11-2 and are listed below:

PROJECT	ROUTE	KM	COST ($b mn.)	DATE	1989 ADT
Betterment	Río Seco-Desaguadero	98	109	1984-1986	382
	Huarina-Achacachi	19	23	1984-1986	483
Major gravelling	Oruro-Toledo	39	12	1981-1983	265
	Achacachi-Warisata	15	5	1984-1986	163
	Achacachi-Ancoraimes	36	13	1984-1986	245
	Viacha-Kapiri	13	4	1984-1986	118
	Warisata-Sorata	38	10	1987-1990	163
	Tiquina-Copacabana	42	13	1987-1990	183
	Viacha-Corocoro	73	25	1987-1990	116
	Patacamaya-Tambo Quemado	219	85	1987-1990	168

Río Seco-Desaguadero is the main highway route to Perú and has been the subject of several studies. This route is discussed in more detail in Appendix 11G and also in Chapter 15.

Patacamaya-Tambo Quemado has also been the subject of a final design study, but the resulting high standard paved design is not recommended by this Study.

Recommended Projects in the Yungas Valleys - Recommended projects are shown in Figure 11-3, and are listed below:

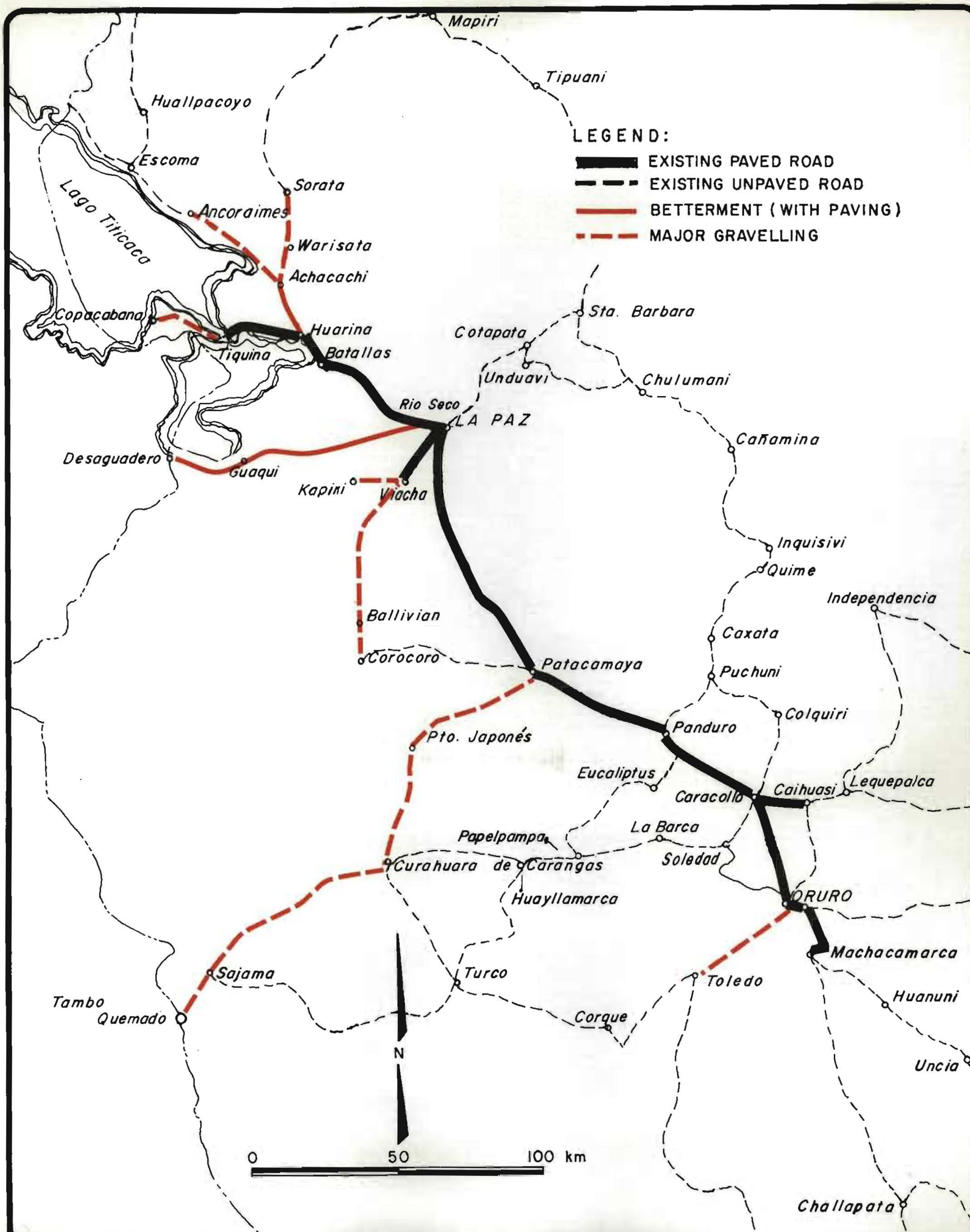
PROJECT	ROUTE	KM	COST ($b mn.)	DATE	1989 ADT
New Road	Santa Bárbara-Bella Vista	99	1,250	1987-1990	610
Major gravelling	Unduavi-Chulumani	67	22	1981-1983	163
	Quillacollo-Sta.Elena	56	19	1984-1986	101
	Inquisivi-Panduro	107	37	1984-1986	115
	Sta.Elena-Independencia	93	26	1987-1990	90
	Caracollo-Colquiri	37	15	1987-1990	220

The new road from Santa Bárbara to Bella Vista is discussed in detail in Chapter 12, and also Appendix 12B. It will complete the La Paz-Trinidad highway which is now in construction in all other sections.

The new road Inquisivi-Independencia was examined by the Study but is not recommended for construction in the next ten years (see later in this Chapter).

Projects in Southern Bolivia - Recommended projects are shown in Figure 11-4, and are listed below:

PROJECT	ROUTE	KM	COST ($b mn.)	DATE	1989 ADT
New Road	Las Carreras-Iscayachi	59	180	1981-1986	300
Betterment	Potosí-Cuchu Ingenio	38	72	1984-1986	424
	Cuchu Ingenio-Totora Palca	31	46	1987-1990	361
Major gravelling	Tomatas-Iscayachi	51	17	1981-1983	334
	Las Carreras-Camargo	74	26	1981-1983	265
	Padcaya-Bermejo	159	48	1984-1986	243
	Villamontes-Yacuiba	104	47	1984-1986	369



RECOMMENDED IMPROVEMENTS TO UNPAVED ROADS IN WESTERN BOLIVIA

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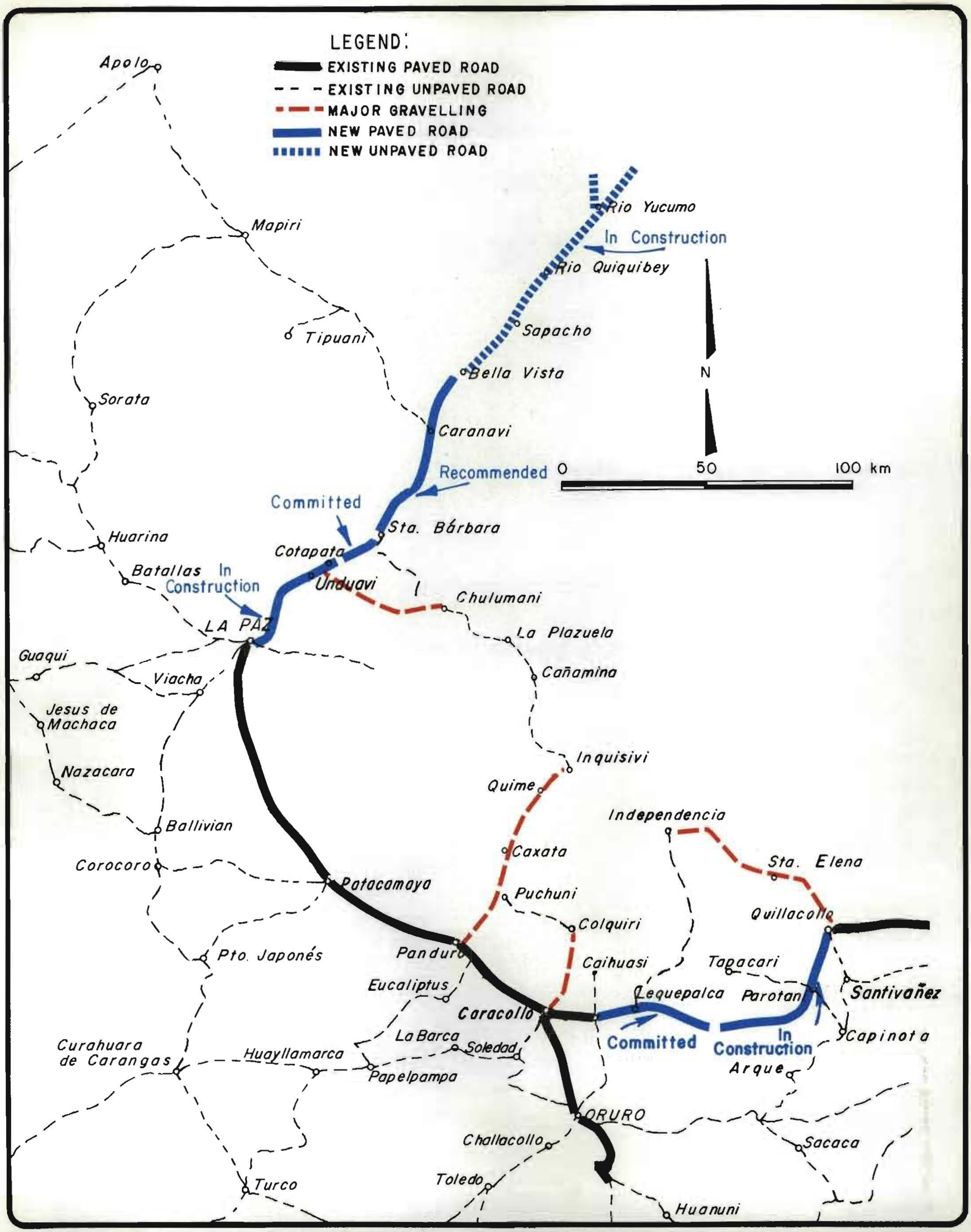
FIGURE 11–2



RECOMMENDED IMPROVEMENTS TO UNPAVED ROADS IN THE YUNGAS VALLEYS

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FIGURE 11–3

PROJECT	ROUTE	KM	COST ($b mn.)	DATE	1989 ADT
Major gravelling (continued)	Santiago de Huari-Challapata	13	5	1987-1990	160
	Totora Palca-Camargo	117	43	1987-1990	239
	Tarija-Villamontes	249	68	1987-1990	163
	Boyuibe-Villamontes	107	47	1987-1990	458
	Peñas-Fortín Villazón	130	18	1987-1990	50
	Tupiza-Villazón	92	39	1987-1990	87
	Cruce San Lorenzo-San Lorenzo	3	2	1987-1990	365
	Palos Blancos-Campo Pajoso	83	27	1987-1990	58

A new gravel section of road of approximately 42 km is required between El Monte and Tres Cruces in the link Las Carreras-Iscayachi, where the road is currently located in the bed of a river.

The route Potosí-Tarija is currently under study by the consultant TRANARG, but no information has yet become available (apart from the cost for El Monte-Tres Cruces given above).

It is noted that there are plans to construct dams in the rivers near Bermejo, but it is unlikely that they will be realized for several years. In this event, relocation of the Padcaya-Bermejo highway will be required. This route is discussed further in Chapter 15, as are two other international routes, Boyuibe-Yacuiba and Peñas Fortín Villazón.

It is understood that an ambitious plan to relocate a large section of the Tarija-Villamontes road have been discussed but no details were available. It is very unlikely that such a major improvement could be justified economically in the foreseeable future.

Recommended Projects in the Cochabamba Region - Recommended projects are shown in Figure 11-5, and are listed below:

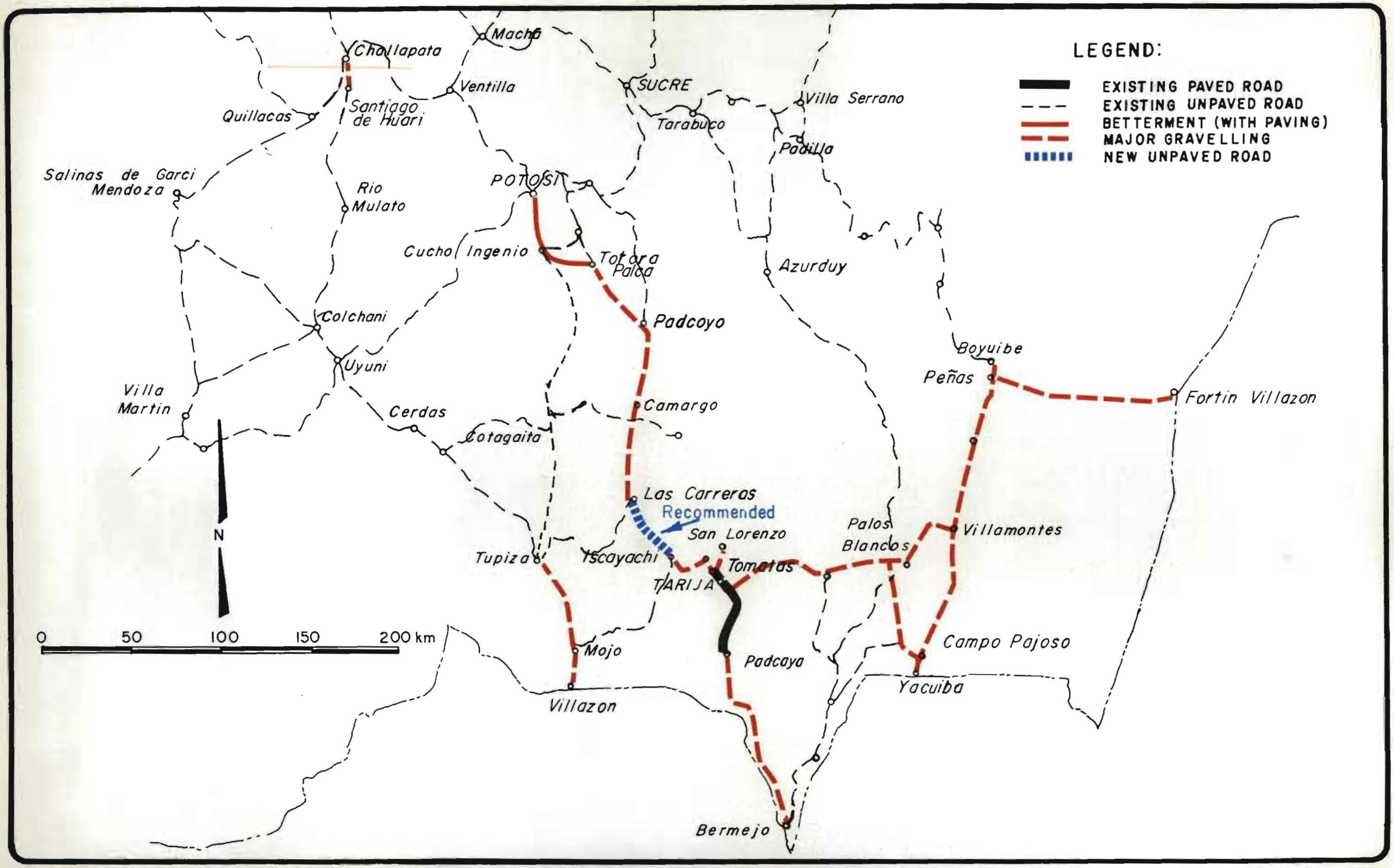
PROJECT	ROUTE	KM	COST ($b mn.)	DATE	1989 ADT
Betterment	Arani-Tarata	30	33	1987-1990	274
	Parotani-Capinota	25	35	1987-1990	483
Major gravelling	Angostura-Cruce Santivañez	5	2	1984-1986	168
	Cruce Santivañez-Tarata	13	5	1984-1986	130
	Aguirre-Chaco	19	5	1987-1990	70

The route Tarata-Cliza-Punata-Arani is close and parallel to the paved Cochabamba-Santa Cruz highway. It has been commented that the recommended paving project is therefore a duplication of the existing highway. This argument is not accepted. There is already a considerable volume of traffic on the gravel roads linking these towns which prefers not to divert at least 14 km to use the main highway. There is ample justification to improve these roads by paving, so that this traffic can enjoy benefits of reduced operating costs.

Recommended Projects in the Oruro-Sucre-Ipatí Corridor - Recommended projects are shown in Figure 11-6, and are listed below:

PROJECT	ROUTE	KM	COST ($b mn.)	DATE	1989 ADT
New Road	Machacamarca-Challapata	96	439	1984-1986	920
Betterment	Machacamarca-Huanuni	22	29	1984-1986	563
	Potosí-Sijllani	59	86	1984-1986	441
	Sucre-Pulquialto	29	53	1984-1986	356
	Challapata-Tarapaya	179	370	1987-1990	372
Major gravelling	Sucre-Tarabuco	64	26	1981-1983	179
	Tarabuco-Zudañez	45	17	1984-1986	135
	Huanuni-Uncía	56	19	1984-1986	277
	Ventilla-Macha	39	13	1984-1986	103
	Uncía-Macha	89	24	1987-1990	121
	Zudañez-Padilla	78	31	1987-1990	94
	Padilla-Ipatí	229	81	1987-1990	84
	Sijllani-Pulquialto	72	29	1987-1990	152

Machacamarca-Challapata is the only new paved road recommended in the central part of the country. It passes through a flat region subject to overflow from Lake Poopó in the wet season, and the proposal, in the 1980 Prudencio Claros-Delcanda Study, is that the new road is constructed on a raised embankment. However, the estimated costs of this project of $b439 million (1977) -- derived from the 1980 estimate of $b614 million -- does seem high, and it is strongly recommended that the design is reviewed to find ways of reducing costs.



RECOMMENDED IMPROVEMENTS TO UNPAVED ROADS IN SOUTHERN BOLIVIA

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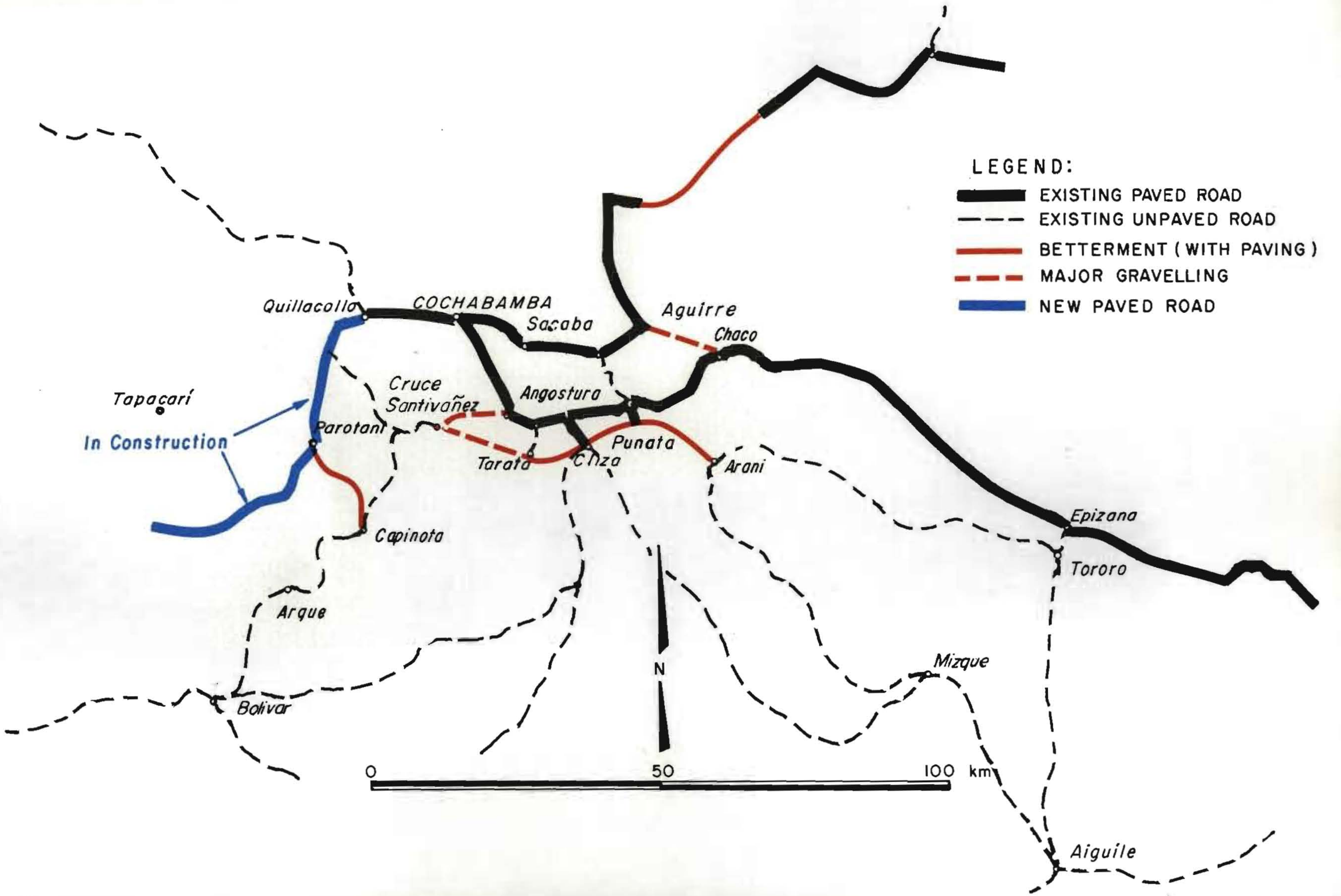
FIGURE 11–4



RECOMMENDED IMPROVEMENTS TO
UNPAVED ROADS IN
THE COCHABAMBA REGION

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FIGURE 11–5

The central road in this corridor from Uncía to Muyupampa via Sucre was the subject of a recent feasibility study. That Study suggested that sections of the road could be worth paving and recommended that detailed engineering studies be undertaken. The recommendation is not supported by this Study for the immediate future. Current and predicted traffic volumes do not justify a major road on this route, especially when funds for transport investment are so limited. It is recommended that any further studies undertaken on this road concentrate of the possibilities for major gravelling, or possible betterment (although this latter project is not recommended in the foreseeable future). It is further recommended that funds for major improvement be concentrated on the road from Oruro to Sucre via Machacamarca, Challapata, Ventilla and Potosí.

Recommended Projects in the Central Region - Recommended projects are shown in Figure 11-7, and are listed below:

PROJECT	ROUTE	KM	COST ($b mn.)	DATE	1989 ADT
Betterment	Oruro-Caihuasi	39	54	1987-1990	675
Major gravelling	Siberia-Comarapa	50	11	1984-1986	64
	Sucre-Epizana	238	102	1987-1990	175
	Aiquile-La Palizada	137	32	1987-1990	56
	Mataral-Vallegrande	53	20	1987-1990	105

Oruro-Caihuasi will provide a more direct link to the paved road to Cochabamba (now in construction).

The gravelling of Siberia-Comarapa was recommended earlier in the chapter in the discussion of the paved Cochabamba-Santa Cruz highway.

Recommended Projects in the Santa Cruz Region - Recommended projects are shown in Figure 11-8, and are listed below:

PROJECT	ROUTE	KM	COST ($b mn.)	DATE	1989 ADT
Betterment	Santa Cruz-Cotoca	18	27	1981-1983	560
	km 87 Puerto Banegas	9	14	1987-1990	679

PROJECT	ROUTE	KM	COST ($b mn.)	DATE	1989 ADT
Major gravelling	Santa Cruz-Abapó	128	59	1984-1986	536
	Cotoca-Puerto Pailas	25	14	1984-1986	50
	Abapó-Boyuibe	217	119	1987-1990	323

The Santa Cruz-Boyuibe route is discussed in more detail in Chapter 15.

The remaining section of paving to Puerto Banegas is recommended as a joint project with the construction of a bridge at this location over the Río Grande.

Other Recommended Projects - Four other projects to improve currently unpaved roads are given below:

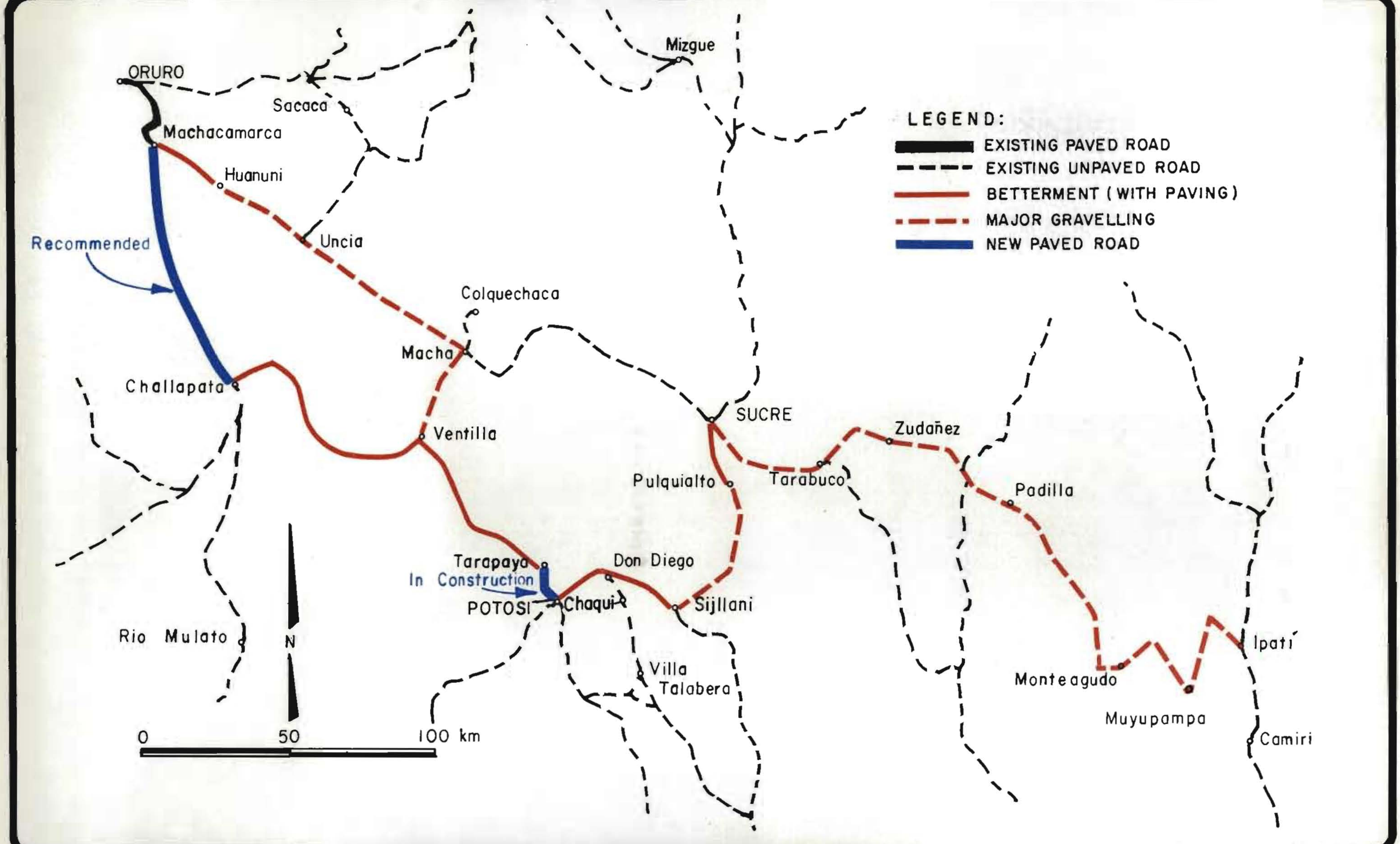
PROJECT	ROUTE	KM	COST ($b mn.)	DATE	1989 ADT
Betterment	Cobija-Porvenir	30	47	1981-1983	750
	Trinidad-Puerto Almacén	14	30	1984-1986	282
Major gravelling	Mutún-Quijarro	44	20	1981-1983	-
	Río Ivivigarzama-Puerto Villarroel	25	12	1987-1990	371

Existing Feeder Roads

Besides the 14,000 km of roads included in the computer network, there are a further 25,000 of unpaved feeder roads, mainly located in the central regions of the country. They range from tracks to important rural access roads vital for agricultural production.

A proper assessment of such roads requires detailed study of the areas served by the road. Assessments must be made of the potential production in the regions served, both from the point of view of the quality of the land and of the people living there, and of the markets which can absorb this production. Such studies are best conducted for comparatively small areas.

This study did not have the resources to conduct the necessary detailed surveys required to prepare detailed recommendations. However, it is recognized that feeder roads play an important role and that a proportion of the transport budget must be allocated for maintenance and improvements of these links.



RECOMMENDED IMPROVEMENTS TO UNPAVED ROADS IN THE ORURO-SUCRE-IPATI CORRIDOR

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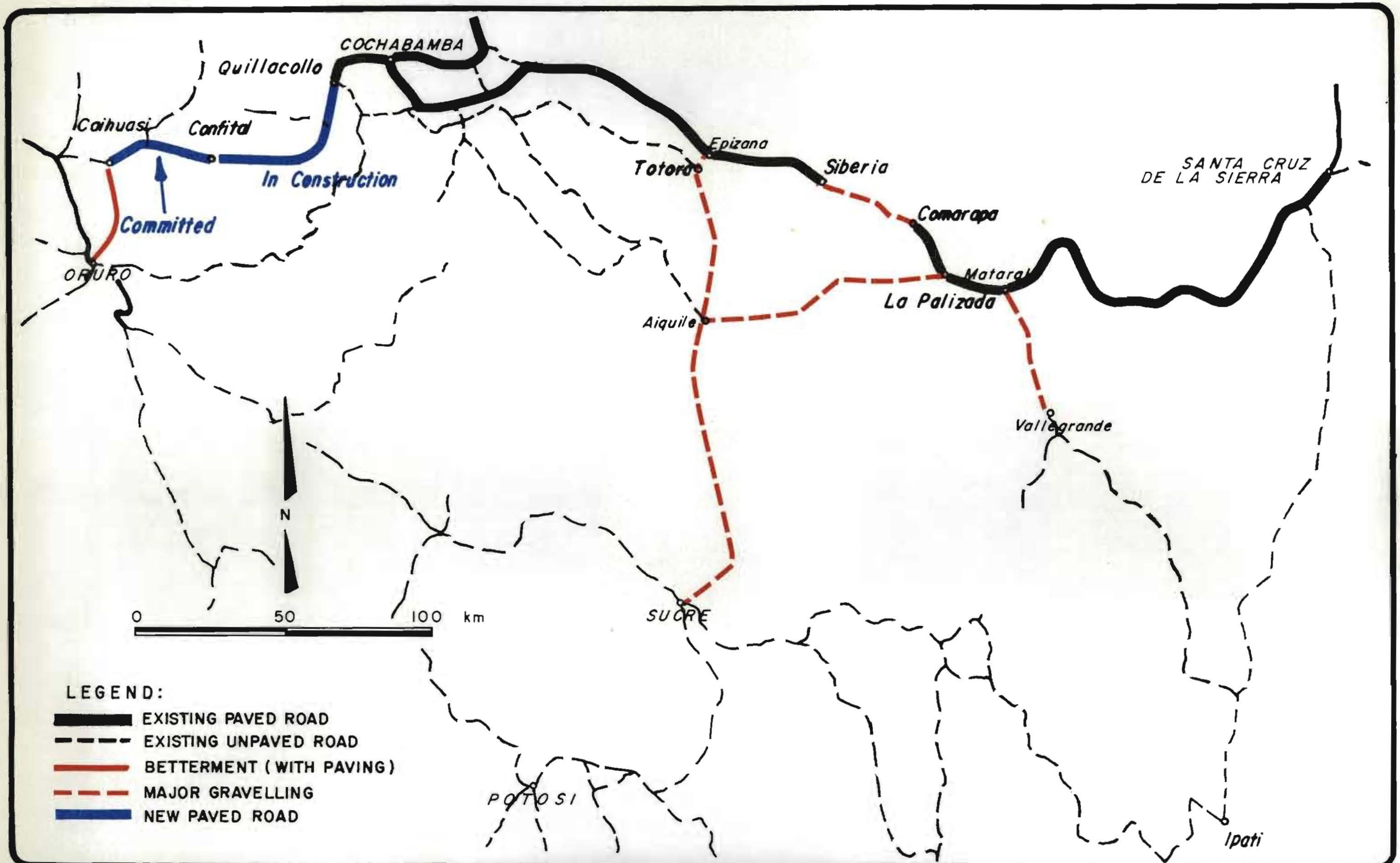
FIGURE 11–6



RECOMMENDED IMPROVEMENTS TO UNPAVED ROADS IN THE CENTRAL REGION

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FIGURE 11–7

Until recently, feeder road maintenance and development had been neglected. However, in 1976, the Feeder Road Department of SNC was created with the task of undertaking rural road improvement, with the assistance of USAID. One USAID project has been started, and another defined, which between them are intended to improve 2,200 km of rural access roads at a total cost of about 700 million pesos. This program was scheduled to be finished in 1983, but there were delays in the early stages, and USAID is currently suspended.

For the purposes of defining an overall investment program, it is assumed that spending on feeder roads will continue at about the current rate.

Road Maintenance Program

An analysis was made of road maintenance policies with two main objectives:

(i) To establish the optimum relationship between investment in road maintenance and investment in road improvements.

(ii) To outline a possible road maintenance program for the decade 1981-1990.

A four year Pilot Maintenance Study, funded by the World Bank, commenced in March 1981. It was originally planned that the Maintenance Study should overlap with this Study, so that the planning of a nationwide maintenance program could take advantage of both the global view provided by this Study, and the more detailed expertise of the Maintenance Study Team. Unfortunately, an overlap was not possible since the Maintenance Study had not commenced before the National Transport Study had ended. Nevertheless, the program presented here is intended to form the basis of a program to be refined and developed by the Pilot Maintenance Study.

Of necessity, the analysis presented here is general in nature. Detailed data about the existing conditions of roads were available only for the La Paz, Cochabamba and Santa Cruz districts of SNC. These had been collected for the World Bank Mission in 1977 and 1978, and by the World Bank Pilot Maintenance Study, completed in 1979. Also, although separate road maintenance costs were identified by region (see Chapter 5), it was necessary to conduct the rather extensive analysis of maintenance policies using average countrywide costs, in order to reduce the scope of work to manageable proportions.

This section is concerned with routine maintenance only. It includes patching and surface dressing for paved roads and grading, routine gravel resurfacing and spot gravelling for unpaved roads. It also includes regular maintenance of ditches, drainage and shoulders for all roads. Major improvements, including overlaying and rehabilitation for paved roads, and betterment and major gravelling for unpaved roads, were considered earlier in this chapter.

Current Maintenance Policies - Road maintenance is the reponsibility of the National Road Service (Servicio Nacional de Caminos-SNC). The work is handled by the ten SNC district offices which are each responsible for between one and six sub-offices (Residencias). (See Chapter 16, Figure 16-4). Unpaved road maintenance dominates since such roads constitute 97 percent of the road network and are more maintenance intensive than paved roads.

Three levels of maintenance, which recognize to some extent different levels of traffic, are defined by SNC as follows:

(i) Permanent maintenance, performed on 9,348 km of relatively high volume roads, including all paved roads, and using SNC equipment and labor.

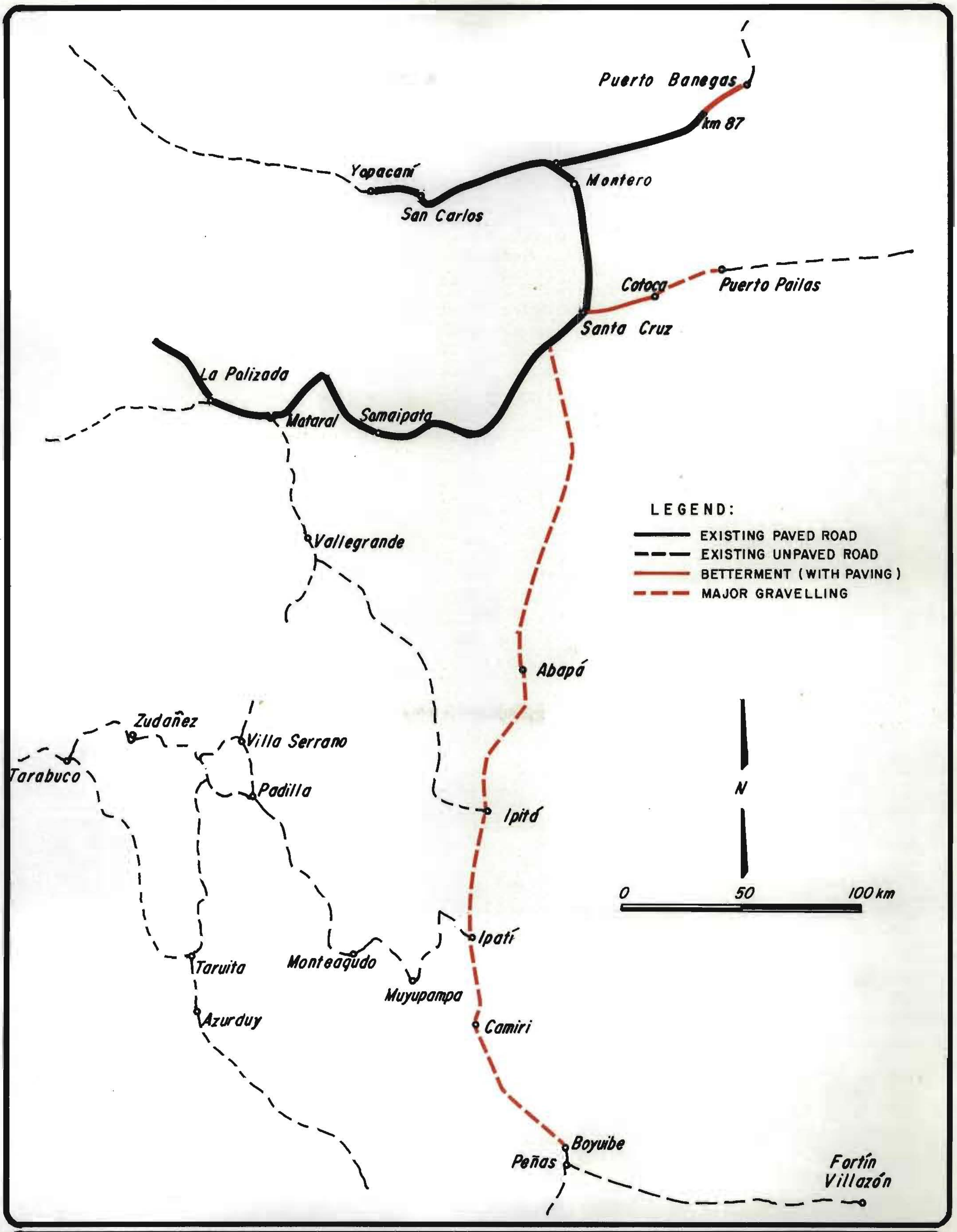
(ii) Temporary maintenance, performed on 8,096 km of less important unpaved roads, again using SNC equipment and labor, but less frequently than permanent maintenance.

(iii) Occasional maintenance performed infrequently on the remaining 21,384 km of roads in the system, using labor from "Prestación Vial" services, and also the work force and equipment of the Feeder Road Department of SNC.

An estimate of the lengths of roads in 1979 by surface and by type of maintenance is given below:

	MAINTENANCE CLASS			
ROAD SURFACE	Permanent (km)	Temporary (km)	Occasional (km)	Total (km)
Paved	1,289	0	0	1,289
Gravel	5,172	1,543	83	6,798
Earth	2,887	6,553	21,301	30,741
Total	9,348	8,096	21,384	38,828

Table 11-10 shows the quantities of maintenance performed by SNC in 1979. Routine paved road maintenance (excluding rehabilitation) was minimal with not much patching (about 0.5 percent of the road surface area) and with little surface dressing or overlaying (about 4 km of each). The result of such a low policy is clearly apparent in the state of the older paved roads, mostly located in Santa Cruz Department. Potholes are frequent , road edges have deteriorated reducing road width, and in some sections, especially parts of the Santa Cruz-Cochabamba road, the pavement has vanished for sections of up to several hundred meters. The result of this neglect is that complete



RECOMMENDED IMPROVEMENTS TO UNPAVED ROADS IN THE SANTA CRUZ REGION

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FIGURE 11–8

Table 11-10

1979 ROAD MAINTENANCE QUANTITIES

OPERATION	PAVED ROADS	GRAVEL ROADS	EARTH ROADS	TOTAL
Unpaved Roads				
Grading (km)	-	80,676	8,163	88,839
Placement of Gravel (cu m)	-	626,698	-	626,698
Paved Roads				
Patching (sq m)	38,183	-	-	38,183
Surface Dressing (sq m)	22,423	-	-	22,423
Overlaying (sq m)	31,760	-	-	31,760
Rehabilitation (sq m)	280,980	-	-	280,980

SOURCE: National Road Service (SNC)

rehabilitation is now required for some roads, as discussed earlier in this chapter. It is noted that while criticism is directed at the quantity of maintenance performed, the quality of the work which has been observed appears to be good.

Gravel road maintenance is more intensive with a grading once every 3,000 vehicle passes on average, or about once per month. The major problem is that it is difficult to keep surface in good condition, even with frequent grading, due to the use of large size gravel. Measurements made in 1977 and 1978 indicated average roughness values of 11,000 mm/km in the wet season and 18,000 mm/km in the dry season, well above an attainable 5-6,000 mm/km for a properly gravelled and maintained surface.

Earth roads receive only light maintenance with the length of grading in 1979 one quarter of the total length of earth roads in the country. On average, one grading pass per year is made on earth roads subject to permanent or temporary maintenance, or about once every 11,000 vehicle passes.

The total cost of maintenance in 1979, including administration and supervision, was estimated at $b 333 million in current prices, or $b 264 million in 1977 pesos. This gives an average maintenance cost of about $b 6,800 per km. These figures can be sub-classified in two ways as follows:

By surface type	Paved	$b 47,479 per km
	Gravel	27,400
	Earth	480
By maintenance category	Permanent	$b 22,507 per km
	Temporary	3,347
	Occasional	1,286

If only routine paved maintenance is considered (i.e. excluding overlaying or rehabilitation which were carried out on a total of about 50 km in 1979), the average expenditure for paved roads reduces from $b 47,479 to $b 6,284 per km.

If only the costs of maintenance by "prestación vial" are considered for occasional maintenance, the expenditure per km drops from $b 1,286 to $b 260.

Evaluation of Future Maintenance Policies - The World Bank HDM Model (see earlier) was used to evaluate alternative routine maintenance policies. The work was carried out in two stages.

In the first stage, a wide range of initial policies were evaluated for each surface type; distinguishing earth, poor gravel (i.e. not subject to major gravelling), good gravel and paved. Initial unpaved policies differed principally in the grading frequency, but also considered different intensities of spot gravelling and gravel resurfacing. Initial paved policies were defined by the frequency of patching and surface treatment operations.

In the second stage, based on the evaluation of the initial policies, the better policies for each surface type were selected, and combined into a set of six alternative overall policies (of which one represented current maintenance). They are presented later in Table 11-13. These overall policies were then evaluated over the ten year period 1981-1990, assuming the improvements included in the recommended road investment program, in order to select the optimum policy.

It is emphasized that the objective of this work was not to specify in detail a set of maintenance operations. This requires detailed consideration of local conditions and materials. Rather, the objective was to investigate priorities and level of funding for maintenance, given also other requirements for highway investment (rehabilitation, betterment, new infrastructure), and limits on budget available. The conclusion is that improved maintenance has a high priority and that current spending should be doubled over the period 1981-1990.

The analyses are discussed below.

<u>Analysis of Initial Unpaved Road Maintenance Policies</u> - A range of policies were examined for each of the three surface types of earth, poor gravel and good gravel.

Existing unpaved roads were first classified by traffic volume, giving four categories each for earth and gravel. For each of the four earth categories, six initial maintenance policies were specified for analysis, each with a different grading frequency but all, except for the two minimum policies, assuming 20 cubic meters per year spot gravelling. Similarly six initial maintenance policies were specified for the four gravel categories based on grading frequency, but also varying the volume of spot regravelling and the resurfacing policy.

Ideally, gravel roads should be subclassified into those with poor gravel surfaces and those with good gravel, but few good gravel surfaces could be identified. Therefore, two sets of HDM Model runs were made, both coded with the same geometric characteristics for existing gravel roads, but one specifying poor gravel surface and the other good gravel. In this way, separate sets of maintenance policies were investigated for the two surface types.

The main differences between poor gravel and good gravel maintenance operations are in the type of gravel placed, and in the sophistication of the maintenance operation. In place of the coarse gravel currently in use, good gravel surfaces require selected and screened materials, either natural or crushed, to give a smoother surface. Also, good gravel maintenance requires watering and compaction every third grading. Therefore, unit costs for maintaining good gravel surfaces are approximately twice as high as for poor gravel but the rate of deterioration is slower and they require less frequent grading.

The initial maintenance policies, as specified above, were tested for each of the earth and gravel road categories, over the period 1981-1990. Traffic growths over this period were derived from the Transport Model. The results of the test, in terms of total discounted economic costs over the period -- the sum of vehicle user costs, vehicle time costs and road maintenance costs -- are shown for each policy in Table 11-11. It is observed that total costs do not vary much over quite a wide range of grading frequencies. For example, costs for earth roads vary by only 10 percent over a range of grading frequencies from once every 1,000 vehicle passes to once every 20,000 passes. The variation in costs for gravel roads is even less. In other words, the decrease in vehicle operating costs due to smoother road surfaces, is balanced by the increase in maintenance costs required to obtain the smoother surface.

On the basis of these results, optimum frequencies were selected as follows:

Earth:	Every 4 to 5,000 vehicle passes
Poor Gravel:	Every 6,000 vehicle passes
Good Gravel:	Every 12,000 vehicle passes.

That is to say, more frequent grading than currently practised can be justified for earth roads, but less frequent grading is appropriate on gravel roads, very much less frequent if good gravel surfaces are placed. This is similar to the conclusion of the World Bank 1978 Highway Maintenance Project Report.

Analysis of Initial Paved Road Maintenance Policies - Paved roads were classified into five groups decided partly by location, and partly by traffic volume and likely traffic growth characteristics. Eight initial paved road policies were defined for analysis, based on variations in the frequency and intensity of the patching and surface dressing operations. These policies were tested for each paved road group for the period 1981-1990, and the results of the evaluations, in terms of total discounted economic costs for each policy, are shown in Table 11-12.

Table 11-11

INITIAL UNPAVED ROAD MAINTENANCE POLICIES

(Total transport costs 1981-1990 in millions of 1977 pesos discounted to 1981 at 12 percent)

ROAD CATEGORY		TOTAL TRANSPORT COSTS BY MAINTENANCE POLICY					
1977 Volume	Length	1	2	3	4	5	6
(vehicles per day)	(km)	(millions of 1977 pesos, except grading frequencies shown in brackets)					
Earth Roads							
(Vehicle passes between gradings)		(20,000)	(11,000)	(5,000)	(4,000)	(2,000)	(1,000)
0-49	4,593	3,090	2,855	2,846	2,840	2,891	3,071
50-99	553	997	953	950	952	979	1,046
100-199	363	1,650	1,553	1,524	1,527	1,576	1,702
200-399	52	373	357	356	358	375	415
Total	5,561	6,110	5,718	5,676	5,677	5,821	6,234
Poor Gravel Roads							
(Vehicle passes between gradings)		(20,000)	(9,000)	(6,000)	(4,000)	(3,000)	(2,000)
0-49	2,383	2,350	2,323	2,353	2,373	2,397	2,449
50-99	1,331	3,403	3,381	3,410	3,447	3,489	3,574
100-199	1,593	6,496	6,455	6,509	6,572	6,643	6,790
200-399	475	4,211	4,198	4,233	4,281	4,333	4,440
Total	5,782	16,460	16,357	16,505	16,673	16,862	17,253
Good Gravel Roads (1)							
(Vehicle passes between gradings)		(30,000)	(16,000)	(12,000)	(9,000)	(6,000)	(3,000)
0-49	2,383	2,131	2,083	2,100	2,101	2,111	2,157
50-99	1,331	3,056	3,008	3,023	3,030	3,052	3,132
100-199	1,593	5,847	5,765	5,803	5,815	5,851	5,987
200-399	475	3,816	3,776	3,793	3,806	3,836	3,938
Total	5,782	14,850	14,632	14,719	14,752	14,850	15,214

(1) There are few good gravel roads in Bolivia. Therefore, to assess good gravel maintenance policies, the existing poor gravel roads were reassessed using the HDM Model assuming that they all had been resurfaced with good gravel.

Table 11-12

INITIAL PAVED ROAD MAINTENANCE POLICIES

(Total transport costs 1981-1990 in millions of 1977 pesos discounted to 1981 at 12 percent)

POLICY DEFINITION			MAINTENANCE POLICIES							
		POLICY:	0	1	2	3	4	5	6	7
Patching (Percent of unpatched cracks)		=	10 (2)	20	20	50	50	50	80	80
Surface Dressing (Percent cracking threshold level) (1)			None	30	15	30	15	5	15	5
ROAD GROUPS	LENGTH (km)	1980 VOLUME (veh.per day)	(millions of 1977 pesos)							
1 : Río Seco-Tiquina	95									
El Alto-Viacha	20									
El Alto-Oruro	207	590	5,869	5,891	5,946	5,859	5,935	6,114	5,896	6,114
Caracollo-Caihuasi	18									
Quillacollo-Confital	105									
	445									
2 : Cochabamba (San Benito)-Santa Cruz (km12)	408	458	3,451	3,686	3,722	3,653	3,658	3,892	3,649	3,826
3 : Cochabamba (Sacaba)-Chimoré	145	285	1,283	1,303	1,294	1,283	1,294	1,371	1,299	1,335
4 : Guabirá-Puerto Banegas	54									
Guabirá-Chané	41									
Cochabamba-San Benito	41									
San Benito-Punata	5	732	2,947	2,989	3,051	2,990	3,039	3,101	3,033	3,082
Tolata-Cliza	8									
Oruro-Machacamarca	31									
Padcaya-Tomatas	53									
	233									
5 : Yapacaní-Guabirá	68									
Santa Cruz-Guabirá	47									
Santa Cruz-Km 12	11	2,142	6,556	5,994	5,893	5,977	5,879	5,793	5,895	5,792
Cochabamba-Sacaba	8									
Cochabamba-Quillacollo	15									
	149									
TOTAL COSTS	1,380		20,106	19,863	19,906	19,762	19,805	20,271	19,772	20.149

(1) Surface dressing initiated when cracks, as percentage of total surface area, reach stated threshold level.
(2) But not more than 100 m^2 per km per year.

The same basic conclusions can be reached as for unpaved road policies; that total transport costs do not vary much over quite a wide range of maintenance policies. The smallest variations observed in total cost over the range of policies tested were for road groups 1 and 4 (4 percent) and the largest was for group 5 (12 percent). In general, policies combining a higher level of patching with a medium frequency of surface dressing appeared to do better. At higher traffic volumes, an increased frequency of surface dressing becomes justified.

Selection of a National Road Maintenance Program - From the analyses of the initial road maintenance policies by road surface type presented above, a set of five policies was selected, combining paved and unpaved policies, for evaluation together with the road improvement investment program. These are specified in Table 11-13, together with a policy representing current practice (0) which was obtained by adjusting the policies in HDM Model in a calibration process until observed maintenance quantities were reproduced.

Some changes were made from the initial policies described above, the most important concerning the maintenance of poor gravel roads. In the analysis of the initial policies presented above, it was assumed that good gravel standards were only attainable on roads subject to major gravelling, as described earlier in the chapter. However, it seemed reasonable to assume that if routine resurfacing and maintenance operations for poor gravel roads started to make use of better gravel, some benefit would be felt. It was considered that the benefits to this better maintenance operation would be about half the benefit derived from a full scale conversion to a good gravel surface. On this basis, improved maintenance operations of this nature could be justified for poor gravel surfaces with volumes above 30 vehicles per day. In addition, the current policy for paved roads assumed a limit of 50 m^2 per kilometer for patching operations, instead of 100 m^2 assumed previously.

Each of the maintenance policies defined in Table 11-13 were tested for the period 1981-1990, assuming an investment program for major road improvements -- committed road projects, road betterment with paving and major gravelling. Each policy was compared to the current policy, and the following net present values were calculated (presented in order of increasing cost):

POLICY	ADDITIONAL COST TO CURRENT POLICY	NET PRESENT VALUE AT 12 PERCENT
1	1,862	1,102
3	2,015	1,227
4	2,023	1,134
5	2,072	1,234
2	2,237	1,059

Table 11-13

SELECTED ROAD MAINTENANCE POLICIES

POLICY	EARTH ROADS	POOR GRAVEL ROADS BELOW 30 VEH/DAY	POOR GRAVEL ROADS ABOVE 30 VEH/DAY	GOOD GRAVEL ROADS	PAVED ROADS UP TO 1500 VEH/DAY	PAVED ROADS OVER 1500 VEH/DAY
0	1.Grade every 11,000 vehicle passes to 6,000 mm/km roughness.	1.Grade every 3,000 vehicle passes to 8,000 mm/km roughness.	1.Grade every 3,000 vehicle passes to 8,000 mm/km roughness.	1.Grade every 16,000 vehicle passes to 5,000 mm/km roughness	1.Patch 10% cracks but not more than 50 m2/km/year.	1.Patch 10% cracks but not more than 50 m2/km/year.
		2.Replace 30% gravel loss but no more than 50 m3/km/year.(spot gravelling)	2.Replace 30% gravel loss but not more than 50 m3/km/year. (spot gravelling)	2.Replace 20% gravel loss but not more than 50 m3/km/year. (spot gravelling)		
		3.Regravel when surface thickness=60 mm adding 60 mm.	3.Regravel when surface thickness=60 mm, adding 60 mm.	3. Regravel when surface thickness =50mm adding 50mm.		
1	1.Grade every 5,000 vehicle passes to 6,000 mm/km roughness.	1.Grade every 6,000 vehicle passes to 8,000 mm/km roughness.	1.Grade every 9,000 vehicle passes to 6,500 mm/km roughness.	1.Grade every 12,000 vehicle passes to 5,000 mm/km roughness.	1.Patch 50% cracks	1.Patch 50% cracks.
	2.Spot gravelling=20 m^3/km/year.	2.As policy 0.	2.As policy 0.	2.Replace 30% gravel loss but not more than 50 m3/km/year. (spot gravelling)	2.Surface Dress when cracks appear on 30% of road area.	2.Surface Dress when cracks appear on 15% of road area.
		3.As policy 0.	3.As policy 0.	3. Regravel when surface thickness = 60 mm, adding 60 mm.		
2	As policy 1.	As policy 1.	As policy 1.	As policy 1.	1.Patch 50% cracks.	1.Patch 50% cracks.
					2.Surface Dress when cracks appear on 15% of road area	2.Surface Dress when cracks appear on 5% of road area.
3	As policy 1.	As policy 1.	As policy 1.	As policy 1.	1.Patch 80% cracks	1.Patch 80% cracks.
					2.Surface Dress when cracks appear on 15% of road area.	2.Surface Dress when cracks appear on 5% of road area.
4	1.Grade every 4,000 vehicle passes to 6,000 mm/km roughness.	As policy 1.	As policy 1.	As policy 1.	As policy 1.	As policy 2.
	2.Spot regravelling=20 m3/km/year.					
5	As policy 1.	As policy 1.	As policy 1.	As policy 1.	As policy 3.	As policy 3.

NOTE: On paved roads, 'cracks' refers to both cracks and holes in the surface.

Policies are worth considering if they show an increase in net present value for increasing cost. On this basis, any of the policies 1, 3 and 5 are worth considering and the best policy depends on what other demands are made on funds for investment. An optimum policy was selected using the budget allocation procedure. The alternative maintenance policies were assumed to be in competition with major road improvement projects -- betterment and major gravelling -- for the same funds.

Under the high budget assumption (see first section of this Chapter), maintenance policy 3 was selected but under the medium budget, no policy was selected - that is to say, the current policy should be continued. However, with only a slight relaxation of the very stringent investment limits in the first period for the medium budget, maintenance policy 1 is selected. If it is assumed that total funds over the period 1981-1990 will correspond to the medium budget, but that more will be available in the first period than previously considered, then maintenance policy 3 is again selected.

It is therefore recommended that maintenance standards as specified in policy 3 (see Table 11-13) should be adopted as a guide to maintenance operations. Maintenance quantities implied by Policy 3, compared with current maintenance, are shown in Table 11-14. The requirement for grading of gravel roads falls as good gravel and better techniques are introduced, but grading on earth roads increases. Surface dressing frequencies on paved roads are high (average of once every five to six years) probably due to the comparatively weak pavements both on existing roads and on roads recommended for betterment. This aspect should be looked at more closely by the new Maintenance Study.

In fact, the total quantities indicated in Table 11-14 will not be achieved as it will take time to introduce the new policies. It is assumed that the recommended new policy will be introduced in the three districts of La Paz, Cochabamba and Santa Cruz over the four years of the Pilot Maintenance Study, and that this same study will also prepare the way for the introduction of better maintenance standards to the rest of the country afterwards. It is expected that more detailed evaluations during the Pilot Maintenance Study will result in modifications to the policy recommended here, at least to introduce local and regional variations.

Maintenance Program Cost Adjustments - The analysis presented here covers only the roads in the Study computer transport network. This includes all paved roads, 95 percent of gravel roads but only 20 percent of earth roads.

Table 11-14

QUANTITIES OF ROUTINE MAINTENANCE

(for roads included in the Recommended Transport Network)

CLASS	ITEM	1981 Current Policy	1981 Recommended Policy	1984 Current Policy	1984 Recommended Policy	1990 Current Policy	1990 Recommended Policy	TOTAL 1981 TO 199 Current Policy	TOTAL 1981 TO 199 Recommend Policy
Gravel	Total Length (km)	(5,441)		(5,677)		(5,834)			
	Grading (km)	64	21	56	27	25	18	425	200
	Gravelling(1) (m^3)	320	315	443	440	224	287	3,558	3,624
Earth	Total Length (km)	(5,469)		(5,316)		(4,857)			
	Grading (km)	6	14	7	16	6	13	62	136
	Gravelling (2) (m^3)	-	109	-	106	-	96	-	1,036
Paved	Total Length (km)	(1,413)		(1,702)		(2,204)			
	Patching (m^2)	103	116	114	399	203	462	1,384	3,346
	Surface Dressing (m^2)	-	1,512	-	1,089	-	3,386	-	21,055

(1) Gravel resurfacing and spot gravelling.

(2) Spot gravelling.

Of this latter category, all roads currently maintained under "prestación vial" (see earlier), and some roads covered by the SNC 'temporary' maintenance category, were excluded from the computer network. To allow for this for budget presentation purposes total gravel road maintenance costs were increased by 5 percent and total earth road costs by 50 percent (assuming that most of these roads have very low volumes of traffic and require little maintenance). The Pilot Maintenance Study should investigate this in more detail.

Also, to allow for a start-up period for improved maintenance, costs were adjusted as follows:

1981-1983 - Additional maintenance under Policy 3 included only for the three districts of La Paz, Cochabamba and Santa Cruz. The deferred maintenance of the Pilot Maintenance Project is assumed to be a part of this.

1984-1986 - Additional maintenance under Policy 3 is included in full for the three districts listed above, together with half the additional maintenance for the remainder of the country.

1987-1990 - All additional costs under Policy 3 are included.

Finally, costs of maintenance so far present exclude costs of administration and supervision - essentially the cost of running the SNC Maintenance Divisions throughout the country; these are added below.

Estimated costs of routine maintenance for the ten years, 1981-1990, are as follows:

PERIOD	CURRENT MAINTENANCE Administration	Other	ADDITIONAL MAINTENANCE (1)	TOTAL
	(millions of 1977 pesos)			
1981-1983	255	387	334 (2)	976
1984-1986	255	387	407 (3)	1,049
1987-1990	340	516	1,058	1,914

(1) Increased costs of Policy 3 compared with the current policy, modified as detailed above.
(2) Only 191 included in investment program for the three districts of LaPaz, Cochabamba and Santa Cruz.
(3) Only 383 included in investment program to allow start-up period for better maintenance outside the three districts given in (2) above.

By the end of the period 1981-1990, average costs of maintenance by surface type would change considerably, as indicated below (averaging over all roads in the country):

SURFACE TYPE	1979 ROUTINE MAINTENANCE COSTS ($b per km)	1990 ROUTINE MAINTENANCE COSTS ($b per km)
Paved	6,284	97,550
Gravel	27,400	27,600
Earth	480	3,900

Paved road costs increase greatly due to more intense patching and also to the introduction of surface dressing on a large scale. Gravel road costs stay about the same, which is the effect of two contrary influences: while unit costs go up due to the introduction of new techniques, including use of good gravel, the frequency of gravel road maintenance operation can be decreased substantially due to the greater durability of the improved surfaces. Earth road maintenance costs increase sharply from the present low levels.

Average traffic volumes on roads included in the computer Transport Network in 1989, according to the results of the Recommended Network Test, were as follows:

Paved	(2,204 km)	=	782 vehicles per day
Gravel	(5,834 km)	=	137 vehicles per day
Earth	(4,857 km)	=	21 vehicles per day

Bridge Construction

The Study made a survey of bridge requirements and identified a total of 325 locations where bridges could be required, totalling 17,700 meters. This compares with between 150 and 200 bridges built in the twenty-one years from 1960 to 1980 with a total length of 9,100 meters. The cost of building all 325 bridges identified is estimated at $b 2,414 million.

SNC also identified for the Study 34 old bridges in need of replacement, totalling 1,327 meters. All of these bridges are for single direction traffic and have low loading limits. The cost of replacing these bridges would be about $b 179 million.

One third of the length of the 325 new bridges are associated with just four projects as follows:

PROJECTS	NUMBER OF BRIDGES	TOTAL LENGTH (meters)
Chimoré-Yapacaní	13	2,735
Santa Bárbara-Bella Vista	14	818
Eteramazama-San Ignacio de Moxos	12	1,852
San Borja-Trinidad	12	858
TOTAL	51	5,903

The Chimoré-Yapacaní project is already committed with construction expected to start in 1982. The other three projects are all discussed in detail in Chapter 12. With the exception of San Borja-Trinidad, the bridges for these projects will require special contracts and the design would be beyond the capacity of the SNC bridge department.

For the remaining new bridge projects, assessments were made of the probable benefits due to bridges through avoidance of traffic interruptions. The extent of road interruptions varies widely, from delays of only two or three hours, up to interruptions of a few days. Interruptions are concentrated in the wet season, which usually last from the beginning of December to the end of March. After a preliminary screening, 69 bridge projects remained for evaluation. The bridge evaluations are described in detail in Appendix 11F.

The cost of delays without bridge construction were calculated separately for short and long interruptions. For short interruptions, it was assumed that only vehicle, crew and passenger time costs were of importance. The number of vehicles likely to encounter the delay were calculated and each was assumed to experience half of the length of the delay on average.

For longer interruptions, cargo delay costs were also taken into account. Also, it was assumed that for long delays, neither passengers nor vehicles or crew would be entirely idle throughout the interruption, but that there would be the ability to compensate by the rescheduling of activities.

The results of the evaluations of the bridges are shown in Table 11-15. First year rates of return are shown for the year 1989 and projects are listed in order of priority.

Table 11-15

EVALUATION OF BRIDGES

PROJECT	NUMBER OF BRIDGES	TOTAL LENGTH	INTERRUPTIONS AVOIDED: No. Per Year	INTERRUPTIONS AVOIDED: Length of Each	1989 TRAFFIC	ESTIMATED COST	FIRST YEAR RATE OF RETURN
		(m)		(hours)	(vpd)	(Millions of 1977 pesos)	(percent)
Villamontes-Yacuiba	9	146	40	8	369	17	46
Boyuibe-Villamontes	7	150	16	12	458	23	18
Puerto Banegas-San Ramón	1	74	5	72	409	7	18
Río Seco-Desaguadero	4	238	15	48	393	25	17
Machacamarca-Uncía	5	280	16	24	360	32	12
SUBTOTAL	26	888				104	
Quillacollo-Independencia	3	90	32	10	94	13	11
Mataral-Vallegrande	2	66	10	36	105	5	11
Sucre-Padilla	1	15	8	6	135	3	10
Epizana-Sucre	2	180	12	18	166	12	9
Camargo-Tomatas	8	136	16	6	293	17	8
Santa Cruz-Boyuibe	2	350	40	24	286	87	8
Potosí-Camargo	11	225	16	6	254	27	5
Potosí-Tarapaya	1	40	-	-	578	4	- (1)
Puerto Japonés-Tambo Quemado	4	85	16	3	166	9	2
Patacamaya-Puerto Japonés	9	205	16	3	175	27	1
SUBTOTAL	43	1,392				204	
TOTAL	69	2,280				308	

(1) No data available to calculate rate of return.

Sixty-nine bridges are considered totalling 2,280 meters and costing an estimated 308 million pesos. Of these, only 26 bridges, totalling 888 meters, attain a first year rate of return greater than 12 percent.

It is notoriously difficult to assess accurately the delays caused by lack of bridges, or the effect that lack of bridges has on restricting the development of a region. Therefore, all bridges shown in Table 11-15, together with the bridges for San Borja-Trinidad and the replacement of existing bridges indicated above, should all be considered as candidate projects for the next ten years. Of these bridges, those on the Patacamaya-Puerto Japonés-Tambo Quemado route are a special case, in that the beds of the rivers crossed are unstable resulting in not infrequent loss of vehicles. These bridges are therefore required to make the route safe, rather than to avoid delays.

Evaluation of the Río Grande Crossing

The Río Grande, east of Santa Cruz, presents a serious obstacle to travel. Although it is crossed by a 1.8 km railroad bridge at Puerto Pailas on the Santa Cruz-Corumbá line, no permanent road crossing exists. Instead, vehicles have to use a ferry crossing further north at Puerto Banegas. A plan of the region is shown in Figure 11-9.

The Puerto Banegas road ferry is unsatisfactory for many reasons. First, it cannot operate for periods during the wet season because of strong currents. Secondly, the pontoons which carry the vehicles are manipulated solely by manual labor and are consequently very slow. Thirdly, the approaches to the ferry are unsatisfactory, passing over mud flats when water levels are low. Fourthly, long delays are often encountered. Lastly, very high tariffs are charged by the operators. Normal tariffs are between $b 200 and $b 400 for a truck, but tariffs charged can rise to between $b 2,000 and $b 2,500 in times of high demand due to the monopoly of the operators.

A preliminary evaluation was made of four alternatives to the existing ferry, as follows:

- Motorized pontoons at Puerto Banegas
- Hovercraft ferry at Puerto Banegas
- Road bridge at Puerto Banegas
- Use of rail bridge at Puerto Pailas.

The results of the evaluations are summarized in Table 11-16.

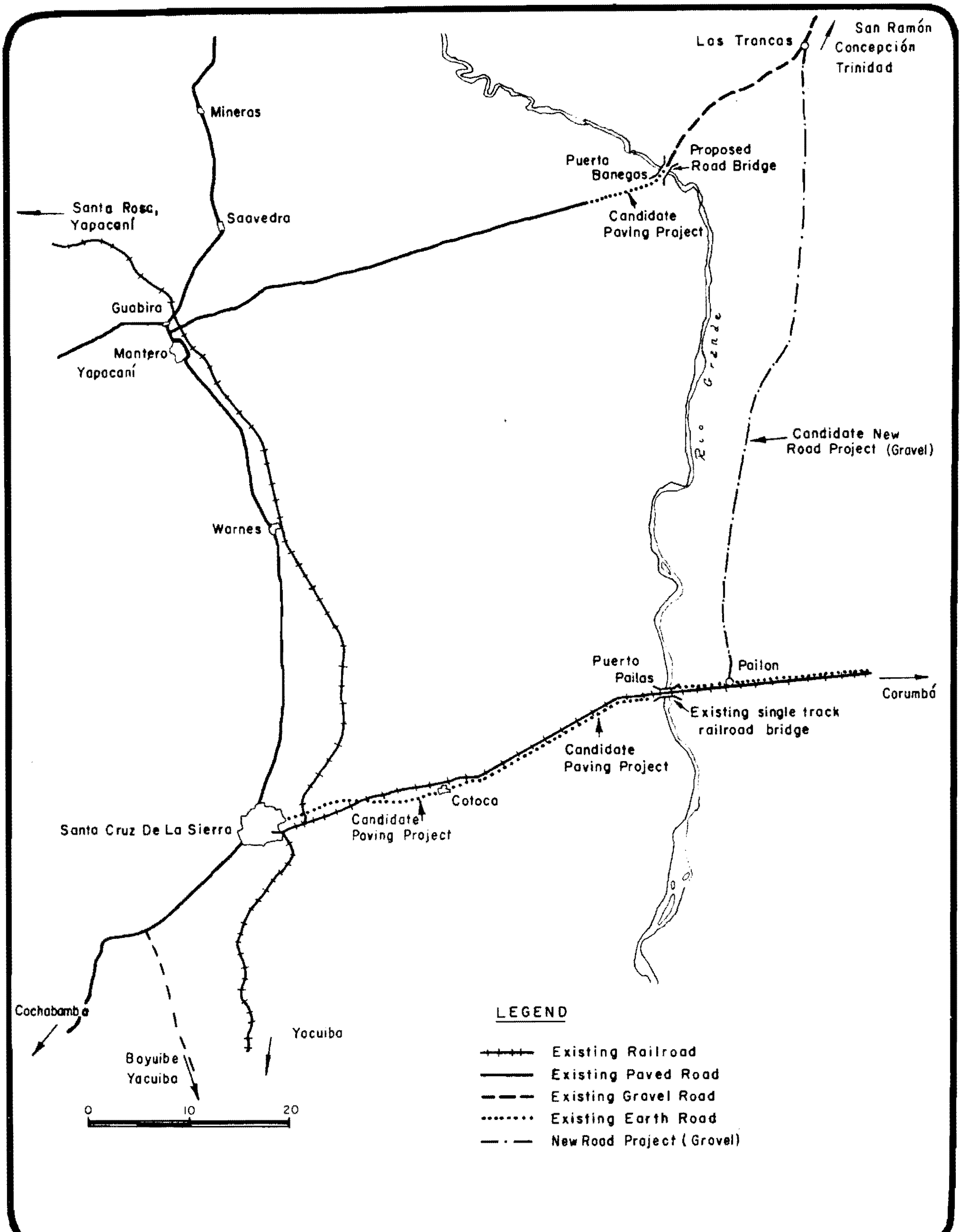
Table 11-16

EVALUATION OF THE RIO GRANDE CROSSING

(Assuming implementation in 1989 with 260 vehicles per day)

ALTERNATIVE	INVESTMENT COST Initial	Replacement	Total	ANNUAL OPERATING COSTS Road (1)	Crossing Services	DELAY COSTS	CHANGE IN ROAD MAINTENANCE COSTS (1)	TOTAL BENEFITS (1)	1989 FIRST YEAR RATE OF RETURN
	(millions of 1977 pesos)								(percent)
Existing Situation	-	-	-	-	4	30	-	-	-
Motorized Pontoon	3	1 (3)	4	-	14	15	-	5	125
Hovercraft	80	25 (4)	105	-	34	2	-	-2	negative
Road Bridge	138 (2)	0	138	-	0	0	-	34	25
Rail Bridge (5)	66	0	66	23	0.1	2	2	7	11

(1) Compared with existing situation.
(2) Single year cost assuming two years to build.
(3) Replacement cost of pontoons in 1999 discounted to 1989 with a 12 percent discount rate.
(4) Replacement cost of hovercraft in 1999 discounted to 1989 with a 12 percent discount rate.
(5) Assuming a new gravel road from Pailas to Los Troncos.



ALTERNATIVE CROSSINGS OF THE RIO GRANDE

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FIGURE 11–9

Traffic volumes in 1989 are estimated at 260 vehicles per day, or roughly 95,000 vehicles per year, of which 70 percent would originate in Santa Cruz and 30 percent in the Montero area.

It is assumed that two motorized pontoons with a capacity of 6 vehicles would be required at a cost of $b 1.5 million each. Likewise, a minimum of two hovercraft would be needed. Hovercraft costs are likely to be about $b 40 million each for a craft capable of taking about three trucks. In both cases, it is assumed that pontoons and hovercraft would have to be replaced after 10 years.

The cost of a 1.5 km road bridge was estimated at $b 130 million based on estimate costs for a 1 km bridge in the Chimoré-Yapacaní contract currently being negotiated. Investment costs for the rail bridge include decking the bridge, providing a telephone system, paving the road from Cotoca to Puerto Pailas and the construction of a new 70 km gravel road from Pailón to Los Troncos on the east bank of the Río Grande.

Operating costs for the current service, the motorized pontoon and the hovercraft were estimated at 40, 150 and 360 pesos per vehicle respectively. Operating costs for the rail bridge alternative consist of salaries for an attendent at each end of the bridge to operate an alternating one-way traffic system.

Road vehicle operating costs and road maintenance costs were calculated using values estimated by the Study (see Chapter 5). Delay costs assumed the following delay values:

	AVERAGE LENGTH OF DELAYS	
	Light Vehicles	Heavy Vehicles
Existing Situation	1.0 hours	3.0 hours
Motorized pontoon	0.5	1.5
Hovercraft	0.25	0.25
Road bridge	0	0
Rail bridge	0.25	0.25

Results of the Evaluation - The motorized pontoon appears economically feasible, but probably such a service is not technically feasible due to the shallow water and the constantly moving sand bars. Neither would it remove the problem of the approaches to the ferry at low water levels, which pass over mud flats.

Hovercraft, which could negotiate the sand bars and mud flats, are not economically feasible since both initial investment costs and annual operating costs are relatively high. Moreover, the hovercraft requires a higher investment for lower benefits than the rail bridge alternative.

The rail bridge alternative does appear to be feasible, despite the higher road vehicle operating costs due to the need for vehicles to travel a longer distance on gravel roads. However, the new road bridge is also feasible with a single year rate of return on the additional investment over the rail bridge alternative of nearly 40 percent. Even if the present plans to implement the rail bridge alternative are completed, the additional benefits of the road bridge justify the total investment required. Also, given that the rail bridge alternative is implemented, it would still be better to build the road bridge than to pave the Pailón-Los Troncos road.

In fact, the evaluation is very conservative. It takes no account of the exorbitant fees currently charged by the ferry operators, assuming that the authorities could regulate the existing services better than at present. Also, current delays can be very much longer then the three hours assumed for trucks so that, again, the evaluation assumes that considerable improvements could be made in the existing ferry services. Finally, no account was taken of the interuption to the existing ferry service each year or of the potential benefits from exploiting the regions on the east bank of the Río Grande.

On the basis of this analysis, a road bridge at Puerto Banegas appears to be a worthwhile project, even if construction costs were to double over present estimates. It is the best alternative since it would remove completely the problem of delays, would cost nothing to operate (apart from maintenance), would be in the best location for most potential traffic, and would make full use of the already available paved road system on the west bank of the Río Grande. A detailed feasibility study investigating bridge location and cost, as well as traffic levels and development potential on the east bank of the Río Grande, is strongly recommended. For investment programming purposes, it is assumed that the project will prove to be feasible for the period 1987-1990.

New Roads in the Central and Southern Regions

Some projects were identified for new roads in the more developed regions of the country. In all cases, they were for low standard unpaved roads linking comparatively small population centers. None of the projects proved to be feasible solely as strategic transport links. Some could perhaps be justified as part of a rural development scheme, but this requires further study.

The projects are shown in Figure 11-10 and are listed below:

1. Inquisivi-Independencia
2. Lambate-La Plazuela
3. Río Caine-Anzaldo
4. Bolívar-Anzaldo
5. Villa Serrano-Pucara
6. Vallegrande-Ipitá
7. Trementinal-Caraparí.

In the case of Vallegrande-Ipitá, a road does exist but three bridges are required as well as improved surface and drainage. The road is currently impassable.

All roads were included in the 1989 Test Transport Network and flows were estimated using the Transport Model. Forecast flows were low or even zero in some cases, and it is not possible to justify construction of any of these links by 1989. Forecast flows on the Trementinal-Caraparí road were the highest of this group but even so, the rate of return was only 7 percent. The physical characteristics, estimated costs, forecast flows and results of the evaluations are summarized in Table 11-17.

In all cases, these roads could serve to open up new agricultural land, although in the case of the two routes in the Yungas valleys, the additional land would be marginal. The region of the Vallegrande and Pucara roads is underpopulated and the prospects for agricultural exploitation would probably depend upon a well-organized rural development scheme. A similar conclusion can be reached about the Trementinal-Caraparí road, although this route has a more important network function than the other roads, and therefore requires less rural development benefits. In contrast the region of Anzaldo is comparatively densely populated with good agricultural prospects.

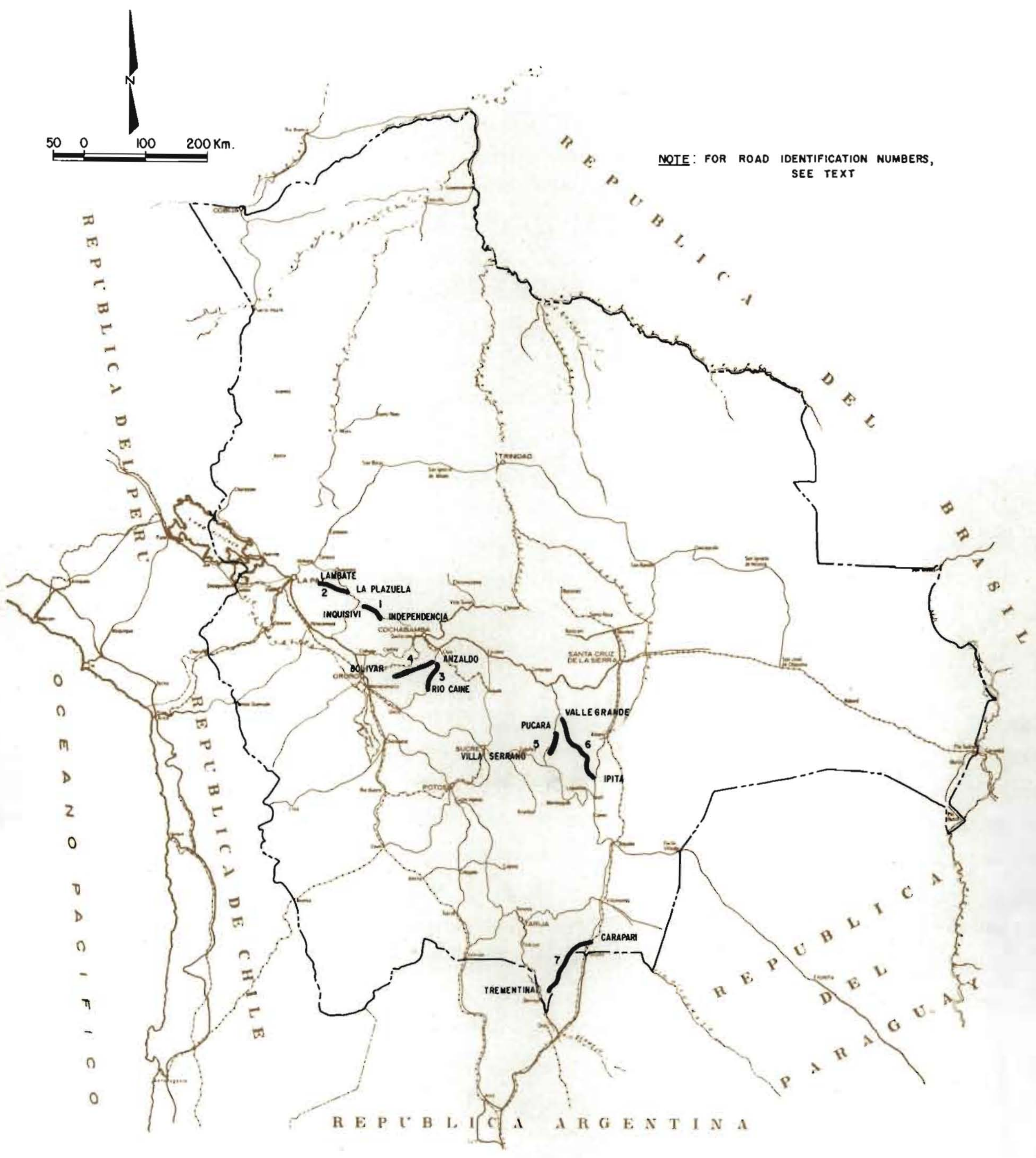
In conclusion, it can be affirmed that these roads would have a minimal function as part of the strategic road system and could not be justified at the present time on this basis. Combined with rural development projects these roads could be useful in opening up new areas, with the best chances of success being in the Anzaldo and Trementinal regions. Studies of the potential of these two regions are recommended. Without combined rural development projects, it is not recommended that any of these roads are constructed.

Table 11-17

EVALUATION OF NEW ROADS IN CENTRAL AND SOUTHERN BOLIVIA

PROJECT	LENGTH (km)	ESTIMATED COST (1989) (millions of 1977 pesos)	FORECAST 1989 FLOW (vehicles per day)	FIRST YEAR RATE OF RETURN IN 1989 (percent)
1. Inquisivi-Independencia	96	355	30	3
2. Lambate-La Plazuela	54	209	0	0
3. Río Caine-Anzaldo	27	105	0	0
4. Bolivar-Anzaldo	75	292	28 (1)	- (2)
5. Villa Serrano-Pucara	99	196	38	3
6. Vallegrande-Ipitá	177	143 (3)	7	- (2)
7. Trementinal-Caraparí	106	281	86	7

(1) All Light vehicles.
(2) Less than 1.
(3) For three bridges totalling 500 meters, plus gravelling and drainage.



CANDIDATE NEW ROAD PROJECTS IN THE CENTRAL AND SOUTHERN REGIONS

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FIGURE 11–10

Program of Studies

In this chapter and others (in particular Chapter 12) a considerable program of road construction and improvement is recommended. In a few cases, feasibility and design studies have been completed, and the Study has drawn on this information. In other cases, feasibility studies have been completed but based on design standards which this Study considers are too high; for example, the designs for Santa Cruz-Yacuiba, Río Seco-Desaguadero (by Prudencio Claros-Delcanda) and the preliminary design for Uncía-Sucre-Muyupampa. Before most of the projects recommended by the Study can be implemented, further studies will be required. These studies should reconsider, where appropriate, the question of modal competition between road and rail in the same corridor.

Two types of studies are needed (although they are often merged): feasibility studies to investigate levels of design in relation to technical problems and to prove economic feasibility; and design studies, to prepare construction plans and final costs. In the investment program, all necessary studies are assumed to cost two percent of the final project cost. This figure was based on an analysis of recent road feasibility and design studies.

In general, studies should be completed two to three years in advance of the projected construction date, to allow time for detailed project programming and letting of contracts. In some cases, though, it is best to complete a feasibility study for a complete route, and then follow with design studies nearer the planned construction date for each stage. This particularly applies to the penetration roads recommended.

There is no point in preparing a detailed program of studies for the next ten years since it can be expected that priorities will change from those specified in this Report, as more information becomes available, or as circumstances change. Therefore, a study program is specified for only the next three years.

Studies of seven types of projects are considered below:

(i) Penetration roads
(ii) Betterment
(iii) Existing paved roads
(iv) Major gravelling
(v) Bridges
(vi) New highways
(vii) Other studies.

Penetration Roads - Three major penetration roads are recommended by the Study:

(i) Rurrenabaque-Ixiamas-Guarayos-Chivé

(ii) Trinidad-San Ramón-Puerto Siles-Guayaramerín

(iii) Puerto Suárez-Quituanquiña

The first two of these roads are recommended for completion in the period 1981-1990, and an overall feasibility study is required for each route as soon as possible. Such studies should take into account the needs for feeder road construction, and should be coordinated closely with the plans of other affected Ministries (Agriculture, Migration, etc.). Individual design studies for each section should be completed according to the staging of construction.

The completion of Puerto Suárez-Quitunquiña is not recommended in the next ten years, so a complete feasibility study does not have high priority. Design studies are required for the two sections recommended in Chapter 12.

Betterment - About 600 km of betterment (see earlier) have been recommended in the next ten years, but it is accepted that this concept of road improvement is untried. Therefore, it is strongly recommended that the first betterment projects are treated as pilot studies, with the objective of determining cost and benefits of such projects in more detail. Such pilot studies should try to establish general rules on the application of this technique throughout the country.

Two projects are suggested as pilot studies:

(i) Río Seco-Desaguadero
(ii) Challapata-Ventilla.

These two projects pass through different types of terrain -- mainly flat for the former and at least partly mountainous for the latter. Although the latter project is not recommended for construction until 1987-1990, it would be a very suitable route to study.

If it is objected that betterment is not appropriate for Río Seco-Desaguadero, (being an international highway subject to special treaty - see Appendix 11G), then Huarina-Achacachi could be substituted.

Apart from these pilot studies, feasibility and design studies (probably combined) will be required for the following betterment projects:

(i) Santa Cruz-Cotoca
(ii) Cobija-Porvenir
(iii) Trinidad-Puerto Almacén
(iv) Huarina-Achacachi
(v) Río Seco-Desaguadero
(vi) Machacamarca-Huanuni
(vii) Potosí-Cucho Ingenio
(viii) Potosí-Sijllani
(ix) Sucre-Pulquialto.

Major Gravelling - Major studies are not required for these projects, but route surveys must be completed to determent the work required on new drainage structures. Such surveys do not need to be prepared so far in advance of the construction date as recommended for other projects. The following routes should be studied in the next three years.

(i) Unduavi-Chulumani
(ii) Oruro-Toledo
(iii) Camargo-Las Carreres
(iv) Iscayachi-Tomatas
(v) Sucre-Tarabuco
(vi) Mutún-Quijarro.

Existing Paved Roads - A program of just over 500 km of overlaying and 188 km of rehabilitation is recommended for the next six years. Probably, no detailed studies are required for overlaying, but designs must be prepared for the rehabilitation projects. These are:

(i)	Comarapa-Jorochito	(120 km)
(ii)	Guabirá-Yapacaní	(68 km)

Also, a design study will be required for paving the 29 km section still unpaved in Cochabamba-Villa Tunari.

Bridges - SNC are already in the process of preparing plans for nineteen bridges of the recommended bridge program, for possible financing by the Interamerican Development Bank (IDB). In general, bridge construction should coincide with other route improvements where possible, and this should determine the appropriate program for feasibility and design studies.

New Highways - Studies are required for new roads but not until later in the decade, e.g. Eteramazama-San Ignacio de Moxos and Santa Bárbara-Bella Vista. Studies are already complete, or nearly complete, for San Borja-Trinidad, Machacamarca-Challapata and Las Carreras-Iscayachi. In the case of San Borja-Trinidad, though, it is recommended that investigation, and perhaps experiments, are made on a method of sealing the road surface avoiding the use of expensive gravel (see Chapter 12). It is also recommended that the design for Machacamarca-Challapata be re-examined to see if costs can be reduced.

It was noted earlier that none of the seven new roads studied in central and southern Bolivia could be recommended for strategic reasons, although some could be worthwhile as part of a rural development project. Two of these roads -- Bolivar-Anzaldo and Trementinal-Caraparí -- are particularly recommended for such studies.

Other Studies - An axle load measurement program is specified in Appendix 11A, but this should be studied in more detail before initiation.

Concluding Remarks on Design Studies - Many expensive design studies have been undertaken in recent years, three of which were listed in the introduction of this section. Such studies, by preparing designs which cannot realistically be justified or afforded for many years to come, serve very little purpose. It is strongly recommended that future studies are defined within the framework of the Investment Program recommended by this Study, including the studies outlined above for the next three years.

Conclusions on Existing Highways

Projects for paving 736 km of unpaved roads and for major gravelling of a further 3,643 km are recommended in the central, more developed regions of the country for the next decade. To a large extent, the projects recommended will mean a change in emphasis in road planning. Apart from committed projects and the Machacamarca-Challapata highway, no major new highways are recommended. All the remaining paving projects are for betterment, where the road is improved on the existing alignment.

Betterment includes widening, improved drainage, improvement of sharp curves and provision of a 6-meter pavement. Major gravelling consists of improvements to drainage and placing a new surface of selected and compacted gravel.

In addition, several new highways are recommended in the remote regions (see Chapter 12), but these are generally low volume penetration and feeder roads with gravel or earth surface. The only paved highway recommended in Chapter 12 is Santa Bárbara-Bella Vista, but it is recommended that this road is built to lower design standards than currently envisaged.

The emphasis has been given to such relatively low level improvements because there are no unpaved roads in Bolivia with volumes higher than 300-400 vehicles per day, and only 527 km carry volumes higher than 200 vehicles per day, so that high capacity routes are not required for some time to come. The emphasis in the next decade must be on improving surfaces; improvements to alignment must take second place.

Also recommended is an extensive program of improvements to existing paved roads, some of which have deteriorated badly. It is considered that 820 km will require treatment in the next ten years with 211 km of overlaying recommended for the first three years.

It is recommended that the current program of improvements to existing feeder roads (financed by USAID) be continued at about the current levels.

An improvement in maintenance standards is also strongly recommended. The new gravel surfaces (recommended as major gravelling) will require improved maintenance techniques, and benefit can also be obtained by placing better gravel on the existing poor surfaces.

On paved roads, patching should be increased from the present negligible levels and routine surface dressing introduced. For gravel roads, better graded gravel should be used together with watering and compacting every third grading. With these improvements, frequency of grading could be reduced from current levels. On the other hand, more intensive grading and spot gravelling is required on earth roads.

Construction of a total of 103 bridges is recommended over the next ten years, apart from bridges required for new highway projects. 34 of the 103 bridges are required as replacements for existing deficient structures.

In addition, a feasibility study is recommended for a new bridge over the Río Grande at Puerto Banegas near Santa Cruz. It is estimated that such a bridge could be economically feasible by 1987.

All projects recommended by the Study will require more detailed feasibility studies, and a program of such studies is recommended. In particular, more detailed studies are required of the concept of betterment (see above) and it is recommended that two pilot studies are undertaken, one in flat terrain and the other in undulating to mountainous terrain. Where appropiate feasibility studies should reconsider the question of modal competition.

CHAPTER 12

NEW PENETRATION ROADS AND OTHER TRANSPORT LINKS IN REMOTE AREAS

CHAPTER 12

NEW PENETRATION ROADS AND OTHER TRANSPORT LINKS IN REMOTE AREAS

The road and rail networks are concentrated in the center and southwest of the country, where most of the people live. The previous chapter was devoted to projects for improving the roads in that area where there are already roads. In this chapter, the attention remains mainly on roads but shifts to the northern and eastern quarters of the country where there are few people and little transport except by air or river.

It might be argued that, with so much land, it would be better to concentrate on the best and ignore the rest. By and large, the people have chosen the Altiplano and have turned their backs on the hot lowlands. But the capacity for agricultural production on the Altiplano is limited, and that area is becoming less able to provide for the growing population. The lowlands have a difficult climate and lack the attractions of the Andes, but they offer the possibility of greater agricultural production, as evident from Figure 12-1. Moreover, Bolivia is a nation and there are already communities of Bolivians scattered through the remote forests and pampas of Pando, the Beni and Santa Cruz. Government policy is to strengthen the links with these isolated outposts of the nation and foster the development of the natural resources that abound there.

The technology of our time makes it inevitable that roads should be the leading form of transport for opening up new regions. Air transport has a pioneering role to play but is too expensive and restrictive to remain the sole, or dominant means of transport. Railroads, to be economic, need large, concentrated volumes of traffic, which are difficult to foresee in these parts of Bolivia. Rivers offer the cheapest, but much the slowest, form of transport; since the beginning of history they have provided impressive natural transport systems, particularly in the Amazon basin, but they have generated little development along their banks and little traffic. It is roads, of simple construction, offering cheap, reasonably fast and convenient transport by truck, bus and car, that give the best chance of opening up new areas. That is why this chapter is almost exclusively about roads.

The first part of the chapter is about penetration and feeder roads. These are pure development roads, driven into empty, inaccessible areas with the sole or predominant intention of stimulating settlement and development. The second part is concerned with new links in the national network,which pass through large remote areas. Trinidad, though at present only a small unpretentious town, is the focus of these links. There is the long, difficult link between La Paz and Trinidad, descending the Andes and crossing extensive cattle country now dependent on air transport. There is the proposed road from Cochabamba to Trinidad, passing through an area which, although practically at the geometric center of the country, is almost unknown. Finally there is the Central Beni Corridor, a transport spine proceeding from Santa Cruz northwards through Trinidad and beyond, involving the Mamoré River and the railroad extension from Yapacaní, as well as more roads.

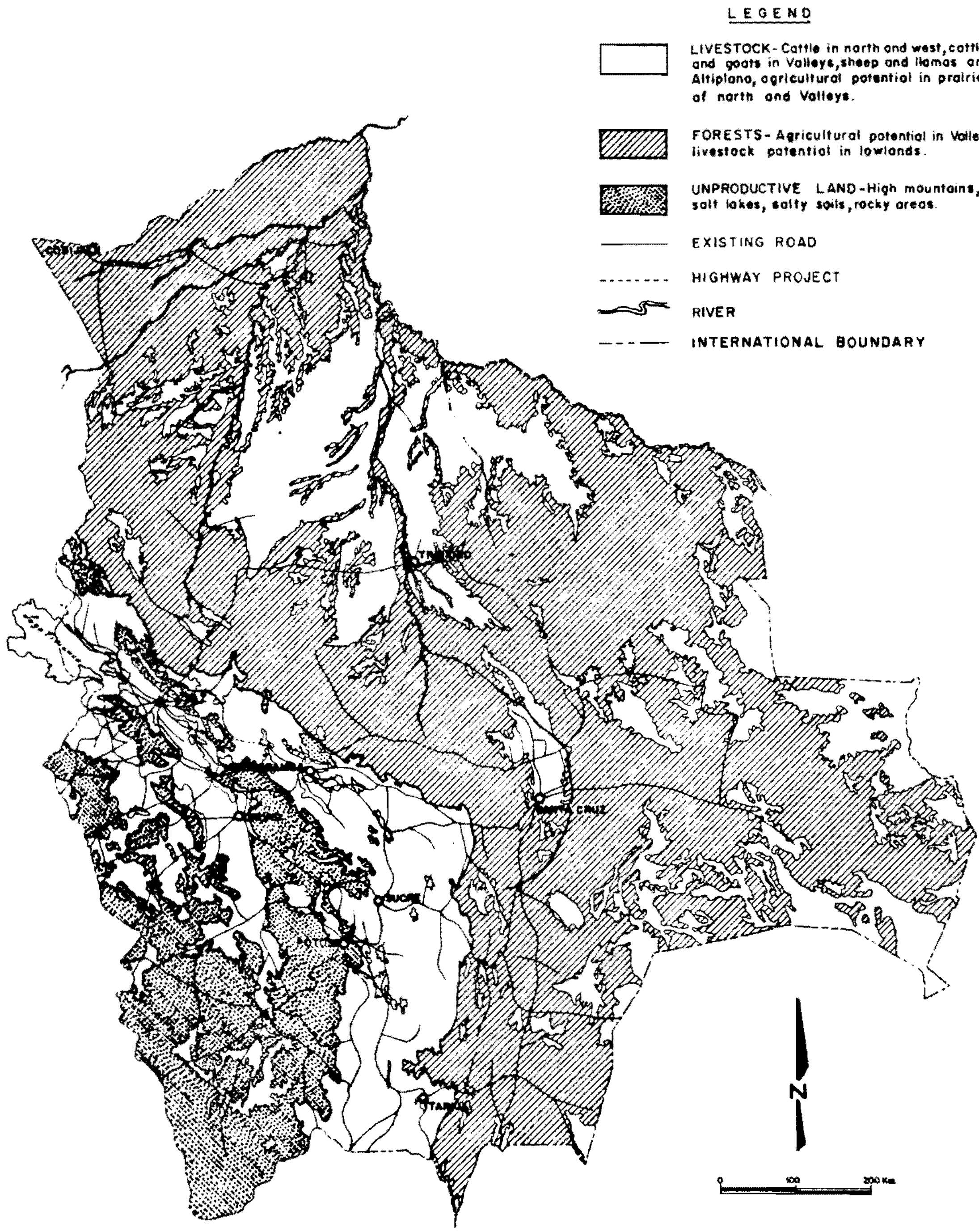
New Penetration and Feeder Roads

In function there is no difference between a penetration road and a feeder road, but the penetration road is of a higher class, permitting higher traffic speeds and hence possessing the capability of opening up more remote areas. Given a large inaccessible area, the logical way to open it up is to build one or more penetration roads into it, supported by a number of feeder roads. The design of such systems of penetration and feeder roads was studied theoretically, as presented in Appendix 12A.

An important principle to be observed is that it is seldom economic to build long stretches of penetration road without feeder roads (and without rural development programs accompanying them). The roads should generally be focussed on a market so that transport costs to the market from all the extremities of the system are equal. The angle and spacing of the feeder roads should be calculated to maximize the net benefit from the whole development. The optimum spacing of feeder roads depends critically on the cost of off-road transport, i.e. the cost of moving produce from the point of production to the feeder road, and this depends on the nature of the terrain and the type of product.

It is considered that, in cattle country, feeder roads should be built at intervals of approximately 10 km. This allows farms of 5,000 hectares to be established with direct access to a public road. In areas of arable farming, it is assumed that feeder roads would be provided at invervals of about 5 km unless there are geographical obstacles.

Conditions for Successful Development - A penetration road is intended to enable people to move into the neighboring area, to exploit its possibilities, be they agriculture, cattle breeding, forestry or whatever, and to transport their surplus output to market. Many such roads, however, have failed to produce that impact. The essential requirements for a penetration road are:



CURRENT LAND USE

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FIGURE 12–1

(i) it must give access to areas of productive potential;

(ii) it must also give access to a market where the output of the area can be sold;

(iii) market prices must offer an attractive profit over and above costs of production and transport;

(iv) the size of the market must be sufficient to absorb the new source of supply without prices being forced down to an unprofitable level.

Three other conditions which may, in the case of Bolivia, be equally essential, are:

(v) substantial investment may be needed in production facilities; roads are not likely to be worthwhile if they generate only primitive, extensive farming, especially for livestock, producing very low yields per hectare; if the value of the road depends on more intensive farming methods, requiring some capital investment, there must be good reason to believe that this will be achieved;

(vi) there must be a sufficient supply of immigrant labor;

(vii) adequate living conditions must be provided to attract the migrants, i.e. homes, schools, medical facilities, shops, etc.

If the right conditions prevail, there are three reasons why it could be in the national interest to open up new areas of agriculture, including livestock, forestry and fish: first, to reduce imports of commodities like wheat that could be produced in Bolivia; secondly, to create new sources of exports; and thirdly, to enable part of the population to move from areas of low productivity to areas where it could be much higher.

The first two reasons are related to the country's balance of payments problem, which is probably the biggest obstacle at present to economic growth. The third reason is related to the distribution of population, which is a major cause of low incomes in Bolivia. In these ways, it may be argued, the opening up of new areas of primary production could not only raise incomes directly but could do so in a way that improves the external balance of payments and thus helps to promote further growth.

Before accepting the need for penetration roads, however, one should consider two other questions. First, are there not already penetration roads that have failed to attract development? For example, the road from Cochabamba to the Chapare was partly built as a penetration road but little developemnt has taken place since its construction. Secondly, before attempting to move people from the poor Altiplano, is it not possible to increase their productivity where they are?

It will be difficult to predict that new penetration roads will attract development if existing roads in equally promising places have failed to do so. In certain cases, their lack of success may have been due to the absence of supporting feeder roads, and this Study therefore considers these as a necessary complement to major penetration roads. The failure of certain past road investments to attract development may also have been the lack of accompanying settlement and agricultural programs, further discussed below.

The second issue concerns the efficiency of existing agricultural production. Instead of expanding the area under cultivation it might be more economic to invest money and effort in raising the productivity of land already in cultivation. It is a considerable undertaking, and a great social upheaval, to shift thousands of people from one part of the country to another, to clear great areas of forest and to establish new farming communities, together with transport and marketing facilities. The final result could be simply a transfer of inefficient farming from one part of the country to another. Before commencing such an undertaking one should be sure that the prospect of higher productivity in the new areas is realistic and that there are not easier ways of achieving the same gain in productivity by improving the methods of cultivation on existing farms.

This question, however, lies beyond the scope of this Study, as a transport analysis cannot investigate the efficiency of agricultural production. Nevertheless it would be wrong to build new roads on the supposition that they will attract efficient and profitable agriculture without putting into action a complementary development program to ensure that this will actually happen.

The case for penetration roads obviously depends on the existence of potentially profitable areas. In Bolivia it is easy to find areas where various kinds of commodities could be produced, but to be profitable they must have an adequate market. Within Bolivia, the market for such commodities lies mostly in La Paz, Cochabamba, Santa Cruz and, to a smaller extent, the other towns of appreciable size, but this market is already well supplied from domestic production with all important agricultural commodities except wheat, apples and pears. The domestic market is, of course, growing and will provide an outlet for steadily increasing production, but this will not be sufficient to support schemes for large and rapid expansion. For them, one must look to export markets.

There are few export opportunities in the neighboring countries, because they tend to be surplus producers of the same products; one important exception being the sale of meat in the cities of Chile and Peru. The main opportunities, however, lie in Europe and Japan, for meat, leather and timber, and in the United States for timber. If these markets are to be developed, cheap, efficient transport connections are essential, which at present do not exist.

Other things being equal, new agricultural areas should be near to La Paz, Cochabamba and Santa Cruz if their target is the domestic market, and near to good export routes if they are aiming for foreign markets. One of the objectives of this Study was to find ways of improving the export routes through the Amazon Basin and the Paraguay River. The assessment of penetration roads considered that such improvements can and will be made.

Finally, there is in Bolivia another reason for penetration roads. Some areas have already been partly opened up by means of air transport. These areas are mainly in the Beni and depend on the production of meat for La Paz and the Altiplano. Without roads, the economic and social development of these areas is strictly limited. The introduction of roads is sorely needed and will undoubtedly transform life in these areas. Several of the roads discussed in this chapter are of this sort; they are designed, not to open up virgin territory, but to stimulate a fuller and more efficient development of areas already under production.

Selection of Penetration Road Projects

The study of penetration roads assumed that there was a need for such roads, if promising conditions could be found. Figure 12-2 demonstrates that it is above all the north and east of the country that lacks road access. It was mostly in these areas that a systematic examination of agricultural and mineral potential (summarized in Appendix 12A) revealed more than 20 possible penetration roads which, in most cases, would be supported by feeder roads.

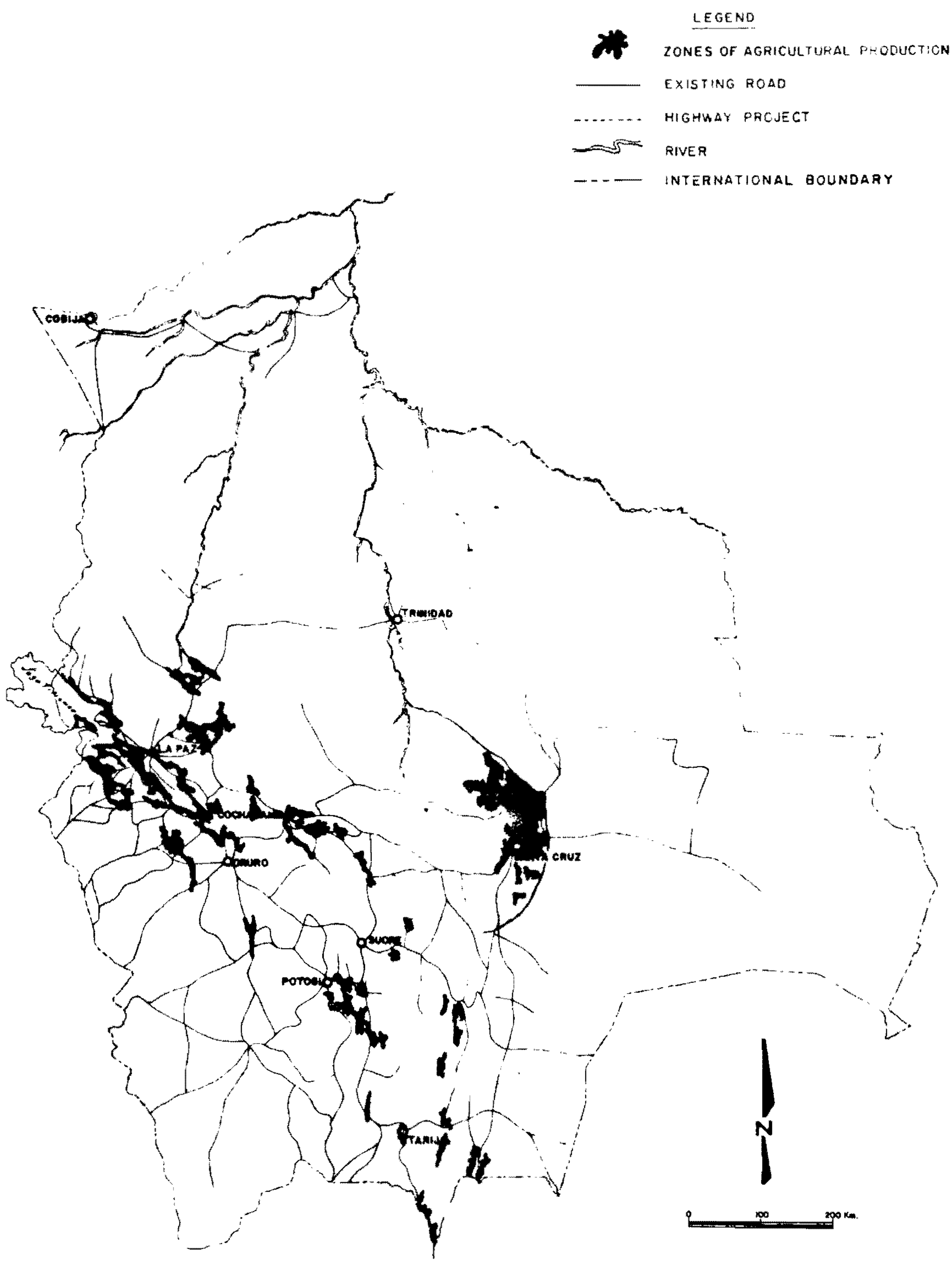
After an initial screening process, 16 roads were selected for detailed evaluation; they are shown in Figure 12-3, and Table 12-1 lists them together with their lengths and construction costs. They were studied in six groups. Three roads are in northern La Paz near Ixiamas where coffee, cacao, rice, citrus fruits and hardwoods are of interest. Two together cover the length of Pando with the idea of stimulating the production of rubber and nuts. Five are designed to open up cattle farming in the Beni. One is a long road running along the Brazilian Shield in Beni and Santa Cruz departments, which is dependent on the discovery of mineral deposits there. Then there are four roads in eastern Santa Cruz department, of which two are alternative routes to San Matías; the other two are between Santa Cruz and Puerto Suárez in an effort to promote the development of the Tucavaca valley with wheat, corn and yucca for the home market and soya, meat, timber and fruit for export down the Paraguay River. The last road goes from Chuguisaca to the far south of Tarija through an area capable of producing olives, vines and a great variety of other fruit.

The cost of these 16 roads is estimated at $b 10,653 million but, when properly supported by feeder roads, the total cost would probably be over $b 27,000 million, which is about half of the budget likely to be available for road investment outside urban areas in the next 20 years. Clearly they will not all be built in that time, and a process of selection and ranking is necessary.

Method of Approach for Evaluation of Penetration Roads

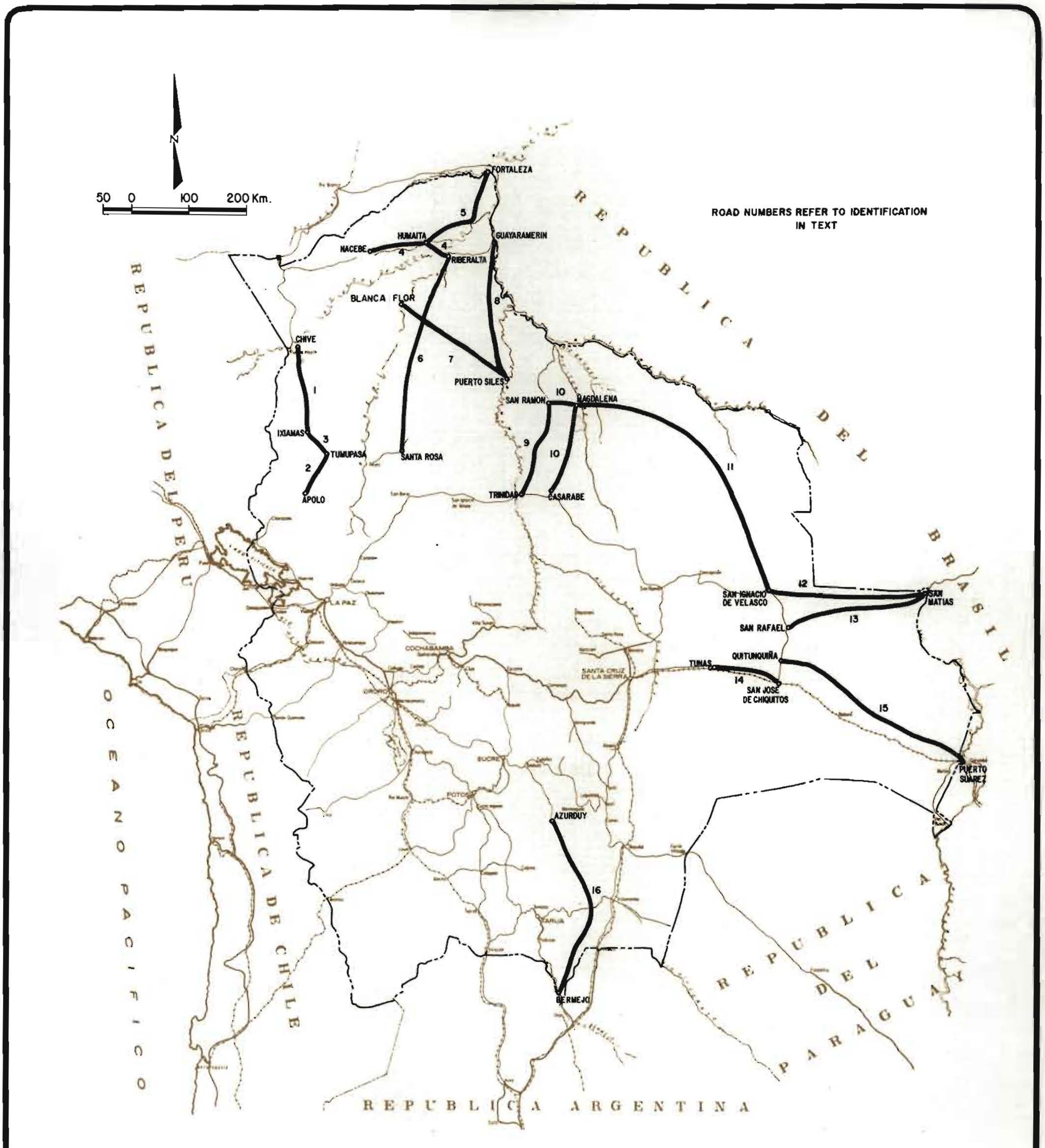
The conventional method, when comparing and choosing between a number of road proposals, is to predict and evaluate their costs and benefits over a long period of years, and to express their net benefits as a rate of return on capital cost or, alternatively, as a net present value.

This approach was not considered practicable here. It is not possible to predict with any assurance the impact of a penetration road. It is not only the nature and magnitude of the impact that is difficult to predict, although this is difficult enough, but the speed with which it will occur, which is vital to the rate of return on investment. There is no empirical basis on which to forecast either the scale or the pace of such developments.



EXISTING ROADS AND AGRICULTURAL AREAS

Wilbur Smith and Associates FIGURE 12–2



CANDIDATE PENETRATION ROADS

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FIGURE 12–3

Table 12-1

POTENTIAL PENETRATION ROADS

ROAD PROJECTS EVALUATED (1)	LENGTH	CONSTRUCTION COSTS AT 1977 PRICES
	(km)	(million pesos)
Northern La Paz		
1. Ixiamas-Chivé	219	635
2. Tumupasa-Apolo	190	730
3. Ixiamas-Tumupasa	45	210 (2)
Pando		
4. Nacebe-Riberalta	181	388
5. Humaitá-Fortaleza	230	492
Beni		
6. Santa Rosa-Riberalta (3)	270	600
7. Blanca Flor-Puerto Siles	220	470
8. Guayaramerín-Puerto Siles	215	460
9. Trinidad-San Ramón (4)	191	408
10. Casarabe-San Ramón	294	643
Beni-Santa Cruz		
11. Magdalena-San Ignacio	560	1,224
Santa Cruz		
12. San Ignacio-San Matías	280	592
13. San Rafael-San Matías (5)	195	427
14. Tunas-San José de Chiquitos	107	226
15. Quitunquiña-Puerto Suárez	366	774
Chuquisaca-Tarija		
16. Azurduy-Bermejo (6)	501	2,161
	4,064	10,440

(1) See Figure 12-3 for location.
(2) Includes 80 million pesos for improvement of existing San Buenaventura-Tumupasa road.
(3) A 135 km section from Riberalta and a 15 km section from Santa Rosa have been built the remainder of the road measures 270 km.
(4) A road has already been built beyond San Javier which could be continued to San Ramón. The distance shown is from San Javier. But an alternative route, designed to avoid flooded ground, would commence on the road between Trinidad and Casarabe and would be of similar length.
(5) The first section of 55 km from San Rafael has been constructed and is not included in the distance.
(6) The last 7 km to Bermejo have been constructed and are not included in the distance.

SOURCE: Projects for New Penetration and Feeder Roads, Working Paper 66, Bolivia National Transport Study.

Consequently a less precise approach was adopted. The starting point is the construction cost of the road, or of the first section of the road, together with feeder roads. Then the minimum benefit necessary to justify the investment can be calculated. The net benefit from the road consists of the net profits of the induced agricultural development, over and above a normal return on capital employed therein, less road maintenance costs and any other net public expenditure. Given a knowledge of the crops to be produced, their production costs and market prices, one can translate the required benefits into the number of hectares of land that must be developed at an assumed rate per annum; and the slower the rate of development, the larger the number of hectares that must be developed. What is the probability that the scale and pace of development will equal or exceed these requirements? That is the key question to be answered. And, given several proposals for penetration roads, which ones offer the highest probability of meeting their respective requirements?

Thus the problem was turned from what would have been a spurious attempt to estimate a rate of return into a probability judgement that there would be a clearly defined minimum amount of development.

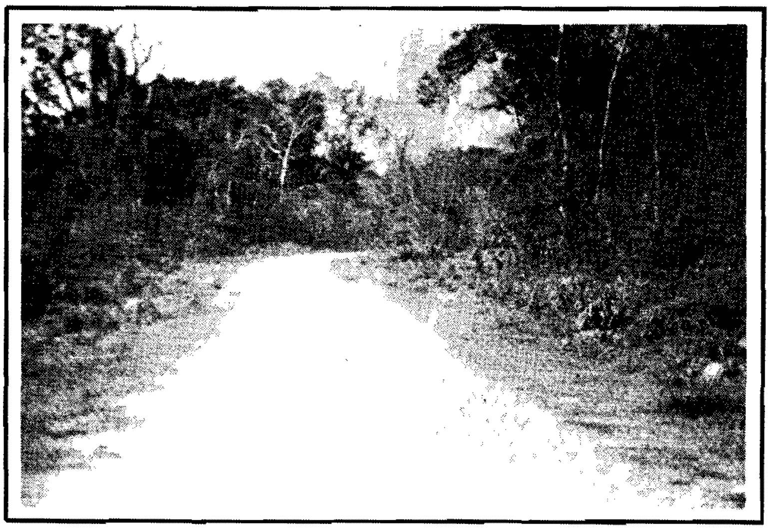
The subsequent analysis took the following steps for each project:

(i) Estimate road construction and maintenance costs;

(ii) Assess production potential of area accessible to proposed road and feeder roads, i.e. the type of products possible, the methods of production and likely yields per hectare;

(iii) Calculate minimum requirements of net benefit to justify investment and maintenance; this follows from the above information together with assumptions about the minimum rate of return, which was taken as 12 percent, and the starting-up period, which is discussed below;

(iv) Translate these requirements into hectares developed and profit margins after starting-up; for a given profit per hectare one can calculate the number of hectares that must be developed to produce the minimum benefit requirements; thus one obtains a number of possible combinations of hectares and profit margins that would satisfy the requirements; it is assumed that profit, over and above a normal return on capital invested in agriculture, is an acceptable measurement of economic benefit;



NEAR TRINIDAD

NEAR SAPECHO

FEEDER ROADS

(v) Estimate costs of production per hectare, for each relevant crop;

(vi) Identify possible markets and transport costs to market;

(vii) Consider present and future market prices and profit margins;

(viii) Assess limitations of market size and other constraints on output;

(ix) Assess need for migrant labor and capital, and prospects of attracting it;

(x) Assess probability that development will exceed minimum requirements; this assessment is not a numerical measurement of probability but is arrived at by a method of numerical scoring.

The last two steps, (ix) and (x), have to be taken with all the proposed roads together, since all are competing for migrants and capital. In the final analysis one must consider that the more roads are built, the smaller is the chance of any of them being a success.

Starting-Up Period - This important aspect needs explanation. A particular problem with development roads is that the development takes time. A starting-up period is needed after the road is built, during which the development can take place. Hence the benefits from the road will probably be low in the first year and below the required rate of return for several years at least. The internal rate of return and net present value are severely affected by this starting-up period.

It can be shown that if it takes 12 years for the developmental impact of a road to take place, the required final annual rate of return must be double the required average annual rate on the whole investment, i.e. double the required internal rate of return.

In fact the most unpredictable aspect of penetration roads is the speed with which development will follow. It will depend on how fast they are built. If they outstrip the available supply of migrants, the starting-up period will be needlessly long. A basic assumption in this analysis is that the building of penetration roads will be gradual and will be related to the need, i.e. the construction program will be flexible and will proceed just as fast as is necessary to absorb the supply of migrants in an efficient way.

Even so, there will still be a starting-up period. At the very least it takes time for migrants to prepare their land and bring it into full production. This period might be 3 years for annual crops and could be as much as 10 years for intensive cattle farming. On the other hand, some land suitable for agriculture contains saleable timber which must be quickly removed and sold, thus bringing an immediate once-and-for-all return. Land to be used only for timber production may also begin to yield a maximum income in the first year.

It was assumed that the starting-up period would be 6 years in arable areas, 12 years in cattle areas and 3 years in forestry areas. Where an immediate income is possible from cleared timber, this was deducted from the capital cost of the project. It follows that the minimum annual rate of return required on the net capital cost of the project when in full production is 18 percent from arable development, 24 percent from cattle, and 15 percent from timber.

These rates of return refer to the profits accruing to land owners and farmers after a reasonable return has been allowed on capital invested in the land itself. A similar return should also be deducted for any net capital expenditure from public funds on social infrastructure but the estimate of each capital investment should be strictly net of the expenditure that would have been necessary anyway somewhere else.

Minimum Benefits Required - The annual benefits required after the starting-up period were calculated, taking account of road construction and maintenance, and the effect of the starting-up period. The benefits could in theory be obtained from smaller or larger areas of cultivation with correspondingly higher or lower profits per hectare. The larger is the area, the greater is the length of penetration and feeder roads needed to serve it but, as shown in Appendix 12A, there are quite big economies of scale in feeder road networks, so the required profit per hectare diminishes as the area of development expands.

Table 12-2 shows the annual benefits required from each road for five alternative areas of development, and the required profit per hectare, which varies from $b 2,950 for a small development on road No. 2 (Apolo-Tumupasa) to $b 230 for a large development on road No. 12 (San Ignacio-San Matías). This demonstrates the wide range in profitability required to justify the provision of roads, resulting from variations of construction cost, maintenance cost, starting-up period and scale of development.

Economic Potential of Candidate Penetration Roads

Each road was examined in accordance with the above method. The details are described in Working Paper 66. The conclusions regarding economic potential are summarized below.

Road No. 1, Ixiamas-Chivé - This 219 km long road, shown in Figure 12-4 together with others considered in northern La Paz, passes through country of modest agricultural potential. It is very poorly situated in relation to markets. Coffee could be produced in certain areas and exported profitably through Arica or Matarani. A possible market for rice and citrus fruits exists in La Paz, and there is a possibility of developing beef exports by air freight from Ixiamas to Peru and Chile. It is probable that development, if it occurred, would be on a relatively small scale. No more than an initial 90 km section of penetration road from Ixiamas towards Guarayos, with feeder roads, could be justified economically within the foreseeable future. To justify the investment, annual benefits of about $b 2,300 per hectare are likely to be required. This return seems easily obtainable from coffee and citrus fruits, and also from rice. Beef might also be profitable, if produced intensively. For strategic reasons, it may be desirable to extend this road another 129 km to Chivé, thereby completing a continuous land connection from La Paz to Pando's capital, Cobija. It would also form part of a major international connection (Carretera Marginal de la Selva) planned to connect eastern Peru with Brazil and Argentina.

Road No. 2, Apolo-Tumupasa - There appear to be some highly profitable opportunities in the Apolo-Tumupasa area, particularly in the production of cacao, rice and coffee. But the area is badly located for export markets and must depend mainly on the La Paz market. The potential for expanding sales of rice and coffee in La Paz is small, and the possibility of developing a sizeable market for cacao in La Paz is uncertain. Furthermore, this 190 km long road would be costly because of the difficult terrain.

Table 12-2

ANNUAL BENEFITS NEEDED TO JUSTIFY ROAD INVESTMENT AND MAINTENANCE

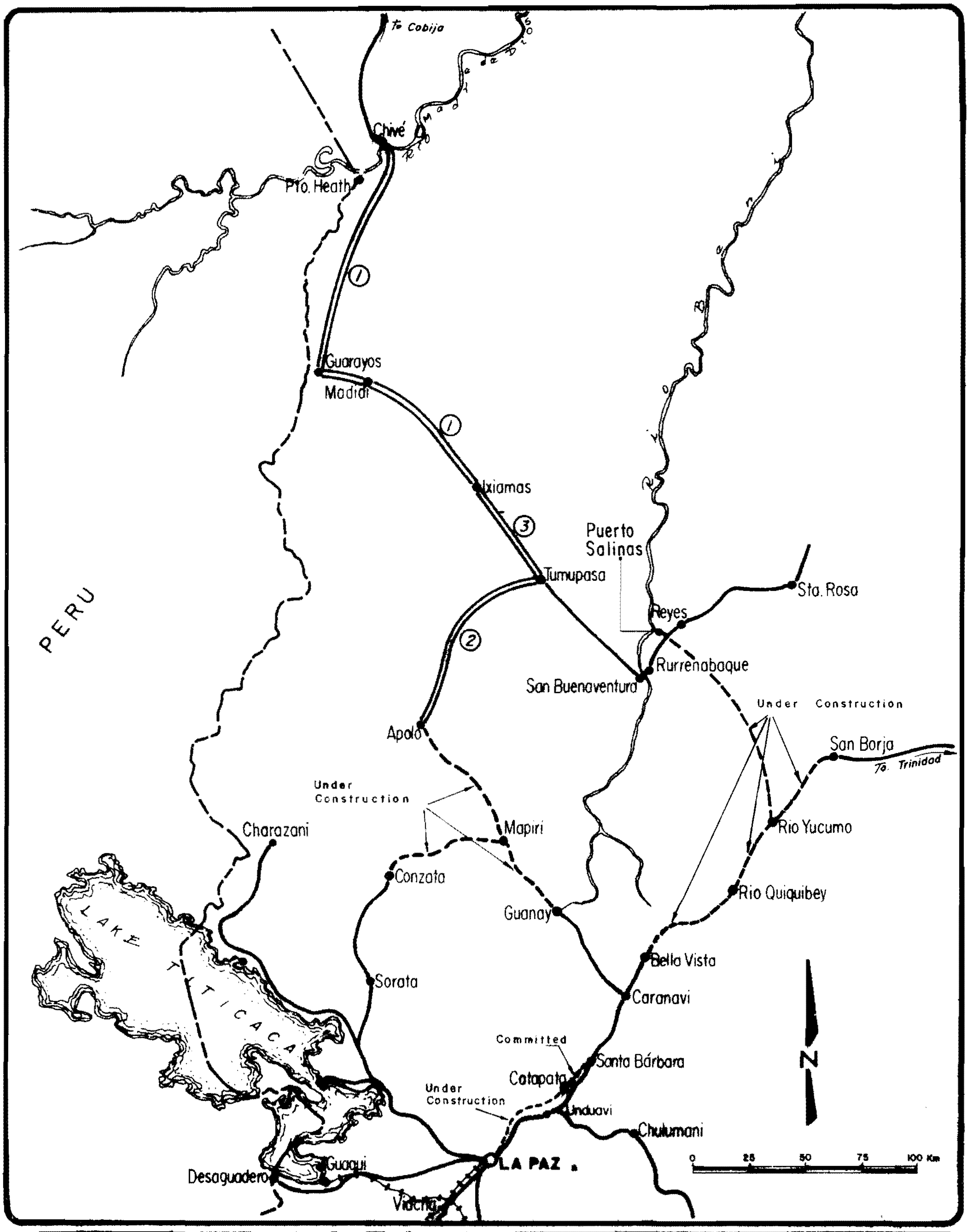
(millions of 1977 pesos; in parentheses, benefits per hectare in thousand pesos)

ROAD NO	REQUIRED RATE OF RETURN (%)	AREA OF INFLUENCE (hectares) 20,000	150,000	500,000	1,000,000	1,500,000
1	18	46 (2.30)	231 (1.54)	619 (1.24)	1,127 (1.13)	1,564 (1.04)
2	18	59 (2.95)	297 (1.98)	794 (1.59)	1,450 (1.45)	2,004 (1.34)
3	15	39 (1.95)	194 (1.29)	n.f.	n.f.	n.f.
4-5	16	19 (0.95)	87 (0.58)	222 (0.44)	395 (0.39)	543 (0.36)
6-9	24	20 (1.00)	79 (0.53)	190 (0.38)	327 (0.33)	440 (0.29)
10	24	19 (0.95)	74 (0.49)	174 (0.35)	298 (0.30)	397 (0.26)
11	18			Not applicable (1)		
12	24	17 (0.85)	65 (0.43)	152 (0.30)	258 (0.26)	342 (0.23)
13	24	20 (1.00)	79 (0.53)	188 (0.38)	323 (0.32)	433 (0.29)
14	18	17 (0.85)	74 (0.49)	182 (0.36)	320 (0.32)	434 (0.29)
15	20	19 (0.95)	82 (0.55)	201 (0.40)	353 (0.35)	479 (0.32)
16	21	58 (2.90)	289 (1.93)	758 (1.52)	n.f.	n.f.

(1)Road No. 11, being a mineral development road, does not possess an area of influence in any meaningful sense.

n.f. = not feasible.

SOURCE: Prospects for New Penetration and Feeder Roads, Working Paper 66, Bolivia National Transport Study.



CANDIDATE PENETRATION ROADS
IN NORTHERN LA PAZ

Wilbur Smith and Associates

FIGURE 12–4

It must be concluded that the development potential of this road is doubtful and small in scale. It is therefore improbably that one could justify in the foreseeable future more than a short section, north of Apolo.

Road No. 3, Ixiamas-Tumupasa - This road is short, only 45 km, and would serve both as a development road and, together with an improvement of the existing Tumupasa-San Buenaventura road, as a network link connecting Ixiamas to La Paz. The developmental potential of the road is modest and probably does not justify any feeder roads in the foreseeable future. But there is some potential for timber for local consumption, and possibly for the La Paz market, which would yield relatively high benefits and would go a long way towards justifying the cost of the road. The road could be justified by the San Buenaventura sugar refinery project alone if this went ahead quickly and successfully. It could also be justified by successful agricultural development along road No. 1 north of Ixiamas.

Roads Nos. 4 and 5, Nacebe-Riberalta and Humaitá-Fortaleza- As shown in Figure 12-5, the proposed roads (181 km and 230 km in length) are in an extremely isolated area where the costs of transport to market are very high. The agricultural potential of the area is limited to rubber, nuts and timber, but there is little commercial prospect for rubber, or for coconuts. There are possibilities of profitable export of cashew nuts and wild Brazil nuts, and there may be a market for high-quality timber. But the scale of development is likely to be small and thus, for as long as this remains true, there is no case for building more than a short 50 km section of road from Riberalta to Humaitá.

As funds become available, either to national entities or the Pando Development Corporation, it will be desirable to continue the road as far as Nacebe, a distance of 131 km. This, then, would provide a road connection from Riberalta/Guayaramerín to Cobija, which currently is only possible through Brazilian territory.

Roads Nos. 6 to 10 in Beni Department - All five penetration roads considered in the Beni (see Figure 12-6) run through large areas of prairie land where, given adequate feeder roads, very large cattle development could take place exceeding 0.5 million hectares per road. The required annual benefit to justify the roads would be $b 300-400 per hectare; this appears to be easily achievable in export markets.

It would take several decades to develop fully the cattle opportunities of the Beni. It would therefore be wasteful to build all five penetration roads, with feeders, in the near future, supposing that this were feasible. An order of road development is needed. The economic criteria for determining this order are as follows:

- Quality of land
- Proximity to markets
- Proximity to urban facilities
- Utility of road as national network link
- Cost of road construction.

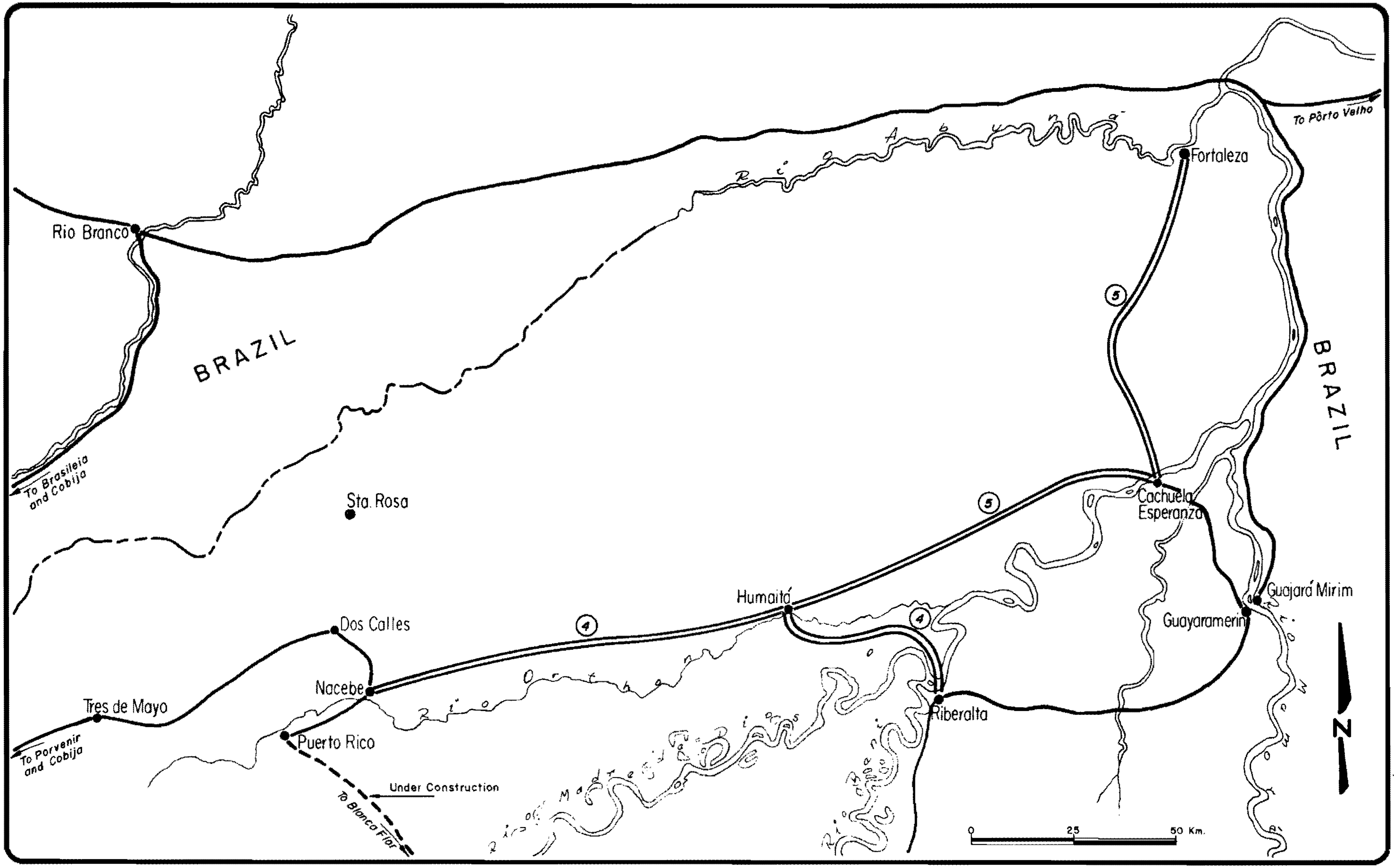
The roads, or sections of roads, that best satisfy these criteria are the ones most likely to produce profitable and speedy development. Having taken all these criteria into account, the following order of development is suggested:

ROAD NO.	
9	Trinidad - San Ramón, first section, 60 km
8	Guayaramerín - Puerto Siles, first section, 100 km
9	Trinidad - San Ramón, second section, 60 km
8	Guayaramerín - Puerto Siles, second section, 50 km
9	Trinidad - San Ramón, third section, 71 km
8	Guayaramerín - Puerto Siles, third section, 65 km
10	San Ramón - Magdalena, 60 km
6	Santa Rosa - Riberalta, in sections, 270 km
7	Blanca Flor - Puerto Siles, first section, 110 km
10	Casarabe - Magdalena, 234 km
7	Blanca Flor - Puerto Siles, second section, 110 km

Road No.9 has the further advantage that it passes relatively near to Santa Ana de Yacuma, a major meat producing center and currently the fourth largest town in Beni Department. It is proposed that one of the feeder roads be built to a somewhat higher standard, so that it effectively also serves as an access spur to Santa Ana. Moreover, the purchase of a motorized pontoon will be required to provide a crossing of the Mamoré River.

It does not follow that the whole, or indeed any, of the above program is recommended in the next 20 years. That decision must wait until the merits of roads in the Beni are compared with those of other roads.

Road No. 11, Magdalena-San Ignacio - The main purpose of the proposed 560 km long road is to serve possible mining ventures in the Precambrian hills, which are believed to contain important deposits of tin, tungsten, silver, gold, uranium, phosphorus and other valuable minerals. Exploration of this huge area is still in progress and the final results of the geological survey are not expected until 1981. At present it is not certain that commercial mining will be justified. There is no case for a road until a decision has been taken to start such operations. If and when the decision is made, a road will become immediately essential and its costs should be fully taken into account in the making of the decision itself. If the mining potential is or real value, the cost of the road should be relatively insignificant.



CANDIDATE PENETRATION ROADS IN PANDO

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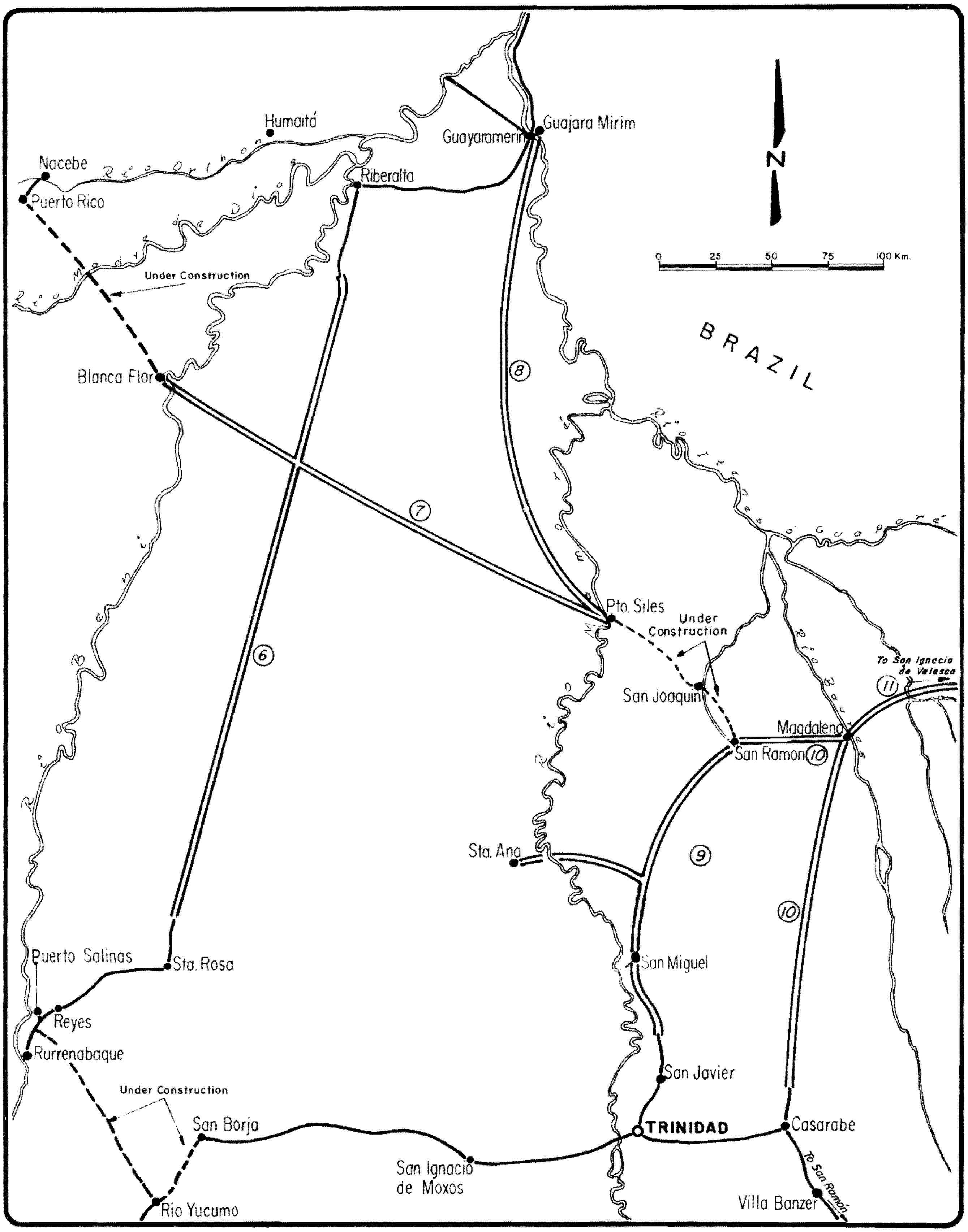
FIGURE 12–5



CANDIDATE PENETRATION ROADS IN BENI

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FIGURE 12–6

Hence this road project, or part of it, could become a project of top priority, and its length and precise location would be determined by the prospective mining operations. But equally, it could prove to be entirely unnecessary. The position will doubtless become clear, one way or the other, within the near future. The project cannot be recommended yet but the long-term program for road construction should allow for its possible inclusion at short notice.

Roads Nos. 12 and 13 to San Matías - It is clear that beef can be produced in the Pampas Ganaderas de San Matías at a cost well below market prices and in large quantities. Assuming that development ocurred fast enough, i.e. in 12 years, the penetration road could be justified by 85,000 hectares of intensive cattle rearing. But the market in Brazil appears small and unreliable. The market through Buenos Aires is unlimited in size but depends on the establishment of efficient processing plants and transport to and down the Paraguay River.

The geographical location of the various penetration roads considered for eastern Santa Cruz is shown in Fugure 12-7. The 280 km long road, No. 12, which proceeds directly from San Matías to San Ignacio, gives a journey distance between the two points 55 km shorter than road No. 13, of which a part already exists, leaving 195 km yet to be built to San Matías. Because of the swamply terrain, however, it would be $b 168 million more costly to build. To justify the more expensive road, traffic savings (including savings in road maintenance costs) should exceed $b 21.49 million a year. It is calculated that a traffic volume of over 120 vehicles a day would be needed to justify the extra cost of road No. 12. There is no prospect of this traffic volume in the foreseeable future; therefore road No. 13 must be preferred over road No. 12.

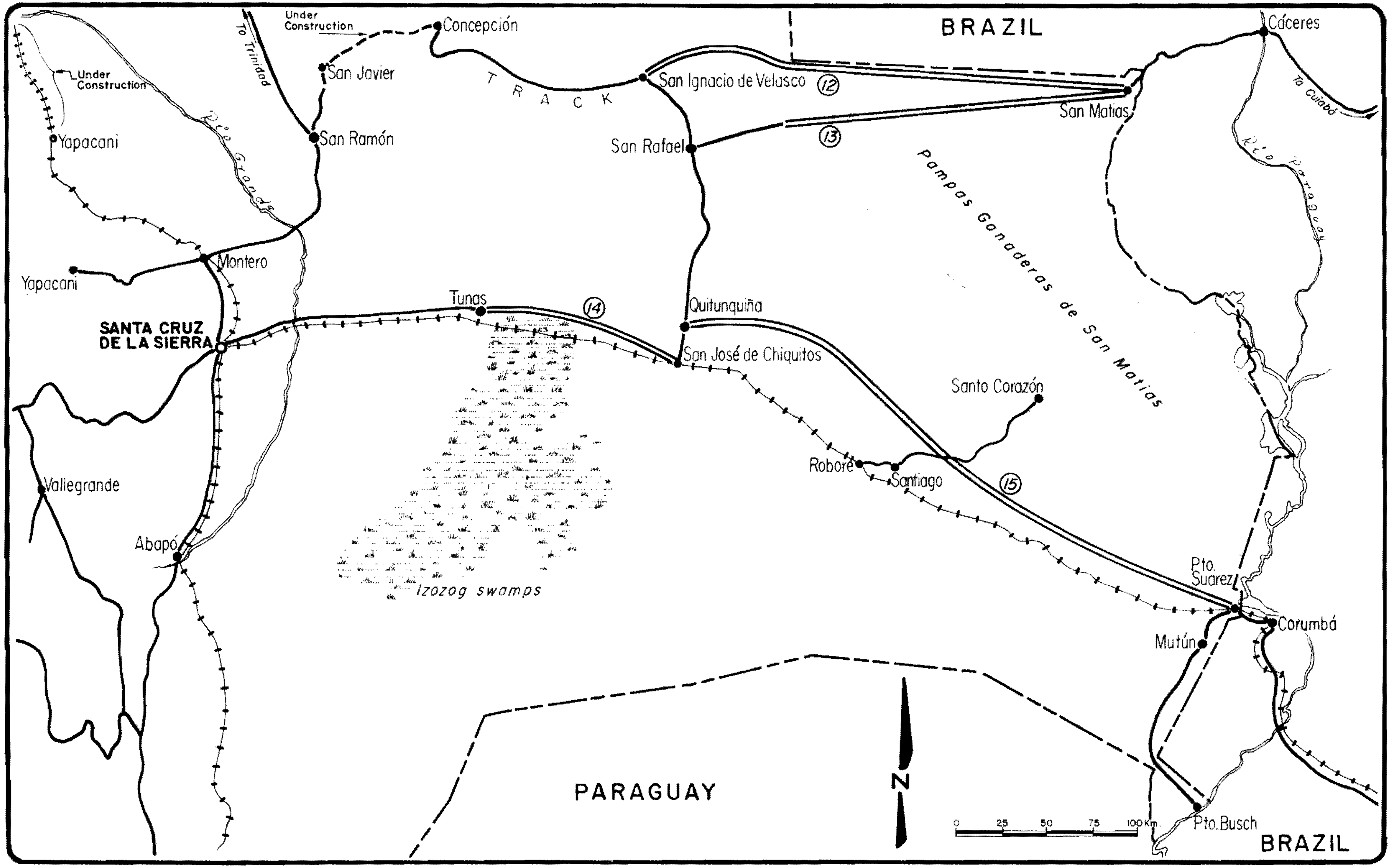
Road No. 14, Tunas-San José de Chiquitos - The potential soya production between San José and Santa Cruz is large. Only a small part of the potential would need to be developed in order to justify the 107 km long road. The product should be readily marketable and is not very sensitive to price fluctuations. Moreover, the black soils east of Tunas would permit a second crop of cotton during the rainy season.

However, the same products can also be grown west of Tunas, although not quite as efficiently. Thus, it is considered more useful to promote the construction of feeder roads off the existing road west of Tunas, before extending it eastwards across the margin of the Izozog swamps.

Road No.15, Quitunquiña-Puerto Suárez - This road would open up the Tucavaca valley, a large area of great agricultural potential. Wheat and corn could be profitably produced and transported via Santa Cruz for the domestic market, eliminating the necessity to import these products. Soya, citrus fruits, rice and other crops could be highly profitable exports, given efficient transport down the Paraguay River. The area nearer Puerto Suárez is potentially valuable for cattle, which could also be profitably exported via the Paraguay River, given a packing plant at the river port. There are also possibilities of exporting timber. This area has the advantages of agricultural potential, large-scale, easy development and proximity to a cheap export route.

The scale of the Tucavaca development is such that it will take several decades for the necessary settlers to migrate to that area. Also, more practical experience is required about the agricultural potential of the Tucavaca Valley and its approaches, before the entire 366 km road from Quitunquiña to Puerto Suárez can be justified. As a first phase, it is proposed to implement two sections of about 40 km each in conjunction with a colonization scheme. The continuation of these roads should then be moved ahead in accordance with the success of the agricultural development. The initial roads are recommended in the area west of Puerto Suárez (potential for cattle raising) and in the area east of Roboré which is likely to have the best land for the cultivation of soya and wheat. They will effectively be feeder roads to the existing railroad which will remain the only complete transport facility on the Santa Cruz-Corumbá axis. Much will depend on the quality of rail services, and the later continuation of the road in this corridor may not be pressing if rail access proves to be adequate for the needs of agricultural development.

Road No. 16, Azurduy-Bermejo - This would be a long (501 km) and costly road, and a long section would have to be built from Azurduy before a useful amount of land is opened up to cultivation. The area is capable of producing crops that are difficult to produce anywhere farther north (this side of the Equator) and which therefore command good prices. The cost of transport and the perishability of the products dictate that they should be processed and sold in canned or bottled form, thus increasing greatly the value added. Good markets are seen for olive oil and avocado butter in Europe and for jams, juices, canned fruit wine and brandy in the domestic market and in the other Andean Group countries. The estimated annual benefits per hectare appear potentially very high, much higher than the minimum required to justify the road. Because output needs to be shipped by rail from Villazón or Villamontes, it would be necessary to construct the road to Palos Blancos, a distance of 251 km (see Figure 12-8).



CANDIDATE PENETRATION ROADS
IN EASTERN SANTA CRUZ

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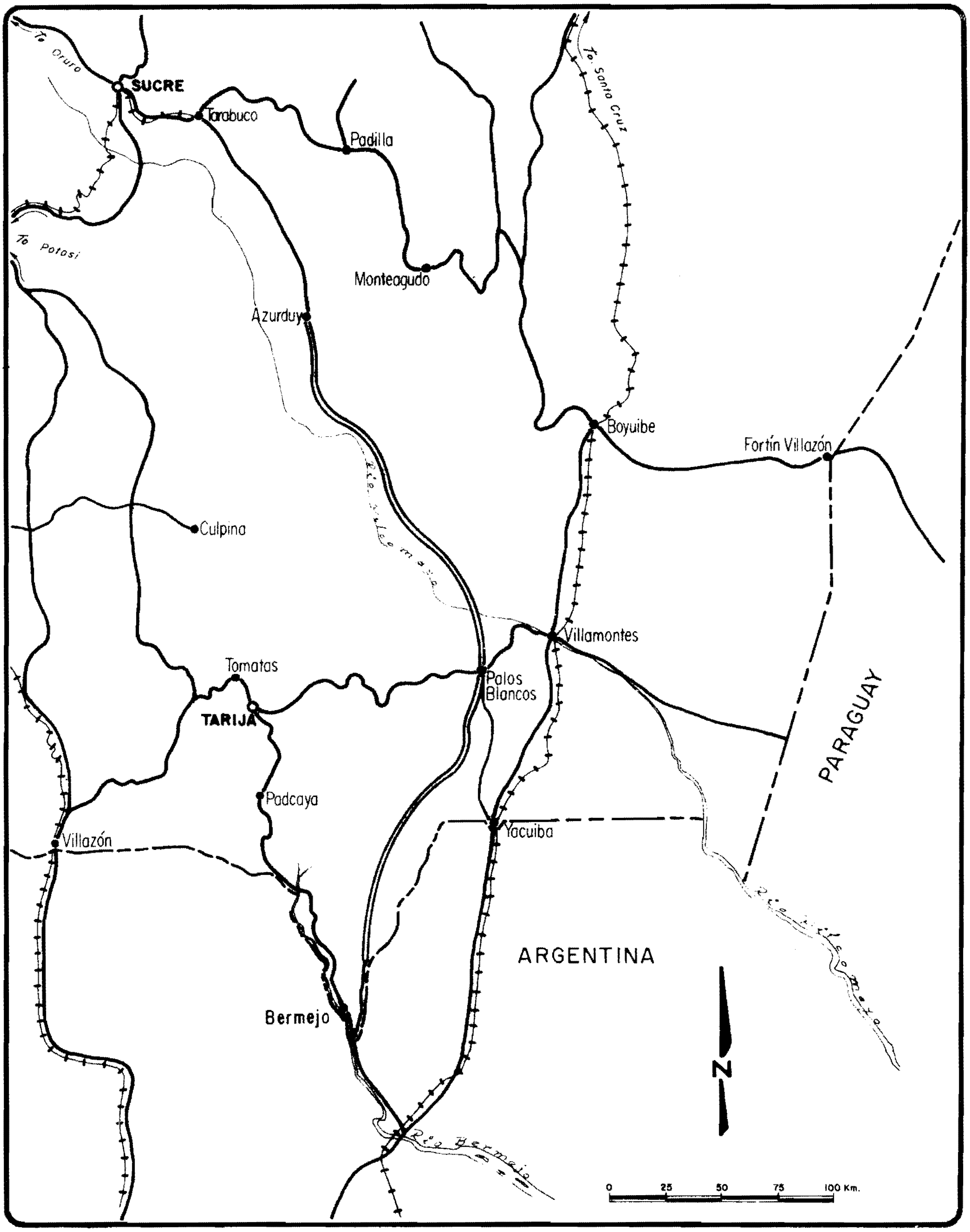
FIGURE 12–7



AZURDUY-BERMEJO CANDIDATE PENETRATION ROAD

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FIGURE 12–8

Constraints on Development

The construction of a road removes one fatal constraint on development . In the right place, it creates an opportunity for people to come and work and sell their output at a profit. The profit motive is a powerful force in Bolivia as elsewhere,as has been amply demonstrated in Santa Cruz and the Beni. But there are still obstacles. The majority of potential migrants are to be found in the Altiplano and Valleys, where they are rooted in a strong culture and, in some parts at least, live in a moderate climate. Most of the penetration roads lie far away in hot, flat country where the way of life could be very different.

Nevertheless, since 1950 over a million peasants have moved to the equally different environment of the city. Evidently the break can be made, but it will be made much more easily with government support in the form of publicity, travel assistance,colonization and other schemes to help provide housing, services and welfare facilities. And, other things being equal, the roads lying closest to the Altiplano and with the most agreeable climate will find it easier to attract migrants.

Supply of Migrants - It is calculated that in order to achieve the potential development of all the proposed penetration roads, omitting Nos. 5, 7, 11 and 12 as of no interest in the near future, about 261,000 migrants would be needed of which 120,000 would be in the Tucavaca valley where the type of agriculture would be labor-intensive. Cattle areas use far less labor, and only 26,000 migrants would be required in the Beni.

A study of migration between 1950 and 1976 showed that 1.3 million people left rural areas but the great majority went to the cities, to some degree those of neighboring countries. Only 65,000 peasants moved to rural areas, principally in western Santa Cruz, the Beni and North Yungas. It is considered improbable that more than 200,000 migrants could be attracted to areas of new rural development in the next 20 years. This places a major constraint on the prospects of penetration roads, particularly in the Tucavaca valley.

Supply of Capital - The amount of capital required is relatively modest because the areas studied do not need irrigation or other costly works. Forest clearance is generally needed but this could often be profitable in itself. Private investment is needed in plantations, livestock, barns and fences, but the envisaged methods of production do not require a large amount of machinery. The Azurduy-Bermejo road requires considerable investment in processing plant. The problem, however, is not so much in the amount of capital needed as in arranging a practicable mechanism for making it available to the farmers and entrepreneurs that need it.

Evaluation of Potential Penetration Roads

In concluding the study of penetration roads, the final aim was to assess the probability of achieving the required level of benefits on each candidate road or a part of it. Since the roads are in competition with each other, it was necessary to compare their prospects. There was no purpose in including roads where there was no prospect of profitable development (Nos.5 and 11), and for other roads where development is limited by the size of market it was assumed that only a part of the road would be built. Road No.12 was excluded in favor of the alternative No. 13.

The method of evaluation was a points system, and Appendix 12A describes this in detail. Points were scored, normally in the range from 1 to 10, in respect of the following ten criteria:

- Level of benefits needed, in pesos per hectare, given the expected area of development;
- Estimated profitability, in pesos per hectare (weighted by crop); this was scored from 1 to 15;
- Price variability; volatility of market price increases the risk and discourages development; the historic variability of prices was calculated, and an index, weighted by crop, calculated for each road;
- Price prospects, a measure of the prospects for international market prices, using World Bank forecasts;
- Market size, judged broadly in terms of the number of hectares that could be developed in order to satisfy the market;
- Labor intensiveness; in view of the shortage of labor, points were scored in favor of developments that needed relatively little labor;
- Capital intensiveness; points were also scored against developments that needed much capital;
- Climate, scored from 1 to 5;
- Isolation, a measure of distance from the five nearest cities;
- Distance from Altiplano and Valleys.

Weighting of Criteria - Given the ten evaluation criteria described above, it would be unreasonable to weight them all equally. All of them contribute to the objective of assessing the probability that each penetration road will achieve the minimum required development to justify itself. But some are more important than others and must be given greater weight.

The choice of weighting is largely a matter of judgement; the following weights were chosen:

CRITERIA	WEIGHT
(1) Level of benefits needed	2.0
(2) Estimated level of profitability (1)	1.2
(3) Price variability	1.0
(4) Price prospects	1.5
(5) Market size	1.5
(6) Labor intensiveness	0.7
(7) Capital intensiveness	0.4
(8) Climate (1)	1.0
(9) Isolation	0.4
(10) Distance from Altiplano and Valleys	0.3
	10.0

(1) Profitability was given a maximum score of 15, instead of the normal 10; therefore its true weighting is 1.8. Conversely climate, with a maximum score of 5, has a true weighting of 0.5.

Network Links - A final factor taken into account was the possible value of some of the roads as links in the national network, serving through traffic. The 1989 model projections showed that roads Nos. 8 and 9, joining Guayaramerín to Trinidad, would attract flows of 40 to 50 vehicles a day, excluding international traffic. The other roads attracted very little.

Conclusions on Penetration Roads

In the light of the above analysis it is considered that, in a program of new penetration roads, top priority should be given to roads 8 and 9 in the Beni (Guayaramerín-Puerto Siles and San Javier-San Ramón) and to sections of road 15, opening up the Tucavaca valley in eastern Santa Cruz. Roads No. 3 (Ixiamas-Tumupasa) and No. 1 (Ixiamas-Chivé) and parts of No. 4 (Riberalta-Humaitá) also appear well worthwhile. At much lower priority, short sections could be built from Santa Rosa towards Riberalta (No. 6) and from San Ramón to Magdalena (No. 10).

It is worth pointing out that, apart from the basic program of new penetration roads, the departmental Development Corporations, other local entities and private organizations will (and should) continue the construction of new roads with funds outside the basic transport investment budget. The detailed decisions on developmental roads should be made at the local level where the greatest knowledge exists on characteristics and potentials of the zones to be opened up. The penetration roads discussed in this chapter contribute not only to agricultural development, but also to national integration. A possible construction program of these roads, together with recommended starting dates, is as follows:

RECOMMENDED STARTING DATES	NO.	PENETRATION ROAD	LENGTH	FEEDER ROADS	COST
			(km)	(km)	($b million)
1981-1983	9	Trinidad-San Ramón, first section	60	120	188
1984-1986	8	Guayaramerín-Puerto Siles, first section	100	40	212
	15	Puerto Suárez-Quitunquiña, first and second sections	80	86	187
	3	Ixiamas-Tumupasa	45	-	210 (1)
	4	Riberalta-Humaitá	50	36	116
1987-1990	9	Trinidad-San Ramón, second section	60	240 (2)	300
	8	Guayaramerín-Puerto Siles, second section	50	100	157
	9	Trinidad-San Ramón, third section	71	220	273
	8	Guayaramerín-Puerto Siles, third section	65	100	174
	1	Ixiamas-Guarayos-Chivé	219	37	673
1991 and later	10	San Ramón-Magdalena	60	100	196
	6	Santa Rosa-Riberalta, first section	50	48	124
	16	Azurduy-Palos Blancos	251	165	1,380
			1,161	1,292	4,190

(1) Includes 80 million pesos for improvement of existing Tumupasa-San Buenaventura road.
(2) Includes access road and ferry crossing to Santa Ana de Yacuma.

The estimation of feeder road requirements is based roughly on estimates of the feasible area of development by 1999. The principal constraint is the number of migrants (assumed to be 200,000). This greatly limits the feasible development of the Tucavaca valley and, to a lesser extent, the Tarija area.

The whole program includes 2,453 km of new road, of which 573 km are of gravel, the rest of earth. The cost of the whole program is estimated at nearly $b 4,200 million but this could not be completed until the 1990s.

It has been commented by SNC that construction of the Santa Rosa-Riberalta road has been taking place at amazingly low cost -- $b 16 million pesos has so far been spent on 150 kms. No information has been received on the quality of the work, but it is agreed that this project can be added to the program specified above, on condition that construction can be continued at the same low cost. A sum of $b 22 million pesos (1977) should be added to the above program for this project (270 km), evenly divided between the periods 1981-1983 and 1984-1986.

Flexibility - The impact of a penetration road is difficult to predict. Many judgments and assumptions have had to be made, and time will probably show some of the conclusions to be faulty. Whatever program is adopted, therefore, flexibility should be preserved to enable the program to be changed in response to the evolving situation.

In particular there is the possibility of mineral development in the Brazilian Shield or in Potosí department. This could create an urgent and unquestionable need for new penetration roads such as No. 11 (Magdalena-San Ignacio, or part thereof) or others near Uyuni in southwestern Bolivia.

Supporting Action - None of the penetration roads is likely to achieve its intended impact unless other supporting action is taken. This Study cannot advise on colonization, agricultural reform or marketing, but some action must be taken to stimulate migration if there is to be rapid development. None of the proposed roads will be sufficient in itself to attract a rapid flow of migrants. The need for housing, schools, electricity, water, etc. must be attended to. If farmers are not given the means to sell their output, there cannot be any development.

Most of the roads are intended to promote production for export. Marketing organizations must be established to purchase the produce from the farmers, to ship it and sell it in foreign markets. The new export trades envisaged depend vitally on the river routes, through the Amazon and the Plate Rivers, both of which are now so poorly provided, both physically and commercially, that they are barely used. Proposals for their improvements are discussed in Chapter 15. They are vital for the success of the penetration roads Nos. 4, 8 and 15.

Similarly, road No. 3 (Ixiamas-Tumupasa) depends largely on the San Buenaventura development, and all the cattle roads depend on a radical modernization and reorganization of the meat trade and methods of cattle rearing.

The recommendations for penetration roads assume that these necessary supporting actions will be taken. If not, the roads may have little impact and the money spent on them will be wasted.

La Paz - Trinidad Link

The road between La Paz and Trinidad is 631 km long and passes through some of the most difficult terrain in the country. Typical travel time in the dry season is 27 hours, excluding stops and river crossings, giving an average travel speed of 23 km/hour. The first 100 km out of La Paz pass through the extremely steep valleys of the Yungas, where construction costs are exceptionally high. After passing through a further 250 km of mountainous terrain, the road reaches the flat lowlands and crosses large swamps and numerous rivers for about 280 km before it arrives at Trinidad. This part of the road becomes impassable for 3 to 4 months a year during the wet season.

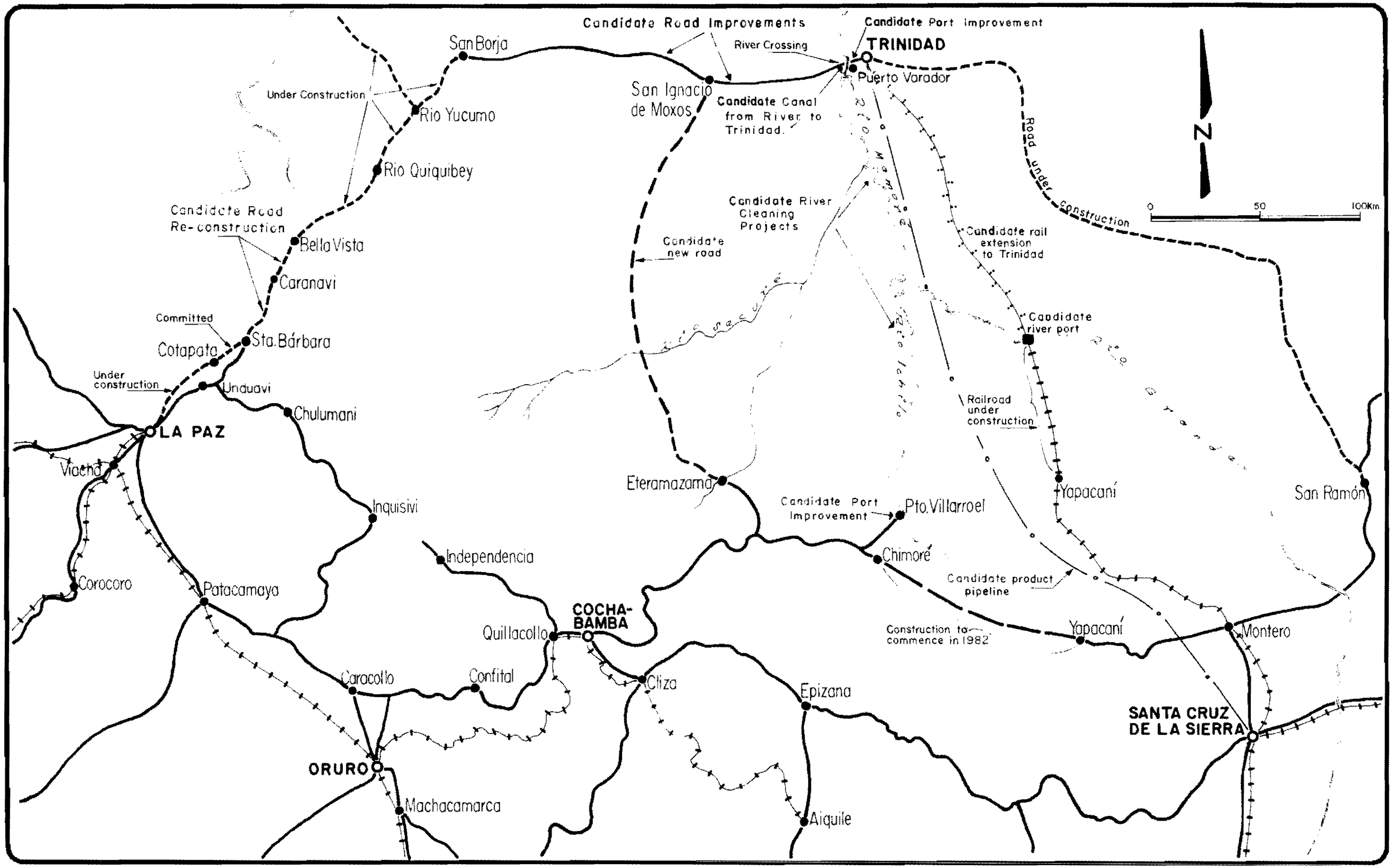
Projects - Some major improvements have been in progress since 1977 and will undoubtedly start generating new traffic and activity in the area before the new projects, now to be considered, could come into effect. There are four new projects, which are illustrated in Figure 12-9, as follows:

(i) Santa Bárbara-Bella Vista: this project considers the reconstruction and paving of the section, which is currently of gravel surface and poor construction standard. The length would be reduced from 111.5 km to 99 km. 1977 cost: $b 2,900 million.

(ii) San Borja-San Ignacio de Moxos: this project should be considered in two parts. First, the existing earth road of 140 km would be graded and gravelled at a cost of $b 131 million. Secondly, it would have bridge and culvert improvements to eliminate flooding and thus turn it into an all-year road. The cost of this part is $b 108 million.

(iii) San Ignacio de Moxos-Trinidad: this would involve the same staged construction as the previous project. The cost of this 88 km long section is estimated at $b 41 million for the first stage and $b 71 million for the second.

(iv) Mamoré River Crossing: this project considers the possible improvements to the crossing of the Mamoré River, just west of Trinidad. Costs depend upon the nature of the improvement, for which several alternatives are available.



GROUND CONNECTIONS WITH TRINIDAD

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FIGURE 12–9

Evaluation of Santa Bárbara-Bella Vista Highway - Traffic volumes were derived from existing count data and from the estimations of generated traffic made in an earlier Study by De Leuw Cather, Canada Ltd. (DELCANDA)(1). Benefits in 1989 were calculated as savings in vehicle operating costs, savings in the cost of meat transport through use of refrigerated trucks rather than air and benefits of increased agricultural production in the Beni. The latter were also derived from the DELCANDA Study. Taking into account a slight rise in road maintenance costs due to increased traffic, 1989 benefits total $b 210.5 million compared with a 1989 construction cost of $b 3,500 million. Hence a first year rate of return of only 6.0 percent can be calculated. The details of this evaluation are set out in Appendix 12B.

Thus, the project as currently designed cannot be justified by 1989. However, it is considered that the project is overdesigned for the rather low traffic volumes expected to use it. The current plan envisages a relatively high-standard road, considering the difficulty of the terrain, with a maximum gradient of 7 percent and a minimum radius of 75 meters. These design criteria make it necessary that about 80 percent of the road would have to follow an entirely new alignment. It is strongly recommended that the design for this project be re-assessed making maximum use of the existing alignment with the objective of reducing costs by 50 to 70 percent. On this basis, construction could be justified by the late 1980s. $b 1,250 million is included in the investment program for this project.

It is noted in Appendix 12B that the costs of this project may be overestimated due to too much weight being put on the costs of the La Paz-Cotapata contract. Hence, the task of reducing the costs of this project to the levels necessary for economic justification in the 1980s might not be quite so formidable as indicated here.

Evaluation of San Borja-Trinidad - This route, considered in two separate sections on either side of San Ignacio de Moxos, is currently being improved gradually. On forecast traffic volumes, the first project for each section (gravelling and grading) appears to be feasible, as indicated below.

SECTION	1989 COST	TRAFFIC BENEFITS	INCREASED MAINTENANCE	NET BENEFITS	1989 FYRR
	(millions of 1977 pesos)				
San Borja - San Ignacio	156	14.5	1.3	13.2	8.5
San Ignacio - Trinidad	49	12.0	0	12.0	24.0
	205	26.5	1.3	25.2	12.3

(1) Estudio de Factibilidad para el Camino La Paz-Rio Alto Beni (Feasibility Study of the La Paz-Alto Beni River Highway) De Leuw Cather, Ltd. and Prudencio Claros y Asociados for Ministry of Transport, Communications and Civil Aeronautics, La Paz, 1974.

The first part of the project from San Borja to San Ignacio is not feasible on its own, but it can be argued that it contributes to the traffic between San Ignacio de Moxos and Trinidad, and that the two projects merit joint treatment. In addition, improvement of the road can be expected to generate development benefits, but these are very hard to quantify.

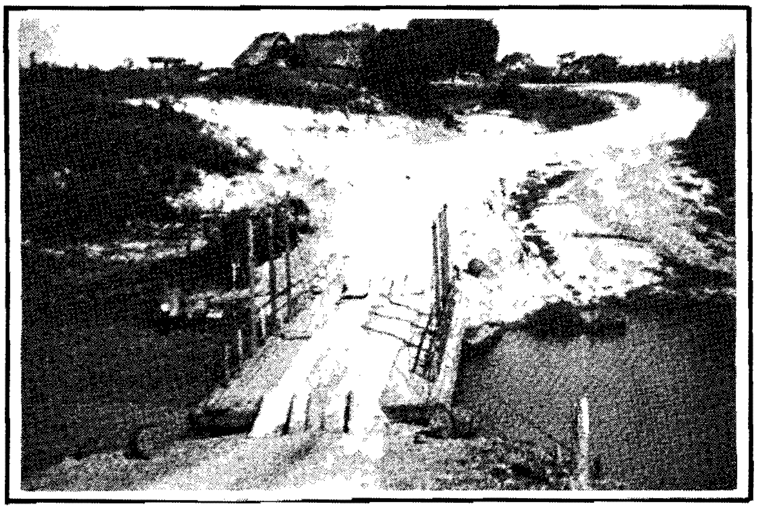
One must also consider the second part of the project, namely the upgrading to all-year standard of the road between San Borja and Trinidad. This adds $b 179 million to the investment cost. The benefit of this part of the project is to make trips possible which would otherwise not be possible during 3 to 4 months of the year. If one assumes that the daily number of trips during the wet season would then be the same as during the dry, the number of trips thus generates in 1989 would be as follows.

	SAN BORJA-SAN IGNACIO	SAN IGNACIO-TRINIDAD
Light vehicles	3,105	3,600
Buses	2,025	2,520
Trucks	6,750	13,320
	11,880	19,440

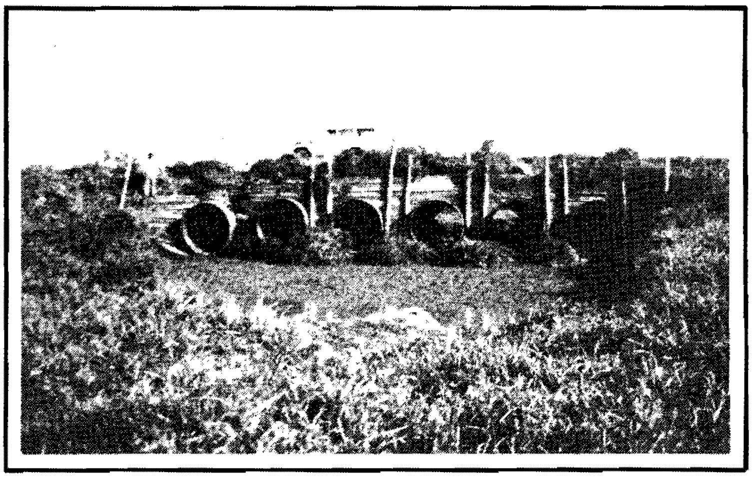
If the minimum acceptable rate of return is 8 percent, the annual benefits from the investment of $b 179 million should be not less than $b 14.3 million. This amounts to $b 457 per trip, counting separately the trips on the two parts of the road. One must consider whether the users of this road would be willing to pay, on average, this amount of money, additional to their operating costs, in order to make these trips. It seems unlikely.

On the other hand, it might be argued that the closure of this road for a large part of each year is seriously impeding the growth of Trinidad and the development of the Beni, and that traffic volumes would be considerably higher than here suggested if all-year connection with La Paz was assured. There is probably some validity in this argument, in which case the benefits of these projects have been underestimated.

It is therefore recommended that spot improvements to this road are continued with a program of new culverts and bridges, with the objective of gradually reducing the periods of wet season interruption until they can be eliminated entirely. Additional thought should also be given -- and experiments made -- concerning the use of a light seal road surface in this region where the aggregates needed for a gravel surface are relatively expensive. $b 297 million is included in the investment program for this project.

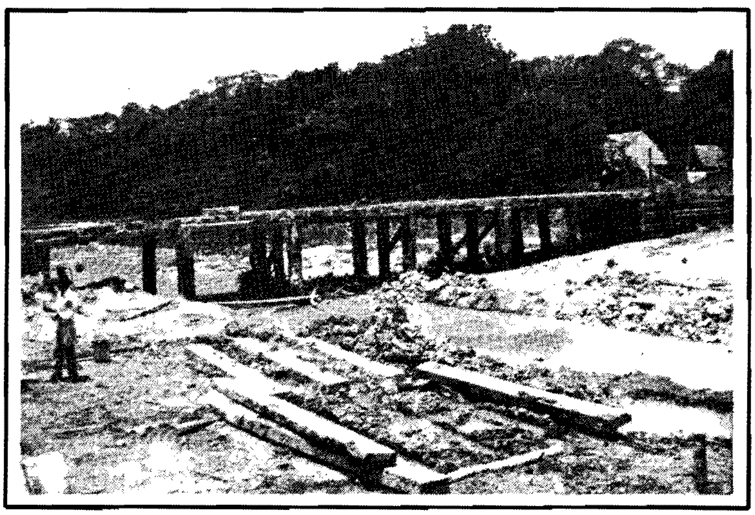


PONTOON RIVER CROSSING



DRAINAGE STRUCTURES

WOODEN BRIDGE



SAN BORJA-TRINIDAD HIGHWAY

Mamoré River Crossing - The Mamoré River must be crossed to reach Trinidad both from La Paz and also on the proposed new road from Cochabamba. The river varies greatly from season to season in width and also undergoes frequent changes of course. Three alternatives were examined for crossing this river:

- Construction of a bridge
- Use of a ferry boat
- Use of motorized pontoons.

Because of the great variation in width and position of the river, the Development Corporation of the Beni department has estimated that a 6 km long bridge would be required. This bridge would cost approximately $b 1,200 million to build, thus for an eight percent first year rate of return, a benefit of $b 96 million is needed. At an estimated 132 vehicles a day in 1989, the saving per vehicle would have to be $b 1,990 which is far more than the global costs of providing the river crossing by other methods, examined below.

An alternative to the bridge is a 320-ton ferry boat costing $b 12 million. The 1989 annual operating costs are estimated at $b 3.4 million to which must be added the costs of vehicle delay of $b 7.8 million. An additional expenditure in this case would be the construction of suitable berthing facilities on each side of the river.

To remove the need for these facilities, the use of motorized pontoons was considered. Two of these pontoons would be required, each capable of carrying six large trucks and costing $b 1.5 million each. The cost of vehicle delays would be unaltered, but the annual running costs would be reduced to $b 2.8 million. The average cost per vehicle crossing would be about $b 240.

The system used at present is that trucks unload freight into a barge which is then reloaded into other trucks on the far side of the river. The estimated annual cost of these loading operations, and consequent vehicle delays, is $b 14.4 million and that of operating the barges is $b 2.2 million giving a total of $b 16.6 million.

Therefore, it is concluded that the best course of action is to purchase two motorized pontoons for $b 3 million, giving a benefit of $b 6 million in 1989 over the current system. In fact the pontoons become economically viable at a volume of about 20 vehicles a day and so should be instituted in the near future.

Cochabamba - Trinidad Road

A major deficiency in the road network is the lack of a connection between Cochabamba and Trinidad. The area lying between these two departmental capitals is one of the most uninhabited and unknown in the country; in fact the boundary between the two departments remains undefined. At present there is a road from Cochabamba to Eteramazama, a distance of 180 km, from which point it is proposed to construct a link to San Ignacio de Moxos on the Trinidad-San Borja road. The distance would be 272 km.

The proposal consists of two separate projects: Eteramazama-Río Securé, 132 km, and San Ignacio-Río Securé, 140 km. The combined cost is estimated at $b 1,116 million, including the cost of bridges of about $b 440 million, if completed in 1989. The road would be gravel surfaced and 8 meters wide. The location of the route is shown in Figure 12-9 (see earlier).

Traffic Predictions - Freight traffic currently moving between Cochabamba and Trinidad takes the road to Puerto Villarroel and continues by boat down the Ichilo-Mamoré. It is expected that much of this traffic would transfer to the new road, which would be much faster though not very different in cost.

The average transport costs used in the analysis for the two routes are shown in Appendix 12C for the main origin-destination movements contributing traffic to the new road. About one half of them show a cost saving of up to 22 percent from the new route, but for the others the old route is cheaper.

Utilizing the same diversion curves as were produced for road-rail competition, the model produced traffic predictions for the new route and for the old road-plus-river route. The predicted volume of goods traffic on the new road was 188,000 tons per year in 1989, in 28,750 trucks of different sizes.

Evaluation - The evaluation of a project which introduces a new mode in competition with an existing mode is complex. The method of evaluation is explained in Appendix 3H. The benefits to traffic transferring to the new road were estimated at $b 46.7 million for agricultural products and $b 92.6 million for non-agricultural products. Goods traffic generated by the new road was valued at $b 2.5 million for agricultural products and $b 5.3 million for non-agricultural products.

The additional maintenance costs of the new road were estimated at $b 6.7 million per year in 1989. Hence the benefits from goods traffic alone gave a single-rate of return of 12.6 percent on the investment of $b 1,116 million. Assuming a project life of 20 years and a construction period of 4 years, the project net present value would be $b 200 million at 12 percent discount rate.

Thus this road seems to be an excellent prospect for an all-weather connection to Trinidad, and also opening up the relatively unknown area between the two cities. The rate of return obtained indicates that this road would become viable towards the end of the decade with the construction start date probably depending on budget limitations.

The Central Beni Corridor

The Central Beni Corridor is the name given to the set of transport links between Santa Cruz, Trinidad and Guayaramerín. The dominant transport modes in the corridor at present are the Mamoré River for freight and air for passengers, but other modes are beginning to appear. The road from Santa Cruz to Trinidad is a committed project expected to be completed by 1982. The road north of Trinidad to San Ramón, with a branch to Santa Ana, is also under construction, though not with high priority. Earlier in this chapter, the road to Guayaramerín from Puerto Siles, which is already linked to San Ramón, was recommended as a priority development road. Thus a basic road could be completed within the next decade linking Santa Cruz, Trinidad, Santa Ana and Guayaramerín.

A railroad is also being built from Santa Cruz to the Río Grande, the extension of which to Trinidad is a project for evaluation in this Study. Finally, a petroleum product pipeline has been proposed to supply Trinidad from Santa Cruz.

Although the river is facing increasing competition, there are several projects to improve its facilities, which are now very primitive. There are projects to improve port facilities at Puerto Villarroel, Trinidad and Guayaramerín and to construct port facilities at the rail terminus on the Río Grande. A canal is proposed to give Trinidad year-round access by boat from the River Mamoré and there is an important river-cleaning project to clear the Mamoré of obstructions between Puerto Villarroel and Guayaramerín.

Each project is discussed below and a summary of the evaluations is given in Table 12-3. Project locations are shown in Figure 12-9 (see earlier).

Product Pipeline from Santa Cruz to Trinidad - The proposed pipeline is 440 km long and estimated to cost $b 516 million in 1989. Projected volumes are about 40,000 tons per year by 1989 rising to nearly 100,000 tons by 1999, of which about half are for Trinidad with the rest destined for the Riberalta-Guayaramerín region. The alternative route for these products is by rail as far as Río Grande and then by river and road. Estimated benefits were only one percent of investment cost in 1989, so the project cannot be recommended for the next decade, nor , at projected growth rates, for the decade after. This conclusion would be reinforced were the rail line to be completed to Trinidad.

Río Grande to Trinidad Rail Line - This is a 149 km project costing just over 1,000 million pesos to provide the final link of the rail line from Santa Cruz to Trinidad. A throughput of 110,000 tons was forecast for this line for 1989, rising to nearly 300,000 tons by 1999. The alternatives to the rail line are the Santa Cruz-Trinidad road, and the Mamoré River via the committed paved road to Chimoré.

Benefits forecast for 1989 are very low and do not offset fixed costs of operations and maintenance. By 1999 though, benefits could be greater than fixed costs and a first year rate of return for that year was calculated of 2.6 percent. Details of the evaluation are given in Appendix 12E.

In conventional terms, this evaluation demonstrates that the project is not viable within the next twenty years, and this is not surprising for a project which is comparatively expensive to construct but which generates such small flows.

However, conventional terms of economic justification may not be entirely applicable, because there is the strong probability of financing from Argentina for this project on very favorable terms. If loan agreements established for earlier phases of the project are followed, a possible loan would involve interest charges of 3 percent per year and an amortization rate of 5 percent per year, both payments starting after the project is completed.

It can be demonstrated, for example, that at a constant rate of inflation of 5 percent per year, and with an opportunity rate on capital of 12 percent, the rate of return required to

Table 12-3

SUMMARY OF THE CENTRAL BENI CORRIDOR PROJECT EVALUATIONS

PROJECT	LENGTH (km)	ESTIMATED COST 1977 (millions of 1977 pesos)	ESTIMATED COST 1989 (millions of 1977 pesos)	IMPLEMENTATION PERIOD (year)	1989 VOLUMES ('000 of tons)	1989 BENEFITS (millions of 1977 pesos)	1999 VOLUMES ('000 of tons)	1999 BENEFITS (millions of 1977 pesos)	RATE OF RETURN (%)	NET PRESENT VALUE (1980) (millions of 1977 $b at 12%)
402 Santa Cruz-Trinidad Petroleum Products Pipeline	440	450	516	3	39	5.9	99	-	1.0[10]	-
102 Río Grande-Trinidad Rail line	149	1,003	1,154	4	110	negative[1]	288	35[1]	negative	-
210-213,216 Port Projects	-	46[2]	-	2	100[2]	negative	-	-	-	-
209 Río Mamoré-Trinidad Canal	14	300	345	2	139	1.2	-	-	-[10]	-
214 Ichilo-Mamoré River Cleaning Project	276[3]				95	1.1	71	0.8		
	216[4]	41.5[6]	-	7[7]	212	1.8	150	1.2	10.3[8]	- 45
	845[5]				95	3.6	203	7.7	13.8[9]	40

(1) After deducting fixed costs of million pesos per year.
(2) Standard design for 100,000 tons cargo. The evaluation results based on 100,000 tons throughput did not warrant further investigations.
(3) Puerto Villarroel - Río Grande.
(4) Río Grande - Trinidad.
(5) Trinidad - Guayaramerín.
(6) Includes 30 million pesos for basic boat and equipment and 11.5 million pesos for operating costs in cleaning period.
(7) Assumes 2 years to build and equip boat and 5 years to clear river.
(8) Internal rate of return assuming 30 million pesos for boat and equipment.
(9) Internal rate of return assuming 20 million pesos for boat and equipment.
(10) 1989 single-year rate of return.

justify a project with such loan conditions is reduced, from the point of view of Bolivia, to 5.0 percent. If dollar inflation is assumed to be 15 percent per year, the rate of return required reduces to only 2.9 percent.

Such arguments, though, are a little academic. A loan for this project will presumably not be negotiated until the current extension of the rail line to the Río Grande is completed, perhaps in 1985. Inflation rates are notoriously difficult to predict and it is impossible now to say what they might be in five years time, let alone how they might vary over the following twenty years. In any event, it is impossible to realistically predict inflation rates which would make this project viable on the basis of benefits calculated by this Study.

There remains the possibility that benefits have been underestimated. In particular, development benefits have been ignored, but this has been for good reasons. The line under construction to the Río Grande passes through largely unexplored territory which may well have potential for development which the rail line now under construction may tap. In contrast, much of the section north of Río Grande, through which the new project will pass, is already accessible by road from Trinidad and it is difficult to see how much more the railroad can contribute to the exploitation of this region. The development potential of the railroad should first be proved south of the Río Grande, before attributing such benefits to the section between the Río Grande and Trinidad.

The volumes predicted on the project are not negligible in Bolivian railroad terms, and yet measured benefits indicate that the project will not be viable for at least the next ten years and probably not for the next twenty. Despite the possibility of a cheap loan from Argentina, this project is not recommended for the foreseeable future. In any event, it is firmly recommended that construction beyond the Río Grande does not proceed without a detailed feasibility study.

It is acknowledged that Argentina has been very consistent in their financing of Bolivian railroad development. It was they who made possible the construction of the Yacuiba to Santa Cruz line, and the line to Trinidad can be seen as an extension to that project. The reason stated for Argentinian interest in this line is a desire to connect Argentina with the Amazon basin river system. If this is the reason for Argentina's persistence in advancing this project, the objective will have been achieved when the section currently under construction reaches the Río Grande. Therefore, it is suggested that the Bolivian government negotiate with Argentina to transfer the funds for the Trinidad railroad to projects more beneficial to Bolivia. For example, the rehabilitation of the Santa Cruz-Yacuiba rail line (although not proved to be fully economically viable in the 1980s - - see Chapter 13) might be a better project for Argentinian financing and would take up half of the funds otherwise required for the new railroad.

The Ichilo-Mamoré River Projects - Increasing competition by road and rail in the Central Beni Corridor means that river volumes are unlikely to increase significantly as the Beni develops, and in some parts will actually decline.

The decline is most likely to be felt in the upper reaches of the river between Puerto Villarroel and Trinidad. The rail line now under construction from Yapacaní to Río Grande is expected to draw off much of the traffic between Puerto Villarroel and Río Grande, and the road being built from Santa Cruz to Trinidad will also have its effect, so that river volumes could fall to about half today's levels. If the rail line is completed to Trinidad, the effect of halving current river volumes will be felt throughout this section (this rail project is not recommended by the Study).

North of Trinidad, competition from the proposed Trinidad-Guayaramerín road link would keep volumes at today's levels but this could change dramatically if meat exports via Guayaramerín become a reality. It could be expected that live cattle would be sent down-stream by boat from the areas near the river and this could double volumes on this section of the river by 1999.

In the light of these figures, the various river projects are reviewed below.

River Ports - Projects to improve existing river ports were considered for Puerto Villarroel, Trinidad and Guayaramerín, and a new port was considered at the terminus of the rail line under construction to Río Grande.

A design was studied capable of handling 100,000 tons per year. It included a river quay 100 meters long, a paved area and a transit shed. Mechanical handling equipment was envisaged including fork lift trucks and mobile cranes. One of the functions of the transit shed would be to disengage the loading and unloading activities of trucks and boats with the object of reducing waiting time for both. The cost of such a port would be nearly 50 million pesos.

Unfortunately, the estimated benefits of time savings for boats and trucks do not offset the additional costs of running such a port. While labor is abundant and cheap, it does not pay to install such a comparatively sophisticated facility. Also, with increasing competition from other modes, the type of cargo likely to remain on the river will make less demands on a breakbulk port. Live cattle, aggregates and petroleum products are all easily transferred between boat and river bank, although movement of the latter two products is greatly aided by quite simple mechanical aids. It is concluded that the remaining breakbulk cargoes are best handled by manual labor, as at present.

Other doubts must be raised by the instability of the river bank, especially at Trinidad and further south. Past experience has shown that a fixed port would be in danger of damage, or even total loss, due to floods and river bank subsidence.

Some minor investments could be justified: for example, a bulldozer to help reshape the access paths to the river bank from time to time, a small mobile crane to handle particularly awkward loads and some mobile conveyor belts for loading and unloading gravel. Such equipment could cost between half a million and one million pesos per port. A sum of $b 6 million is included in the investment program for the four ports listed at the beginning of this Section.

Canal to Trinidad - Trinidad can be reached by boat when the river is high but for half the year boats have to discharge and receive cargo on the River Mamoré at Puerto Varador, some 14 km from Trinidad. A canal has therefore been proposed to give all-year access.

Such a canal would be expensive. In the dry season, the level of the Mamoré drops to 7 meters below high water level and it is estimated that excavation for a canal would have to be at least 7 meters deep and would cost about $b 300 million.

It is estimated that benefits in 1989, measured as the savings over alternative road transport costs, including transfers, and the difference in maintenance costs between the canal and the road, would amount to much less than one percent of the estimated project costs, and so the project is not recommended.

River Cleaning - With help from the Belgian Government, some preliminary work has been done on this project. The objective is to remove embedded tree trunks and semi-dams (essentially sand bars formed around a collection of embedded trees) in order to reduce delays and hazards to navigation. It has been estimated that with a suitably equipped boat, it would take three years to clean the 492 km from Puerto Villarroel to Trinidad and another two years to clean the 845 km from Trinidad to Guayaramerín (which has less obstructions).

Cost estimates for an equipped boat are vague. A figure often quoted is $b 30 million for a metal hulled boat from Belgium, including equipment. Other sources maintain that a wooden boat built on the Mamoré using local materials, labor and techniques would be adequate to take all the necessary equipment, which would still have to be imported. Cost estimates for the locally built boat are not available, but are expected to be much less than for the imported alternative.

Benefits would be derived from two sources. One is the saving in boat and crew time due to faster navigation. It is estimated that nearly 2,000 boat-days could be saved per year between Puerto Villarroel and Trinidad, with a further 2,500 boat-days saved in the section from Trinidad to Guayaramerín, at today's volumes. A second source of benefit is the saving in boat losses, which are currently estimated at about $b 500,000 per year.

Appendix 12D sets out the details of the evaluation of this project. If the cost of boat with equipment is $b 30 million, the project, if started in 1981, would have an internal rate of return of 10.3 percent. If the cost could be reduced by one third, as seems likely with a locally built hull, the internal rate of return would increase to nearly 14 percent. The benefits are much higher in the section north of Trinidad and it is recommended that this section of the river be cleared first. A sum of $b 20 million pesos is allowed in the investment program for equipment.

CHAPTER 13

RAIL TRANSPORT

CHAPTER 13

RAIL TRANSPORT

The historical role of the railroads has been to link Bolivia with its neighboring countries, and in particular with the ports of the Pacific and the Atlantic. The rail system has been in development for the past hundred years and the process still continues, with the line from Santa Cruz to the Río Grande, south of Trinidad, currently under construction. The most obvious gap is the lack of a connection between the eastern and western systems within Bolivia. Proposals for such a connection are among the projects examined in this chapter.

Fortunately, the entire rail system has been constructed to a consistent one-meter gauge, and all the connections with neighboring countries, except that with Peru via Lake Titicaca, also use this gauge. However, construction standards are low, alignments are poor, bridges and drainage structures are inadequate in places and the track has been laid without ballast. Therefore, in addition to projects to extend the rail system, there are also schemes to rehabilitate existing lines, continuing work already started with World Bank assistance.

This chapter reviews the Study's forecasts of rail freight traffic and presents the evaluation of the rail projects, including railroad rehabilitation. The future of the railroads as a passenger carrier and the need for new equipment in the next ten years are also examined. Finally, railroad operations and the organization and management of the National Railroad Company (Empresa Nacional de Ferrocarriles - ENFE) are discussed.

Projections of Rail Freight Demand

Rail is associated primarily with transport between Bolivia and abroad and accounts for a large share of this traffic. In 1977, rail carried 81 percent of all imports and 58 percent of all exports; in total 970,000 (1) tons of freight. In contrast, the rail share of domestic traffic is low. Only 258,000 tons of freight were carried in 1977 which represents less than 2 percent of all internal freight movements, although accounting for about 6 percent of all ton-kilometers. The share of ton-kilometers reflects the increased competitiveness of rail over longer haul

(1) Based on ENFE statistics and referring to the volume of these movements moving within Bolivia. In fact,some of these movements moved externally by other modes,e.g. about 42,000 tons of imports which arrived by Lake Titicaca and then transferred to rail.

distances. Domestic freight currently accounts for only twenty percent of all rail freight movements.

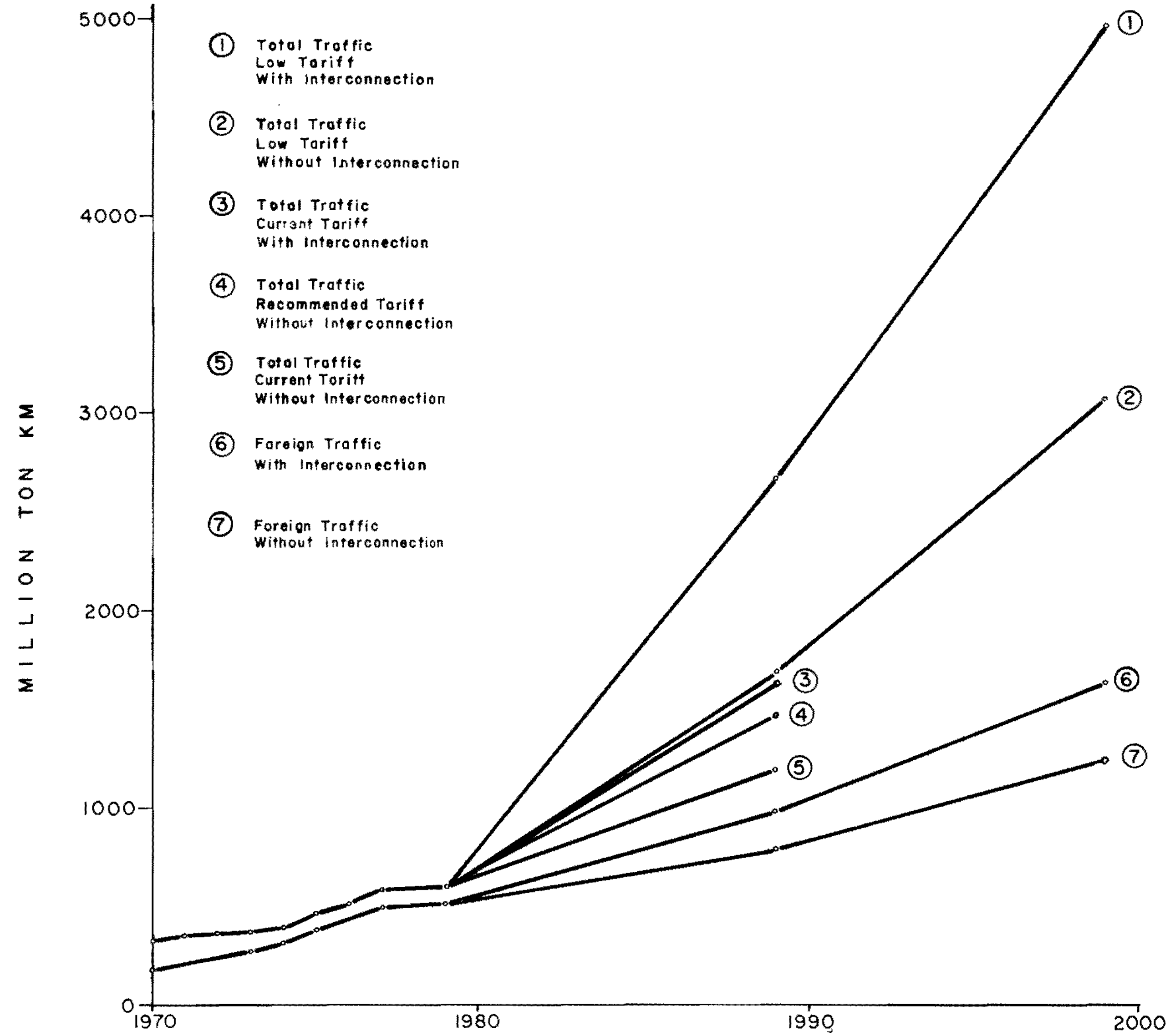
Table 13-1 presents past traffic and the Study's rail freight forecasts for 1989 and 1999. Trends and forecasts in ton-kilometers are presented graphically in Figure 13-1 and the allocation of flows by line are shown in Figure 13-2, contrasting current and forecast movements.

Foreign trade movements are expected to increase steadily following past trends in the growth of this traffic. The rail interconnection (2) is not expected to change the tonnage of foreign trade (although international transit traffic will be strongly affected) but it is expected to change the routes chosen, mainly due to increased use of the Pacific ports by products originating or destinating in the east of the country. Although the overall effect would be to decrease distances to and from ocean ports, haul lengths within Bolivia would increase, leading to the forecast increase in ton-kilometers shown in the table.

It is domestic traffic which, under certain assumptions, is forecast to increase substantially, following a recent downward trend. With low tariffs, and with a rail interconnection, domestic traffic (measured in ton-kilometers) is forecast to increase nearly forty times between 1979 and 1999. Although this predicted rate of increase appears unrealistically high, the total domestic tonnage forecast by 1999 is not so very great. A total of 3,340 million ton-kilometers on a system of over 4,000 km (including the interconnection) gives an average density of less than one million tons per year, and this should not be regarded as unattainable. Current domestic volumes are very small, and this is why the forecasts appear so large. Nevertheless, the factors behind the forecast increase are worth discussing.

There are principally three assumptions which influenced the forecast growth in domestic traffic. The first is the forecast traffic of products from Mutún to Santa Cruz, which could reach 567,000 tons by 1989, generating 364 million ton-kilometers. Without this traffic, it is estimated that domestic rail freight would decline to only about half of current volumes, under existing tariffs. The second assumption is the construction of the rail interconnection from Cochabamba to Santa Cruz, which would not only open up a new corridor for rail goods transport but would also, because of its situation on the main transport axis of the country, permit an increase in the average length of rail haul and therefore in ton-kilometers carried. The third assumption is the low tariff policy (discussed in detail in Chapter 17).

(2) Not recommended at the present time for opening in the 1980's -- see later in this chapter.



RAIL: PAST TRAFFIC AND FORECAST GROWTH

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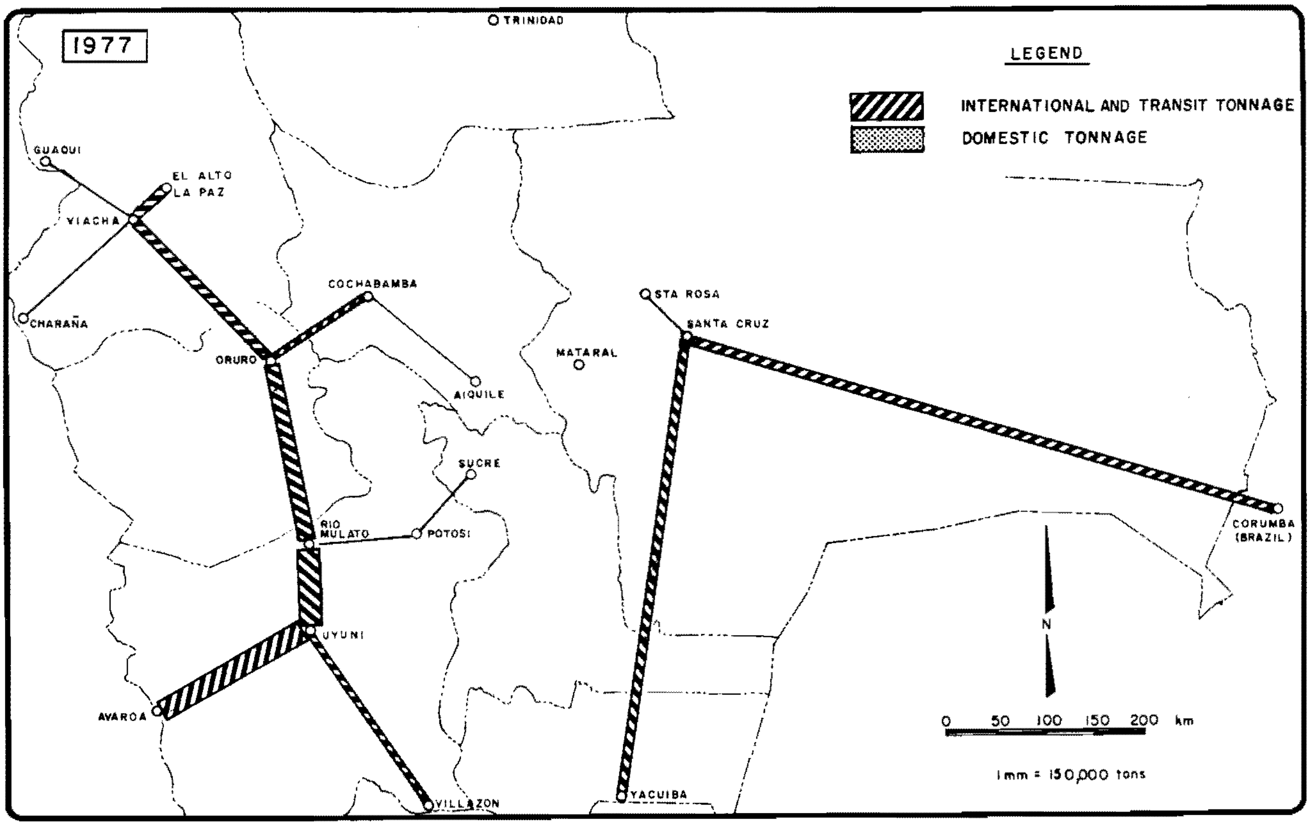
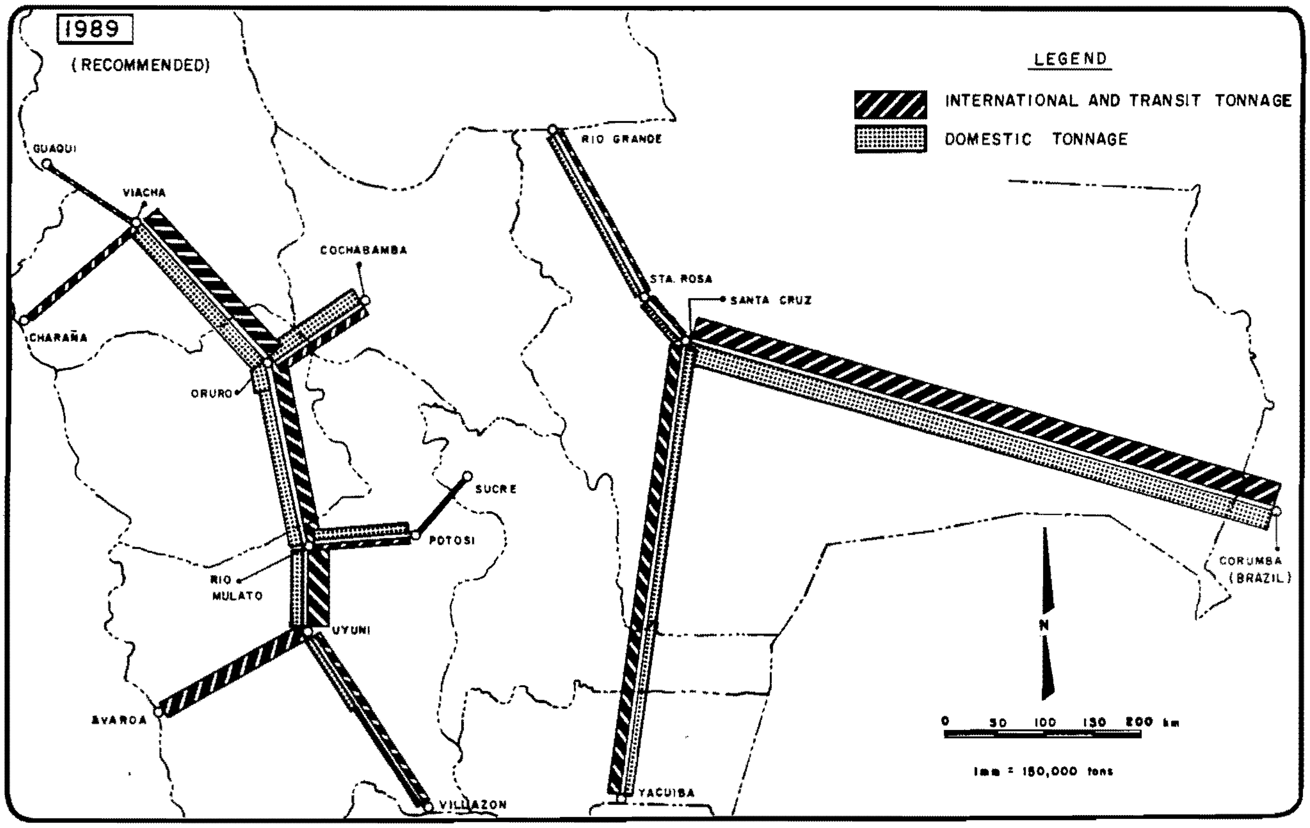
FIGURE 13–1





ANNUAL TONNAGE FLOWS BY RAIL IN 1977 AND 1989

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FIGURE 13–2

Table 13-1

RAIL FREIGHT TRANSPORT - TRENDS AND FORECASTS

YEAR	TARIFF ASSUMPTION	INTERCONNECTION ASSUMPTION	TONS Internal	TONS External	TONS Total	TON-KM Internal	TON-KM External	TON-KM Total	AVERAGE HAUL Internal	AVERAGE HAUL External	AVERAGE HAUL Total
			(thousands)			(millions)			(km)		
1970	-	-	705	470	1,175	149	177	326	211	377	277
1974	-	-	386	713	1,099	80	316	396	207	443	360
1977 (2)	-	-	258	970	1,228	83	500	583	322	515	475
1979	-	-	287	964	1,251	90	506	600	314	525	480
1989	Current	Without	707	1,334	2,041	408	789	1,197	577	591	586
	Current	With	753	1,334	2,087	601	1,037	1,638	799	777	785
	Low	Without	1,978	1,334	3,312	896	789	1,685	453	591	509
	Low	With	2,185	1,334	3,519	1,630	1,037	2,667	746	777	758
	Recommended	Without	1,574	1,334	2,908	717	789	1,506	455	591	518
1999	Low	Without	4,410	2,060	6,470	1,839	1,246	3,085	417	605	477
	Low	With	4,871	2,060	6,931	3,340	1,628	4,968	686	790	717

NOTE: Generated traffic and international transit traffic are excluded from this table.

(1) Refers to the candidate rail project linking the Eastern and Andean rail systems.

(2) Breakdown as recorded by ENFE. This is slightly different from the Study estimates based on an analysis of ENFE magnetic tapes and reported in Chapter 9.

(3) Based on the model test of the Recommended Network and recommended rail tariff policy (discussed in Chapter 17).

SOURCES: ENFE and Bolivia National Transport Study.

How realistic are these forecasts? The increase in traffic due to the development of Mutún can be regarded as realistic, and, similarly, the forecasts accurately reflect the increased competitiveness of rail which would be brought about by the rail interconnection. However, the forecast effects of lower tariffs are less certain.

The mechanism used in the transport model to allocate traffic betwen modes is described in detail in Appendix 3F. The allocation procedure is based on the relative transport costs by each mode but it also takes into account user preferences. In general, given similar costs between modes, users have tended to prefer road transport, although the degree of preference depends on the commodity to be transported. No criticism of rail operations is implied or intended by these remarks. User preferences simply reflect the fact that rail transport, in general, is more complex, slower and less convenient than road transport for certain types of shipment, and that users are sometimes prepared to pay the higher costs of road in order to avoid these disadvantages. It is a worldwide phenomenon and not confined to Bolivia.

The effect of the low rail tariffs would be to drastically change the relationship between road and rail costs so that many more users would switch to rail. The important question is, have user preferences been measured accurately enough so that confidence can be placed in model forecasts assuming a radical change in relative costs between modes? It is evident that a large increase in rail traffic would take place, if the railroads are ready to meet the demand, but it has to be accepted that the magnitude of the increase is very difficult to predict accurately. The increase could be low if users stubbornly stick to road transport. On the other hand, the increase could be higher if, as ENFE claims, demand for rail was supressed in 1977 due to lack of equipment, resulting in the Study over-estimating the preference for road transport.

Despite the uncertainty, it is the recommendation of the Study that a lower tariff policy be implemented for some classes of traffic, and the rationale for this recommendation is discussed in Chapter 17. The recommended tariff level is not quite as low as the lowest policy tested. Hence the 1989 traffic is not quite so high, showing a five and a half times increase in domestic traffic from 1979, compared with the seven times increase forecast with the lowest tariff policy. The effects of the new policy could be far reaching, leading to rail becoming a more influential transport mode for internal as well as for external transport. The implementation of such a policy would have to be very carefully planned and monitored.

The Rail Interconnection between the Andean and Eastern Systems

The two rail systems of Bolivia are quite separate with the only possible connection at present involving a detour through Argentina. The Andean System is located on the 4,000 meter high Altiplano with two branch lines extending into the Eastern Cordillera to Cochabamba and to Potosí and Sucre. The Eastern System is located entirely in the lowlands connecting the city of Santa Cruz with Brazil and Argentina, and also with northern Santa Cruz department.

An interconnection between the two systems within Bolivia has long been sought by successive governments, and five possible routes have been examined by this Study, based on past proposals. Some construction work has already been undertaken including a 216 km line east of Cochabamba to Aiquile, a 78 km line east of Sucre to Tarabuco with basic engineering structures completed for a further 61 km to Zudañez, and a 40 km line from Boyuibe to Cuevo. However, no work has been done on any of these lines in the past 25 years, and only Cochabamba-Aiquile is still in use. The proposed lines, and work already completed, are shown in Figure 13-3.

The main obstacle to completing an interconnection is the difficult terrain separating the two systems, resulting in high construction costs. The estimated costs of the five possible alternatives are as follows:

LINE	LENGTH (km)	ESTIMATED MINIMUM COST (millions of 1977 pesos)
Aiquile-Santa Cruz (via Mataral)	391	9,478
Tarabuco-Santa Cruz (via Zudañez and Mataral)	472	9,040
Tarabuco-Boyuibe (via Zudañez and Cuevo)	363	7,608
Balcarce-El Palmar (via Tarija)	470	14,856
Cochabamba-Yapacaní (via Villa Tunari)	380	9,720 (1)

(1) Approximate estimate -- less reliable than others quoted.

Since the entire transport budget for all modes of transport for the next ten years is not likely to be more than 34,000 million pesos (see Chapter 8), the building of a rail interconnection would absorb a large part of available funding.

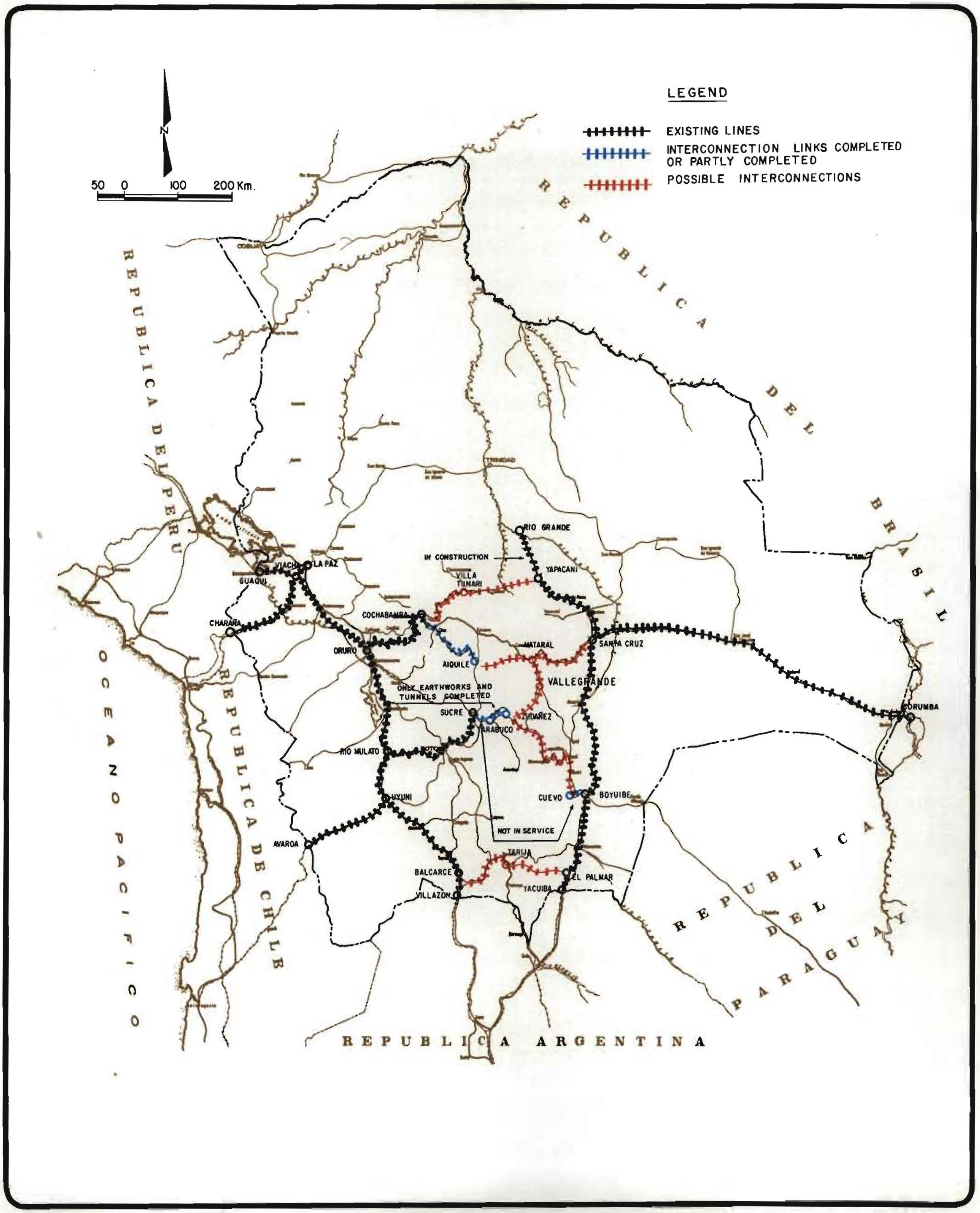
Previous Studies and Routes Chosen for Analysis - The link from Sucre to Boyuibe was studied in the 1940s with the possibility that Argentina might finance the construction. On the basis of this work, the short links from Boyuibe to Cuevo, and from Sucre to Tarabuco and (in part) to Zudañez were constructed, but no work has been done since 1955.

Of more relevance today is a detailed engineering study completed in 1977 by the Brazilian firm Sondotecnica with Brazilian financing. Several alternative alignments were examined for a single track of one-meter gauge from Cochabamba to Santa Cruz. The alignment recommended by the Brazilian Study links Aiquile with Santa Cruz via Mataral and includes a branch line from Mataral to Vallegrande. Costs developed by the Brazilian study have provided the basis for cost estimates not only on this alignment, but also on other routes through similar terrains. Although the Brazilian study recommended that the project go ahead, it calculated an internal rate of return of only 6.5 percent for an investment estimated then at 10,400 million pesos.

A study is planned for the link between Sucre and Mataral (assuming the Sondotecnica alignment from Mataral to Santa Cruz). No study has yet been undertaken or is planned of the link from Balcarce to El Palmar or of the northern alignment via Villa Tunari. The latter route would branch off the recently built rail line at Yapacaní, pass through generally flat terrain until Villa Tunari and then climb steeply to Cochabamba. Despite the high construction and operating costs in this last section, this alignment deserves fuller study.

It seems probable that the most likely alignment of a rail interconnection would be on, or near, the alignment chosen by Sondotecnica, basically because this is on the main transport axis of the country and would provide the most direct link between the three largest cities, La Paz, Cochabamba, and Santa Cruz. Hence this alignment was chosen as the principal link for testing with the transport model. Also included in the model test was the link from Sucre to Mataral. The two other possible interconnections (excluding the northern alignment via Villa Tunari) were evaluated, but it was concluded that they are not feasible. This is discussed later in this chapter.

<u>Cost Assumptions</u> - Sondotecnica produced detailed construction cost estimates at 1976 prices. These figures were adjusted to 1977 values, and were also used to estimate the cost of the Sucre-Mataral line. ENFE have reviewed these construction cost estimates and conclude that they could be reduced substantially. Thus, alternative cost estimates are available which are presented below.



CANDIDATE RAIL INTERCONNECTION PROJECTS

Wilbur Smith and Associates

FIGURE 13–3

PROJECT (1) NUMBER	LINE	LENGTH (km)	CONSTRUCTION COST ESTIMATES Sondotecnica Based	ENFE Based
			(millions of 1977 pesos)	
100	Aiquile-Mataral	184	5,494	4,462
101	Mataral-Santa Cruz	207	6,174	5,016
104a	Mataral-Vallegrande	55	994	994
103	Tarabuco-Zudañez	61	372	300
104	Zudañez-Vallegrande	150	2,730	2,730
132	Rehabilitate Cochabamba-Aiquile	216	-	406
139	Rehabilitate Sucre-Tarabuco	78	-	141

(1) See Chapter 10 and Appendix 10A.

Hence the total costs of the two main interconnections can be summarized as follows, including adjustments to 1989 levels (factored by 1.2 for relative changes in costs):

	1977 PRICE LEVELS High Estimate	Low Estimate	1989 PRICE LEVELS High Estimate	Low Estimate
	(millions of 1977 pesos)			
Cochabamba-Santa Cruz (1)	12,074	9,884	14,500	11,860
Sucre-Santa Cruz (2)	10,411	9,181	12,500	11,000
Both interconnections (1)(2)	16,311	14,049	19,600	16,860

(1) Including cost of rehabilitating Cochabamba-Aiquile.
(2) Including cost of rehabilitating Sucre-Tarabuco.

Fixed operating costs (excluding maintenance) were estimated for 1977 at 116,500 pesos per km for the Andean System and 107,500 pesos per km for the Eastern System. For the interconnections, averages of 113,000 pesos per km (1977) and 135,500 pesos per km (1989) are assumed.

Railroad maintenance costs are presented in Appendix 13A. Assuming a properly ballasted track in good condition, the following maintenance costs can be assumed:

22,000 + 0.021 T (1977) pesos per km
23,500 + 0.023 T (1989) pesos per km

where T = tons per year.

Forecast Traffic - Almost all the benefits associated with the interconnection are expected to accrue to freight traffic. Forecasts were made of normal internal traffic (traffic diverting from other modes), generated internal traffic (traffic brought about by the stimulus of the interconnection), foreign trade traffic to and from Bolivia and international transit traffic. These estimates are presented below, assuming that the two interconnections are built:

	TONS OF FREIGHT PER YEAR 1989	1999
Normal Internal Traffic	977,000	2,437,000
Generated Internal Traffic	531,000	1,325,000
Foreign Trade Traffic to and from Bolivia	350,950	574,727
International Transit Traffic-Low Estimate	319,000	518,000
International Transit Traffic-High Estimate	392,000	925,000

It is noted that some international transit traffic currently exists in the Cochabamba-Santa Cruz corridor, making use of road transport between Cochabamba and Santa Cruz, and rail for the rest of the journey. In 1979, 6,901 tons moved between Peru and Brazil, and 6,341 tons between Chile and Brazil, using this service. The products were mainly metals (see Chapter 9).

If the link from Sucre to Mataral is not built, the international traffic would be unaffected. For 1989 and 1999 respectively, the normal internal traffic would drop to 873,000 and 2,300,000 tons, and the generated traffic to 429,000 and 1,192,000 tons.

Calculation of Benefits - Benefits to internal traffic were estimated using the evaluation procedure described in Appendix 3H. Total benefits to this traffic were calculated to be as follows (in millions of 1977 pesos):

YEAR	COCHABAMBA-SANTA CRUZ ONLY	BOTH INTERCONNECTIONS
1989	374	442
1999	923	1,061

The cost saving to external traffic by using the rail interconnection instead of road is 494 pesos per ton. It was assumed that most ot the traffic would gain the full benefit of this cost saving but that, on average, the forecast traffic would gain only three quarters of this benefit. Thus benefits to external traffic were estimated as 130 million pesos for 1989 and 213 million pesos for 1999.

Benefits to transit traffic accruing to Bolivia were calculated as the revenues from tariffs that could be charged from one border to the other, less the marginal costs of transporting the goods.

Marginal costs were estimated as follows:

Marginal operating cost = 0.21 pesos per t-km (see Chapter 5, Figure 5-2)

Marginal maintenance cost = 0.0135 pesos per t-km (see Appendix 13A)

Average distance Peru/Chile to Brazil = 1,800 km

Hence marginal cost = 400 pesos per ton.

Guidance on likely revenue was taken from the tariffs currently charged on this route, which now requires transfer to truck for the section between Cochabamba and Santa Cruz; this is about 2,000 pesos per ton. It was assumed that this figure, in 1980 pesos, might represent a possible tariff for this traffic for 1989, but measured in 1977 pesos. Two alternative assumptions were then made:

(i) That the tariff would have to be substantially reduced to obtain the increased transit flow through Bolivia.

(ii) That the tariff could be increased with the interconnection, since the service level could be so much improved.

On this basis a low and a high tariff were chosen at 1,200 pesos and 2,400 pesos per ton, giving benefits of 800 and 2,000 pesos per ton, respectively. Hence total benefit to transit traffic can be estimated as follows:

	1989	1999
	(millions of 1977 pesos)	
Low Traffic, low benefit	254	414
high benefit	636	1,036
High Traffic, low benefit	313	740
high benefit	782	1,850

These represent considerable ranges of possible benefits in each year and it is clear that transit traffic benefits are the crucial element in a possible justification of the interconnection.

Savings in variable maintenance costs on the roads were also considered but they were very small. The additional fixed costs of rail maintenance (as specified above) were significant, however.

Evaluation of the Interconnection - It is clear that two interconnections, linking Santa Cruz to both Cochabamba and Sucre, could not be justified. Of the two, the Cochabamba-Santa Cruz connection has clear advantages, being likely to carry over three times as much traffic. Additional benefits with having both interconnections would amount to only about 70 million pesos in 1989, while the additional cost would be at least 4,000 million pesos for construction alone. Allowing a five-year construction period, this would give a first year rate of return (FYRR) in 1989 of under two percent. Hence it is concluded that the Sucre-Mataral line cannot be justified in the foreseeable future. The remainder of the evaluation concentrated on the Cochabamba line.

Evaluation of the Cochabamba-Aiquile-Santa Cruz Interconnection - For both costs and benefits, a range of values was estimated, reflecting the uncertainties involved in such a project. These values are summarized below:

	LOW ESTIMATE		HIGH ESTIMATE	
	1989	1999	1989	1999
	(millions of 1977 pesos)			
Construction Costs	9,884	9,884	12,074	12,074
Fixed Costs (non-maintenance	82	82	identical for low and high	
Fixed Maintenance Costs	14	14	identical for low and high	
Benefits to Domestic Traffic	374	923	identical for low and high	
Benefits to Foreign Trade Traffic	130	213	identical for low and high	
Benefits to International Transit Traffic	254	414	782	1,850

In calculating the first year rate of return (FYRR) assumptions are required about the length of time for construction and the discount rate to be used. Values of 5 years and 8 percent and of 10 years and 12 percent were assumed for an optimistic and a pessimistic case respectively. FYRRs for the optimistic and the pessimistic case respectively, are 8.6 percent and 2.6 percent for 1989, and 20.8 percent and 5.7 percent for 1999. The most optimistic case makes the following assumptions:

(i) Construction costs will be as low as ENFE estimated.
(ii) The construction period will be five years.
(iii) A discount rate of 8 percent is applicable.
(iv) International transit volumes will reach nearly 400,000 tons per year by 1989 and over 900,000 tons per year by 1999.
(v) A tariff of 2,400 pesos per ton can be charged for international transit traffic with a rail interconnection.
(vi) Lower domestic tariffs will lead to a large increase in rail freight traffic.

If all these optimistic assumptions could be fulfilled, the rail interconnection from Cochabamba to Santa Cruz would be justified for construction to start in 1984 and operations in 1989. However, in view of the competition for the scarce investment resources by other transport projects, it must be concluded that an 8 percent rate of return is too low for project viability and that 12 percent must be taken as the minimum. In this case, the earliest date when construction could be justified is 1988 (the earliest year when it could achieve a First Year Rate of Return greater than 12 percent), with operations starting in 1993. On this assumption the project would have an IRR of 16 percent.

The pessimistic case presents quite a different picture. The rates of return are very low and would not justify the project, even by 1999.

Conclusions on the Rail Interconnection - The economic evaluation of this very important project demonstrates that under the most optimistic assumptions of construction time, construction cost, traffic and revenues, the interconnection could be justified for the early 1990s with construction starting in 1988. It would be unlikely, though, for all these assumptions to combine so favorably, and it is therefore concluded that construction of the interconnection probably will not be feasible until the 1990's.

Two factors could change this conclusion. The first is if a detailed study of the northern alignment from Cochabamba to Yapacaní showed substantially lower construction costs than for the alignment currently considered via Aiquile and Mataral. Although the estimated construction cost of this alternative (shown earlier) is very similar to the estimates for other alignments, it was based on approximate data and could be very much lower. A one to two month investigation by railroad engineers should be sufficient to judge whether this alternative is worth pursuing further. Secondly, the viability of the interconnection depends heavily on the benefits accruing to Bolivia from international transit traffic. Further study may reveal that even the optimistic assumptions made by the Study are low, or that revenues per ton could be higher. It is therefore recommended that these two factors are studied in greater depth to see whether construction could, in fact be justified to commence in the 1980s.

It is accepted that other aspects may influence the decision of government, such as the need for regional integration, or extreme interest in the project by neighboring countries. It must be recognized, though, that a very large expenditure is being contemplated which could amount to at least one third of all expenditure on transport in the next ten years and account for between five and ten percent of all public investment in that period. Building the rail interconnection would surely divert money from other transport projects and would probably divert spending from other sectors of the economy.

A decision to implement this project cannot be taken lightly. Hitherto, no economic justification of the project has been made, although many people have advocated it. It is now established that a potential does exist, although some doubts remain. It is recommended that the additional studies are made of the northern alignment and of the potential for international transit traffic, either one of which could result in a change in priorities, before any further commitments are made on this project. The proposed National Transport Center (see Chapter 19) could assist in these studies.

It is also recommended that the recently introduced bimodal system for handling international transit traffic, using road transport between Cochabamba and Santa Cruz and rail for the rest of the journey, should be encouraged. This is basically an organizational and marketing problem for ENFE.

Evaluation of Other Rail Projects

Besides the rail interconnection, several other projects for new rail lines were proposed for evaluation. Projects dealt with in other chapters are (referring to candidate project numbers given in Chapter 10):

102 - The Río Grande Trinidad line (in Chapter 12)

106/107 - The Motacucito-Mutún-Puerto Busch line
113 - The realignment of the Santa Cruz-Corumbá line near Roboré
115 - The Orán-Bermejo railroad spur
111 - The Guaqui-Desaguadero-Puno line
(all in Chapter 15)

This section deals with the remaining projects, which are:

112 - Improvements to the Oruro-Cochabamba line
105 - Construction of Zudañez-Cuevo
108 - Construction of Balcarce-Tarija
109 - Construction of Tarija- El Palmar
110 - Construction of La Paz-Rurrenabaque.

With the exception of the improvements proposed on the Oruro-Cochabamba line, all these rail projects are extremely expensive and would attract little traffic. Making the most generous assumption about the volume of traffic which would transfer to rail and which would be generated by the new line, assessments were made of the likely benefits, and these are summarized in Table 13-2. In two cases, benefits barely meet or fall short of fixed costs of operations, let alone covering any part of amortizing capital expenditures. In only one case does the FYRR exceed one percent. It is therefore recommended that none of these projects be considered for construction.

The proposed improvements on the Oruro-Cochabamba line are discussed below:

Oruro-Cochabamba Line - This is a 204 km branch line leaving the main Viacha-Oruro line just north of Oruro at San Pedro. It passes through difficult terrain, and some sections are unstable and subject to earth slides. Interruptions are common in the wet season with an average 58-day suspension of services each year between 1975 and 1979.

In 1979-80, the Japan International Cooperation Agency (JICA) made a study of this line and evaluated three projects to alleviate the problems in the affected zones. The three projects are illustrated in Figure 13-4 and are summarized below.

	ESTIMATED COST (millions of 1979 pesos)
1. Construct tunnel from km 48 to km 57.65	236
2. Relocate track from km 103 to km 109.4	247
3. Raise track level from km 112.5 to km 116.5	124

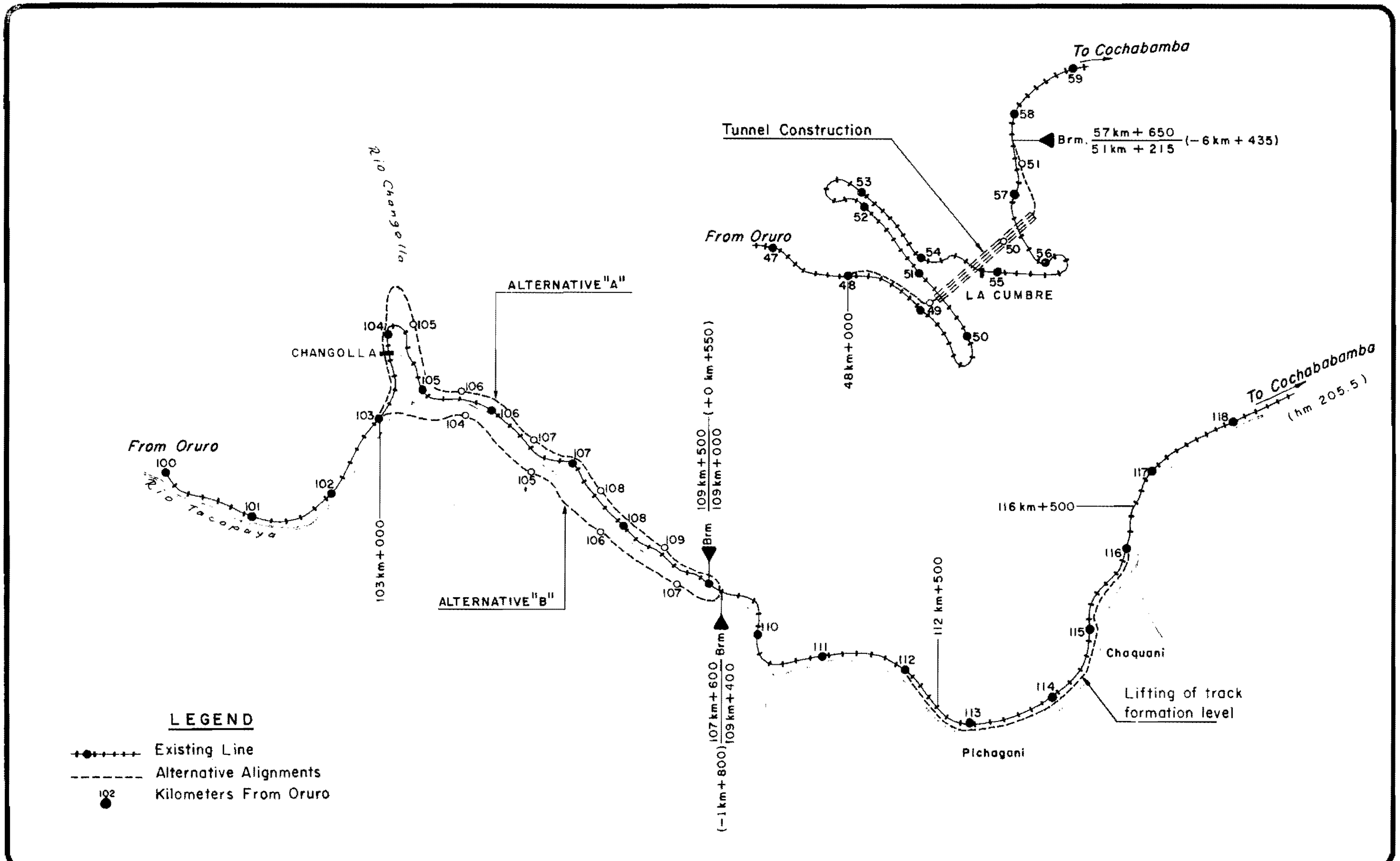
The second two projects were recommended by JICA, but the tunnel project did not prove to be feasible. The evaluations are examined here and commented on in the light of the Study traffic forecast for 1989.

Table 13-2

EVALUATION OF RAIL PROJECTS

	PROJECT	LENGTH	ESTIMATED 1989 COST	1989 FORECAST TRAFFIC		1989 ESTIMATED BENEFITS	1989 ESTIMATED FIXED COSTS		1989 FYRR (1)
				Normal	Generated		Maintenance	Other	
		(km)	(million of 1977 pesos)	(thousands of tons)		(millions of 1977 pesos)	(millions of 1977 pesos)		(%)
105	Zudañez - Cuevo	302	8,770	80	96	51	7	42	0.02
108	Balcarce - Tarija	250	12,600	246	315	138	6	35	0.8
109	Tarija - El Palmar	180	5,227	171	315	110	4	25	1.5
110	La Paz-Rurrenabaque	500	19,920	141	243	61	12	70	Negative

(1) Assuming seven years to build and 10% discount rate.



CANDIDATE RE-ALIGNMENT PROJECTS ON THE ORURO-COCHABAMBA RAIL LINE

Wilbur Smith and Associates

FIGURE 13–4

Tunnel Project - The tunnel would be about 1.5 km long and involve a further 1.75 km of new track. Savings are estimated by JICA at $b 2.35 million (1979) and comprise savings in maintenance and running costs due to the reduction in length of 6.4 km and the elimination of a steep grade. In terms of values estimated by this Study, both benefits appear to be overstated. Since the benefits estimated by JICA are only one percent of the total costs, it can be confirmed that this project is not feasible.

Track Relocation and Track Raising - These two projects, totalling 10.4 km, were evaluated together by JICA. The benefits were estimated for forecast 1984 traffic volumes (196,000 tons) on the assumption that 46 days suspension of service per year could be avoided by the new alignments. The benefits estimated by JICA are as follows:

	ANNUAL BENEFITS (millions of 1979 pesos)
Savings to passenger traffic	1.0
Savings to freight traffic	10.6
Avoidance of need to repair track	14.8
Reduced maintenance	1.2
	$b 27.6

On the basis of these benefits, JICA estimated an initial internal rate of return (IRR) of 10 percent. Sensitivity analyses, varying the extent of interruption each year, produced a range of IRRs of between 7.44 and 10.67 percent. However, the first year rate of return (FYRR) in 1984 was only 8 percent and, on the basis of JICA figures, would not rise to the minimum required by this Study (12 percent) until 1993.

Savings to passenger traffic were estimated by JICA as the avoidance of sales loss, both by wayside inhabitants to train passengers and by peddlers using the trains to sell goods to wayside inhabitants. The benefit to the project of maintaining these sales is small and have been maintained as estimated by JICA. However, it should be noted that JICA made no allowance for the temporary suspension of sales to be made up by increased selling afterwards.

Calculations of the freight transport savings appear to have been overcounted. The total volume of traffic affected by 46 days of suspension has been calculated and each ton of traffic is assumed to be affected by the entire delay. Since the total annual interruption is made up of a number of short breaks in service, a more realistic figure would be about 3 or 4 days on average. This would reduce the benefit calculated by a factor of at least 10.

The annual cost of repairing damage in the affected sections was derived from ENFE estimates and can be assumed to be reliable. Costs, in real terms, are said to be increasing at 6 percent per year. The savings in maintenance costs appear, if anything, to be slightly understated.

Compared with JICA, the Study has forecast more freight traffic based on existing tariffs, and much more if tariffs are reduced. On these assumptions, revised benefits for 1989 can be set out as follows:

	CURRENT TARIFF	RECOMMENDED TARIFF (1)
1989 freight volume (tons)	283,000	517,000
Savings to passenger traffic	1.0	1.0
Savings to freight traffic	1.3	2.5
Avoidance of need to repair track	20.0	20.0
Reduced Maintenance	1.4	1.4
	$b 23.7 million	$b 24.9 million

(1) See Chapter 17.

The 1989 project costs are estimated to total $b 496 million. In the most optimistic case of high freight volumes associated with the low recommended tariffs, a first year rate of return of only 5 percent is calculated compared with 12 percent required for feasibility. It has been suggested that the costs of track repairs each season in the absence of this project could be much higher, but they would have to rise to nearly three times the assumed value (which itself is higher than current costs) to make the project worthwhile. For higher volumes of traffic, which would be associated with the rail interconnection (not recommended for opening within the next ten years), the effect of traffic disruptions would be more extensive and the project could become worthwhile. At this stage, it is not recommended.

Analysis of Existing Lines

It was commented earlier that the original construction standards of the railroads were low so that, as a consequence, much of the track today is in an unsatisfactory state. This results in poor operating conditions and hence high operating and track maintenance costs.

In 1979, ENFE completed a study of maintenance costs and concluded that at current levels of maintenance, which are quite costly, the track is gradually deteriorating. That is to say, costs of maintenance are high, because of the poor state of the track, but costs should be yet higher to prevent further deterioration. This is a serious situation and calls for positive action.

The basic choice is between raising track maintenance to the required levels, or completing a rehabilitation of the line, which would have the effect of reducing track maintenance costs. The important elements to consider are the annual operating and maintenance costs before and after rehabilitation, the cost of the rehabilitation work and, very importantly, the volumes of traffic using each line, both now and in the future. Rail volumes are low in Bolivia with no line exceeding 500,000 tons per year, and some lines are experiencing a decline in traffic. Although rehabilitation will always reduce maintenance and operating costs, the cheapest solution on lightly used lines may well be not to rehabilitate but simply to spend larger sums on annual maintenance. For the very lightly used lines, especially when volumes are declining, the best solution may be to close the line entirely.

Six basic options were identified for evaluation:

1. Maintain track in present condition
2. Rehabilitate track
3. Revise track (a less thorough operation than rehabilitation)
4. Re-align and rehabilitate track
5. Close line immediately
6. Operate the line over a period of time with minimal maintenance and with a gradually decreasing service level, until the line is phased out completely.

In general, the outcome of these policies can be summarized as follows. Policy 1 will be characterized by high maintenance and operating costs. If the line has already been rehabilitated, these costs will be correspondingly lower. Policies 2-4 will involve an initial cost but will thereafter be characterized by lower maintenance and operating costs. Policies 5 and 6 will eliminate all rail costs, either immediately or after a run-down period, and will transfer traffic to other modes.

Logically, it is desirable to consider first whether lines are worth keeping open; this is done in the remainder of this section. Then, for those lines that are worth keeping open, the subsequent section considers rehabilitation and maintenance policies.

Rail Line Closures - The theoretical possibility of closure was considered for all lines, but a preliminary analysis showed that benefits justified the retention of almost all of them.

The preliminary analysis considered the value of each line for external traffic only, in all cases assuming no rail interconnection. In each case, the alternative costs by truck transport and by rail were compared over routes within Bolivia. Truck costs were calculated for the recommended road network, (see Chapter 10). The savings in cost by using rail transport were then compared with total rail fixed costs, in all cases assuming the highest level of fixed maintenance costs for an unrehabilitated track.

For the Eastern System, each of the main lines was considered separately. For the Andean System, which is more complex, a basic system was defined linking La Paz, Viacha, Oruro, Uyuni and Avaroa (formerly Ollagüe), and this was evaluated. Having established the viability of the basic system, other links were treated as branch lines to the basic system.

The results of this rather conservative analysis are set out in Table 13-3. In almost all cases, the savings in variable operating costs for external traffic using rail exceed the fixed costs of rail operation. For Oruro-Cochabamba, savings by rail cover only 75 percent of the fixed costs, and for Villazón-Uyuni 85 percent. However, it can be reasonably assumed in these two cases that internal traffic savings make up the difference.

On the lines Viacha-Guaqui, Potosí-Sucre and Cochabamba-Aiquile, benefits to rail are either very low or negative, and certainly do not cover fixed costs. In the case of Viacha-Guaqui, the future depends very much on the possibilities of linking with the Peruvian system at Desaguadero (see Chapter 15) and therefore a decision on closure for this line is not recommended until the position on the construction of Puno-Desaguadero becomes clearer. Sucre-Potosí and Cochabamba-Aiquile are discussed in more detail below.

Potosí-Sucre Line - This is a 175 km line, linking the capitals of Potosí and Chuquisaca departments.

Fixed costs of operation in 1977 were just under 19 million pesos and it is estimated that these would rise to 22 million pesos in 1989 (in 1977 pesos) at current levels of maintenance, and to 42 million pesos if a higher level of track maintenance were adopted to prevent track deterioration. Revision of the line (see later for definition) would reduce fixed costs to 17.1 million pesos in 1989, but would require an initial outlay of at least 172(3) million pesos.

(3) Figure supplied by ENFE especially for this line which is below the value calculated using generalized unit costs of revision as set out in Table 13-5.

Table 13-3

RAIL LINE CLOSURE ANALYSIS

SECTION	LENGTH	1989 EXTERNAL VOLUMES	UNIT VARIABLE OPERATING COSTS Road (1)	UNIT VARIABLE OPERATING COSTS Rail	TOTAL VARIABLE OPERATING COSTS Road	TOTAL VARIABLE OPERATING COSTS Rail	RAIL BENEFITS	RAIL FIXED COSTS (2)
	(km)	(thousands of tons)	(1977 pesos per ton)		(millions of 1977 pesos)		(millions of 1977 pesos)	(millions of 1977 pesos)
Andean Basic System								
La Paz-Avaroa (3)	729	117	1,310	274	153.3	32.1	121.2	-
Oruro-Avaroa (3)	486	146	1,038	153	151.5	22.4	129.1	-
Río Mulato-Avaroa (3)	277	75	668	77	50.1	5.6	44.5	-
Uyuni-Avaroa (3)	172	21	432	44	9.1	0.9	8.2	-
Total	1,664	359					303.0	208.0
Oruro Andean Lines								
Villazón-Uyuni	289	113	726	121	82.0	13.6	68.4	78.7
Oruro-Cochabamba	205	202	311	77	62.8	15.6	47.2	63.8
Cochabamba-Aiquile	216	24 (4)	328	73	7.9	1.8	6.1	43.9
Viacha-Charaña	209	147	698	108	102.6	15.9	86.7	30.9
Viacha-Guaqui	65	101	112	268	11.3	27.1	-15.8	26.2
Río Mulato-Potosí	174	109	520/270 (5)	98/105 (5)	55.2 (6)	10.7 (6)	44.5	39.8
Potosí-Sucre	174	27	286	271	7.7	7.3	0.4	42.1
Eastern Lines								
Santa Cruz-Yacuiba	539	210	1,054	130	221.3	27.3	194.0	105.6
Santa Cruz-Corumbá	651	454	1,426	137	647.4	62.2	585.2	132.4

(1) From the Recommended Network.

(2) Assuming desirable maintenance costs for the unrehabilitated track - See Appendix 13A on railroad rehabilitation costs.

(3) Formerly Ollagüe

(4) From the Chaguarani mine.

(5) Costs from Uyuni and Challapata respectively. There is no road parallel to the railroad in this section.

(6) Assuming that 95 percent of the traffic is to and from the Uyuni direction.

Benefits of keeping the line open were estimated for both internal and external traffic. These benefits vary greatly depending on whether or not the Potosí-Sucre road is paved. They are summarized below:

ASSUMPTION	ANNUAL BENEFITS IN 1989 Internal Freight(1)	External(2) Freight	Total
	(millions of 1977 pesos)		
Potosí-Sucre road is paved	4.4	2.4	6.8
Potosí-Sucre road is not paved	20.5	6.8	27.3

(1) From the Recommended Network Test.
(2) Benefits to external freight are higher than calculated in Table 13-3, since road costs are here compared with rail marginal costs rather than rail variable costs.

If the line is to be maintained to the standard suggested by ENFE and if the Potosí-Sucre road is not paved, the fixed costs of operations by 1989 will exceed the likely benefits. If the line is operated with current levels of maintenance, benefits would exceed fixed costs, but the line will eventually become too dangerous to operate under these conditions. If the line is revised at a cost of 172 million pesos, benefits would again exceed fixed costs but the benefits give a single-year rate of return of only 6 percent on the investment in revision. In all cases, if the road between Potosí and Sucre is paved, the line will no longer be viable. It can be commented that this Study is recommending paving of about two thirds of this road in the 1980s.

Benefits were estimated on the assumption that traffic volumes will increase greatly over today's volumes due to the introduction of a new tariff policy. Recent traffic is summarized in Table 13-4 together with the forecast made by the Study for 1989. Freight traffic has halved over the past two years. In contrast, the Study estimates based on lower tariffs are over eight times the 1979 freight volume, and yet barely warrant keeping the line open. Passenger traffic also dropped by one third between 1977 and 1979, and although volumes have probably increased during 1980(following the introduction of new express train services), increased revenues are unlikely to have offset the fixed costs of this line. An analysis of ENFE revenues for 1979 indicates a loss on the line of about 18 million pesos.

Table 13-4

RAILROAD TRAFFIC ON THE SUCRE-POTOSI LINE - 1977-1979 AND FORECASTS FOR 1989

(tons per year and passengers per year)

ITEM	1977	1978	1979	1989
Freight - External	27,222	19,183	11,087	27,000
- Internal	5,045	948	3,940	100,000(1)
	32,267	20,131	15,027	127,000
Passengers - Train	23,085	14,497	16,784	
Ferrobus	13,406	13,384	19,004	68,000
Autocarril	21,956	19,531	14,000	
	58,447	47,412	49,788	68,000

SOURCES: ENFE and Bolivia National Transport Study.

(1) From the Recommended Network test.

It is concluded that the line is probably no longer viable, although reduced tariffs may induce a recovery. It is recommended that the line be continued in operation at the present maintenance levels and that the effects of freight tariff reductions be carefully monitored. When the point of track deterioration is reached that the line would have to be either closed or rehabilitated, the results of the new tariff policy should be assessed to see whether a better case can be made for keeping the line open. If not, the line should then be closed. In any event, if the line is closed due to major damage by earth movement, it should not be reopened.

As a footnote to this analysis, it is commented that the line does have considerable tourist appeal. It is one of the highest railroads in the world, passes through spectacular mountain scenery and links two of the historic centers of Bolivia. Properly marketed, a special service for tourists could be profitable and contribute to the costs of keeping the line open.

Cochabamba-Aiquile - This is a 216 km line currently carrying very low volumes of traffic as shown by the following figures:

	PASSENGERS	FREIGHT (tons)
1977	36,379	7,849
1978	27,099	8,747
1979	24,493	11,665

Even with the recommended low tariffs, only 12,000 tons of freight were forecast to use the line in 1989. Fixed costs were estimated at 16 million pesos in 1977 and these would rise to an estimated 44 million pesos in 1989 if the higher standards of maintenance were applied, sufficient to keep the line continuously in operation. It is estimated that in 1979, the line made an operating loss of nearly 17 million pesos.

This line, which serves only a lightly populated region with one small mine (Chaguarani), could only be viable in the event of the rail system interconnection being built, a project which is not recommended by this Study for completion within the next 10 years. However, in order to serve as a link on the rail interconnection, this line would have to be completely rehabilitated, but it is unlikely to be required for this purpose before the mid 1990's. This indicates that maintenance should be left at today's levels until operations are no longer possible, but that after operations are closed, the track should be left in place pending a decision on the interconnection.

Railroad Rehabilitation

A track rehabilitation program was started in 1976 with assistance from the World Bank. So far, in three phases, 433 km of rehabilitation have been completed, evenly divided between the Eastern and Andean system, and a further 272 km are programmed for completion by the end of 1981. Funds were available for 70 km to be completed in 1980, and completion of the remainder depends on further availability of funds.

When this program of work is completed, the Andean System will be rehabilitated between El Alto and Río Mulato and three sections of the Santa Cruz-Corumbá line totalling 312 km will be rehabilitated on the Eastern System.

Plans are in preparation for a fourth phase of rehabilitation, including a further 780 km in the west and a further 382 km in the east. The map in Figure 13-5 shows work so far achieved, work programmed and work tentatively planned.

The work so far completed has been to a good standard, but has fallen badly behind schedule. This has been attributed to the difficulties in setting up ballast production, which is a fundamental requirement of the rehabilitation work. Hence the program is in financial difficulties with most of the money spent and much of the work remaining.

This section looks at the economic return on rehabilitation and makes some general recommendations about future work. Detailed planning of the program is not dealt with, since this requires a more intimate knowledge of the local conditions of each section of the line.

Assumptions on Railroad Rehabilitation - A rehabilitation project implies a partial reconstruction of the track requiring substantial investment. The size of the investment is determined by the extent of the rehabilitation work and a range exists between simple "revision" (see below) to a major realignment of the track.

The purpose of a rehabilitation project is to reduce the costs of track maintenance and train operations. Also, by improving the condition of the track, rehabilitation reduces the risk of derailments and other accidents. It has been suggested that without rehabilitation, rail lines would have to close down, but this does not seem to be the prevailing view now.

Rehabilitation, as considered in the analysis presented in this section, specifically excludes projects designed to eliminate service interruptions due to earth slides or flooding; these are treated separately on a case by case basis (see earlier section on Oruro-Cochabamba and Chapter 15 for a discussion of Taperas-Roboré).

In general, then, four classes of costs need to be identified as follows:

(i) Costs of rehabilitation
(ii) Track maintenance costs, before and after rehabilitation
(iii) Operating costs, before and after rehabilitation
(iv) Costs of accidents caused by the bad state of the unrehabilitated track (but excluding costs of accidents due to earth slides or flooding).

Assumptions made on these costs are set out in detail in Appendix 13A (4), and are briefly discussed below.

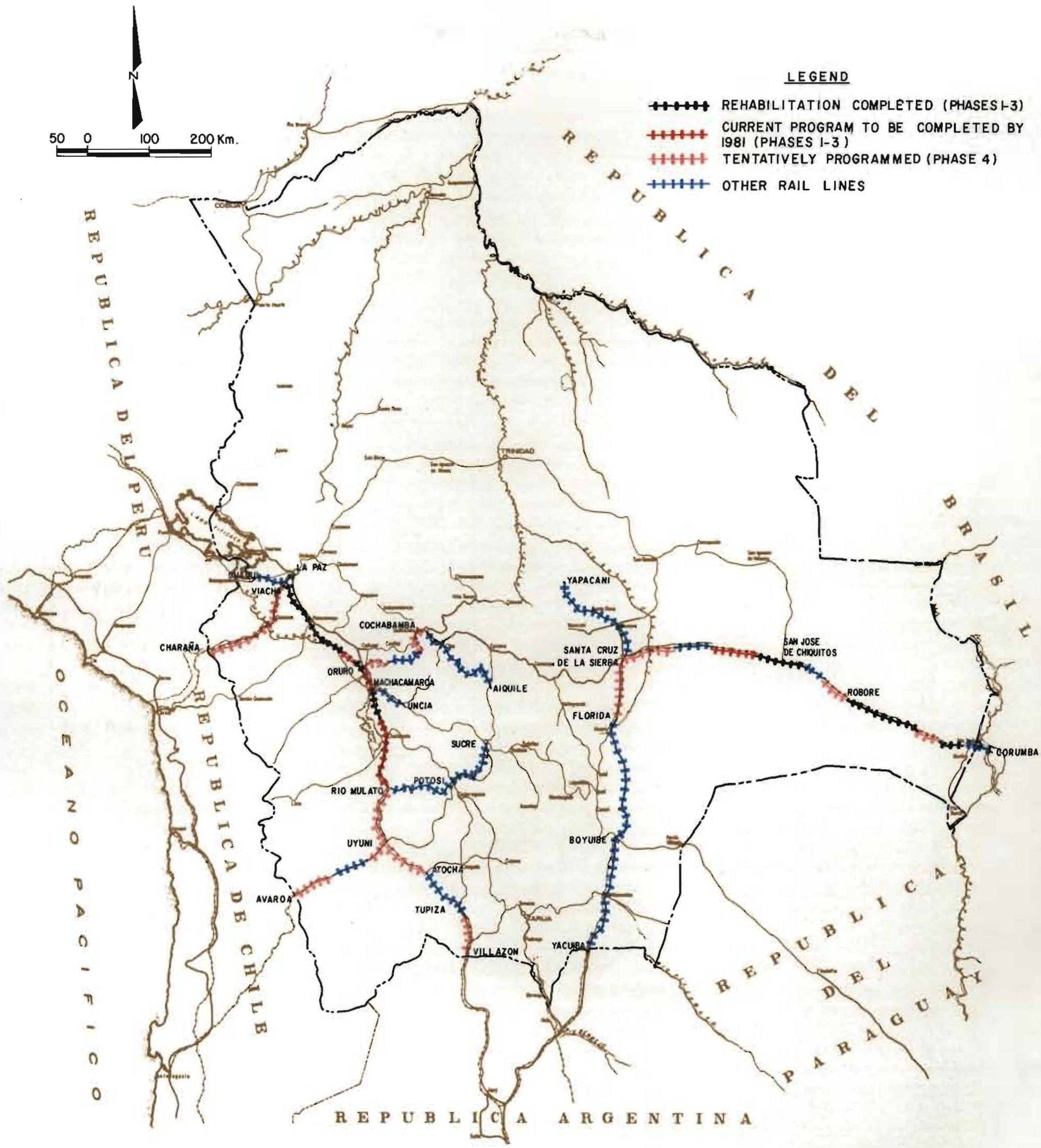
Rehabilitation Schemes - Three types of rehabilitation schemes were considered -- revision, reconstruction and re-alignment:

1. Revision - A low grade rehabilitation employing, where possible, used materials from other rehabilitated lines. Ballasting is not generally provided, except where corrections of alignment are required. Where necessary, the track is re-leveled with selected sand placed under the sleepers. Switch points in stations are replaced to permit higher operating speeds for through trains. This is an operation particularly suitable for lightly used lines.

2. Reconstruction - Essentially the type of work currently being performed by ENFE. Defective materials (particularly sleepers and, if necessary, rails)are replaced, rails are welded into 40 m sections and the track is fully ballasted. Switch points in stations are also replaced to permit higher operating speeds by through trains.

3. Re-alignment - A higher grade operation with the aim of eliminating tight curves to allow higher operating speeds. This is done at the same time as reconstruction of the track, and all costs given below for re-alignment reflect both operations. Re-alignment considered here refers exclusively to geometric improvements and not to new line construction which is treated elsewhere on a case by case basis.

(4) Based on data received from ENFE.



RAILROAD REHABILITATION:
WORK COMPLETED, PROGRAMMED
AND PLANNED

Wilbur Smith and Associates

FIGURE 13–5

All three types of improvement produce a similar reduction in maintenance costs. Re-alignment allows a greater reduction in operating costs through higher speeds. Revision, while producing the same operating and maintenance benefits as reconstruction, has a shorter life.

The estimated lives for each operation, in terms of cumulative freight tons, are reported below:

PROJECT	LIFE OF PROJECT BY REGION Altiplano	Mountain	Eastern
	(millions of tons)		
Revision	50	15	40
Reconstruction	160	50	130
Re-alignment	200	100	160

Costs vary according to the state of the sleepers, and are detailed in Appendix 13A. The following costs are examples which apply for tracks where 30 percent of sleepers need replacing. They do not include rail replacement, which would have to be undertaken whether or not the line is rehabilitated.

PROJECT	COST OF PROJECT BY REGION Altiplano	Mountain	Eastern
	(thousands of 1977 pesos per km)		
Revision	542	1,142	593
Reconstruction	705	1,548	762
Re-alignment	930	3,347	994

Estimated costs of rehabilitation for each section of the line are shown in Table 13-5. Costs are shown for 1985, the average year for the period under consideration, and were obtained by factoring Appendix 13A values by 1.14.

Benefits from Rehabilitation - The main benefit from rehabilitation is the reduction obtained in track maintenance costs. Current maintenance is insufficient to prevent deterioration of the track and ENFE has supplied estimates of how much would need to be spent to prevent further deterioration of unrehabilited lines. Also, estimated costs are available from ENFE for the maintenance of rehabilited lines. These are summarized below:

Table 13-5

ESTIMATED COSTS OF REHABILITATION

LINE	REGION(1)	LENGTH	SLEEPERS (2) IN POOR COND.	COST OF REHABILITATION Revision	Reconstruction	Realignment
		(km)	(%)	(millions of 1977 pesos)		
La Paz - El Alto	M	17	0	22	30	65
El Alto - Viacha	A	25	0	-[3]	-[3]	-[3]
Viacha-Oruro	A	204	0	-[3]	-[3]	-[3]
Oruro-Machacamarca	A	24	60	16	19	26
Machacamarca-Rio Mulato	A	184 [4]	49	105	135	179
Rio Mulato-Uyuni	A	105	30	65	84	111
Uyuni-Atocha	A	93	20	57	74	98
Atocha-Villazón	M	196	41	257	348	750
Viacha-Charaña	A	207	15	125	164	217
Uyuni-Avaroa	A	175	52	112	144	189
Oruro-Cochabamba	M	211	44	277	375	807
Cochabamba-Aiquile	M	216	50	285	384	828
Rio Mulato-Potosí	M	174	14	225	304	661
Potosí-Sucre	M	175	7	225	306	665
Viacha-Guaqui	A	65	100	43	56	73
Santa Cruz-Corumba	O	643 [5]	19	283	365	477
Santa Cruz-Yacuiba	O	539	20	360	464	606
Santa Cruz-Yapacani	O	204	0	133	172	226

(1) A = Altiplano M = Mountain O = Eastern

(2) Average over line

(3) Rehabilitation completed

(4) Of this, 18 km already rehabilitated: costs shown are to rehabilitate the remainder.

(5) Of this, 219 km already rehabilitated : costs shown are to rehabilitate the remainder.

MAINTENANCE LEVEL	TRACK MAINTENANCE COSTS BY REGION		
	Altiplano	Mountain	Eastern
		(1977 pesos per km)	
Current without rehabilitation	38,000 + 0.017 T	52,000 + 0.065 T	45,000 + 0.030 T
Desirable without rehabilitation	71,000 + 0.030 T	165,000 + 0.200 T	61,000 + 0.040 T
After rehabilitation	20,000 + 0.007 T	27,000 + 0.030 T	23,000 + 0.015 T

where T = Traffic in tons per year.

Reductions in operating costs due to rehabilitation (taking into account increased speeds, lower fuel consumption, less wear and tear on equipment, etc.) are shown in Appendix 13A. In general, such reductions are not very great, averaging 10 percent for a revision or reconstruction and 15 to 20 percent for a re-alignment.

Accident costs, effectively the costs of dealing with minor derailments, were estimated at 0.006 pesos per ton-km in 1979.

Evaluation of Rehabilitation Projects - The three alternative rehabilitation projects were evaluated for each line in the ENFE system, excluding only those lines already rehabilitated. The evaluation was undertaken with all values for costs and benefits adjusted to 1985 values, representing average values for the period under consideration. It was assumed in all cases that maintenance costs of the unrehabilitated track would be at the desirable level specified above. In no case did the alternative of re-alignment prove worthwhile and so this alternative is dropped from further consideration.

The details of the evaluation are shown in Appendix 13B and the results are summarized in Table 13-6. The First Year Rate of Return (FYRR) for revision and reconstruction are shown for each line, assuming alternative years for the projects of 1980 and 1989, and assuming also two different possible growth rates in traffic to 1989. Low growth signifies that the freight tariff policy is unchanged while high growth assumes the growth in freight traffic forecast by the Study under the recommended low tariff policy (see Chapter 17). In both cases for 1989, passenger traffic is assumed to double from the 1979 volumes used in the 1980 evaluation. Several conclusions can be drawn from these data.

Table 13-6

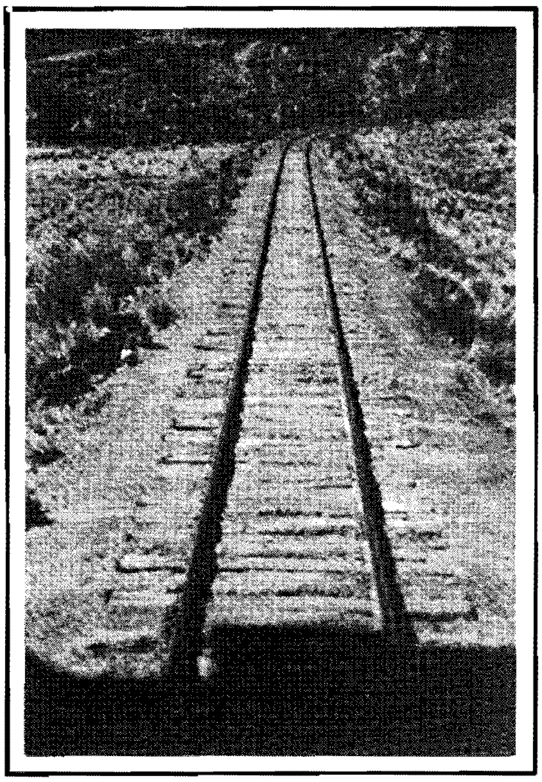
SUMMARY OF RAIL REHABILITATION EVALUATION

SECTION	REGION (1)	LENGTH	REVISION FOR DIFFERENT YEARS: COST	REVISION: 1980	REVISION: 1989 (Low Growth) (2)	REVISION: 1989 (High Growth) (3)	RECONSTRUCTION FOR DIFFERENT YEARS: COST	RECONSTRUCTION: 1980	RECONSTRUCTION: 1989 (Low Growth) (2)	RECONSTRUCTION: 1989 (High Growth) (3)
		(kms)	($b mn 1977)	(Percent FYRR)			($b mn 1977)	(Percent FYRR)		
La Paz-El Alto	M	17	22	11.1	16.0	18.9	30	8.2	11.7	13.8
Oruro-Machacamarca	A	24	16	10.2	10.9	12.2	19	8.6	9.1	10.3
Machacamarca-Rio Mulato	A	166 (4)	105	11.1	11.9	13.3	135	8.6	9.2	10.3
Rio Mulato-Uyuni	A	105	65	13.9	14.8	16.0	84	10.7	11.5	12.4
Uyuni-Atocha	A	93	57	9.6	9.9	10.5	74	7.4	7.6	8.1
Atocha-Villazón	M	196	257	11.8	12.2	13.2	348	8.7	9.0	9.7
Viacha-Charaña	A	207	125	8.4	9.0	9.0	164	6.4	6.9	6.9
Uyuni-Avaroa	A	175	112	10.0	9.7	9.8	144	7.8	7.5	7.6
Oruro-Cochabamba	M	211	277	12.2	14.3	17.7	375	9.0	10.6	13.1
Cochabamba-Aiquile	M	216	285	9.7	9.8	9.8	384	7.2	7.3	7.3
Río Mulato-Potosí	M	174	225	10.6	12.2	14.4	304	7.9	9.0	10.7
Potosí-Sucre	M	175	225	10.0	10.7	12.1	306	7.4	7.9	8.9
Viacha-Guaqui	A	65	43	9.9	12.9	13.0	56	7.6	9.9	10.0
Santa Cruz-Corumbá	O	424(5)	283	10.9	16.9	18.2	365	8.5	13.1	14.1
Santa Cruz-Yacuiba	O	539	360	6.4	7.7	8.6	464	4.9	6.0	6.6
Santa Cruz-Yapacaní	O	204	133	2.9	3.1	3.4	172	2.2	2.4	2.6

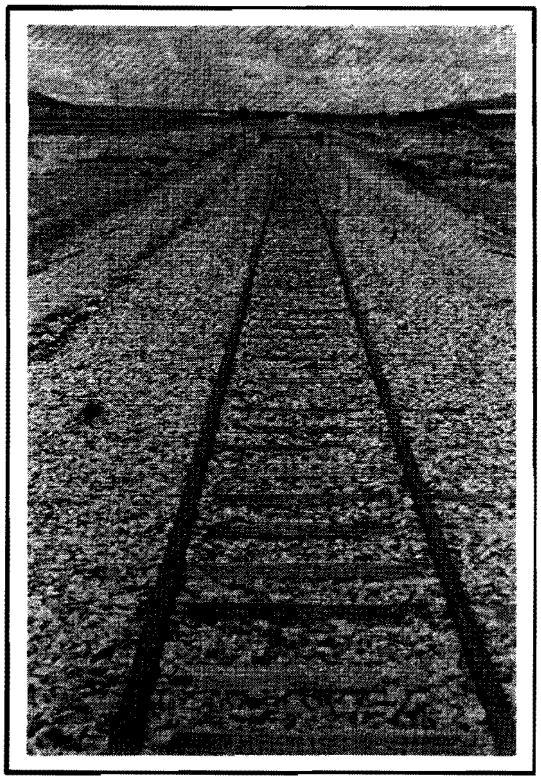
(1) A = Altiplano, M = Mountains, O = Eastern.
(2) Assumes existing tariffs for freight traffic, no interconnection.
(3) Assumes recommended tariffs for freight traffic, no interconnection.
(4) Excludes 18 km already rehabilitated.
(5) Excludes 219 km already rehabilitated.

RAIL WELDING ON THE
SANTA CRUZ - CORUMBA LINE

UNREHABILITATED LINE
ORURO - COCHABAMBA



REHABILITATED LINE
LA PAZ - ORURO



RAIL REHABILITATION

The main conclusion is that rehabilitation, as currently carried out by ENFE (reconstruction in Table 13-6), is not economically feasible at the present time, if it is considered that a minimum 12 percent FYRR is required. On the other hand, the cheaper and lower standard revision is feasible in 1980 in two cases -- Río Mulato-Uyuni and Oruro-Cochabamba -- and closely approaches feasibility on many other sections. This conclusion, that revision is the better project in almost all cases, presents the paradox that it should be undertaken using materials from previous reconstructions, where possible. Clearly, if revision only is contemplated, such used materials will not be available. Therefore, reconstruction must be often considered, even where revision has proved to be the better project.

This situation is not very much different in 1989. With low traffic growth, only Santa Cruz-Corumbá is economically feasible for reconstruction, and with high traffic growth, just three more lines can be added; La Paz-El Alto, Río Mulato-Uyuni and Oruro-Cochabamba. In contrast, revision can be justified for almost every line by 1989 when considering high traffic growth.

It can also be concluded that rehabilitation is, in general, easier to justify on mountain lines, even with comparatively low traffic volumes. This conclusion is contrary to the philosophy so far followed in the rehabilitation program, which has placed more importance on rehabilitating lines on the Altiplano and in the East.

The reason why mountain lines achieve better results in this evaluation lies in the nature of the benefits to be gained by rehabilitation. It is apparent that the major savings are due to reductions in routine maintenance costs, and these savings are very significant on the mountain lines. On the other hand, benefits from reduced costs of train operations are comparatively small.

The savings in routine maintenance cost on mountain lines are so great that rehabilitation of even the Potosí-Sucre line is justified. This analysis, of course, does not answer the question of whether or not the line should be kept open. This was answered earlier in the Chapter. It only affirms that if the Sucre-Potosí line is to continue in operation, then it will be cheaper to rehabilitate and spend less on annual maintenance (but only if operations are continued for many years). The conclusions on this line reached earlier are not invalidated by these results.

Conclusions of Rehabilitation - The railroad rehabilitation program does not appear to offer significant economic advantages over the alternative of more intense routine maintenance, except for lines in mountain areas where the positive results of the evaluation depend upon perhaps dubious assumptions. This is not to say that the railroads should be abandoned. It was demonstrated earlier that almost all of the railroad system is viable for external traffic alone, even where maintenance costs are raised from current levels to those necessary to prevent track deterioration. The results of the rehabilitation evaluation simply demonstrate that the high costs of rehabilitation are not justified, or are only barely justified, by the reduction brought about in operating and maintenance costs.

However, much money has already been invested in rehabilitation -- in buying track equipment and materials, in obtaining a good supply of ballast and transport for it, and in the training of maintenance crews. If the costs of rehabilitation supplied by ENFE contain an element of amortization of previously acquired equipment, then the marginal costs of continuing the rehabilitation program would be lower than quoted, thus improving the economic return. Rehabilitation also has the advantage that the lower maintenance needs after rehabilitation are less vulnerable to cut-backs in funds in times of economic difficulty. Finally it is necessary to recognize that the evaluation of rehabilitation presented here is based on generalized costs and benefits. It is quite possible that more detailed line by line studies could modify these conclusions in particular cases.

The Study therefore cautiously recommends that rehabilitation continue, but with the following provisions:

(a) Ways of reducing costs are found, with a view to approaching the standard of revision rather than reconstruction, employing used materials where appropriate.

(b) Benefits of rehabilitation in mountain areas are reviewed to see whether the priority accorded to the rehabilitation of lines in these areas is justified.

(c) Each line is evaluated in more detail, using specific knowledge of the improvements to be made and the benefits to be obtained, before inclusion in the rehabilitation program.

(d) The following priorities are observed:

Andean System - Mountain lines (depending upon the results of the re-analysis of such lines).
- Altiplano lines from Machacamarca to Villazón.

Eastern System - Santa Cruz to Corumbá.

(e) When major renewal of track and ballast equipment becomes necessary, the economics of rehabilitation are reviewed again. An important factor to be considered in this review will be whether or not significant traffic growth has ocurred since the base year for this evaluation (1979). With little or no growth, rehabilitation would be hard to justify economically.

Concerning priorities, it does not appear that the Viacha-Charaña line is worth rehabilitating, although it is included in the proposed ENFE phase 4 rehabilitation program.

For investment planning purposes, and making the optimistic assumption that traffic growth will be as predicted under a new lower tariff policy, it is assumed that an additional 1,070 km of rehabilitation at a cost of approximately $b 1,000 million (1977) will be justified in the next ten years, beyond the rehabilitation committed in phase 3 of the rehabilitation program.

Whatever policy is followed on rehabilitation, it is recommended that ENFE immediately upgrade their current maintenance operation to the "desirable" levels quoted earlier, to avoid further track deterioration. It is estimated that an additional expenditure of 220 million pesos (1977) will be required in the period 1981-1990 above current maintenance costs, but that by the end of the decade, the reduced costs on rehabilitated lines will offset the additional maintenance costs on the remaining lines.

The Machacamarca-Uncía Railroad

This 105 km railroad is considered separately from the rest of the rail system since it is the only section not administered by ENFE, being instead operated by the National Mining Company (COMIBOL). The corridor containing the line is shown in Figure 13-6.

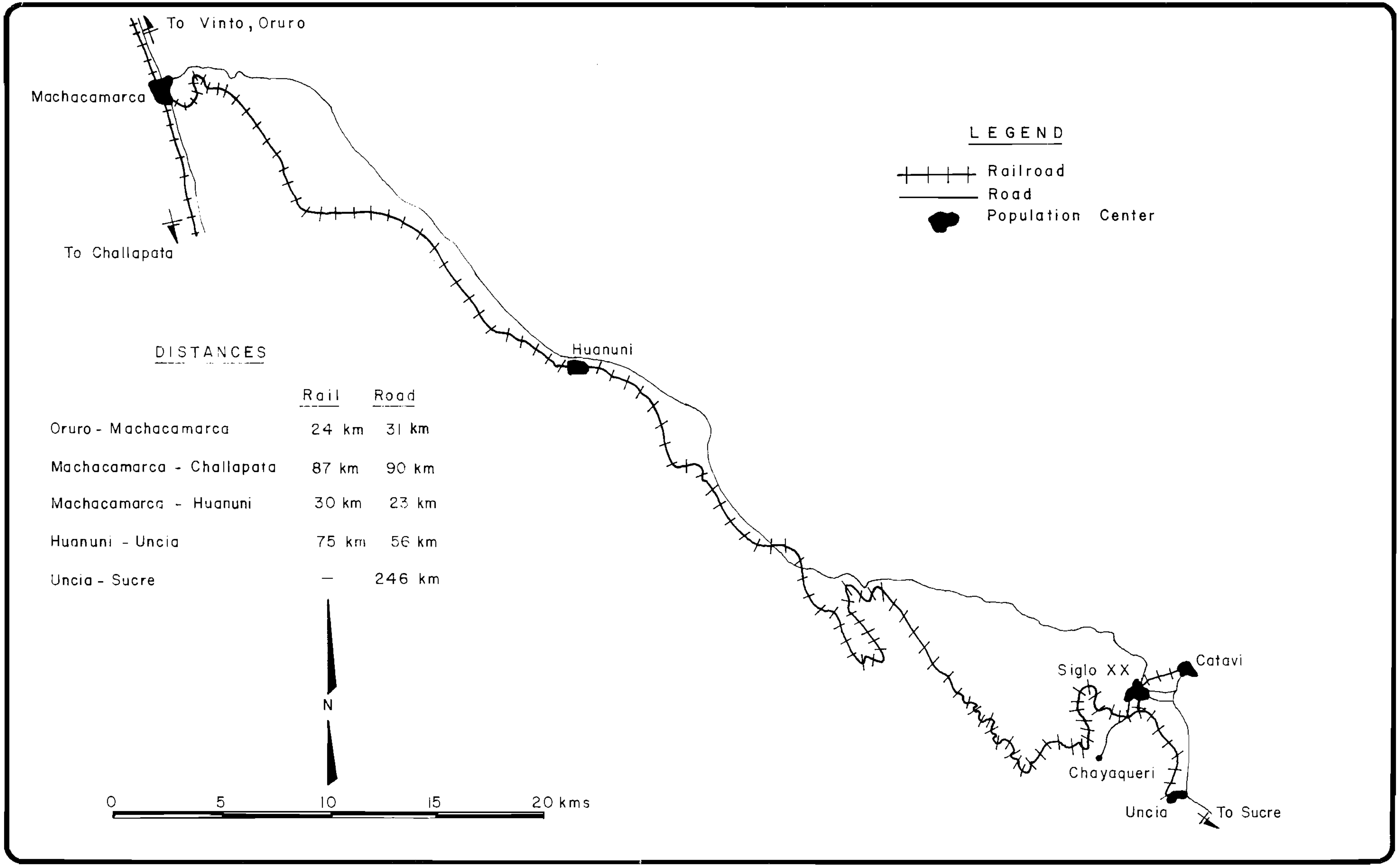
The line is in very poor condition with light rails, no ballasting (in common with most of the Bolivian railroads) and low levels of routine maintenance. Equipment is elderly and since spare parts are no longer available, they have to be manufactured in the COMIBOL workshops. These latter are poorly equipped.

The line is also very lightly used. In 1977, the major flow of approaching one million tons per year took place on what amounts to a siding off the main track, linking the mine of Siglo XX with the mineral processing plant at Catavi, a distance of about 9 km. This is effectively an interplant movement and as such deserves to be fully under the control of COMIBOL. Movements of processed minerals from Catavi for export are sent by truck, but currently amount to no more than 45 tons per day.

Other mineral movements take place between Huanuni and Machacamarca (30 km), but the quantity is unknown, although probably less than 30,000 tons per year. About 6,500 tons of general cargo consisting mainly of inputs to the Huanuni and Siglo XX mines, and with an average haul length of 80 km, together with about 3,000 passengers per year with an average trip length of 30 km, also use the line.

Apart from the short Siglo XX to Catavi branch line, it seems strange that this line should be operated by COMIBOL. It is likely that both equipment and track maintenance problems could be substantially reduced were ENFE to take control, and a better utilization of the line could be obtained if it were properly integrated into the ENFE system. However, a more fundamental question than ownership is whether or not the line is worth continuing in operation.

Fixed costs of operation, including very low maintenance, were estimated at $b 14.9 million in 1977. If maintenance levels were increased to prevent further track deterioration, fixed costs would rise to $b 30 million by 1989. Rail marginal costs are lower than road operating costs but even if all the traffic in the corridor (estimated at 315,000 tons between Machacamarca and Huanuni and 227,000 tons between Huanuni and Uncía in 1989) were to move by rail, the savings in operating costs over using road would amount to only $b 23 million per year i.e. less than the fixed costs of rail operations.



DISTANCES

	Rail	Road
Oruro - Machacamarca	24 km	31 km
Machacamarca - Challapata	87 km	90 km
Machacamarca - Huanuni	30 km	23 km
Huanuni - Uncia	75 km	56 km
Uncia - Sucre	—	246 km

THE MACHACAMARCA-UNCIA CORRIDOR

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FIGURE 13–6

If the line were to be rehabilitated to the level of revision (see above), fixed operating costs would drop to about $b 15 million. Thus the savings over using road would exceed fixed costs by $b 8 million in 1989. However, this would only show a 6 percent first year return on the investment cost of revision, estimated at $b 138 millions.

This is a very conservative analysis. Revision costs would be likely to be higher than assumed due to the very poor state of the track, and it extremely unlikely that all traffic would switch to rail as assumed in the analysis. Despite these assumptions, which clearly favor the rail case, the line is shown not to be viable economically. Hence it is concluded that operations can no longer be justified and the Study recommends closure of the main Machacamarca-Uncía line. The operation between Siglo XX and Catavi is a COMIBOL interplant operation on the economies of which, the Study cannot comment.

Electrification of the Railroad System

It has been suggested that due to the energy crisis and the consequent rise in price of hydrocarbon fuels, serious consideration should be given to the electrification of the Bolivian railroad system, thus substituting domestic hydro-electric power for imported diesel fuel. The Study examined this suggestion but concluded that electrification could not be justified in the foreseeable future.

Two assumptions each were made on the cost of electricity and the cost of diesel fuel. The electricity costs were derived from a range of industrial tariffs and the two diesel fuel cost assumed: 1) the continuation of the 1980 cost of 4 pesos per liter and 2) a rise in cost to 30 pesos per liter. The 1989 capital costs of electrification were estimated at $b 2.1 million per km for the Altiplano and Eastern Lines and $b 3.0 million per km in the mountains.

The volumes of traffic required to justify electrification were then calculated for different regions of the country with the following results:

MINIMUM ANNUAL TRAFFIC UNITS TO JUSTIFY ELECTRIFICATION

REGION	Current Diesel Cost: Low Elec.Cost	Current Diesel Cost: High Elec.Cost	High Diesel Cost: Low Elec.Cost	High Diesel Cost: High Elec.Cost
	(million of traffic units(1) per year)			
Altiplano	12.5	37.9	1.2	1.32
Mountain	5.7	11.0	0.6	0.6
Eastern	18.5	(2)	1.6	1.8

(1) Sum of tonnage plus passengers.
(2) Very high.

Under the most optimistic assumptions of the relative change in diesel and electricity costs, some of the busier lines could possibly be approaching the volumes required to justify electrification by 1989. Certainly, at todays volumes of traffic and relative costs, electrification cannot be justified.

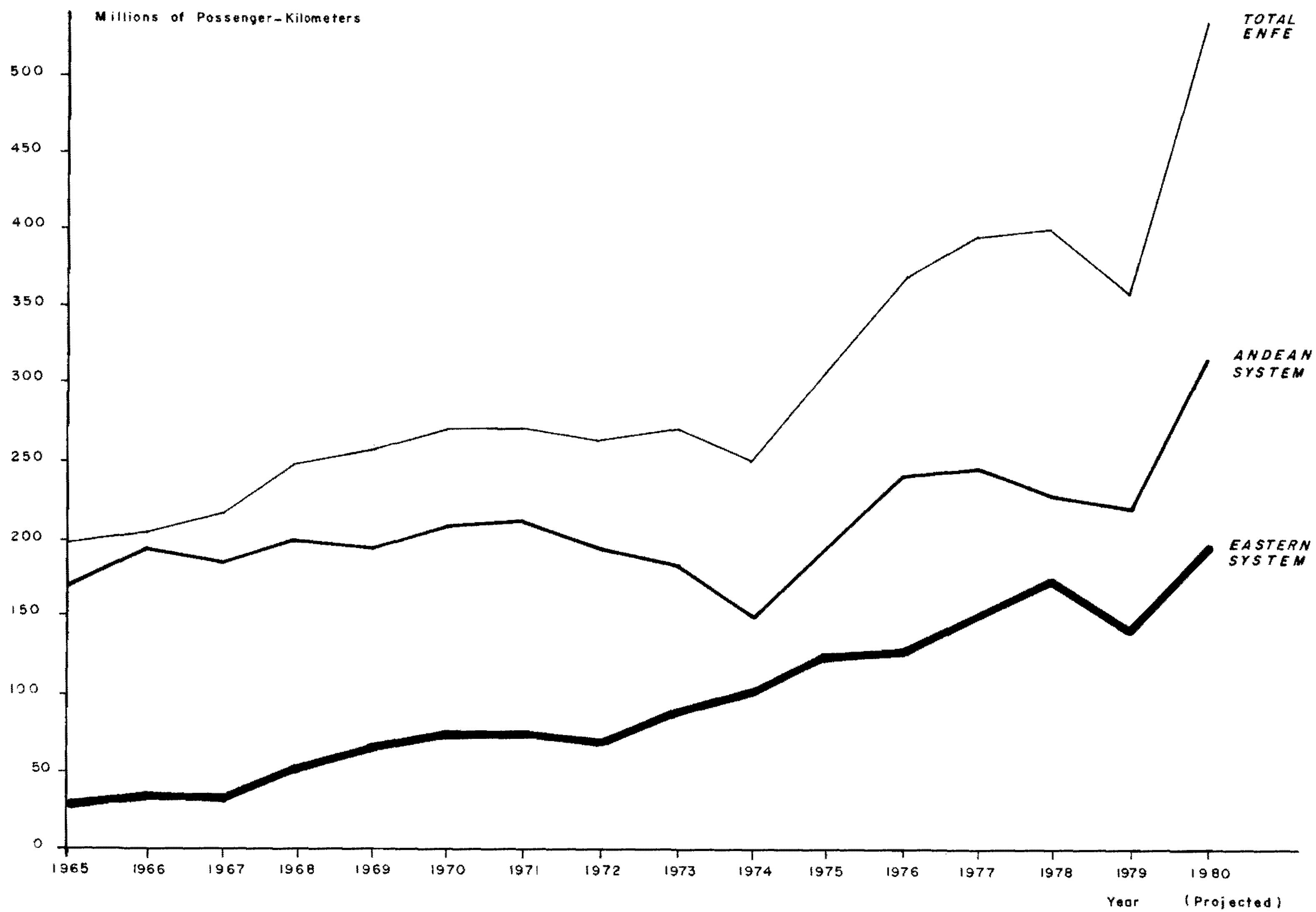
It is highly improbable that electrification could be justified within the next ten years and justification is considered unlikely within the next twenty years. Of course, if diesel fuel costs rise even faster than assumed here, or if traffic increases at a greater rate than predicted by the Study, electrification would be worth investigating further.

Rail Passenger Transport

In 1977, the railroad carried only about 3 percent of non-urban passenger transport and these services made a loss. The question is therefore raised whether it might not be better to abandon these services, allowing the railroads to concentrate on the transport of freight, where rail can be competitive. This section discusses these issues, taking into account the large increase in rail passenger travel in 1980.

Passenger Traffic and Revenues - The growth of rail passenger traffic in the fifteen years since the formation of ENFE is shown in Figure 13-7. Overall growth was moderate up to 1974 and was entirely due to traffic on the new lines in the east. Growth then generally accelerated until 1979, when interruptions on the Santa Cruz-Corumbá and Oruro-Cochabamba lines brought about a decline in traffic. In 1980, though, a very sharp increase in traffic was observed. The projections in Figure 13-7 are based on nine months of operations. Overall growth from 1965 to 1974 averaged under 3 percent per year, while from 1974 to 1980, it is expected to have averaged over 12 percent per year.

The sudden rise in traffic in 1980 is most notable on the Andean System and has been attributed to two factors. One is the introduction of three new express train services: La Paz-Cochabamba, La Paz-Sucre and La Paz-Villazón. These trains use recently acquired Fiat coaches, and service times are said to be similar to ferrobuses. In fact, they have largely taken over from ferrobus services, as shown in Figure 13-8 and this has been explained by the poor availability of ferrobuses due to lack of spare parts. Secondly, bus passenger fares, both interprovincial and interdepartmental, have gone up by about 70 percent over the last three years, while train fares on the Andean System have risen on average only 20 percent.



GROWTH IN RAILROAD PASSENGER TRAFFIC

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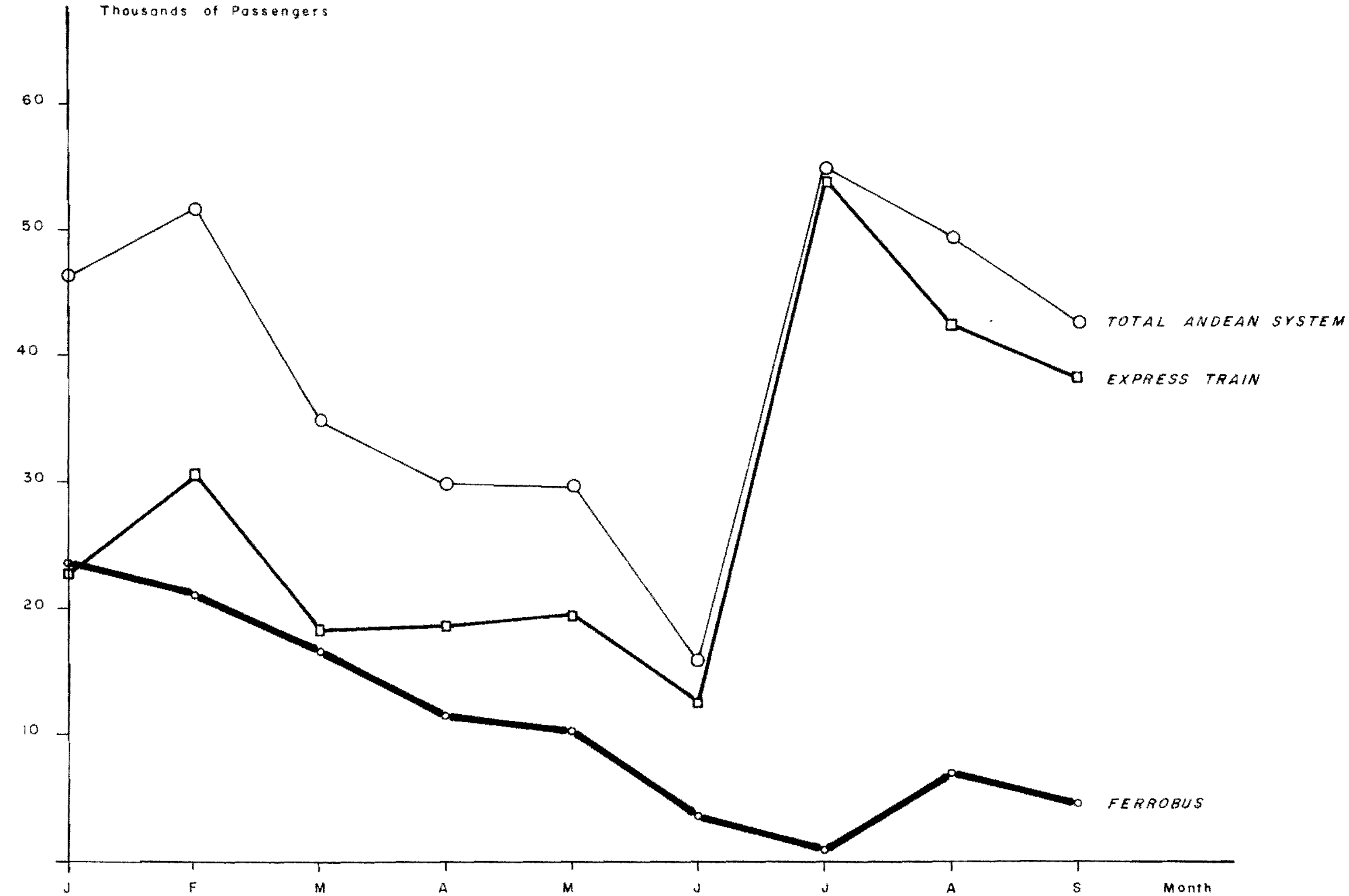
FIGURE 13–7



1980 RAIL PASSENGER VOLUMES
ON THE ANDEAN SYSTEM

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FIGURE 13–8

The 1980 increase in traffic on the Eastern System is in line with trends before the long interruption in service in 1979.

Passenger Revenues - Table 13-7 sets out details of passenger traffic and revenues by type of service for each part of the ENFE system, for the years 1977-1979 and with an estimate for 1980 (based on nine months data).

It is evident that very different commercial policies are being followed in the Andean and Eastern System. Revenues per passenger-kilometer rose 30 percent on average on the Eastern System during 1977-1980, which breaks down to a 26 percent rise in train revenues and a 46 percent rise in ferrobus revenues (both per passenger-kilometer). Most of the rise occurred between 1979 and 1980.

On the Andean System, revenue per passenger-kilometer has risen by 20 percent on average, but this is due almost entirely to the change in mix of passengers. Local train revenues per passenger-kilometer rose only 5 percent and ferrobus revenues by 12 percent over the period. It is the new express train services, priced at about 10 percent below ferrobuses, which have caused the increase in traffic and revenues. If ferrobuses and express train services are considered jointly, the rise in revenues per passenger-kilometer since 1977 has been only 3 percent. Therefore, making allowances for the change in passenger mix on the Andean System, it can be concluded that revenue levels per passenger-kilometer have increased by only 3 to 5 percent in the past three years.

1977 Passenger Costs - Detailed cost data were available only for 1977 and these are presented in Table 13-8. It is apparent that income did not cover the costs of passenger services in 1977, although variable costs, which represent about 30 percent of the total, were covered with a little to spare.

Ferrobus services were the least unprofitable, covering their variable costs and about half their attributed fixed costs. They carried about 30 percent of the total rail passenger traffic. In contrast, train services, which carried 70 percent of rail passenger traffic, cost 50 percent more per passenger-kilometer than did the ferrobuses but brought in 30 percent less revenue per passenger-kilometer. Revenue did not cover variable operating costs and amounted to only 30 percent of total costs. Autocarril services covered only 11 percent of their operating costs, but accounted for less than two percent of total rail passenger services. In total, rail passenger traffic in 1977 accounted for 31 percent of ENFE's operating costs, but contributed only 12 percent of the income.

Table 13-7

RAIL PASSENGER VOLUMES AND REVENUES, 1977-1980

YEAR	SERVICE	ANDEAN SYSTEM Travel (1)	ANDEAN SYSTEM Total Revenue (millions of current pesos)	ANDEAN SYSTEM Revenue per pass/km (pesos)	EASTERN SYSTEM Travel (1)	EASTERN SYSTEM Total Revenue (millions of current pesos)	EASTERN SYSTEM Revenue per pass/km (pesos)	TOTAL ENFE Travel (1)	TOTAL ENFE Total Revenue (millions of current pesos)	TOTAL ENFE Revenue per pass/km (pesos)
1977	Train	188	38	.20	88	16	.18	276	54	.20
	Ferrobus	56	17	.30	57	15	.26	113	32	.28
	Autocarril	4	1	.24	3	1	.25	7	2	.25
	Total	248	56	.23	148	32	.22	396	88	.22
1978	Train	162	36	.22	121	22	.18	283	58	.20
	Ferrobus	59	19	.32	51	14	.27	110	31	.28
	Autocarril	3	1	.28	1	-	.19	4	1	.25
	Total	224	56	.25	173	36	.21	397	90	.23
1979	Train	166	38	.23	87	16	.18	253	54	.21
	Ferrobus	52	17	.33	55	17	.31	107	34	.32
	Autocarril	2	-	.26	2	-	.21	4	1	.23
	Total	220	55	.25	144	33	.23	364	89	.24
1980 (2)	Express Train	148	45	.30						
	Local Train	127	27	.21						
	Train Sub-Total	275	72	.26	122	28	.23	397	100	.25
	Ferrobus	44	15	.34	60	23	.38	104	38	.37
	Autocarril	1	-	.30	4	1	.25	5	2	.26
	Total	320	87	.27	186	52	.28	506	140	.28

(1) Millions of passenger-kilometers.
(2) Based on nine months traffic for the Andean system, and eight months traffic for the Eastern system.

SOURCE: ENFE.

Table 13-8

RAIL PASSENGER COST DATA, 1977
(million of 1977 pesos)

SYSTEM	SERVICE	TRAVEL (millions of pass-km)	REVENUES	COSTS		
				Variable	Fixed	Total
ANDEAN	Train	188	38	41	78	119
	Ferrobus	56	17	9	15	24
	Autocarril	4	1	3	5	8
	Total	248	56	53	98	151
EASTERN	Train	88	16	17	52	69
	Ferrobus	57	15	8	18	26
	Autocarril	3	1	4	6	10
	Total	148	32	29	76	105
TOTAL ENFE	Train	276	54	58	130	188
	Ferrobus	113	32	17	33	50
	Autocarril	7	2	7	11	18
	Total	396	88	82	174	256

SOURCES: ENFE and Bolivia National Transport Study.

The extent to which fixed costs should be attributed to passenger traffic can be argued. In the analysis provided by ENFE, all fixed costs were allocated to either passenger or freight, whereas in reality, many of the costs are joint -- that is to say, they would not be avoided unless both freight and passenger services were abandoned. Inspection of the data indicated that only about half of the fixed costs in the preceding table would be avoided in the absence of passenger services. The conclusion still remains that passenger services were not profitable in 1977, even though variable costs were covered.

Viability of Current Passenger Services - Detailed data were not available on passenger costs for 1980, but it was possible to make estimates based on overall ENFE costs published for 1977 and 1979. These are as follows:

ENFE TOTAL COSTS

	1977			1979		
	Andean	Eastern	Total	Andean	Eastern	Total
	(millions of current pesos)					
Administration and General	68	59	127	88	43	131
Maintenance	174	117	291	258	161	419
Operation	144	57	201	176	77	253
Other	49	24	73	130	85	215
Total	435	257	692	652	366	1,018

Total costs rose 47 percent, comprising 50 percent in the Andean and 42 percent in the Eastern systems. Costs of operation appeared to go up less, but care is needed in interpreting the items of "other" costs which have risen substantially. These consist mainly of food subsidies to staff in lieu of salary adjustments, and should therefore be allocated among the other three items. If this is done on a pro rata basis, operating costs rose 43 percent in the period overall; 36 percent in the Andean and 60 percent in the Eastern system. Total traffic units (ton-kilometers plus passenger-kilometers) rose slightly on the Eastern and fell slightly on the Andean system. Taking this into account, unit cost factor increases for variable costs from 1977-80 can be estimated at 1.5 and 1.6 for the Andean and Eastern systems, respectively.

Comparing these cost increase factors with revenues per passenger-kilometer, the following conclusion can be drawn.

Eastern System revenues have risen substantially and it can be expected that they largely cover variable costs. This must be true for ferrobus services where revenues were double variable costs in 1977, and whose revenues per passenger-kilometer increased by 50 percent in the period.

On the Andean System, the conclusion is quite different. It was estimated that revenues per passenger-kilometer have risen only 3 to 5 percent while operating costs have probably risen nearly 50 percent. Much depends on the operating costs of the new express trains. It is concluded that they must be at least as costly as ferrobuses, and perhaps even more so since the trains are rather short in some cases. Since revenues barely covered variable costs in 1977, it seems unlikely that the Andean System passenger services are covering their variable costs now.

Prospects for Interurban Train Services - Interurban rail services operate on the Andean System between La Paz, Oruro, Cochabamba, Potosí and Sucre. Table 13-9 compares the services offered in 1977 with those provided by bus and air.

Rail volumes in 1977 were low, accounting for just over 10 percent of the total number of passengers on these routes. Bus transport clearly dominated but air was also important in certain corridors. The one route where rail competed strongly was that between La Paz, Oruro and Cochabamba, the volumes on which account for 80 percent of the total of all rail passenger travel shown in the table.

In general, ferrobus services were faster than road but tariffs were about 60 percent higher. Air, of course, was much faster but tariffs were 2 to 3 times those of rail. Despite the higher tariffs, air carried 60 percent more passengers than rail between La Paz and Cochabamba.

The situation has been changed somewhat by the introduction of the new express train services in 1980. Preliminary estimates by ENFE indicate the following changes in numbers of passengers:

	1979	1980
	(thousands of passengers per year)	
La Paz-Oruro	3	7
La Paz-Cochabamba	84	111
Oruro-Cochabamba	119	183

Table 13-9

COMPARATIVE INTER-URBAN PASSENGER TRAFFIC,1977

ROUTE	NUMBER OF PASSENGERS			DISTANCES			TIMES			FARES		
	Rail	Bus	Air	Rail	Bus	Air	Rail	Bus	Air (1)	Rail (2)	Bus	Air
	(Passengers per Year)			(km)			(Hours)			(pesos)		
La Paz- Oruro	3,361	1,343,037	-	267	221	-	4.2	3.5	-	-	33	-
- Cochabamba	83,898	237,850	136,835	466	382	241	8.3	9.5	1.5	116	80	300
- Potosí	6,264	70,260	444	649	543	484	11.3	11.5	2.3	153	85	545
- Sucre	6,816	26,691	15,742	824	710	415	15.9	17.9	1.8	205	130	470
Oruro - Cochabamba	119,253	210,300	2,847	211	219	117	4.8	7.0	1.5	65	45	150
- Potosí	3,178	66,347	-	382	322	-	7.1	8.0	-	-	65	-
- Sucre	3,734	15,129	-	557	490	-	11.7	14.4	-	-	100	-
Potosí- Sucre	28,617	61,565	-	175	127	-	4.6	6.4	-	-	35	-
	255,121	2,031,179	155,868									

(1) One hour added to represent time at terminals.

(2) Lower ferrobus fare -- pullman fare was on average 18 percent higher.

SOURCES: Various.

These are significant increases from the point of view of ENFE and are probably due partly to the greater comfort and capacity of the new coaches used on the express services, and partly to the virtual equalization of tariffs between bus and rail.

Although ENFE have now captured a significant share of the interurban passenger market, it is believed that they will have difficulty in maintaining their position. On the main route from La Paz to Cochabamba, buses are now handicapped by the poor road between Oruro and Cochabamba, but by the mid-1980s, a new paved road(now under construction) will be in service. Much of the Oruro-Cochabamba rail traffic, which is now at about half the road volume, can then be expected to switch to road. For confirmation of this view, one needs only to look at the La Paz-Oruro corridor which has now had a paved road for over ten years, and where rail carries less than one percent of the passenger traffic.

Paving of a number of roads is being recommended by this Study in order to reduce vehicle operating costs. As road paving extends, so rail services will tend to become less competitive. It is not only buses that will provide competition in the future, but the private car, which at present is scarcely used for interurban travel, will become increasingly popular.

It is difficult to see how intra-urban passenger services can be made competitive. With single, narrow gauge track and difficult alignments through the mountains, the superior type of passenger services which are attracting business in Europe and Japan cannot be offered in Bolivia. Moreover, as rail freight traffic builds up, as projected by this Study, it will become less easy to operate passenger services effectively on the same track.

It is concluded, therefore, that in the face of increasing competition and from road transport and growing pressure from rail freight services, the rail passenger services operated on the Andean System are likely to decline, despite the rise in traffic in 1980.

Prospects for Services to Remote Areas - There are some lines where the alternative road transport is extremely poor or non-existent, and these are shown in Table 13-10, together with passenger volumes over the past three years. The lines are:

- Uyuni-Atocha
- Atocha-Villazón
- Oruro-Cochabamba
- Cochabamba-Aiquile
- Potosí-Sucre
- Santa Cruz-Corumbá.

Table 13-10

RAIL PASSENGER SERVICES TO REMOTE REGIONS, 1977-1979

YEAR	SERVICE	LENGTH OF LINE (km)	TRAIN Pass	TRAIN Pass-km	TRAIN Length (km)	FERROBUS Pass	FERROBUS Pass-km	FERROBUS Length (km)	AUTOCARRIL Pass	AUTOCARRIL Pass-km	AUTOCARRIL Length (km)	TOTAL Pass	TOTAL Pass-km	TOTAL Length (km)
			(thousands)			(thousands)			(thousands)			(thousands)		
1977	Uyuni-Atocha	93	209	19,000	91	-	-	-	-	-	-	209	19,000	91
	Atocha-Villazón	196	297	28,000	94	-	-	-	-	-	-	297	28,000	94
	Oruro-Cochabamba	211	172	20,000	116	145	26,000	179	-	-	-	317	46,000	145
	Cochabamba-Aiquile	216	18	2,000	111	-	-	-	19	2,000	105	37	4,000	108
	Potosí-Sucre	175	23	4,000	174	13	2,000	154	22	2,000	91	58	8,000	138
	Santa Cruz-Corumbá	643	137	45,000	328	72	37,000	514	4	1,000	250	213	83,000	390
1978	Uyuni-Atocha	93	191	17,000	89	-	-	-	-	-	-	191	17,000	89
	Atocha-Villazón	196	178	24,000	135	-	-	-	-	-	-	178	24,000	135
	Oruro-Cochabamba	211	179	22,000	123	133	28,000	211	-	-	-	312	50,000	160
	Cochabamba-Aiquile	216	19	2,000	105	-	-	-	4	0	0	23	2,000	87
	Potosí-Sucre	175	14	2,000	143	13	3,000	227	20	2,000	100	47	7,000	149
	Santa Cruz-Corumbá	643	173	63,000	364	77	39,000	506	9	0	0	259	102,000	394
1979	Uyuni-Atocha	93	192	18,000	92	-	-	-	-	-	-	192	18,000	92
	Atocha-Villazón	196	173	22,000	127	-	-	-	-	-	-	173	22,000	127
	Oruro-Cochabamba	211	157	20,000	127	113	24,000	212	-	-	-	270	44,000	163
	Cochabamba-Aiquile	216	24	2,000	83	-	-	-	-	-	-	24	2,000	83
	Potosí-Sucre	175	17	2,000	118	19	3,000	158	14	2,000	143	50	7,000	140
	Santa Cruz-Corumbá	643	141	46,000	326	55	26,000	473	24	1,000	42	220	73,000	332

SOURCE: ENFE.

Although Oruro-Cochabamba and Potosí-Sucre both have parallel main roads, they are some distance away in different valleys, and several communities along the railroads have poor road access.

It is the local train and, to a lesser extent, the autocarril services that really provide the access to these remote areas; the ferrobuses merely pass through. On some lines, particularly Uyuni-Villazón, trains also provide a through service for international traffic.

Statistics for international traffic are difficult to disentangle from those for internal traffic. This is because ENFE statistics are based on ticket sales and do not distinguish between international passengers and passengers travelling to and from the border towns. Making allowance for international traffic, however, the volumes of local traffic on these lines in 1979 were estimated as follows:

	NUMBER OF PASSENGERS	
	Per Year	Per Day
Uyuni-Atocha-Villazón	120,000	330
Oruro-Cochabamba	170,000	470
Cochabamba-Aiquile	37,000	100
Potosí-Sucre	37,000	100
Santa Cruz-Corumbá	101,000	280

In the cases of Uyuni-Atocha-Villazón, Oruro-Cochabamba and Santa Cruz-Corumbá, the volumes are quite high and abandonment of service would clearly have an impact on the communities served by the railroad. In the cases of Cochabamba-Aiquile and Potosí-Sucre, volumes are much lower and, although these routes would be affected by the withdrawal of services, it must be questioned whether the cost of keeping the line open simply to provide these passenger services is justified. It would amount to an annual subsidy per passenger trip of over 1,000 pesos. These two lines are recommended for eventual closure, as discussed earlier in this chapter.

Local passenger train services are heavily subsidized. It is estimated that only about one quarter to, at the most, one half of the transport provided by train and autocarril services can be classified as essential to otherwise isolated regions, and about half of these are for transport on the Santa Cruz-Corumbá line. It is doubted whether the degree of subsidy provided to other rail passengers, which must have risen substantially over the past three years, can really be justified.

<u>Conclusions on Rail Passenger Services</u> - Passenger services on the Eastern System appear to be operating satisfactorily. Although fares have risen substantially over the past three years, travel continues to increase, largely because there is little road competition. The ferrobus services are almost certainly more than covering their variable operating costs, and a social case can be stated for a degree of subsidy to the local services, since no other means of transport exists. As long as increasing costs can continue to be offset by fare increases, there seems no reason why these services should not continue.

On the Andean System, rail passenger operations are less satisfactory. They almost certainly do not cover variable operating costs, neither on the new interurban express train services nor the local services. By charging low tariffs, rail has managed to capture an increasing share of the rail passenger market but these tactics are probably not in the interest of the country as a whole.

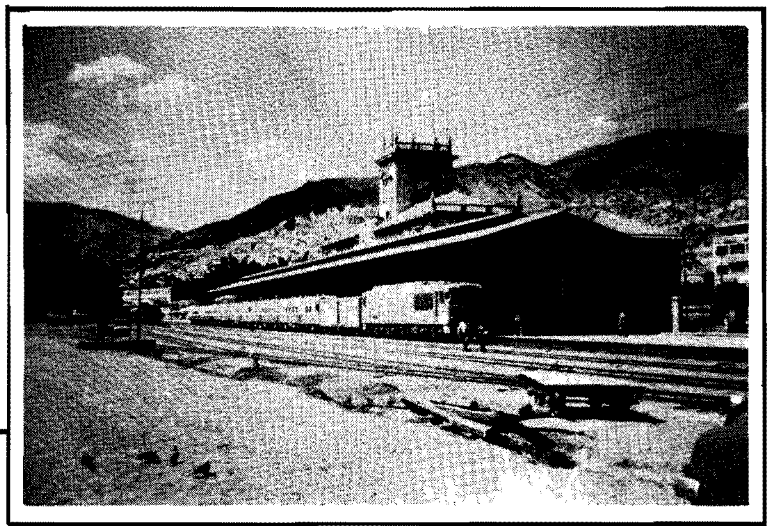
Despite the recent growth in traffic on the Andean inter-urban services, the future for this type of rail passenger traffic is not good. Increasing competition from road is likely to reduce rail traffic, and increasing pressure will be put on the rail system by the growth in freight traffic, which will make it more difficult to provide attractive passenger services.

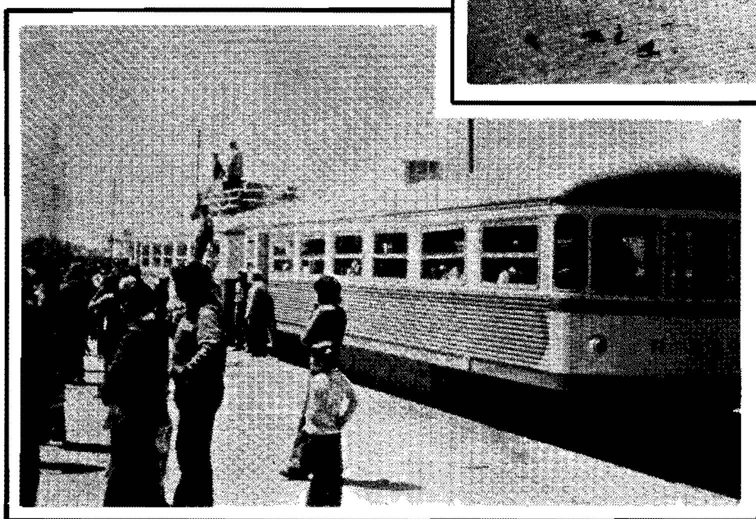
However, the new passenger coaches have been purchased and placed in service and the Study accepts that these services should continue. Revenues should at least cover variable operating costs, although not necessarily the depreciation of the new coaches since it is not envisaged that they will ever need replacement, and fares should immediately be increased to do so. Certainly, no further purchases of rolling stock for this type of service can be justified.

Concerning local train services on the Andean System, these too run at a loss although only a part of these services are to genuinely isolated regions with no other transport access. It is recommended that fares be immediately raised to cover the variable cost of these services.

In the longer term, it is questionable whether the costs of providing rail passenger services on the Andean System can continue to be justified. Assuming that only half of the fixed costs allocated to rail passenger services are truly avoidable, the sum of 100 million pesos was paid in 1977 to provide these services for revenues of only 56 million pesos. Costs have risen considerably since then and it can be assumed that the deficit is greater now. Much could be done with these funds to improve road access to currently isolated areas, which is where rail services currently fill a genuine need, and this deserves fuller study.

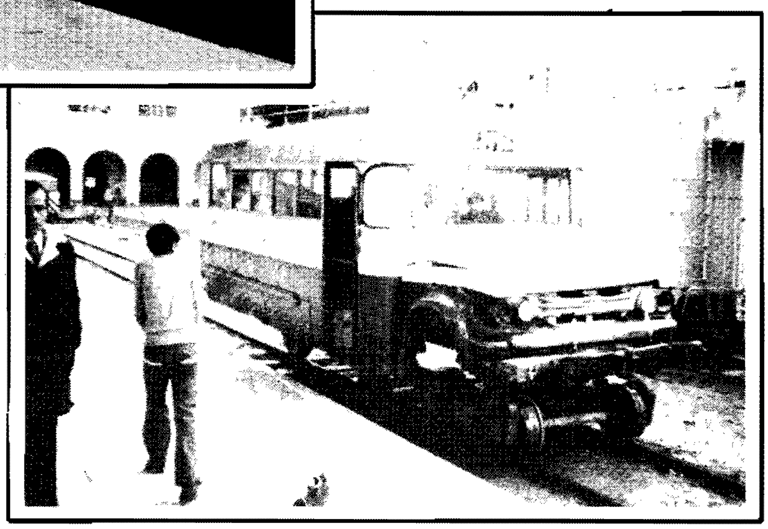
MODERN TRAIN AT LA PAZ





FERROBUS AT ORURO

AUTOCARILL AT COCHABAMBA



PASSENGER TRAINS

A useful project for the proposed National Transport Center recommended in Chapter 19 would be to study these isolated areas in more detail and to evaluate a program for providing road access. This would take into account the cost savings possible from a suspension of rail passenger services in these areas.

Rail Equipment Requirements

This section analyzes the needs for rail transport equipment which would be required to carry potential traffic forecast for the 1989 committed rail system, consisting of the current rail system with the addition of the new line from Yapacaní to Río Grande but without the rail interconnection. This analysis takes into account the need to replace old equipment as well as purchase new stock.

In planning infrastructure requirements, it is necessary to evaluate each item of investment against the benefits which it could be expected to generate. However, there is no need to justify each individual investment in rail equipment since the operating costs used in the model included equipment costs. In other words, if traffic is allocated to rail as the most efficient mode, then the equipment needed to carry it is justified.

Locomotives for Freight Services - The calculation of locomotive requirements for freight services is set out in Table 13-11. The first stage of the calculation was to determine the number of trains per week required, by dividing the tonnage flow on the section in the heavier direction by the carrying capacity of each train. This was usually rounded to an exact number of trains per day. Using this, with the round trip distance and the number of locomotives per train, the total locomotive-kilometers per year were calculated. These totals were then divided by 100,000 which represents a desirable average annual number of kilometers for each operational locomotive, and is close to the figure ENFE achieved in 1979. The number of locomotives per train was determined by allowing 800 tons of gross trailing weight per locomotive on most lines and 500 tons on the very mountainous lines. It was assumed that locomotives would not be dedicated to a particular service but that the total fleet would be available for all types of rail service performed. The number of locomotives arrived at by those calculations was 73.

Table 13-11

LOCOMOTIVES FOR FREIGHT SERVICES IN 1989

SECTION	ROUND TRIP DISTANCE (km)	TRAINS/WEEK	GROSS TRAILING LOAD (tons)	FREIGHT HAULED (tons)	LOCOMOTIVES/ TRAIN	LOCOMOTIVES
La Paz-Viacha	84	28	500	330	1	1.22
Viacha-Oruro	408	21	1,000	660	2	8.92
Oruro-Rio Mulato	416	14	1,200	800	2	6.06
Rio Mulato-Uyuni	210	14	850	560	2	3.06
Uyuni-Villazón	578	14	320	210	1	4.21
Viacha-Charaña	414	7	500	330	1	1.51
Uyuni-Avaroa	350	14	500	330	1	2.55
Oruro-Cochabamba	422	14	700	460	2	6.14
Rio Mulato-Potosí	348	21	520	340	2	7.60
Potosí-Sucre	350	21	320	210	1	3.82
Viacha-Guaqui	130	2	800	530	1	.14
Andean System						45.23
Santa Cruz-Corumba	1,286	14	1,500	1,000	2	18.72
Santa Cruz-Yacuiba	1,078	7	1,500	1,000	2	7.84
Santa Cruz-Santa Rosa	208	7	750	550	1	.76
Santa Rosa-Rio Grande	368	2	750	500	1	.38
Eastern System						27.70
TOTAL						72.93

Wagon Requirements - The calculation of wagon requirements for freight service is set out in Table 13-12. The annual tonnages by each commodity for internal and external movements were divided by the average load per wagon to produce the number of annual loads per commodity. The average loads per wagon were derived from ENFE's performance in 1977 allowing some improvement for more modern wagons; overall the increase in average load was about 35 percent.

The number of annual loads was then divided by the average number of loads per wagon per year, calculated on the basis of an 8-day average turnround for internal movements and 12 days for external movements. This is slightly better than ENFE achieves at the moment but should be possible with improved wagon control and loading techniques.

The number of wagons required was then increased by an out-of-service factor of 7 percent, which should be attainable with newer equipment. The above calculations produced a total wagon requirement in 1989 of 3,122.

Passenger Equipment - No further purchase of ferrobuses or passenger cars are envisaged in the next ten years. The number of locomotives needed to haul passenger trains has been taken to remain constant at the 1977 level of 12; these locomotives are of course interchangeable with those used for freight operations.

Other Services - To handle the freight movements forecast it will be necessary to establish or improve marshalling facilities at the major interchange points of Viacha, Oruro, Río Mulato and Uyuni, and also to increase the freight handling facilities at such places as Cochabamba, Potosí and Santa Cruz. These will require the provision of shunting engines to supplement the work of the main-line locomotives, and these engines will have to be purchased as demand grows.

Summary of Rail Equipment Needs - The above calculation shows that, to achieve the traffic levels forecast, ENFE will require about 85 operational locomotives and 3,122 rail wagons by 1989. ENFE has at present 53 locomotives, of which however only about 36 are operational. Thus a further 49 will be required which will cost about $b 640 million. The total stock of rail wagons in 1979 is 2,353, but of these 1,214 were built before 1950 and most will probably have to be replaced during the next decade. Assuming that ENFE's internal services continue to account for 400 extra wagons and that interchange with other railroads balances, there will be a requirement for 2,383 new wagons at a cost of $b 1,660 million.

Table 13-12

RAIL FREIGHT WAGON REQUIREMENTS FOR 1989

COMMODITY	INTERNAL MOVEMENTS Tonnage(1) thousand ton)	Load/Wagon (tons)	Wagons	EXTERNAL MOVEMENTS Tonnage	Load/Wagon (tons)	Wagons	TOTAL WAGONS
Agriculture	166	20	182	299,260	35	281	463
Mining	100	35	63	143,110	35	134	197
Hydrocarbons	170	30	124	28,500	25	37	161
Food	179	25	157	187,350	30	205	362
Textiles	2	15	2	29,550	15	65	67
Wood and Paper	157	25	138	151,850	25	200	338
Chemicals	59	20	65	52,330	25	69	134
Building Materials	300	30	219	109,250	35	103	322
Metals	400	35	250	151,460	30	166	416
Vehicles and Machinery	41	15	60	181,810	15	398	458
Total	1,574		1,260	1,334,470		1,658	2,918
Average		27.5			26.5		

(1) Recommended Network.

Railroad Operations

The quality of railroad operations is of fundamental importance. The process of sending goods by rail involves many more steps than road transport, both for the user and for the operator. Therefore improvements in efficiency at the various stages of rail transport -- receipt of goods, wagon loading, train formation and dispatching, wagon marshalling, wagon unloading and delivery of goods -- can make the service provided much more attractive. Similarly, accumulations of inefficient operations at each of these points result in long transit times, causing users to seek other means of transport more under their own control, even if more expensive.

Improvements in efficiency also have the great advantage of being cheap to implement, although this is not to say that they are easy. This is why the consultants Sofrerail were employed by ENFE, on the advice of the World Bank, to study the ways in which ENFE operation can be improved. Over the course of several years, several reports have been completed by Sofrerail and recommendations made and implemented on the following subjects:

- Organization of work in stations
- Maintenance of fixed facilities
- Maintenance of rolling stock
- Commercial policies
- Staff productivity
- Staff training.

Recent Performance of ENFE - Statistics are now available covering the 1979 operations of ENFE and it is interesting to compare these with targets set by the World Bank in 1977, in the Third Railroad Project Report. Table 13-13 shows targets set for 1977 and 1979, and the actual performance of ENFE in 1979.

These expectations have evidently not been attained, and scarcely any of the targets have been met, the exceptions being availability of freight cars, the load per wagon and daily ton-kilometers per wagon.

Other statistics can also be quoted which show the same story. Availability of ferrobuses and autocarriles fell from 70 percent and 58 percent respectively in 1975 to 50 percent and 53 percent in 1979. The net cargo per train fell slightly from 196 tons in 1975 to 193 tons in 1979 although reaching a peak of 258 tons in 1977.

Table 13-13

ENFE OPERATING TARGETS AND 1979 PERFORMANCE

	1977 TARGET		1979 TARGET		1979 PERFORMANCE	
	Andean	Eastern	Andean	Eastern	Andean	Eastern
1. Availability of mainline diesel locomotios (%)	80	80	85	85	64	68
2. Availability of freight cars (%)	86		88		89	
3. Availability passenger coaches (%)	70		80		63	
4. Average daily run of diesel locomotives (km)	440	440	450	470	344	285
5. Average daily run of freight cars in service (km)	55.6	81.6	58.0	84.0	27.6 (1)	34.8 (1)
6. Average load per freight car (tons)	21.0	17.5	21.2	17.9	24.3	21.4
7. Net ton-km per car day in use	690	930	720	985	838	930
8. Wagon turn round time (days)	10.8	9.2	10.6	8.9	11.7	
9. Numbers of staff	6,044		5,900		6,502	

(1) Obtained as tn km ÷ Average load passenger ÷ No wagon in service ÷ 365. Possibly a different basis to the IBRD figure.

SOURCES: IBRD and ENFE.

While most indicators of performance have shown a downward trend, the number of employees has increased, contrary to intentions stated by ENFE. Employment levels are now higher than in 1973, when a program of staff reduction was started.

A detailed assessment of the reasons for ENFE's recent poor performance has not been made as part of this Study, but an immediate review is very necessary. From discussions with officials, the following points appear to be important.

Equipment maintenance has been poor, resulting in low availability rates, for a number of reasons. In particular, spare parts have not been available when required as a result of inadequate planning for parts requirements, and also as a result of inadequate financing. Employee productivity has also been low, partly due to a lack of technical training and partly a result of continuing employment of over-aged staff on strenuous manual work. It is believed that better incentives to employees, coupled with more accurate measures of the performance of the different workshops and teams, would have a beneficial effect. Also, the program of employee redundancies, which has faltered recently, should be renewed.

It is also suggested that there are still too many workshops, although some progress has been made in rationalizing the services provided. Too many repair places may result in the inadequate staffing, equipping and supervision of each, with consequent lack of overall efficiency.

It is also claimed that service to customers has been poor, with inadequate information about train dispatches and progress of cargoes through the system. Certainly low availability rates for equipment have not helped, but a more vigorous commercial policy, and more attention to the customers needs, is required.

Organization and Management of ENFE

The organization of ENFE is currently as set out in Figure 13-9. The central offices are located in La Paz, although there are important offices in Oruro and Cochabamba. The central organization is responsible for operating the Andean rail system but the Eastern system, which is not physically linked with the Andean system within Bolivia, is operated independently by a separate management located in Santa Cruz.

The changes in rail operations recommended by this Study would place a severe load on the organization of ENFE. In particular, the implementation of a new tariff policy would require very careful planning to ensure that the pace of implementation is matched by the ability to encourage and accept new freight traffic expected to be brought about by the change.

Similarly, the phasing out of some passenger train services would require careful coordination with other transport improvements to ensure that currently isolated communities have continuity of transport links. In this latter case, it is suggested that the proposed National Transport Center could plan a most useful role in supervising the necessary coordination between modes.

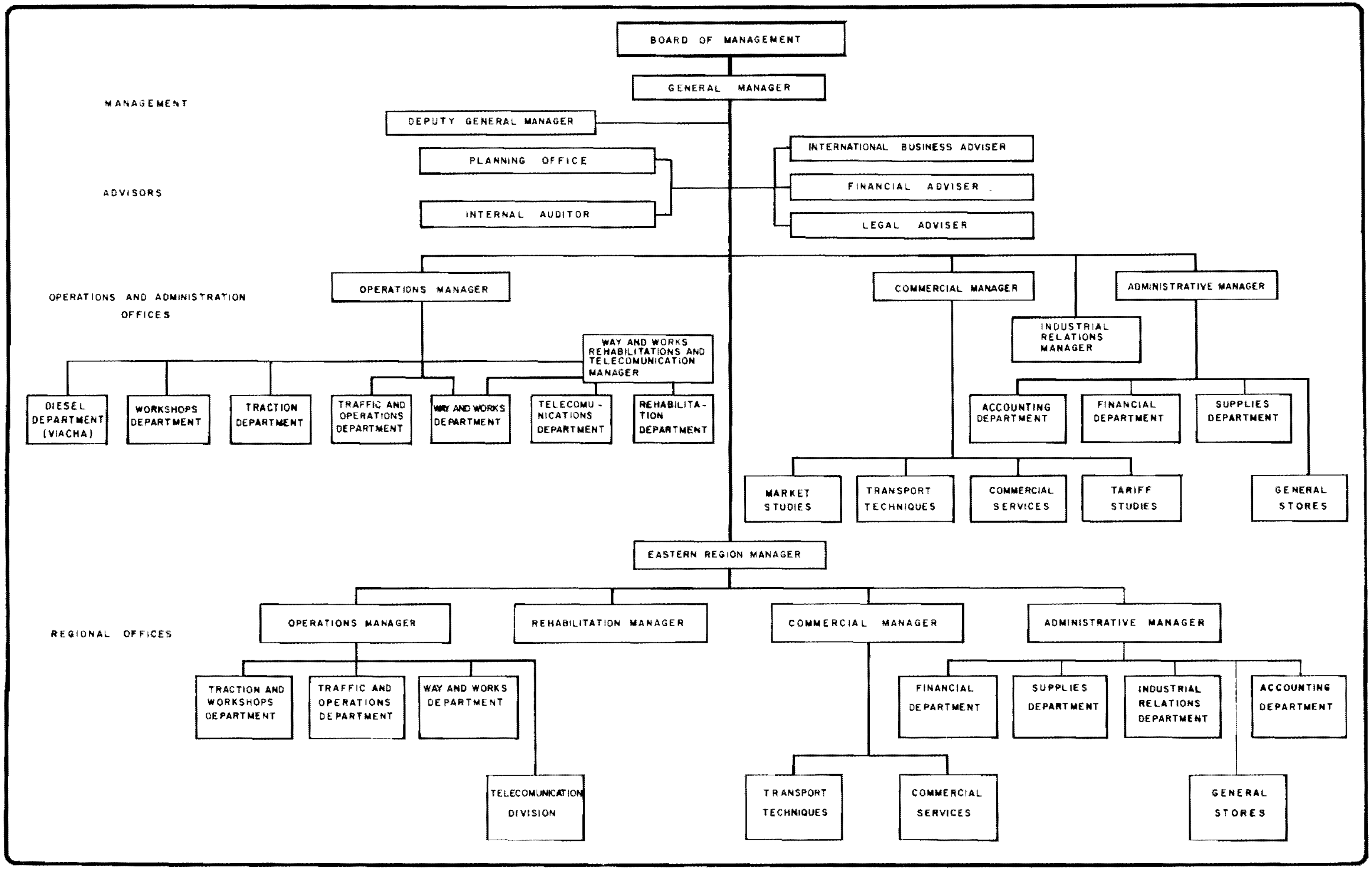
As far as the task of establishing and implementing a new commercial policy is concerned, there is a definite need to put greater emphasis on this aspect. As will be discussed in Chapter 17, a flexible tariff policy is proposed, with the aim of attracting traffic with a comparatively high demand elasticity. This will probably require a substantial strengthening of ENFE's commercial department as well as the Ministry of Transport's General Directorate of Railroads. It is very much in the government's interest that this work be carried out not just from the point of view of ENFE, but with the general public interest in mind. A strong monitoring function by the Ministry is particularly important if some subsidy is required to pay for selected low-tariff services.

Changes are also recommended in the basic structure of the ENFE organization. In general terms, it is recommended that certain of the overall aspects of railroad administration and planning should be more completely centralized, probably in La Paz, while other operational aspects whould be decentralized and put under the control of regional centers. The function of a central organization would be as follows:

- Preparation of overall budgets
- Major purchases, such as equipment
- Financial organization
- Legal organization
- Commercial policies
- Tariff studies
- Overall planning
- Establishment of standards and monitoring of performance.

The implementation of policies decided by the central administration should be the responsibility of district offices, each responsible to a regional office (Eastern and Andean). The locations of district offices and their dependencies would have to be studied carefully but probably a reduction in the number of ENFE offices and workshops would be desirable.

The statistics provided by ENFE each year are very complete, but more needs to be done to set standards and to monitor performance so that weaknesses and failures of the system are identified rapidly and corrected. The responsibility to monitor



CURRENT ORGANIZATION OF ENFE

Wilbur Smith and Associates

FIGURE 13–9

performance and take action on a day-to-day basis should be with the regional office and to some extent with the district offices. The overall review of trends and the setting of standards should be the responsibility of the central planning division.

It is commented that ENFE could attach more importance to economic evaluation and planning. Evaluations that are now carried out are generally made by consultants, recent examples being the evaluation of the rail interconnection by the Brazilian firm Sondotecnica and the evaluation of the improvements to the Oruro-Cochabamba and the Santa Cruz-Corumbá lines by JICA. However, no economic evaluations were made of the Yapacaní-Río Grande line now under construction at a cost of $b 550 million (1977).

The ability to conduct economic studies, or at least to assess the studies made by others, is fundamental to a planning department. Such an ability is not evident in the present ENFE organization and it is strongly recommended that attention is paid to this. A group devoted to economic studies should be formed within the planning department, either using qualified economists already working with ENFE or, if necessary, by hiring the necessary expertise. Tasks for this group would include evaluation of rehabilitation projects and the further studies recommended on the rail system interconnection.

Conclusions on Rail Transport

Major changes are recommended in railroad operations. They must be seen in the context of a new tariff policy (discussed in Chapter 17), which could have a dramatic impact on the volume of domestic freight carried by rail.

It is recommended that ENFE raise tariffs on rail passenger services on the Andean System and, in the long term, possibly withdraw from passenger services on this network. If a withdrawal policy is adopted it should be phased over a number of years and coordinated closely with the development of alternative transport services where necessary.

The Study concludes that an interconnection linking the two rail systems between Cochabamba and Santa Cruz cannot be justified in the 1980s. However, further studies are recommended on two aspects. A more northerly alignment via Chimoré and Yapacaní should be evaluated to see whether construction costs could be significantly reduced. Of more importance is an investigation of the likely volumes of transit traffic between Peru, Chile and Brazil, and the tariffs which could be charged. Without any doubt, this is the crucial element, for without the revenues from transit traffic, the rail interconnection could not be justified economically.

Two new sections of rail line are recommended, one from Mutún to Motacucito on the Santa Cruz-Corumbá line and another from Guaqui to Desaguadero. This latter line should be built only when the Peruvian line from Puno to Desaguadero is nearing completion. The rebuilding of the damaged section of the Santa Cruz-Corumbá line can be justified, but with a more modest scheme than previously proposed (see Chapter 15 for discussion). Major rebuilding and realignment in the difficult parts of the Oruro-Cochabamba line does not appear justified at the present time.

No other rail projects were found to be feasible including the line from Río Grande to Trinidad (see Chapter 12 for discussion). In the latter case, even the prospect of a cheap loan from Argentina was not sufficient to make up for the lack of benefits associated with this project.

It was concluded that although the rail rehabilitation program does not appear to provide a high economic return, work should proceed using the equipment already acquired and making use of the trained crews. General levels of track maintenance should be raised on unrehabilitated lines.

The disappointing results of the rehabilitation analysis should not be interpreted to mean that rail services are generally uneconomic. They simply reflect that the low volumes on the Bolivian rail system do not warrant substantial investment in track, and that less money would be spent overall with higher maintenance of unrehabilitated track.

Electrification of the railroad systems was examined but rejected, certainly for the next ten years.

Three lines were identified where closure should be considered. These are Cochabamba-Aiquile, Machacamarca-Uncía (currently operated by COMIBOL) and possibly Potosí-Sucre. The rest of the system is well worth keeping for external freight traffic alone, and the high volumes of domestic freight forecast by the Study reinforce this conclusion.

Much stress has been laid by the railroad authorities on the need for new investment in rail, and particular importance has been given to the need for a railroad interconnection between the Eastern and Andean system. It is agreed that this would have substantial operating benefits, but not, in the view of the Study, sufficient to warrant the immediate commitment of very large sums of public money -- over one third of all public funds available for transport over the next ten years, or about 8 percent of all public investment.

The high freight forecast by the Study indicates the potentially bright future for the railroad. But it is only a potential. To realize it, a new tariff policy will have to be established and the quality of rail operations will have to be improved.

CHAPTER 14

AIR TRANSPORT

CHAPTER 14

AIR TRANSPORT

As has been described elsewhere in the Report, air transport plays an extremely important role within the Bolivian transport sector. Internally, many small communities have no contact with the rest of the country except by means of air. Given the high costs of road construction and the generally sparse population in the outlying regions of the country, air service will continue to provide for some time the most economic means of integration and communication in the remote regions. External air services also provide vital access for this landlocked country. In this chapter the most critical areas of the sector are analyzed and recommendations made for the future development of air transport in the next decade.

Analysis of Future Air Passenger Service Patterns

The possible future pattern of air passenger services, which is central to the evaluation of the passenger sector, was analyzed using a two-phase model. The first part of the model is a simple regression procedure which predicts inter-zonal passenger movements on the basis of the total gross domestic product in the zones of origin and destination, the cost of the flight and the difference in time between surface public transport and air travel (these had been found to be the most significant variables). The second phase of the process includes an adjustment for flight frequency which in other studies has been found to be a significant factor in generating demand, until a level of seven flights a day between cities in each direction is reached. The simple model tends to underestimate trips between zone pairs with high flight frequency and overestimate trips between zones with poor frequency. When the adjustment for frequency was made, a much better result was achieved for the base-year situation. The basic patterns of service tested are shown in Figures 14-1 and 14-2.

The model was then applied to a number of alternative service patterns for the years 1989 and 1999, assuming that aircraft types operating in the future will be similar to those presently in service in terms of capacity and operating cost (whereby allowance is made for increases in fuel cost). Three different scenarios were tested: a greatly expanded service by regular airlines reaching many more small communities with scheduled flights, a continuation of the present pattern of service (with slight expansion), and a move to different patterns of operation with jet service operating to a number of key airports (at present served by F-27s) which are the focus of feeder services. In all tests, a load factor of 60 percent was required for the service to continue: this was altered to 50 percent and 70 percent to examine the sensitivity of the service to this factor.

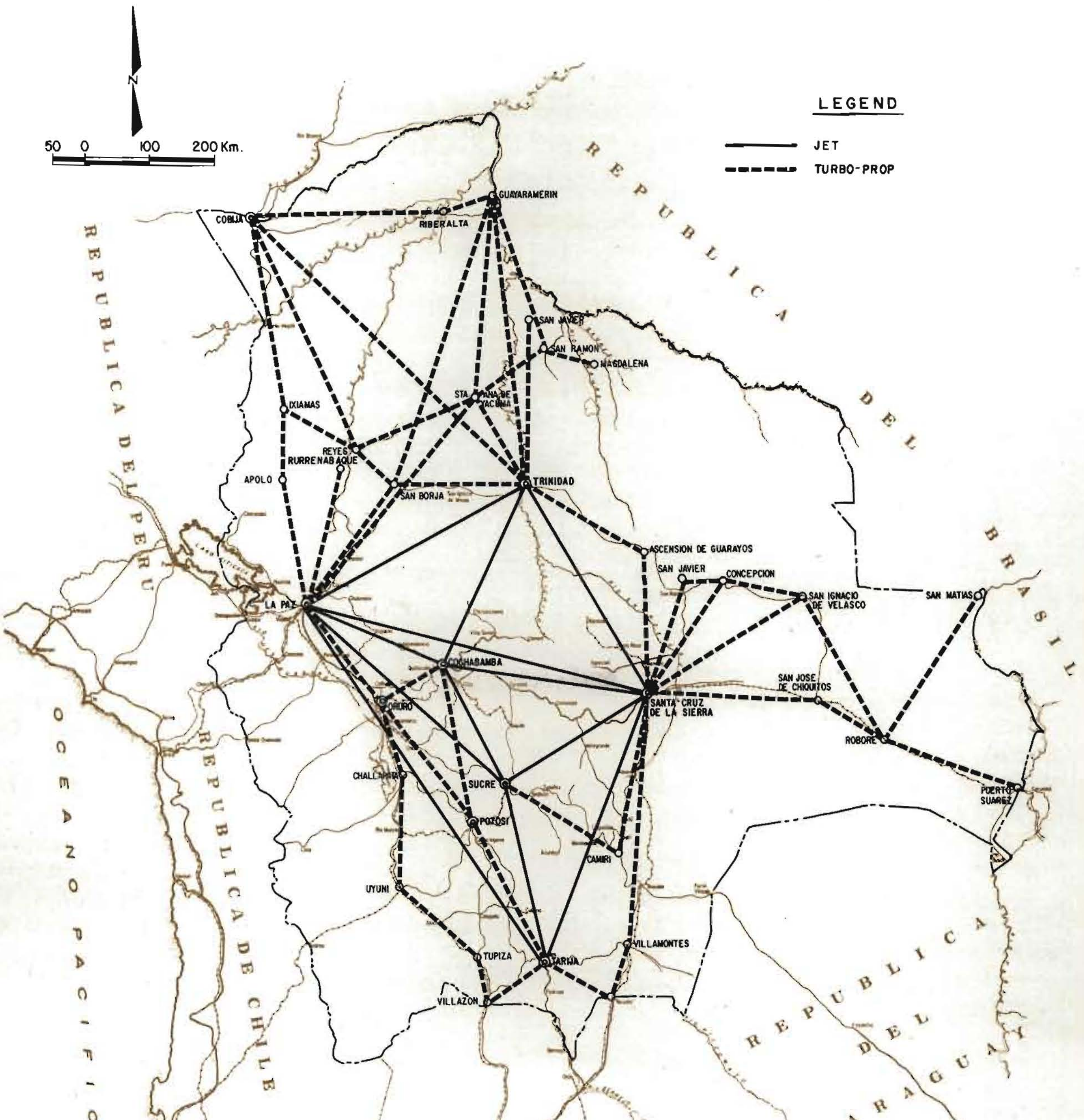
The basic conclusion arising from the analysis is that there is little scope for a major increase in scheduled air service to the remote regions of the country: there is insufficient predicted growth in either population or income to provide the volumes required to support such services. However, the flight pattern which extends jet service to a number of regional centers proved to be viable, and desirable in view of the lower operating costs of jet service and the present lower than optimum utilization of the aircraft fleet. This service pattern has certain implications for the airport infrastructure requirements which receive further consideration later in this chapter when the national airport plan is discussed. A possible basic service pattern is shown in Figure 14-3.

Evaluation of Non-regular Air Services

An important part of the air sector is "non-regular" air transport, described briefly in Chapter 4. These are privately operated air services whose main task is to transport meat from the remote northern cattle regions, in particular Beni Department, to the markets of the Altiplano and valleys; principally La Paz, Cochabamba, Oruro, Potosí and the mining centers. Supplies to the remote regions are carried as backhaul, and some passengers are also carried. These services exist mainly because there is no surface access, except by river, and air transport offers the cheapest way of transporting meat. Use of air transport also means that refrigeration is not required, and thus cattle slaughtering facilities can be simple and cheap.

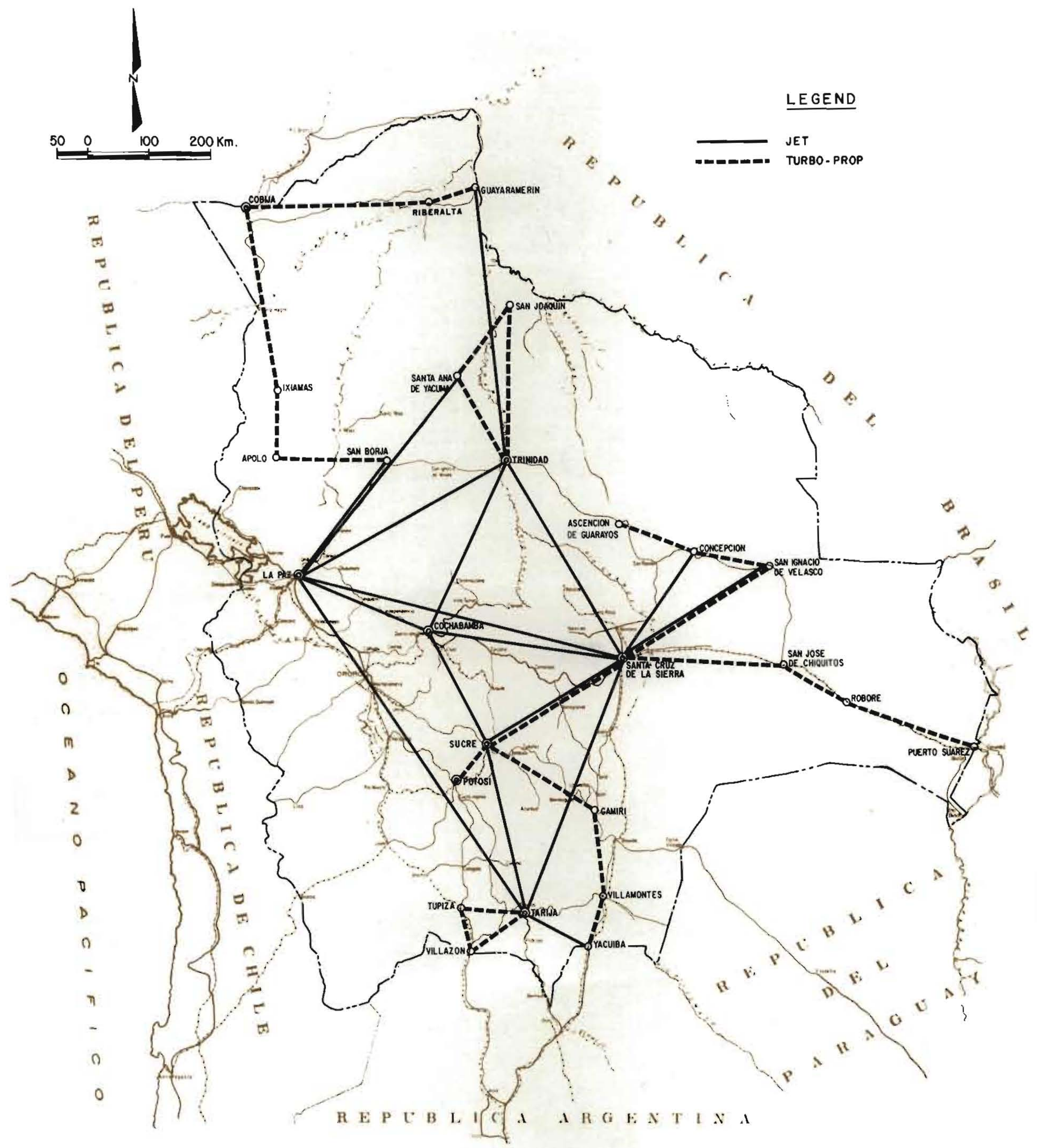
Characteristics of the Non-regular Air Services - There are about 25 operators who between them in 1977 operated some 50 aircraft with a total of 12,000 flying hours and carrying some 33,000 tons of cargo. Half of this total was performed by the Curtiss C-46; the next most used planes were the Convair 440 and the Douglas C-54. Disregarding some very infrequently used aircraft, the average operating time per aircraft in 1977 was 600 hours.

The age of the aircraft used on non-regular services (mostly between 25 and 40 years old), the primitive air strips, mainly of earth surface and poor maintenance of both aircraft and airstrips, has resulted in a poor accident record (see Appendix 4E).



EXPANDED SERVICE PATTERN TEST

Wilbur Smith and Associates FIGURE 14–1



EXPANSION OF JET SERVICE TEST

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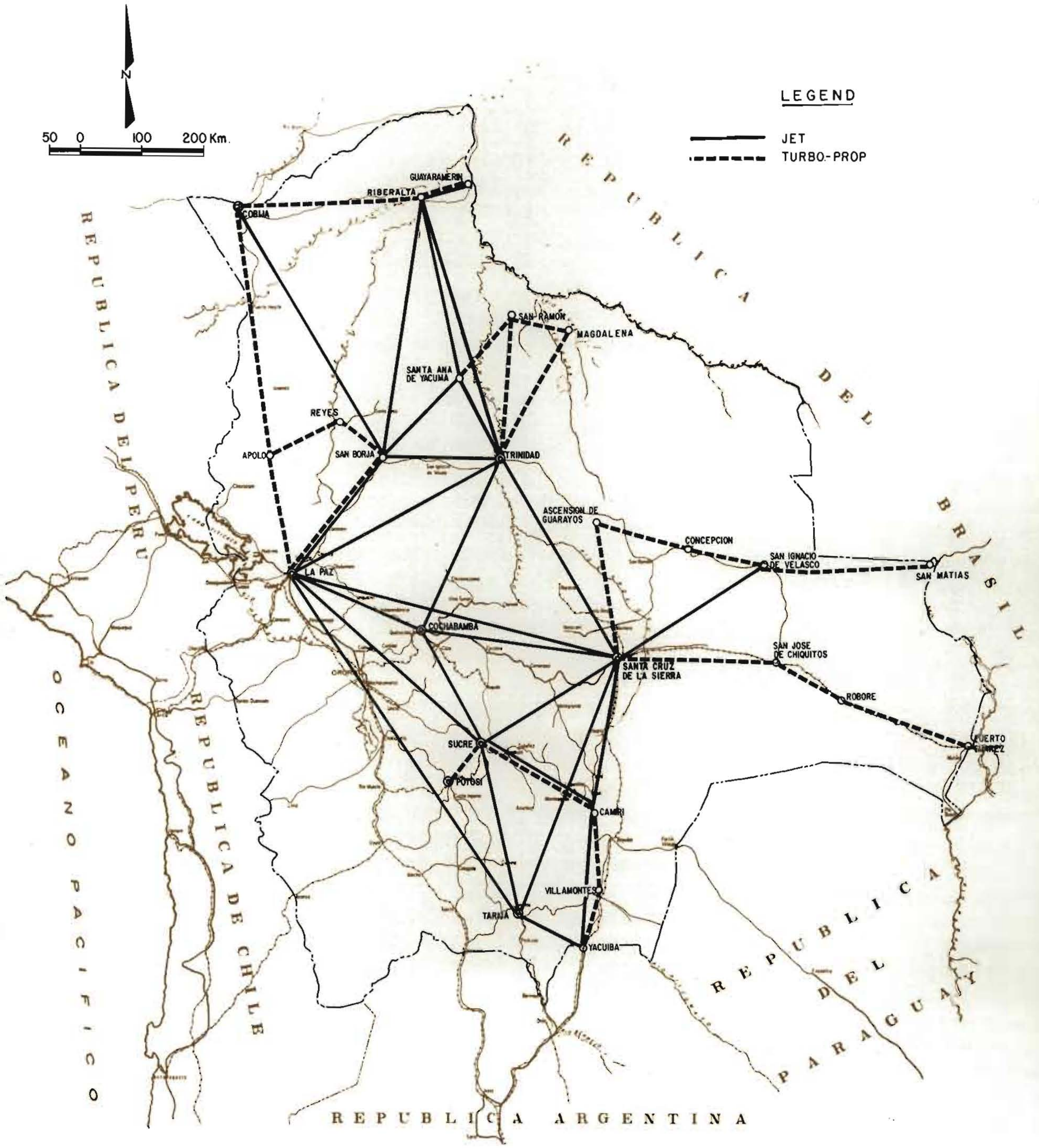
FIGURE 14–2



A POSSIBLE 1989 LAB SERVICE PATTERN

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FIGURE 14–3

Poor maintenance of aircraft prevails, partly because of lack of government control but also because of the lack of properly trained mechanics. Probably more important than both of these factors, however, is the financial disincentive to good maintenance. The price of meat in the market is kept low by government and consequently the operators attempt to reduce costs in every conceivable way. A concession by government to the real economic difficulties of the operators is a fuel subsidy.

Insurance premiums are high, mainly due to the poor accident record. Irregular practices also occur, such as declaring an aircraft to be a total loss for insurance claims, but then rehabilitating the plane and returning it to service.

The non-regular air services are undeniably operating in marginal economic conditions. They survive principally because there is no other feasible way of bringing meat out of the Beni. Also, the owners of these companies are either cattle raisers or, more often, the pilots themselves and the operation of these services is almost a way of life. The income for pilots is good and the mixture of independence and good pay, counterbalanced by comparatively high risk, clearly appeals to some individuals.

The Future of Non-regular Air Services - Non-regular air services currently operate in the absence of competitive land transport to the remote regions, but this is changing fast. Roads from both Santa Cruz and La Paz are being built to Trinidad, the capital of Beni. New roads from Cochabamba to Trinidad, and from Trinidad to Guayaramerín, are also recommended by this Study for the 1980s (see Chapter 12). If the Study's recommendations are followed, 1989 should see all the main meat producing centers of the north connected to the markets by road. Road transport is then expected to be considerably cheaper, even taking into account the costs of refrigerated trucks. For example, it is estimated that the cost from San Borja would be about 0.7 pesos per kilo by refrigerated trucks compared with about 3.70 pesos per kilo by air (1977 economic costs). Clearly, even if the estimate of road costs were increased considerably, there would be no change in the basic conclusions.

It is concluded that the advent of all-year-round road access between the Beni and the consuming centers will lead to a rationalization of the meat trade based on road transport. Cattle raising centers can be expected to concentrate around the new road links with modern facilities for cattle slaughtering and meat freezing. These developments can be expected to encourage the smaller farmers to merge operations with others. Those based in remote areas and still dependent on the non-regular services will find it hard to survive the competition and the non-regular services can be expected to decline.

Immediate Action on Non-regular Air Services - Although the long term future is not secure, there is still an important role to be played by these services over the next ten years; perhaps longer if road development proceeds at a slower pace than recommended by the Study.

Complete modernization of the non-regular fleet by replacing old aircraft with new or second hand turbo-props or jets, is not feasible. Suitable aircraft, such as the DHC-7 Buffalo DHC-SD or the HS 748, cost between five and eight million dollars new and could not be competitive for the current scale of operations. Few second hand aircraft would be suitable, the most likely candidates being the F-27, the CV 580, the YS-11 and the HS 748, which provide similar capacity to the existing fleet. However, the condition of many of the runways in the Beni preclude the use of the F-27 and CV 580, which have problems with landing gear and gravel kick-up into the engines. The YS-11 was only produced in small quantities and availability is restricted. The HS 748 which was successfully but temporarily operated in Bolivia some years ago, is in great demand and the second hand price on the world market is in the region of 1.2 million dollars. Operators would find it difficult to bear such cost at present tariff levels. Therefore, it appears that the sector cannot contemplate major fleet replacement with modern aircraft at the present time.

In fact, there is no good reason why operators should not continue to use most of the veteran aircraft currently in service, with the possible exceptions of the very old C-46 and C-47s. They are not inherently dangerous, provided they are properly maintained, despite the poor accident record; on the contrary, they are remarkably rugged and can operate from poor landing strips with less problems than the more sophisticated modern planes. Since these aircraft were built in large quantities, spare parts are comparatively easily and cheaply available through cannibalization, and this situation should continue for the next 5 to 10 years.

The current poor safety record is of concern and the following actions are recommended:

i) Government should impose maintenance standards and ensure that these are adhered to through a system of regular inspection.

   This is perhaps easier said than done. At present, there is a lack of trained personnel to serve either as mechanics or as inspectors, and it must be a high government priority to set up adequate training facilities to correct this.

It can also be noted that stiffer air safety requirements could lead to the phasing out of some of the aircraft types currently in use --- particularly the C-46 and C-47. An early regulation to be introduced could be a ban on the import of further aircraft of these types for operations, permission only being granted for cannibalization purposes.

ii) Regarding flight practices, the installation of non-directional beacons in Coroico and Caranavi, and a VOR (1) in San Borja, combined with mandatory flight procedures, would considerably facilitate the present perilous crossing of the Cordillera to La Paz, and reduce the likelihood of accidents. This is part of the Air Navigation and Communication Equipment Plan which is discussed later in the Chapter.

iii) Fundamental to the present problems of the sector are the low tariffs and also the organizational structure of the sector, with many small operators without the capacity to raise the necessary capital for modern aircraft. A revision of the tariff structure and system of licensing to reduce the number of operators could improve the situation although growing competition from road transport will probably undermine any major effort to reorganize the sector.

Closely linked with the problem of tariffs is the question of meat prices. The non-regular air services depend upon the profits from meat trade, and yet meat prices are held low in the market place by government. To some extent, the government compensates operators by granting a fuel subsidy but this is not altogether a satisfactory solution in the long run, because it tends to distort the allocation of resources. To a large extent, this problem is bound up with the general strategy of government to combat inflation and the simple solution of just raising meat prices to an adequate level is probably not acceptable. In any case, with the current lack of government control over the non-regular air services, the result of a meat price rise would probably be an increase in aircraft operators' profits, with no discernable change in air safety standards (unless the rise in meat prices is accompanied by an equivalent change in the fuel subsidy).

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(1) Very High Frequency Omni-directional Radio Range.

Conclusion on Non-regular Air Transport - There are no easy solutions to the problems of the non-regular air services. Government should impose more stringent controls on safety and maintenance, but better training of maintenance and inspection personnel is required to make such controls fully effective. Implementation of the Air Navigation Plan should also improve safety records. With more effective controls over this sector, the government must also recognize the financial problems of the operators and find a more lasting solution to the inter-connected problems of non-regular tariffs and market meat prices than the current fuel subsidy. This, however, must be part of the overall government strategy on the economy.

In the long run, the non-regular services are likely to decline with the improvement of road access to the northern cattle raising regions. Therefore, major investments should not be encouraged in this sector, and all investments connected with air safety should be part of the overall need to strengthen government control of the quality of aviation services in Bolivia.

The Role of Air Taxis and Air Services to Small Communities

As a result of the existence of large areas of the country with little or no transport access by any other mode, air plays an important part in promoting national integration. The large numbers of widely distributed small communities makes the provision of regular services to much of the country an uneconomic proposition. In order to provide needed accessibility, the government subsidizes services by LAB to the remote air-ports in northern Beni, and encourages service by the military airline TAM to isolated communities. In addition, there are large numbers of air taxis operating mainly out of Santa Cruz and Trinidad, with tariffs regulated by the central government.

There has been substantial growth in the area of general aviation in Bolivia in recent years; in 1971 there were 80 planes registered; 180 in 1975; and an estimated 329 in 1980. Of these, only some 10 percent are actually registered with the DGTTA (2) as air taxis: in fact it is estimated by the Study that this type of service is provided by about 300 aircraft, i.e. nearly 90 percent of the fleet. Of these 300 aircraft, about 180 are used for private purposes as well and 120 are devoted to air taxi work.

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(2) Dirección General de Transporte y Trabajo Aéreo (General Directorate of Air Transport and Aerial Work).

Government intervention in this sector should be restricted to control of safety and regulation of tariffs. Improved safety measures of two types are required: one relating to the aircraft and the other to the pilot. The present maintenance schedules are adequate but the inspection system needs more stringent enforcement. The "airworthiness certificate" should be subject to annual review and the permission to operate made dependent upon proof of adequate insurance coverage. The critical change that needs to be made in the regulation of the sector is a much clearer distinction between those aircraft which operate purely privately and those which supply a commercial passenger service. For the latter, much more stringent regulations need to be applied, particularly with respect to the licensing of pilots and provision of both theoretical and practical flying time before being granted a Commercial Pilot's License. All pilot licenses should be subject to a stringent annual medical test.

Regarding the current tariff levels, on the basis of an analysis of operating costs carried out by the DGTTA, it would appear that they are a little low. However, the supply of service argues the opposite, although as has been pointed out, many operators provide air taxi service as an occasional occupation, the main use of the aircraft being private.

The question has been raised as to whether air taxi services should be replaced in some areas by regular scheduled services, or conversely whether the subsidized services of LAB/TAM should be replaced by subsidized air taxis. The conclusion with regard to both possibilities is that neither would be economically beneficial: the volumes carried by air taxis at present are too low on individual routes to make a regular scheduled service viable. Similarly the volumes carried by the scheduled services on present routes, although well below the operating aircraft's capacity, are considerably above the volumes that could be more economically carried by air taxi.

There is, however, a possible role for an intermediate aircraft (such as the 20-seat Twin Otter) operating on routes in the north and east of the country over the next two decades. Such a service should be operated either by LAB or by an independent airline with clearly coordinated schedules specifically designed to feed the main routes. It is recommended that a detailed feasibility study be carried out of this type of service. At present there is no aircraft offering capacity between the five-seat air taxi and the 36-seat F-27.

The role of the air taxi is liable to decrease in relative importance in the 1990s, as more road connections are made to the remoter communities. The long distances, however, indicate there always will be substantial demands for this type of service.

Existing Airports and Improvements Proposed by AASANA

Bolivia has over 600 airfields and landing strips throughout the country, ranging from earth strips subject to frequent closure in the rainy season, to the international airports of LaPaz, Cochabamba and Santa Cruz. Six airports have paved runways (the three international airports plus Tarija, Sucre and Trinidad), and of these two are fully equipped for instrument landings (La Paz and Santa Cruz). The present status of the country's most important airports is shown in Table 14-1.

Thirty three of the airports are administered by AASANA (3) through managers of four districts, which are based on the major traffic generating cities of La Paz, Cochabamba, Santa Cruz and Trinidad. The locations of those airports are shown in Figure 14-4. The airports are classified by AASANA by the aircraft most likely to use them -- allowable aircraft types and present runway characteristics are indicated for each airport in Table 14-1.

The need for a National Airport Plan to direct and phase the future development of the airport system is self evident AASANA has proposed such a plan which envisages four levels of commercial airports, defined as follows:

- First Level - Airports with paved runways capable of accommodating at least a Boeing 727-200.
- Second Level - Airports with gravel runways capable of accommodating a Boeing 727-100.
- Third Level - Airports with gravel runways capable of accommodating a Douglas DC 6B or a Hercules C130.
- Fourth Level - Airports with gravel runways capable of accommodating an F27, and a Hercules C130 for special operations with load restrictions.

Table 14-2 shows how AASANA proposed (4) to classify the thirty-three airports under its jurisdiction. Nine level-one airports are proposed which include the existing paved airports plus Cobija, Puerto Suárez and Riberalta. Four level-two airports are proposed at San Borja, Yacuiba, San Ignacio de Velasco and Guayaramerín. These thirteen airports would be the centers for future LAB jet operations. Santa Ana, Potosí and Oruro would make up level three and all other airfields would comprise level four.

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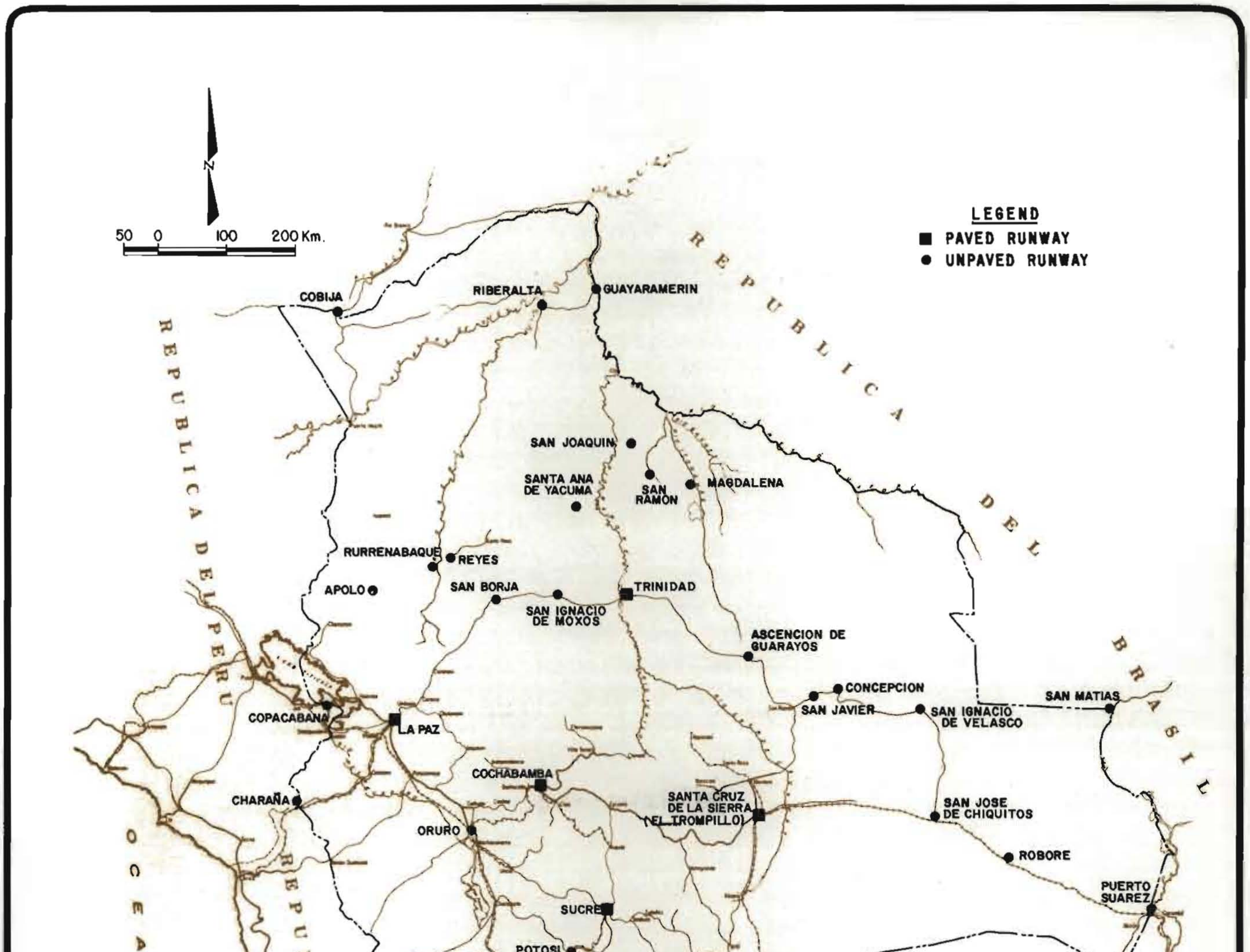
(3) National Airport Administration (Administración de Aeropuertos y Servicios Auxiliares a la Navegación Aérea).
(4) at December 1980



AASANA AIRPORTS

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FIGURE 14–4

Table 14-1

EXISTING CONDITIONS OF MAJOR AIRPORTS

CODE	NAME	1976 POPULATION	NO. OF RUNWAY	MAGNETIC ORIENTATION	GEOGRAPHICAL COORDINATES LATITUDE	LONGITUDE	LENGTH AND WIDTH OF RUNWAY (MTS.)	ALTITUDE	PHSYSICAL CHARACTERISTICS OF LANDING STRIP	AIRCRAFT USE
SLAP	Apolo	1,025	16-34	345/165	14°43' S	63°43' W	1,400 x 30	1,418 IGM	Clay, sand & lime	Hercules- DC3 - C46
SLAS	Ascensión de Guarayos	3,576	16-34	345/165	15°56' S	63°08' W	1,400 x 30	243	Sand covered with grass	DC3-C46-Arava-F27-Hercules
SLBA	Baures (1)	1,121	16-34	340/160	13°08' S	63°36' W	1,200 x 30	245	Sand covered with grass	DC3-C46-Arava
SLBM	Bermejo (1)	13,022	18-36	360/180	22°52' S	64°20' W	1,200 x 30	450	Sand covered with grass	DC3-C46-Arava-F27
SLCA	Camiri	19,782	15-33	332/152	20°01' S	63°33' W	1,250 x 30	877 (3)	Sand and gravel	DC3-C46-Arava-F27-Hercules
SLCO	Cobija	3,636	15-33	330/150	11°01' S	68°47' W	1,110 x 30	252 (3)	Sand, lime cov. with grass	DC3-C46-Arava-F27-Hercules
SLCB	Cochabamba	205,002	04-22 13-31	217/037 317/137	17°25' S	66°10' W	2,515 x 45 1,500 x 30	2,550 (3)	Flexible Pavement Sand, lime compacted	B707-B727-100-200 DC3-C46-DC6B-DC6C-Hercules
SLCC	Copacabana	2,919	04-22	224/144	16°09' S	69°05' W	900 x 30	3,839 (3)	Sand, lime compacted	Small aircraft
SLCP	Concepción	1,817	15-33	337/157	16°15' S	62°03' W	1,100 x 30	530 (3)	Sand covered with grass	C46-DC3-Arava-F27-C-130
SLGY	Guayaramerín	12,504	16-34	342/162	10°48' S	65°24' W	1,800 x 30	169 (3)	Sand, lime cov. with grass	F27-C46-C130-Arava-Hercules
SLLP	La Paz	654,713	09-27 04-22 09-27	274/094 220/040 270/090	16°30' S	68°11' W	4,000 x 46 2,490 x 30 3,230 x 30	4,057 IGM	Paved rigid Sand, lime compacted Sand, lime compacted	DC10-DC8-B707-B727-200 B727-100 DC3-C46-Convair-Hercules
SLMG	Magdalena	3,318	15-33	336/156	13°20' S	64°07' W	1,400 x 30	141 IGM	Sand,lime cov. with grass	F27-Arava-Hercules-C46
SLOR	Oruro	124,121	09-27 18-36	269/089 359/179	17°57' S	67°07' W	1,800 x 30 2,050 x 30	3,702 (3)	Sand, lime, gravel Sand, lime, gravel	DC3-C46-Hercules
SLPO	Potosí	77,334	05-23	237/057	19°35' S	65°45' W	2,340 x 30	3,935 IGM	Sand, lime, gravel	DC3-C46-F27
SLPS	Puerto Suárez	4,243	18-36	360/180	18°57' S	57°52' W	1,500 x 30	137	Sand, lime cov.with grass	DC3-C46-F27-C130
SLPR	Puerto Rico (1)	250	08-26	263/083	11°06' S	67°33' W	1,050 x 30	130 (3)	Sand, lime cov.with grass	DC3-F27-C46
SLRY	Reyes	3,177	15-33	360/180	14°17' S	67°18' W	1,400 x 30	245 (3)	Sand, lime cov.with grass	DC3-C46-F27-C130-Convair
SLRI	Riberalta	18,032	13-31 17-35	306/121 345/165	11°00' S	66°07' W	1,800 x 30 1,100 x 30	134 (3)	Sand, lime, gravel Sand, lime, gravel	DC3-F27-C46-Convair-Arava DC4-DC6B-C130
SLRB	Roboré	6,790	16-34	340/160	18°20' S	59°45' W	1,200 x 30	277 IGM	Sand, lime cov.with grass	DC3-F27-C46-Arava-Hercules
SLRQ	Rurrenabaque	2,050	18-36	360/180	14°28' S	67°34' W	1,400 x 30	274 (3)	Sand, lime cov.with grass	DC3-F27-C46-Arava-Convair
SLSB	San Borja	4,613	18-36	360/180	14°52' S	66°52' W	1,800 x 30	200 (3)	Sand, lime cov. with grass	DC6B-F27-DC3-Convair-C46-C130
SLSM	San Ignacio de Moxos	2,998	14-32	320/140	14°58' S	65°38' W	1,534 x 30	241 (3)	Sand, lime cov. with grass	DC3-F27-C46
SLSI	San Ignacio de Velasco	4,906	17-35	350/170	16°22' S	65°38' W	1,200 x 30	400 (3)	Sand, lime cov. with grass	DC3-F27-C46-C130
SLJV	San Javier	1,686	18-36	360/180	16°16' S	62°28' W	1,100 x 30	100 (3)	Sand, lime cov. with grass	DC3-F27-C46
SLJO	San Joaquín	1,978	14-32	320/140	13°04' S	64°49' W	1,100 x 30	200 (3)	Sand, lime, gravel	F27-DC3-C46-C130-Hercules
SLJE	San José de Chiquitos	4,091	17-35	350/170	17°49' S	60°48' W	1,200 x 30	299 (3)	Sand, lime, gravel	DC3-C46-F27-Arava
SLSM	San Matías	1,574	18-36	360/180	16°21' S	58°21' W	900 x 30	140	Sand, lime cov.with grass	
SLRM	San Ramón	2,096	16-34	340/160	13°17' S	64°42' W	1,500 x 30	213 (3)	Sand and lime	DC3-C46-F27-Arava
SLSA	Santa Ana de Yacuma	5,465	15-33	330/150	13°46' S	65°27' W	1,600 x 40	220 (3)	Sand, lime cov.with grass	F27-DC6B-C46-C130-DC3
SLSR	Santa Rosa de Yacuma(1)	1,686	18-36	360/180	14°10' S	66°53' W	1,700 x 60	245 (3)	Sand and lime	DC3-C46-Arava-F27-C130
SLCZ	Santa Cruz	256,946	14-32	320/140	17°48' S	63°11' W	2,785 x 40	418 (3)	Flexible pavement	B707-B727-200-100-C130-Hercules
SLSE	Samayhuate (1)	(2)	15-33	330/150	21°53' S	62°49' W	1,100 x 30	250 (3)	Sand and lime	DC3-C46-Arava
SLSN	Sanandita (1)	864	01-19	190/010	21°35' S	63°32' W	1,000 x 50	250 (3)	Sand, lime	DC3-C46-Arava
SLSU	Sucre	62,207	03-21	210/030	19°02' S	65°17' W	2,875 x 30	2,903 (3)	Rigid pavement	B727-200-100-F27-C130-Convair-B737
SLTJ	Tarija	39,087	13-31	330/150	21°32' S	64°45' W	2,700 x 45	1,956 IGM	Flexible pavement	F27-DC3-C130-C46
SLTP	Tipuani (1)	1,117	04-23	230/040	15°32' S	68°05' W	850 x 30	457 (3)	Gravel cov.with grassO.ofS.	DC3-C46-Small aircraft
SLTS	Todos Santos (1)	237	08-26	260/080	16°46' S	65°11' W	1,400 x 30	334 (3)	Sand and grass, Out of S.	DC3-C46-Small aircraft
SLTR	Trinidad	27,583	13-31	310/130	14°45' S	64°46' W	2,600 x 36	155 IGM	Flexible pavement	B727-200-100-F27-C130-DC6B-DC3
SLTZ	Tupiza (1)	10,682	01-19	190/019	21°26' S	65°43' W	2,000 x 50	3,800 (3)	Sand, lime, gravel	DC3-C46-Arava-F27
SLVM	Villamontes	6,629	17-35	350/170	21°15' S	63°27' W	1,770 x 30	440 (3)	Sand, lime cov.with grass	DC3-C46-C130-Small aircraft
SLVZ	Villazón (1)	12,536	04-22	220/040	22°05' S	65°36' W	1,200 x 50	3,800 (3)	Sand, lime, gravel	DC3-Arava
SLYA	Yacuiba	10,791	01-19	190/010	22°05' S	63°42' W	1,800 x 30	450 (3)	Sand, lime cov.with grass	DC3-F27-C46-C130
SLCN	Charaña	461	09-27	270/090	17°35' S	69°27' W	2,000 x 30	4,065 (3)	Gravel	DC3-C46
SLCS	Cerdas (1)	244	11-29	290/110	20°49' S	66°29' W	2,600 x 60	3,800 (3)	Sand, lime, gravel comp.	DC3-C46-Arava

(1) Airports not under AASANA Administration.
(2) Not available.
(3) Altitude not controlled nor verified by AASANA.
(4) IGM (Geographical Military Institute)

Table 14-2

AASANA PROPOSED AIRPORT CLASSIFICATION
(as at December 1980)

FIRST LEVEL	SECOND LEVEL	THIRD LEVEL	FOURTH LEVEL
La Paz	San Borja	Santa Ana de Yacuma	Apolo
Cochabamba	Yacuiba	Oruro	Ascención de Guarayos
Santa Cruz	San Ignacio de Velasco	Potosí	San Ramón
Sucre	Guayaramerín		San Javier
Tarija			San José de Chiquitos
Trinidad			Concepción
Riberalta			Villamontes
Cobija			Rurrenabaque
Puerto Suárez			Reyes
			San Matías
			San Joaquín
			San Ignacio de Moxos
			Magdalena
			Charaña
			Copacabana
			Camiri
			Roboré

NOTE: For airport level definitions, see text.

AASANA has proposed an investment plan for the next ten years based on the requirements to upgrade all the airports classified in levels one to three together with improvements to 13 airports of the fourth level. The AASANA proposals are summarized in Table 14-3. The total cost of the AASANA plan would be over $b 10,000 million (1977) which would take up one third of the maximum budget available for transport investments in all modes over the next ten years, excluding additional investments required in new aircraft and the Air Navigation Plan. It was concluded that such levels of investment in air transport could not be justified at the present time and, following the airport evaluations reported later in this chapter, a more modest plan is proposed.

Before discussing the evaluations of individual airport improvements, some comment needs to be made on the status of the projects included in the World Bank Aviation project of 1977. AASANA was to receive funds to assist with:

(i) the design and construction of two new domestic airports (Riberalta and San Borja) and major improvements at two others (Santa Ana and Tarija); Santa Ana would have a sand asphalt sealed runway while the other three would have asphaltic concrete runways;

(ii) the provision of Navigational Aids and Communication equipment at the project airports and a new country-wide "Navaid and Communications" system;

(iii) the provision of general maintenance equipment for AASANA and special runway maintenance equipment for Santa Ana airport;

(iv) the provision of technical assistance and staff training for AASANA; and

(v) the provision of final design for the construction of a new runway, apron and taxiways for Cochabamba Airport (Jorge Wilsterman).

By late 1980, only the paving of the runway at Tarija, the design studies for the new airports and for the improvements at Cochabamba, purchase of maintenance equipment, and part of the technical assistance program had been carried out. With regard to the individual project evaluations themselves, Table 14-4 shows the forecast of traffic volumes and costs made at the time of the World Bank loan, and later revised costs and observed traffic volumes. From these data it is clear that the projects should be re-evaluated.

Table 14-3

AIRPORT INVESTMENT PROJECTS PROPOSED BY AASANA

LOCATION AND LEVEL	PROPOSED IMPROVEMENT	ESTIMATED COST (1) (millions of 1977 pesos)	COMPLETION DATE
FIRST LEVEL (With paved runway for B727-200 and bigger aircraft)			
Santa Cruz Viru Viru	Construction at new location	1,290	1982
Santa Cruz Trompillo	Improvement	25	1981
La Paz	Improvement 1st. phase and studies	590	1985
La Paz	Improvement 2nd. phase and construction at new location	3,050	1989
Cochabamba	Improvement of existing runway	90	
Cochabamba	New runway and Terminal	1,400	1982
Trinidad	Rehabilitation of existing runway	70	1981
Trinidad	New airport at other location	1,430	1986
Tarija	Continue works	180	1981
Sucre	Improvement of existing runway and/or relocation	125	1984
Guayaramerín o Riberalta	Construction	427	1985
Cobija	In construction	260	early 1980s
Puerto Suárez	In construction	250	early 1980s
SECOND LEVEL (With gravel runway 2000 meters long for B727-100)			
Riberalta or Guayaramerín	Construction	70 (2)	1981
San Borja	Construction	216	early 1980s
Yacuiba	Improvement	90	1983
San Ignacio de Velasco	Improvement	160	1987
THIRD LEVEL (With gravel runway 1800 meters long in the lowlands and 3000 meters long in the altiplano for C-130 and DC-6B)			
Santa Ana de Yacuma	Improvement	193 (2)	early 1980s
Oruro	Study of new location	13	1983
Potosí	Improvement	50	1981
FOURTH LEVEL (With gravel runway 1580 meters long in the lowlands and 2300 meters in the altiplano fit for F-27 and special operations of C-180)			
Total sum for 13 small airports	General improvements	300	1989
Roboré	As strategic project	- (3)	- (3)
		10,279	

(1) Costs originally supplied in 1980 pesos -- adjusted to 1977 price levels by dividing by 1.4. Estimates represent costs to completion.
(2) Estimates for gravel runways made in March 1981
(3) No costs or date given.

Table 14-4

WORLD BANK PROJECT AIRPORTS: CURRENT STATUS

AIRPORT	PASSENGER MOVEMENTS					
	Observed		1977		1979	1980 (1)
	1970	1975	Observed (2)	Forecast	Observed	Forecast
Riveralta	7,600	13,600	13,000	17,500	14,000	38,300
Santa Ana de Yacuma	4,400	9,000	3,000	12,000	2,290	18,900
San Borja	1,700	5,100	3,450	6,100	4,000	8,800
Tarija	8,500	18,200	26,562	24,300	32,413	41,500

AIRPORT	PROJECT COST $US (CURRENT)		
	1977 Estimate (3)	1980 Estimate (4)	Cost Difference
Riberalta	6,216,000	23,932,300	17,716,300
San Borja	5,235,000	19,035,300	13,800,300
Santa Ana de Yacuma	4,164,000	20,979,600	16,815,600
Eng. design and supervision	2,006,000	5,953,900	3,947,900
	17,621,000	69,901,100	52,280,100

(1) Include generation and diversion of traffic resulting from project implementation.
(2) LAB passengers only.
(3) World Bank Appraisal 14586-BO.
(4) AASANA estimate 1980.

SOURCE: World Bank Appraisal 14586-BO and AASANA.

Current Status of Air Projects

On its creation in 1980, the Air Ministry inherited a number of projects, either in preparation or actually in construction, as follows (costs shown for completion from January 1981):

Santa Cruz (Viru Viru) *	$b 1,290 million (1977)
Tarija *	180
Riberalta	427
Cobija *	260
Puerto Suárez *	250
San Borja	216
Santa Ana de Yacuma	193
Guayaramerín *	70
Potosí	50
Santa Cruz (El Trompillo) runway repair	25
Trinidad runway repairs *	70
Navigation and Communication Equipment Plan	200
	$b 3,231 million (1977)

* Signifies projects already started by 1981.

In addition, the extension to the runways at Cochabamba ($b 90 million) and La Paz ($b 220 million) are said to be of an emergency nature, and require immediate attention. Plans have also been prepared for a new runway and terminal at Cochabamba costing $b 1,400 million, although this project is not contemplated for immediate construction. Hence, projects in preparation or construction, together with urgent improvements, total about $b 4,800 million. Of this, work has already started on projects worth $b 2,120 million. This represents a much more intensive program of air infrastructure investment than recently (an average of $b 80 million per year for the period 1973-1979). In view of the stringent limits on funds for transport investment (see Chapter 18). These projects were reviewed by the Study to see whether the level and pace of investment could be modified.

Reassessment of Current Air Projects - The Navigation and Communication Equipment Plan is strongly supported by the Study and it is agreed that the works at Tarija and Trinidad should be completed. It is also agreed that the new airport at Santa Cruz (Viru Viru) has been justified for urban planning reasons, beyond the scope of this Study to investigate. Finally, the improvements at Potosí are designed to alleviate conditions at what is currently a poor airport for such a comparatively large (77,000 population) and isolated city, and are accepted by the Study (these improvements are in any case to be financed by local funds).

There is also a strong committment on three of the other airports listed. At Cobija, much work has been completed on a new runway and further work is programmed for this year. However, in order to even out the flow of investments in air infrastructure, the majority of the work to complete this airport has been scheduled for the period 1984-1986 in the Investment Program. The World Bank is committed to part-financing of Riberalta and in order to qualify for these funds, this project should start soon. It has been scheduled to be completed in the period 1984-1986. Work has started at Puerto Suárez with Brazilian funds, and this is scheduled to be completed in the next three years.

The new runway and terminal at Cochabamba has been justified mainly on safety grounds -- the existing runway is badly located with respect to both the surrounding hills and the city. The funds for this project are included in the Investment Program for the last period of the 1980's (85 percent of the project).

There is some doubt about whether the runway repairs at Santa Cruz (El Trompillo) are required and it is recommended that this is re-examined further. If really necessary, funds must be taken from AASANA general funds.

The sums allocated to Tarija are necessary to complete the World Bank project. Further improvements could be allowed in the last period, at the expense of postponing other projects

Work at La Paz is postponed until the last part of the decade. Although there are some restrictions in operations, it is not clear whether additional runway length would solve the problem, due to limits in wheel speeds. It is in any case recommended that a detailed evaluation of the La Paz project is made before committments are made.

The project at Guayaramerín is not considered necessary with committment to Riberalta. Finally, it is recommended that the projects at San Borja and Santa Ana de Yacuma are re-examined. This is discussed in the following sections.

Evaluations of Major Airport Improvements

At the time that the Study conducted the evaluation of airports, the main interest was in improving airports to level-two (gravel runways to accommodate Boeing 727-100 passenger jets). Seven airports were investigated, as follows:

- Riberalta
- Guayaramerín
- San Borja
- Yacuiba
- San Ignacio de Velasco
- Santa Ana de Yacuma
- Concepción

It was concluded that a level-two project as proposed by AASANA (see Table 14-3) could be justified either for Riberalta or Guayaramerín, but nowhere else. Therefore a lower level of design with much reduced construction costs, but still suitable for a Boeing 727-100, was examined for each of these airports. The costs are as follows:

AIRPORT	ORIGINAL AASANA COST	MODIFIED DESIGN COST
	(millions of 1977 pesos)	
Riberalta/Guayaramerin	70	54
San Borja	216	64
Yacuiba	90	17
San Ignacio de Velasco	160	43
Santa Ana de Yacuma	193	64
Concepción	-	43

With these costs, construction at Yacuiba could be justified in 1984, and possibly at San Borja in 1987.

These results are not particularly satisfactory since they indicate that little investment could be justified in airports for the next ten years, apart from what is already committed. This did not seem appropriate in view of the poor state of airports in the remote regions of the country. Therefore, the airports were reassessed to determine what improvements could be made to the existing runway and facilities to allow adequate operations. An airport rehabilitation plan is presented in the next section.

An Airport Rehabilitation and Maintenance Plan

A major change in priorities is recommended for AASANA. Apart from the six existing paved airports, there are twenty seven airfields under the control of AASANA, most of which are in very poor condition, and some of which are dangerous (San Borja for example). LAB have two F28 65-seat jet aircraft on order, due to arrive in mid-1981, with which they plan to replace some of the existing F27 turboprop services. At present, the only airports they can use are the six paved airports, which are already served by Boeing 727 jets.

Based on a recent survey, it is believed that sixteen of these twenty seven airports can be rehabilitated to satisfactory standards for approximately $b 250 million - about the cost of completing Puerto Suárez. $b 81 million pesos is to rehabilitate existing runways at the following six airports to permit F28 operations:

- Guayaramerín
- Camiri
- San Borja
- Santa Ana de Yacuma
- Yacuiba
- San Ignacio de Velasco

A further $b 76 million is required to rehabilitate runways at ten smaller airports for F27 operations as follows:

- Apolo
- Ascensión de Guarayos
- Concepción
- Magdalena
- Reyes
- Roboré
- San Joaquín
- San Matías
- Villamontes
- San José de Chiquitos

Finally, $b 92 million is required to provide small terminals and lighting (mainly for the six F28 airports) at all these airports.

The costs assumed at each airport are shown in Table 14-5 The costs at Reyes and San Joaquín are for the completion of new runways, making use of partly completed, but abandoned, works.

It is emphasized that the costs in Table 14-5 are estimates only, based on conversations with knowledgeable people, and that a more detailed engineering estimate must be prepared for each location. It is accepted also that more detailed analysis may result in a rather different selection of projects, based on the needs of the different communities and of the operators.

Table 14-5

PROPOSED AIRPORT REHABILITATION PLAN

AIRPORT				RUNWAY REHABILITATION				BUILDING AND LIGHTING		
Level	Name	Population	Current Runway Length	Basic	Drainage	Total	With 15% Cont.	Basic	With 15 % Cont.	TOTAL COST
		(thousands)	(m)	(millions of 1977 pesos)						
3 (for F28)	Guayaramerín	12.5	1,800	0.9	3.6	4.5	5.2	8.6	9.9	15.1
(1,800 m)	San Borja	4.6	1,800	18.0	3.6	21.6	24.8	8.6	9.9	34.7
	Santa Ana de Yacuma	5.5	1,600	14.2	3.6	17.8	20.5	8.6	9.9	30.4
	Yacuiba	10.8	1,800	5.8	3.6	9.4	10.8	8.6	9.9	20.7
	San Ignacio de Velasco	4.9	1,200	4.3	3.6	7.9	9.1	8.6	9.9	19.0
	Camiri	19.8	1,250	5.8	3.6	9.4	10.8	8.6	9.9	20.7
	SUBTOTAL			49.0	21.6	70.6	81.2	51.6	59.4	140.6
4 (for F27)	Apolo	1.3	1,400	15.6	2.5	18.1	21.0	2.9	3.3	24.3
(1,600 m)	Ascención de Guarayos	3.6	1,400	4.2	2.5	6.7	7.7	2.9	3.3	11.0
	Concepción	1.8	1,100	0.9	2.5	3.4	3.9	2.9	3.3	7.2
	Magdalena	3.3	1,400	0.4	2.5	2.9	3.3	2.9	3.3	6.6
	Reyes	3.2	1,400	14.2	2.5	16.7	19.2	2.9	3.3	22.5
	Roboré	6.8	1,200	0.6	2.5	3.1	3.6	2.9	3.3	6.9
	San Joaquín	2.0	1,100	2.8	2.5	5.3	6.1	2.9	3.3	9.4
	San José de Chiquitos	4.1	1,200	0.4	2.5	2.9	3.3	2.9	3.3	6.6
	San Matías	1.7	900	1.4	2.5	3.9	4.5	2.9	3.3	7.8
	Villamontes	6.6	1,770	0.4	2.5	2.9	3.3	2.9	3.3	6.6
	SUBTOTAL			40.9	25.0	65.9	75.9	29.0	33.0	108.9
	TOTAL						157.1		92.4	249.5

It is recommended that priority is given to runway improvements in the period 1981-1983, with the highest priority given to the runways for F28s. Work on terminals and lighting, plus remaining runway improvements, can follow in the second investment period 1984-1986.

Technical Feasibility - Probably, the main technical query on this program is whether it is, in fact, feasible to improve airfield runways on the existing alignment. The most doubt concerns the runways at San Borja and Santa Ana de Yacuma and there appears to be a considerable difference of opinion on this matter. AASANA have officially stated that a new runway is required at both locations, basically because of problems with flooding in the wet season. However, in 1980 the AASANA engineering department cooperated in making estimates of improvements to these two runways, which implies acceptance that such improvements are possible. Also, a recent survey indicates that sufficient improvement can be made to allow all-year-round operations.

In defence of the improvements recommended at these two airports, it is said that the runway at San Borja does not get flooded but only become soft in the wet season. The proposal is to place a compacted gravel surface to strengthen the runway, which is expensive as the nearest source of gravel is at Río Yacumo, some 55 km away. At Santa Ana de Yacuma, about 400 meters at each end of the 1,600 m runway can become flooded in the wet season, and therefore the proposal is to raise each end of the runway, and then to place compacted gravel.

Economic Evaluation - No formal evaluation has been undertaken of each project since little reliable data is available on the current operating conditions at each airport. In global terms though, the following calculations can be set out, based on current delays to LAB F27 operations:

Attainable F27 operating hours	1,500 hours per year (1)
Actual operating hours	1,150 hours per year
Loss per aircraft per year	350
Aircraft in LAB fleet	6
Block hour cost	$b 8,540
Loss per year	$b 17.9 million

(1) Based on achievable operations in conditions prevailing in Bolivia.

Almost all this benefit is due to the runway improvements, giving a rate of return of 11.4 percent on this investment ($b 157.1 million). This rate of return could be increased if benefits to other aircraft (TAM, TAB, non-regular, private) were taken into account. A significant part of the total construction cost is associated with terminal buildings, generating quite different benefits which are not quantified here.

Airport Maintenance - Parallel with this upgrading and rehabilitation work, it is recommended that an airport maintenance plan be prepared with urgency. Current maintenance outside the airports with paved runways is almost non-existent, and it is for this reason that many airfields are in poor condition. In fact, the rehabilitation plan outlined above, could rightly be described as a deferred maintenance operation.

The World Bank Aviation Project of 1978 included equipment for maintenance, in two parts:

(i) General equipment for maintaining gravel runways, intended to be rotated around the different AASANA airports. It is said that this equipment is currently being used for light construction work, and that the planned maintenance program using this equipment has not yet been implemented.

(ii) Specialized equipment to maintain the sealed asphalt runway specified for Santa Ana. Although this runway has not been constructed, the maintenance equipment was purchased and is now kept at Trinidad airport.

It is clear that more serious attention must be paid to maintenance requirements than in the past. In the Investment Program the following sums have been allowed for each airport type:

Level one	$b 3.3 million per airport per year
Level two	2.0
Level three	0.8
Level four	0.5

Implementation - In order to prepare the rehabilitation plan and a proper maintenance program, it is strongly recommended that a special survey be undertaken with expert assistance. It is thought that this could be a similar project, but on a smaller scale, to the current World Bank financed Pilot Maintenance Study for highways.

Recommended National Airport Plan

This section brings together the results of the analyses, and present recommendations for each airport.

The Study generally agrees with the four levels of airport proposed by AASANA, presented earlier in this chapter. However, level three should be redefined to include airports for F28 operations (but the desirable runway lengths remain as defined in Table 14-3). Also, projects for level-two airports (gravel runways suitable for Boeing 727-100s) should be postponed until the end of the 1980s.

The allocation of airports to each category recommended by the Study is rather different from that proposed by AASANA and presented earlier in Table 14-2. The Study proposals are summarized below, together with a description of the airport levels:

Level One - With paved runways suitable for Boeing 727-200 or heavier. Apart from the committed project Cobija, Riberalta and Puerto Suárez, there does not seem any good reason to add to the six airports already in this category: La Paz, Cochabamba, Santa Cruz, Trinidad, Sucre and Tarija. Passenger demand is not sufficient to justify including more, and these nine airports (with the committed projects) provide sufficient alternatives to each other .

Level Two - With gravel runways suitable for Boeing 727-100. These airports will serve to extend the main LAB jet services to the remote regions of the country and could eventually include Riberalta or Guayaramerín, Yacuiba and possible San Borja.
These are not considered as priority projects compared with the Airport Rehabilitation Plan. Therefore the four airports just specified should be classed as level three for the immediate future.

Level Three- With gravel runways suitable for F28 passenger jets and Hercules C130 operations. They should include Guayaramerín, Santa Ana de Yacuma, San Borja, San Ignacio de Velasco, Camiri, Yacuiba, Potosí and possibly Oruro.

Level Four - With gravel runways suitable for F27 and for special operations of the Hercules C130 (with limited loads).

The recommendations for each airport are shown in Figure 14-5 and each airport is discussed individually below.

La Paz - A master plan has been prepared for the existing airport at El Alto which includes lengthening the runway 200 meters, extending the terminal and apron, building a taxiway parallel to the main runway and relocating the non-regular operations area. Total costs are estimated at $b 590 million (1977). It is said that these improvements will relieve several operating problems. An economic analysis is required of these improvements to determine economic feasibility and priorities; this applies specially to the parallel taxiway which AASANA claim is required to relieve congestion at peak times.
For investment planning purposes, it is assumed that these improvements can be justified, although national investment restrictions will delay these improvements until late in the 1980s.

The need for a new location for an airport is not apparent and in any case must be preceeded by a detailed study.

Cochabamba - The present runway (04/22) of 2,650 meters has an effective operating length of only 2,000 meters which is insufficient for safe B-727 operation at full load. An extension of 500 meters has been proposed, which necessitates diversion or piping of the Tamborada River. The estimated cost of this project is $b 90 million (1977), including purchase of the necessary land, drainage and lighting. The justification of this project is on grounds of aircraft safety and is supported by the Study.

A much bigger project, said to be justified on grounds of urban safety, is the construction of a new runway (13/31) and terminal at Cochabamba estimated at $b 1,400 million (1977). (5). Funding limits postpone this project until the late 1980s and the size of investment would require funding from outside AASANA. About 85 percent of this project has been included in the investment program for the period 1987-1990.

Santa Cruz - A new international airport is under construction at Viru Viru to replace the existing airport of El Trompillo. An investment of $b 1,430 million (1977) is involved (of which $b 140 million has already been spent) and the new airport will become the focus of international operations in Bolivia. The project has been justified on the grounds of urban environment and safety and, as such, lies outside the scope of this Study. Nonetheless, if, as appears to be the case, AASANA is to be responsible for amortizing the cost of the investment, this airport project may affect the amount of money likely to be available for other projects in the next decade. It is strongly recommended that AASANA should not be responsible for this financial burden. It is noted also that the 1977 World Bank Aviation Project Loan specifically requires that AASANA should not be responsible for financing Viru Viru if this prevents them from complying with the financial covenants of the 1977 loan agreement. It would appear that this condition has been ignored (see Chapter 17).

In addition to Viru Viru, AASANA claims that $b 25 million are necessary to rehabilitate the runway of El Trompillo, which is in the last three years of its useful life before Viru Viru opens. It seems suprising that such extensive repairs are required (overlaying with 4 cm of asphalt) for such a short time, and it is recommended that this be investigated further. If necessary, this work should be funded from the sum included in the Investment Program for AASANA general costs.

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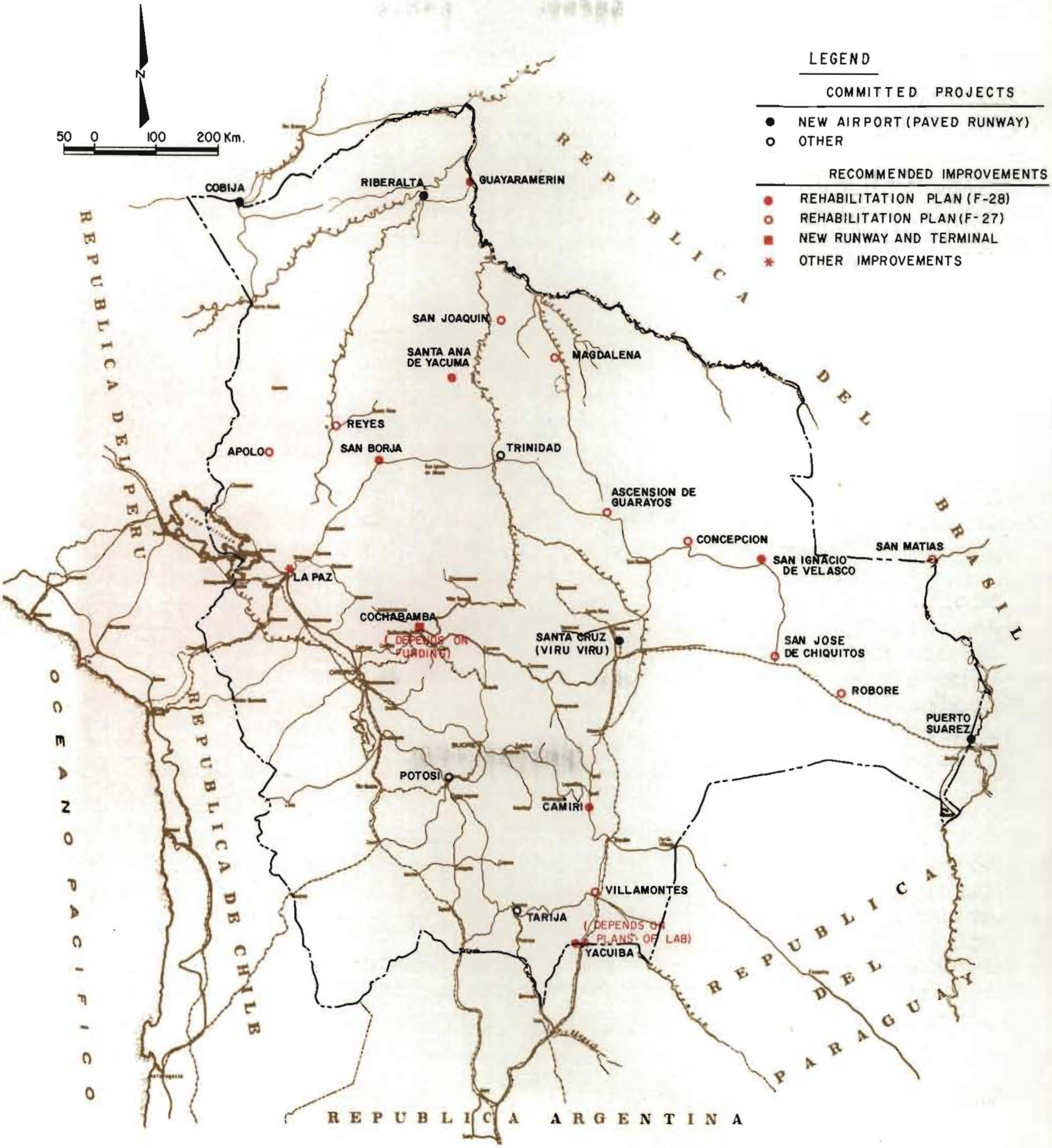
(5) The justification of this project is outside the scope of the Study so it was not evaluated. It has been commented that were LAB to move their maintenance base from Cochabamba (perhaps to Viru Viru), then the new runway would not be required.



RECOMMENDED AIRPORT IMPROVEMENTS TO 1989

Wilbur Smith and Associates

FIGURE 14–5

Trinidad - Work has already started on improvements to the runway at a cost of $b 70 million (1977). These are clearly necessary since the poor state of the runway caused LAB to suspend jet operations on some occasions in 1980.

The AASANA proposal for a new airport to avoid flooding and poor soil conditions at the current site must be preceeded by a study; until then a new airport cannot be supported.

Sucre - This is a new airport completed in 1977 with a concrete paved runway. The suggestion that major new investments are required already, including the possibility of relocating the runway, is incredible. A much better case must be made before even a study would be warranted.

Tarija - It is estimated that $b 50 million are required to finish the World Bank project for this airport and these funds have been taken to be committed. Further investments to extend the runway cannot be justified for commercial operations.

Cobija - $b 90 million have already been spent at Cobija on the base for a new runway. It is accepted that the project should be treated as committed, and completed for the estimated $b 260 million.

Riberalta - A design has been prepared for a new level one airport, costing an estimated $b 427 million and this is taken to be committed.

Guayaramerín - A new runway has been partly completed some 7 km from the present site, but work has now stopped because of the wet season and also because of lack of funds. It is recommended that this work be discontinued and that resources be concentrated in rehabilitating the existing airport for F28 operations for an estimated cost of $b 15 million.

Yacuiba - Improvements are recommended to upgrade to a level-three airport in the period 1981-1983 for F28 operations. Investment costs are estimated to be low at $b 21 million, due to the good layout of the existing airport and the proximity of suitable gravel. It is probable that, for little additional cost, this airport could be upgraded to level-two, suitable for Boeing 727-100 operations, but the need for this would depend on the requirements of LAB.

Santa Ana de Yacuma - Improvements estimated at about $b 30 million are recommended to upgrade to level-three suitable for F28s. The main work would involve raising the level of each end of the runway above flood levels, and placing a compacted gravel surface.

San Borja - Improvements to level-three are recommended on the existing site, costing an estimated $b 35 million. The main expense is associated with bringing gravel from Rio Yacumo for a new gravel surface on the runway.

San Ignacio de Velasco - Improvement to level-three is recommended, at an estimated cost of $b 19 million.

Camiri - Improvement to level three is recommended at an estimated cost of $b 21 million.

Oruro - The existing airport runway is restricted by urban developments at one end and high tension cables at the other. It is unlikely that paving the runway could be justified since major growth is not expected. More detailed studies are required before either improvement or relocation could be justified and such studies are recommended.

Potosí - Work has already started on relevelling the existing runway. Local funds of $b 50 million have been allocated by CORDEPO to complete this work to permit F 28 operations.

Puerto Suárez - A $b 250 million project funded by Brazil has recently started and this is taken to be committed.

Level-Four Airports - Estimates totalling $b 109 million were presented earlier for works at ten level-four airports to improve F27 operations, they are as follows:

- Apolo
- Ascensión de Guarayos
- Concepción
- Magdalena
- Reyes
- Roboré
- San Joaquín
- San José de Chiquitos
- San Matías
- Villamontes

These airports were selected on the basis of the air model passenger estimates (see earlier), population and regional distribution. It is accepted that a more detailed airport plan prepared in accordance with the needs of the communities and the operators, may lead to some changes in airport selection.

Investment Plans - Funds for investment in transport infrastructure are expected to be restricted in the early years of the 1980s, partly because of the economic difficulties of the country and partly because of commitments to many transport projects made in the late 1970s which are now in construction (see earlier). In particular, Viru Viru Airport will require substantial funds for the first three years of the 1980s which must inevitably affect availability of funds for other air projects.

It is recommended that the highest priority be given to the preparation and implementation of an airport rehabilitation and maintenance plan, since this is expected to have the most dramatic impact on airport accessibility and operational reliability.

The investment program is set out in detail in Chapter 18, but the priorities for airport investment are summarized below:

1981-1983	Continue Santa Cruz (Viru Viru) Complete improvements at Potosí Complete Trinidad runway improvements Complete Tarija World Bank project Continue Cobija Construct Pureto Suárez Commence Riberalta Prepare and Commence Airport Rehabilitation Plan
1984-1986	Completion of Santa Cruz (Viru Viru) Completion of Cobija Completion of Riberalta Completion of Airport Rehabilitation Plan
1987-1990	Improvements to La Paz Possible start of new runway and terminal at Cochabamba Possible improvement of Yacuiba to level-two

Analysis of Air Navigation and Communication Equipment Plan

The very poor safety record exhibited by the air sector in Bolivia, while largely attributable to the equipment and maintenance practices of the non-regular and general aviation operators, is also due to the grave lack of air navigation aids throughout the country. This lack also contributes to poor schedule regularity and loss of flying time on the part of the regular sector.

The Bolivian Air Navigation and Communication Equipment Plan was formally adopted by the Ministry of Transport, Communications and Civil Aeronautics in October 1977. Under the terms of the World Bank loan referred to above, funds were provided for the purchase and installation of new communications and navigation aids for Bolivia's principal airports: the Bank's recommendations, supported by ICAO, formed the basis of the Air Navigation Plan, drawn up by AASANA. As yet, however, none of the equipment has been purchased or installed as a result of administrative delays. In the interim, costs have risen substantially and AASANA has offered to be responsible for the installation and maintenance of the navigational aids (NAVAIDS) in order to reduce the cost of the program. A phased plan for installation is urgently required, giving priority to the areas of greatest need, in particular major airports with presently inadequate landing aids.

The conclusions and recommendations of the Study with respect to the Air Navigation and Communication Equipment Plan (summarized in Table 14-6) are as follows:

(i) The plan is adequate overall to achieve its purpose of providing minimum desirable facilities for 38 airports. It is essential that the plan is implemented without further delay. Continual modification to the plan is probably contributing to the delay and it would be better if the plan is implemented as it stands with further modification made afterwards.

(ii) Efforts should be made to reduce costs by using LAB equipment and crew to conduct the proving tests.

(iii) Priorities need to be established. The following are the most critical areas:

(a) At Cochabamba, where the pilots of passenger jets frequently align themselves during runway approach on the city's street lights, new and dependable NDB's (Non-Directional Beacons) are required along with VASIS (Visual Approach Slope Indicator System). It is not recommended that an ILS (Instrument Landing System) be installed due to topography and flight procedure contraints; beacons should be placed upon the surrounding peaks. The navigation plan should be modified accordingly.

Table 14-6

AIR NAVIGATION AND COMMUNICATION EQUIPMENT PLAN: INITIAL EQUIPMENT LOCATION

Airport Lighting (Runway, Taxiway, Apron, Obstruction and Beacon)

Riberalta, San Borja, Tarija and Santa Ana

VOR's (Very High Frequency Omni-Directional Radio Range)

Riberalta, San Borja, Tarija and Roboré, Caranavi

DME's (Distance Measuring Equipment)

Riberalta, San Borja, Tarija and Trinidad, Caranavi

NDB's IKW (Non Directional Radio Beacon) 1 Kilowatt

Trinidad, Cobija, Roboré, Sucre and Yacuiba

NDB's 50 Watts

Riberalta, San Borja, Tarija, Santa Ana, Apolo, Ascensión, Magdalena, San Ignacio de Velasco, San José, San Javier, Guayaramerín

L 50W (Locating Beacon) 50 Watts

La Paz, Guayaramerín, Sucre and Trinidad (2)

VASI (Visual Approach Slope Indicator)

La Paz, Cochabamba (2), Trinidad (2), Santa Cruz (2) and Sucre (2), Riberalta, San Borja, Santa Ana and Tarija

TX HF ISB 1 KW (Transmitter-High Frequency Independent Side Band 1 kilowatt)

Trinidad (4), Cochabamba (2), La Paz (2)

TX HF SSB 150W, 4 Channel (2 at each, total 36) Single Side Band 150 Watt

Cobija, Riberalta, Guayaramerín, Santa Ana, San Joaquín, San Ramón, Magdalena, San Ignacio de Moxos, Sucre, Potosí, Camiri, Yacuiba, Tarija, Apolo, Rurrenabaque, San Borja, Oruro, Charaña

RX HF SSB 4 Channels (4 at each of above, total 72)

RX HF ISB 4 Channels

Cochabamba (4), Trinidad (8)

Tower Equipment (VHF; tape recorders, met., etc)

Riberalta, San Borja, Santa Ana and Tarija

Teletypewriter Equipment

Terminal and Control Equipment
La Paz, Cochabamba, Santa Cruz and Trinidad

Transmitter Group (6 circuits each)
La Paz (3), Cochabamba, Santa Cruz and Trinidad

Receiver Group (6 circuits each)
La Paz (3), Cochabamba, Santa Cruz and Trinidad

Teletypewriters RO
La Paz (18), Cochabamba (6), Santa Cruz (6), and Trinidad (6)

Teletypewriters ASR
La Paz (8), Cochabamba (2), Santa Cruz (2) and Trinidad (2)

Teletypewriters KSR
La Paz (8), Cochabamba (6), Santa Cruz (6) and Trinidad (6)

Portable TD
La Paz (2)

Power Supply
La Paz (5), Cochabamba (2), Santa Cruz (2) and Trinidad (2)

Reperforator
La Paz (18), Cochabamba (6), Santa Cruz (6) and Trinidad (6)

SOURCE: World Bank 1977

(b) Other critical airports are those of Trinidad, Santa Cruz (El Trompillo) and Tarija: these should take priority. The NAVAIDS presently installed at El Trompillo are not operational. Priority should be given to putting this equipment into service, pending the completion of the new facility at Viru Viru. At that time it is proposed to move this ILS installation to the new Viru Viru airport so that both runway approaches will be provided with ILS installations. At present night landing and daylight operations during conditions of low ceilings and heavy rain are difficult except at La Paz. Constraints due to night flights and poor weather seriously affect aircraft utilization and passenger convenience (LAB estimates a loss of $b 7.5 million a year). The NAVAIDS program should facilitate night services and poor weather operations to Cochabamba and Santa Cruz. It is desirable to provide for poor weather operations at Trinidad and Tarija as well. Should financing of the entire package prove difficult, the NDB program should be given priority.

Evaluation of Plans for LAB

As is the case with virtually all airlines in the world, LAB has suffered from the general recession and major rises in wages and fuel prices: the present financial position of the airline is gloomy. LAB's domestic operation must be classified as a low-density, short-haul service in comparison with many other nations. The service between the six major cities of La Paz, Santa Cruz, Cochabamba, Trinidad, Sucre and Tarija is reasonably successful,with load factors averaging over 65 percent.

The same cannot be said of the secondary route services provided by F-27 prop-jet aircraft, many of which operate at a loss, despite an average load factor of 67 percent. The reasons for this are the lack of passenger density in the smaller communities served, the related infrequency of scheduled service by the prop-jet fleet (which serves most of these cities with only two flights per week), and the high cost of operating these aircraft from inadequate airfields. To these must be added the artificially low tariffs which receive further discussion in Chapter 17. There is also the problem of the non-daily schedules of the F-27 which can at times deposit an unexpected group of passengers on already fully-booked flights: this can be alleviated by better ground and air communications allowing for schedule and equipment adjustments when needed.

The plans for LAB's internal service in the future, center around the extension of jet service to local airports currently served by F-27s; namely Yacuiba, Guayaramerín, Riberalta, Santa Ana de Yacuma, San Borja, Camiri and San Ignacio de Velasco, linking in turn with improved feeder services. However, jet aircraft are only cost effective if sufficient volumes exist to achieve a reasonable load factor. The projections of the air model indicate that demand on these routes will reach sufficient levels to justify jet service throughout the 1980s; introduction of such service needs to be phased as demands grows. Two 65 seat F28 jets are reported to be on order for delivery mid-1981, to start these services.

LAB needs to consider within the decade replacement aircraft for its existing jet fleet of Boeing 727s. As international demand grows it may become desirable to invest in larger planes -- perhaps wide-bodied jets -- in order to compete with other international operators. This is unlikely to be necessary before 1985 at the earliest.

A similar problem facing LAB in the more immediate future is the replacement of its present prop-jet fleet of F-27s, which are nearing the end of their life. The airline has an investment of US $ 2.2 million in the fleet and would require at least US $ 14 million for replacement aircraft. While the present F-27s have high operating costs due to high maintenance costs and down-time, the airline will not benefit significantly from aircraft renewal since the savings in operating costs will be offset by the debt service on the new investment. Nonetheless there will be benefits to the users with improved aircraft availability.

The two F28 jets on order are effectively F-27 replacements but whether further aircraft of this type are needed is open to question. It would probably be better to replace the remaining F-27 fleet with a modern turbo-prop such as the DASH-7. Consideration should also be given to a mixed fleet (of, for example, the 50-seat DASH-7 with the 20-seat Twin Otter) to allow for scheduling flexibility and responsiveness to fluctuations in demand. The ability of these aircraft to operate from poor landing strips with minimal maintenance requirements makes them ideal candidates for operation in Bolivia.

Turning to LAB's international services, the picture is grim; the patronage of Miami and Lima services has declined in the early months of 1980, leading to a reduction in the frequency of flights to the United States. LAB has been hampered in developing this traffic by its former lack of membership in IATA (6) and a very limited network of offices throughout the world. International route systems can only

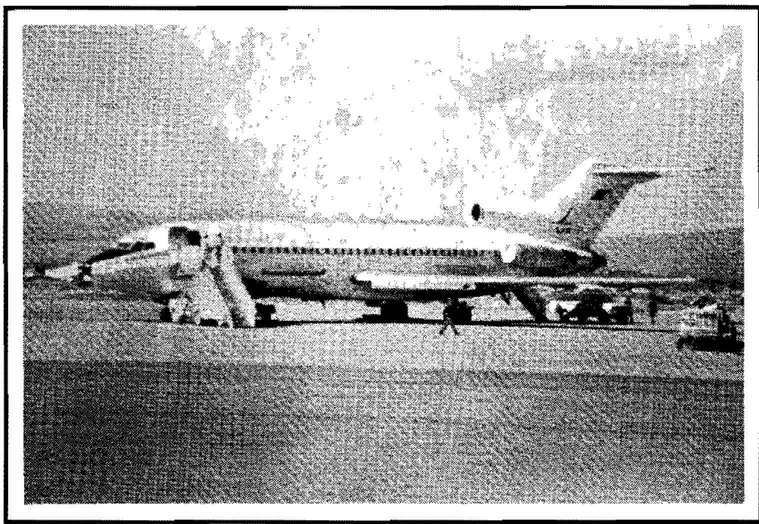
(6) International Air Transport Association.

grow as the result of bilateral agreements; thus attention needs to be given to determining the proper approaches to expansion in this area. However, the present outlook for this industry as a whole is unpromising and it is unlikely that any major expansion of international service can take place in the next five years. Any expansion that does occur needs to be coordinated with a major effort on the part of the tourist industry to stimulate interest in Bolivia. Of present visitors to Bolivia, only a small percentage go beyond La Paz and Santa Cruz to the cities of the interior. Significant growth of tourist traffic also should benefit LAB's international service.

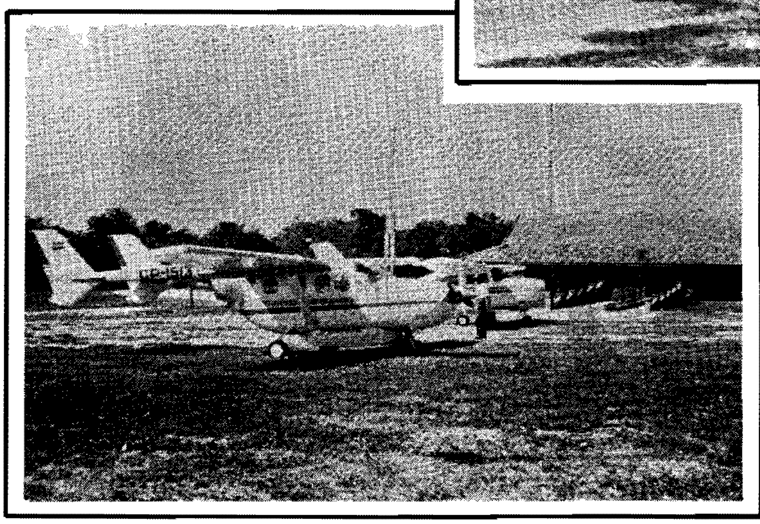
LAB has very recently been admitted as a full member of IATA. Achievement of this step should significantly increase traffic on existing routes and bring other substantial benefits. No major route expansion can be realistically envisaged in the short term, but attention could be given to renegotiating the existing agreements that limit operations (for example, LAB cannot operate direct flights to the USA or elsewhere through Lima). Purchase of aircraft should then be dependent on the prospective growth in international passengers.

The third area of LAB operations that requires comment is the cargo service. While, as will be discussed in Chapter 15, it does not seem desirable for LAB to invest in a B747 aircraft given the uncertainty of international market prospects and the capital costs involved, nonetheless there does seem scope for expansion of freight operation. At present the airline operates one Boeing 707 exclusively for freight. The present low market price of similar aircraft and the undoubted growth in the world market for air freight would seem to indicate that the purchase of a second aircraft and the expansion of this service would be a worthwhile development.

At present, international air freight transport is also provided by the military organization TAB (Bolivian Air Transport) which operates two Hercules freighters. These exist primarily to supply the need of the military installations internally, but are also available for charter. Thus they are competing with LAB freight operations to some degree. However, the two should be able to coexist -- LAB would provide scheduled freight service (which would need to be combined with a vigorous marketing policy) while TAB should restrict its operations to occasional exceptional demands for bulk transport. On no account should TAB, with the majority of its costs underwritten by the government, be permitted to undercut LAB in competition for the same market.


BOEING 727 OF LAB
AT COCHABAMBA


VINTAGE AIRCRAFT OF THE
NON - REGULAR FLEET AT
SAN BORJA


PRIVATE LIGHT AIRCRAFT
AT PUERTO SUAREZ

AIRCRAFT IN SERVICE

The Potential for Air Mass Transit

The large rises in fuel costs experienced in the last decade have led to a revival of interest in the concept of lighter-tahn-air transport, based upon the airship or dirigible. The attraction of these craft lies in their much lower fuel consumption (about 60 percent of that of fixed wing craft, and 50 percent of that of helicopters) and their low requirement for ground facilities (only short runways or no runways at all are needed).

There is potential for their future use in Bolivia in transporting meat and perhaps timber from the more inaccessible areas of the Beni to the markets in La Paz and elsewhere, and also in longer-haul transport to international ports (Buenos Aires, Manaus, Caracas, Santos). However, the state-of-the-art regarding dirigibles is not far advanced. The developments that have received most attention and are being applied commercially are for the most part substitutes for helicopters or tethered balloons, with some short-haul transport application. Dirigibles are being used at present in logging, observation, off-shore oil-rig operations, bridge building and similar tasks where awkward heavy cargoes are involved. There at present seems considerable doubt over the commercial prospects of the airship for long-haul freight usage. The main problem is that, because of their slow speeds, the airships are likely to be only about half as productive as large freight aircraft, on an annyal basis. As a result, the cost of capital plays a very important part in overall operating costs, and it has been estimated by the World Bank that the airship is truly competitive only at distances of over 6,500 km.

Only one company is actually making a commercial long-haul freight dirigible at present. A contract has recently been signed to supply a British freight operator with four craft at a cost of US $ 9.5 million each. It is claimed that the craft, which cruise at 138 km/hour, have operating costs slightly less than those of a Boeing 747 while offering 56 percent greater volume but a considerably reduced payload (58 tons). It remains to be seen whether or not such claims can be realized in practice.

The conslusion of the Study regarding the use of lighter than air transport in Bolivia is that the potential certainly exists for use in the Beni for both short and long haul services. The road network in the region is likely to remain sparse for the next twenty years and the airship offers a direct route with low variable operating costs. However, the feasibility of the entire project depends upon the craft being available at an economic cost. It is therefore recommended that a detailed study be undertaken in about five years

(1985), when the situation regarding rhese craft should be much clearer. With the current lack of construction, maintenance and operational data, it is too early to draw firm conclusions and make specific recommendations.

Conclusions and Recommendations on the Air Sector

The air sector in Bolivia has played, and will continue over the next twenty years to play, a very important role in the development of the nation. After a period of neglect, successive Governments have recognized the importance of the sector and aided its growth through fiscal policies. However, the sector as a whole is at a critical point at the present time; both passenger services and freight transport are suffering from unnecessarily high operating costs resulting from inadequate infrastructure and equipment. The growth in general avaition has raised a new problem of adequate control of safety and regulation of air taxi operation. The quality of service offered to passengers in other than main cities is not good with frequent delays and cancellations through bad weather or unserviceable runways. The accident record of the sector as a whole is poor.

Financially the main passenger carrier LAB is currently running at a loss, and the non-regular freight sector made up of 25 operators is unable to finance its fleet replacement. The institution responsible for the infrastructure of the airport system, AASANA is in a similar position.

In order to remedy the deficiencies of the existing situation and provide a firm basis for the development of the sector over the next two decades, the recommendations of the Study are as follows:

(i) The highest priority should be given to an airport rehabilitation and maintenance plan, which should probably be prepared with expert technical assistance. This could vastly improve operating conditions at about sixteen secondary airports.

(ii) The Air Navigation and Communication Equipment Plan should be implemented as soon as possible. Priority should be given to major airports and to the installation of NDB's (Non Directional Beacon).

(iii) Better regulation of aircraft and safety standards is required in the non-regular sector. To a large extent, this is a long term problem since proper inspection and training procedures must follow improvement in training facilities for inspectors as well as mechanics. The recently created Air Ministry regards this as a priority and this is strongly supported by the Study.

(iv) The structure and organization of the non-regular air sector would be helped by stricter licensing and revision to the tariff and fuel subsidy. In the long run, though, the future of this part of the air sector is likely to be undermined by the development of the road system in the Beni.

(v) Greater control needs to be exercised over the licensing of airplanes and pilots providing air-taxi service.

(vi) Apart from the F28 passenger jets on order, LAB should consider replacing its F-27 fleet with aircraft of mixed size (Twin Otter/DASH-7). An expansion of scheduled freight operations should be pursued.

(vii) Regarding lighter-than-air transport, further study is required in the mid-1980s to determine whether this mode can fulfill its potential role as a short and long haul transport carrier in Bolivia.

CHAPTER 15

IMPROVEMENT TO INTERNATIONAL TRANSPORT LINKS

CHAPTER 15

IMPROVEMENT TO INTERNATIONAL TRANSPORT LINKS

Bolivia, as a landlocked country with a limited domestic market, of necessity places great importance on her links to the outside world. In this chapter, the nature of these links is described, and a number of projects, designed to lower the costs of reaching the world market, are evaluated.

In order to carry out a reasonable analysis of the individual projects, it was necessary to investigate the likely development of Bolivia's foreign trade over the next 20 years, and the probable use of the transport links. The basic procedure that was followed is summarized below.

Transport Analysis of Foreign Trade

For the purpose of determining future trade developments, Bolivia was divided into 16 internal districts, and the rest of the world into 15 external zones. Major trading partners of Bolivia were allocated a zone each; other, less important countries were amalgamated for the purpose of the analysis. Then, on the basis of historical experience, combined with knowledge of likely development projects in the internal districts, trade movements between Bolivia and the rest of the world were projected for each of 10 commodity groups. These projections were reconciled with the overall forecasts of consumption and production for the internal zones, as described in Chapter 7. Particular account was taken of national intentions and various international agreements such as those of the Andean Pact. The resulting foreign trade pattern is shown in Table 15-1. Overall, the total of imports and exports is expected to more than double by 1989 and to more than triple by 1999.

The next step was to allocate these generalized flows to particular modes and corridors. Once again, historical experience was the deciding factor in the distribution: detailed knowledge of foreign trade movements was obtained for 1977 from ENFE and INE data tapes and from the results of the roadside interview survey. A similar pattern was assumed to apply to the flows projected for 1989 and 1999, except where significant changes in the infrastructure had been assumed. Thus in the case of the 1989 Test Network which includes the rail interconnection between Cochabamba and Santa Cruz (not recommended by the Study in the 1980s), the distribution of flows is assumed to change significantly, as imports to and exports from the Santa Cruz region will switch from the Atlantic ports to the nearer Pacific ones. In all cases, flows were assumed to follow the minimum cost route, unless extraneous factors of capacity or policy overrode this criterion.

Table 15-1

EXISTING AND PREDICTED FOREIGN TRADE PATTERN

FOREIGN PLACE	TONS TO AND FROM BOLIVIA: Imports 1977	Imports 1989	Imports 1999	Exports (1) 1977	Exports (1) 1989	Exports (1) 1999
Argentina	157,384	168,011	190,212	59,943	924,207	1,098,220
Brazil	124,825	186,468	214,902	20,111	136,489	147,412
Paraguay	1,202	2,626	3,688	255	13,382	24,758
Uruguay	8,447	8,966	1,847	10,192	24,966	12,446
Chile	75,171	40,454	80,429	29,285	60,128	112,007
Peru	15,426	37,355	68,595	1,625	84,321	232,312
Colombia-Ecuador	2,419	15,496	28,708	1,032	59,217	166,401
Venezuela	22,838	32,593	174,219	1,922	54,534	154,938
Central Am.-Mexico	2,581	3,825	4,541	1,930	7,565	25,021
USA-Canada	138,960	165,662	147,912	251,702	257,114	535,876
Europe	85,672	97,906	99,994	102,367	245,806	382,682
Africa-Middle East	2,180	2,046	1,464	5,058	26,343	93,417
Japan	47,026	53,052	58,285	32,846	38,659	30,853
Asia	5,049	5,676	10,549	960	2,693	11,396
Australia	81	89	189	10	-	-
Total	689,261	820,225	1,085,534	519,238	1,935,424	3,027,739

(1) Table excludes gas and crude oil tonnage

The results of the distribution for surface modes are shown in Tables 15-2 and 15-3 for the years 1989 and 1999, assuming in each case that the rail interconnection does not exist; the impact of the rail interconnection can be seen in equivalent tables in Appendix 9B. The use of the various modes and the changes expected to take place in the distribution between them have been discussed in Chapter 9.

Connections between Bolivia and Ocean Ports

Apart from air transport, ports on the Atlantic and the Pacific Oceans are used for Bolivia's foreign trade with nations outside South America. In the base year, significant volumes of cargo moved through the following six ports: Santos in Brazil, Rosario and Buenos Aires in Argentina, Arica and Antofagasta in Chile, and Matarani in Peru. In 1977 over 65 percent of Bolivia's exports passed through the Pacific ports, and 55 percent of imports (by weight). Of the Pacific ports, Matarani handled 22 percent of exports (mainly minerals) and 14 percent of imports. The Chilean ports handled the remaining cargo, with Antofagasta being the most important with 25 percent of imports and over 36 percent of exports. Ilo at present handles little or no Bolivian cargo.

The point of interest in this chapter, however, is not the ports themselves, but Bolivia's connections to them. These are shown in Figure 15-1 and Table 15-4 indicates the distances of the existing links from major cities within Bolivia to the important ports, by rail and road. At present the great bulk of cargo moves by rail, partly for the reason that no good road alternatives exist and partly due to the definite advantages rail offers on such long hauls. The existing links to each of the ports can be briefly described as follows:

Santos - Since there is at present only very poor road access from Santa Cruz to the Brazilian border, most Bolivian traffic to and from Santos and other Brazilian cities uses the railroad. There exists the potential for the operation of "piggy-back" services between Santa Cruz and Corumbá since road connections in Brazil are mostly good, but at present this is not being done (see later in this Chapter). The northern towns of Cobija, Guayaramerín and Riberalta are directly connected to the Brazillian road system, and there are some imports by truck from Sao Paulo and Santos.

Rosario and Buenos Aires - Road transport takes place all the way from Bermejo and Tarija to these ports but is relatively costly. There are good rail connections through Villazón and Yacuiba, making rail the preferred mode of transport to and from the Argentinian ports.

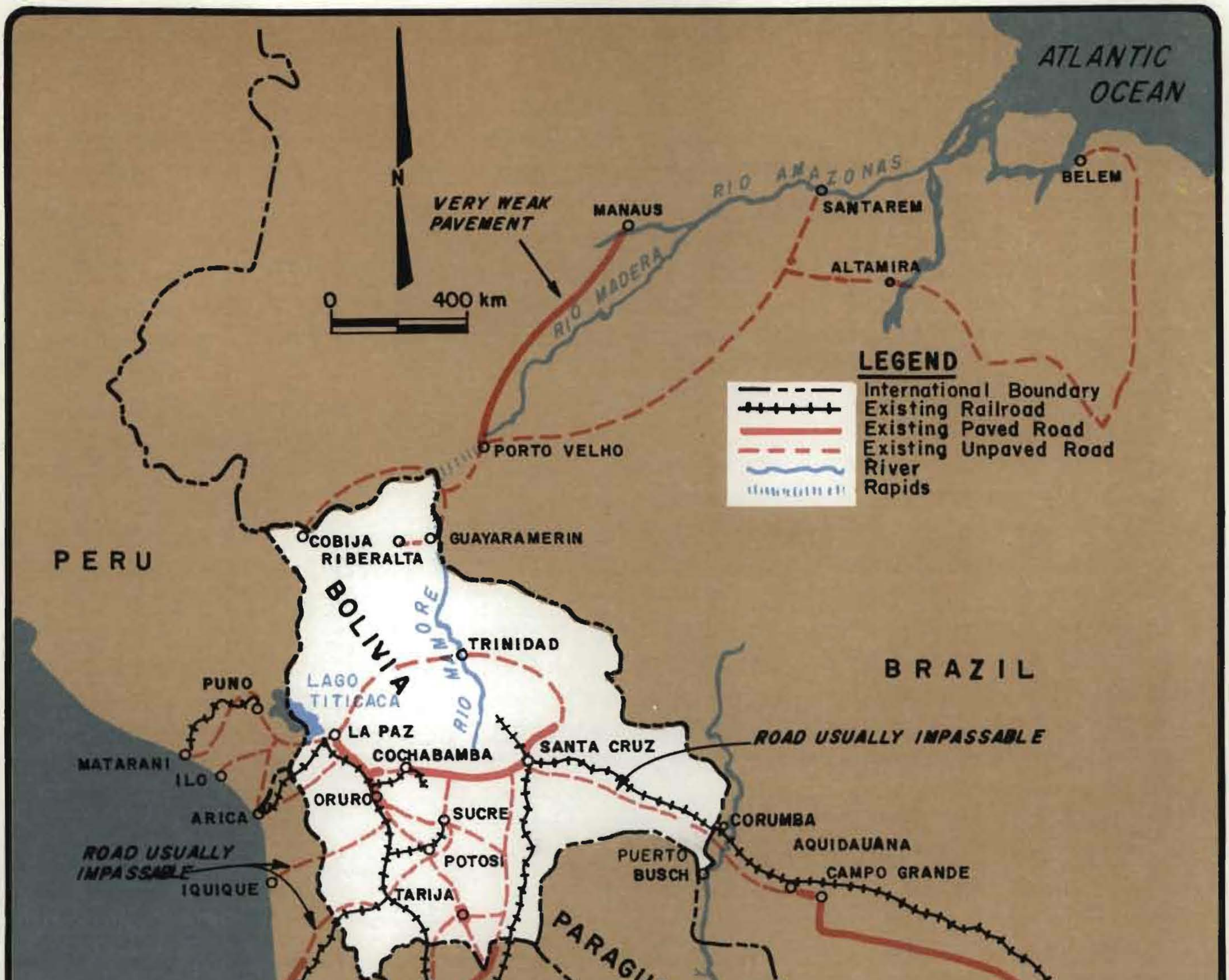
Table 15-2

BOLIVIA'S FOREIGN TRADE FLOWS 1989 BY MODE AND ENTRY/EXIT POINT

(Without rail interconnection in 1,000 tons)

PLACE OF ENTRY/ EXIT AND MODE	AGRICULTURAL	MINERALS	HYDROCARBONS	FOOD	TEXTILES	WOOD & PAPER	CHEMICALS	BUILDING SUPPLIES	METALS	VEHICLES AND MANUFACTURES	TOTAL(1)
Guayaramerín/ Cobija - Truck	64.9	-	-	0.5	-	3.3	-	-	-	3.8	72.5
Avaroa - Rail	81.2	102.0	19.7	49.5	6.2	10.6	27.2	9.4	17.5	36.1	359.4
Charaña - Rail	18.6	11.8	7.0	16.7	7.3	6.6	7.8	1.6	12.4	17.6	107.4
Tambo Quemado - Truck	49.5	10.9	5.4	21.5	7.9	4.0	10.5	1.1	11.6	6.5	128.9
Quijarro - Rail	66.5	7.8	0.3	42.0	9.6	102.2	10.7	68.4	62.7	104.5	474.7
- Water									746.5		746.5
Yacuiba - Rail	74.0	1.7	0.3	54.0	2.0	29.6	4.8	8.0	20.5	10.9	205.8
Yacuiba - Truck	22.2	0.1	-	4.3	0.3	20.0	0.3	0.1	2.7	0.8	50.8
Guaqui - Water	28.4	9.5	-	5.3	0.8	0.1	19.1	6.4	25.6	17.0	112.2
Bermejo - Truck	2.3	-	-	96.2	-	-	6.9	6.0	0.2	2.1	113.7
Villazón - Rail	59.0	20.1	1.2	22.1	0.8	2.9	1.9	20.5	12.8	5.2	146.5
Villazón - Truck	3.0	-	-	4.9	-	0.2	1.0	-	1.0	0.3	10.4
Desaguadero - Truck	65.1	6.7	-	25.3	2.9	1.1	6.0	2.7	12.6	10.2	132.6
Kasani - Truck	-	-	-	5.1	-	-	2.1	-	1.1	-	8.3
P.Acosta - Truck	-	-	-	4.9	-	-	-	-	1.1	-	6.0
Chaguaya-Water	-	22.2	-	-	-	-	-	-	-	-	22.2
TOTAL	534.7	192.8	33.9	352.3	37.8	180.6	98.3	124.2	928.3	215.0	2,697.9

(1) Excludes gas, crude oil, refined hydrocarbons by pipeline and air movements.



EXISTING CONNECTIONS WITH OCEAN PORTS

Table 15-3

BOLIVIA'S FOREIGN TRADE FLOWS 1999 BY MODE AND ENTRY/EXIT POINT

(Without rail interconnection in 1,000 tons)

PLACE OF ENTRY/ EXIT AND MODE	AGRICULTURAL	MINERALS	HYDROCARBONS	FOOD	TEXTILES	WOOD & PAPER	CHEMICALS	BUILDING SUPPLIES	METALS	VEHICLES AND MANUFACTURES	TOTAL (1)
Guayaramerín/ Cobija-Truck	48.1	-	-	5.5	0.5	9.3	1.7	0.3	8.0	28.2	101.6
Avaroa-Rail	139.9	226.2	2.2	119.3	0.7	8.1	19.8	2.0	77.6	73.0	668.8
Charaña-Rail	85.5	19.2	12.8	24.3	6.7	14.7	9.0	1.9	45.1	33.4	252.6
T.Quemado-Truck	60.4	17.5	19.3	41.4	8.5	2.2	12.8	8.7	10.4	32.7	213.9
Quijarro-Rail	244.9	8.6	2.4	91.1	41.0	113.3	13.4	48.2	64.8	100.3	728.0
-Water	-	-	-	-	-	-	-	-	727.9	-	727.9
Yacuiba-Rail	135.3	4.6	1.7	35.8	-	30.9	2.1	7.4	21.8	10.5	250.1
Yacuiba-Truck	50.2	0.4	0.1	2.9	-	1.1	0.4	0.2	-	3.7	59.0
Guaqui-Water	26.4	46.3	-	15.8	7.9	3.0	10.8	4.8	39.4	84.7	239.1
Bermejo-Truck	65.6	-	-	76.1	-	0.6	9.6	18.9	0.2	5.2	176.2
Villazón-Rail	56.9	17.5	8.7	33.9	0.1	5.4	1.9	2.2	14.9	19.6	161.1
Villazón-Truck	42.7	1.2	0.6	9.1	-	0.4	0.5	0.1	1.2	3.5	59.3
Desaguadero-Truck	65.7	18.0	-	66.5	1.4	3.5	22.2	4.0	17.4	57.5	256.2
Kasani-Truck	1.1	-	-	12.3	-	-	3.6	-	-	-	17.0
P.Acosta-Truck	1.1	-	-	12.2	-	-	-	-	-	-	13.3
Chaguaya-Water	-	30.0	-	-	-	-	-	-	-	-	30.0
TOTAL	1,023.8	389.5	47.8	546.2	66.8	192.5	107.8	98.7	1,028.7	452.3	3.954.1

(1) Exludes gas, crude oil, refined hydrocarbons by pipeline, and air movements.

Table 15-4

DISTANCES TO MAJOR PORTS BY ROAD AND RAIL

PORT	TOTAL DISTANCES IN KM FROM															
	LA PAZ		ORURO		COCHABAMBA		POTOSI		SUCRE		TARIJA		SANTA CRUZ		TRINIDAD	
	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Road
Matarani	814	737	977	936	1,188	1,079	1,360	1,264	1,535	1,306	-	1,638	-	1,594	-	1,342
Ilo	-	593	-	792	-	953	-	1,120	-	1,162	-	1,495	-	1,450	-	1,198
Arica	457	581	621	598	832	759	1,004	926	1,179	968	-	1,301	-	1,256	-	1,212
Antofagasta (1)	1,183	1,214	933	989	1,144	1,202	898	874	1,073	1,044	-	1,249	-	1,699	-	1,845
Rosario	2,342	2,612	2,096	2,387	2,307	2,600	2,061	2,059	2,236	2,229	-	1,794	2,137	2,839	-	3,243
Buenos Aires	2,648	2,920	2,402	2,695	2,613	2,908	2,367	2,367	2,542	2,537	-	2,102	2,443	3,147	-	3,551
Santos (1)	-	3,228	-	3,063	-	2,850	-	3,110	-	2,958	-	3,059	2,476	2,352	-	2,791

(1) Road access is very poor, and in some seasons, non-existant. Very little road traffic uses these routes.

Antofagasta - Access is almost impossible by road and only about 260 km of the 1,214 km from La Paz are paved. Good service is provided by the Antofagasta Railway which carries nearly all the cargo moving through this port.

Arica - Access is possible by both road and rail, although only 160 km of the 581 km road from La Paz are paved. The railroad service is poor, due to the poor state of the track on both sides of the border, and also to lack of equipment in the Chilean sector. The Chilean railroad restricts movements of Bolivian imports to only 7,000 tons per month.

Matarani - Again both road and rail connections exist with this Peruvian port. Rail access at present involves a shipping link on Lake Titicaca between Guaqui and Puno, where cargo transfers to the Peruvian railroads. These are unable to meet existing demand at present for lack of traction and rolling stock. Road access is poor, involving a journey of 737 km over roads which are, for the most part, in extremely poor condition. The road access is further complicated by the large number of checks and controls existing on this route, and restrictions on night travel.

Ilo - Only road access exists to this little used port, but roads are in poor condition and are subject to interruption in the rainy season. However, the route Ilo-La Paz is much shorter than that from Matarani.

There thus exists considerable potential for improving Bolivia's access to the ocean ports. The individual projects for improvement are now considered individually.

Use Of The Paraguay River

The Paraguay River, which touches the Bolivian frontier in the southeastern corner of the country at Puerto Busch, is a potentially important international route for goods transport. Figure 15-2 shows existing and possible land connections with the river, and with the nearby iron ore mine of Mutún.

The Paraguay River offers the possibility of river transport to Rosario, Buenos Aires or the Uruguayan deep-water port of Nueva Palmira, for transshipment to ocean-going vessels, or to the steel works at San Nicolás in Argentina. For traffic originating in the east of Santa Cruz department, this route would be considerably cheaper than the alternatives by road or rail. At present, the volume of Bolivian traffic using the river is small, consisting of about 50,000 tons of Mutún iron ore per year, small quantities of timber for export, and some limited import flows transferring to the railroad at Ladario.

The prospect of large exports of iron and manganese from Mutún, and also of frozen meat and agricultural products from future developments in the Tucavaca valley and eastern Chiquitos Province, opens up the need for more efficient transport facilities on the Paraguay River. At present the output from Mutún is small, and the large area of agricultural potential north of the railroad line is almost completely uninhabited and inaccessible, but estimates of future annual exports from the region are in excess of one million tons of either processed iron pellets or unprocessed iron ore, as well as large quantities of agricultural produce including meat. Certainly the production potential is there, given the necessary labor and infrastructure, but markets must be found, and they can only be abroad. An inexpensive and efficient transportation corridor down the Paraguay River is important and probably essential to the development of the whole area, for both iron and agriculture.

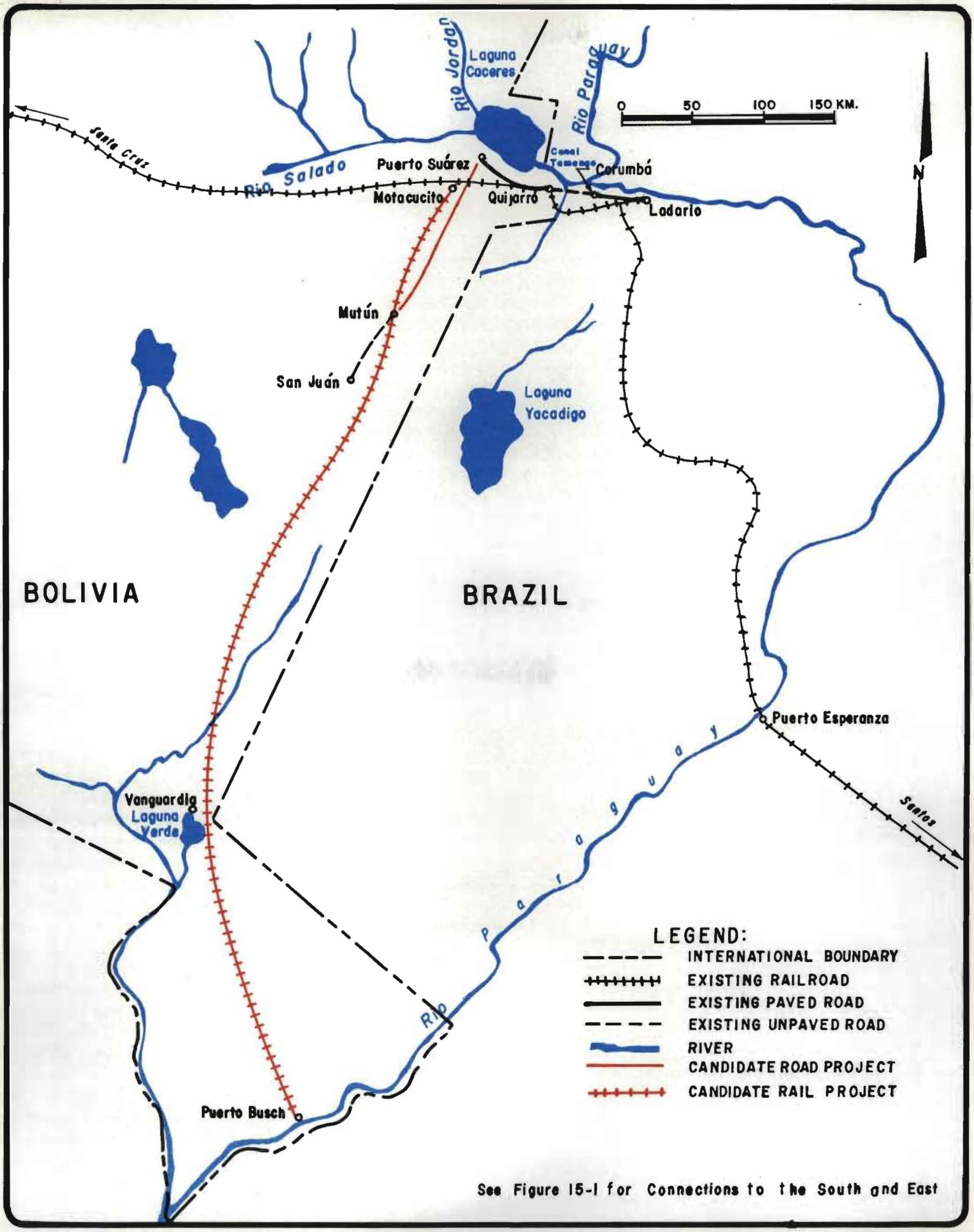
The Paraguay River is already navigated to Corumbá by barge trains with capacities of up to 9,000 tons during high water. In places dredging is desirable, with most of the recorded locations with low water (48 out of 51) located in the 900 km section down-stream of Puerto Busch. The cost of dredging these 900 km has been estimated at $b 860 million; however, since the river is navigated by sizeable boats at present, the need to dredge is not seen as a high priority for the limited volumes envisaged in the immediate future.

There are three ports currently available for Bolivia, but all are located in Brazil: Corumbá, Ladario and Puerto Esperanza. Puerto Suárez, located in the Cáceres Lagoon in Bolivian territory, is no longer usable due to lack of water. A simple landing facility exists at Puerto Busch which can be used to assist in loading and unloading minerals, but there is no land access in times of high water. Of the Brazilian ports, Ladario is the most attractive with rail access, modern loading facilities and ample room for expansion.

A New River Port in Eastern Bolivia - It has long been an aim of Bolivia to construct a new port for the Paraguay River within Bolivian territory. There are two obvious locations to choose from; Puerto Busch and Quijarro. At once, three major issues can be identified, all of which should influence the final choice:

(i) Technical - Can a port be built successfully at each location? The problem at Puerto Busch is possible flooding and the problem at Quijarro is the converse -- possible lack of water in some dry seasons.

(ii) Economic - Assuming a port can be built at either location, what are the comparative costs? Access to the ports by land must be taken into account and consideration must be given to both the initial capital costs, and the operating costs thereafter.



CONNECTIONS WITH THE PARAGUAY RIVER

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FIGURE 15–2

(iii) Political - This concerns the interpretation of, and compliance with, agreements, statements and principles covering the use and regulation of international rivers (rivers passing through several countries). This matter could be complex in the case of Quijarro.

The following summarizes the features of a new port at each location:

Puerto Busch - The side lies 245 km downriver from Quijarro, but it also lies 107 km from the source of iron ore at Mutún and 133 km from Motacucito, the point on the existing rail line from Santa Cruz to Corumbá from which all general cargo would have to be transported. In times of high water, this region is flooded to a depth of 2 to 3 meters, and flood waters can extend as far north as the region of Mutún (San Juán).

Land would have to be reclaimed for a port site, and a road or railroad would have to be constructed from Mutún on a high embankment. A road, being much wider than a single-track railroad, would be more costly to build and also imply much higher operating costs that would be possible with unit trains for iron ore. In view of the high road costs involved, the evaluation of a port site at Puerto Busch assumed the connection to be by rail.

Quijarro - In order to locate a port at Quijarro, dredging is needed along the Tamengo Channel which joins it to the Paraguay River. A rail connection from Mutún to Motacucito (26 km) would also probably be required. An alternative possibility would be a conveyor system, but this would cost about $b 500 million to install for the 44 km between Mutún and Quijarro, and would not be economically feasible at the volumes contemplated. (A conveyor system would not be suitable for Puerto Busch, because of the need to carry general cargo along this link). A rail connection would also serve to carry minerals from Mutún to Santa Cruz for domestic consumption. No special facility would be needed for general cargo.

A disadvantage of Quijarro is that traffic would have to travel through Brazilian territory for most of the 245 km to Puerto Busch. Also, navigation in this stretch of the river is impeded by the narrow spans of the rail bridge at Puerto Experanza, which makes it necessary for barge trains to break apart and reassemble, an operation which is said to last four hours (although a maximum of 24 hours has also been quoted). There is also the structure of an overhead water supply at the entrance to the Temengo Channel, but this does not seem to be a major obstacle to navigation. Quijarro, being further upstream than Puerto Busch, and therefore with a greater river distance, would require a larger river fleet, although this disadvantage is off-set by the additional rail equipment requirements for Puerto Busch. A disadvantage of Quijarro is the risk of lack of water in the Tamengo Channel in periods of low water, but whether this would be the case after dredging is uncertain.

Conclusions on a Paraguay River Port - Given the severe restrictions on investment in transport infrastructure (see Chapter 18), construction of a new port on the Paraguay River probably could not be contemplated for the volumes of Bolivian traffic currently using the river. Although there is a great potential for agricultural exports from eastern Santa Cruz Department, they are unlikely to increase greatly over the next few years, and can continue to use the Brazilian ports of Corumbá and Ladario. The development which would make a Bolivian port both feasible and desirable would be large scale exports of iron ore, or iron ore products, fron Mutún. It is therefore recommended that the selection and financing of a port with the necessary land connnections should be considered as part of a comprehensive Mutún project.

It would be premature for the Study to make a judgment on the technical, economic and political issues outlined above, but the Study recommends that the following principles are followed:

(i) That a new ~~river~~ port in Bolivian territory should be built only if it is needed for a major export project based on the iron ore resources at Mutún (although it could then be used for general foreign trade);

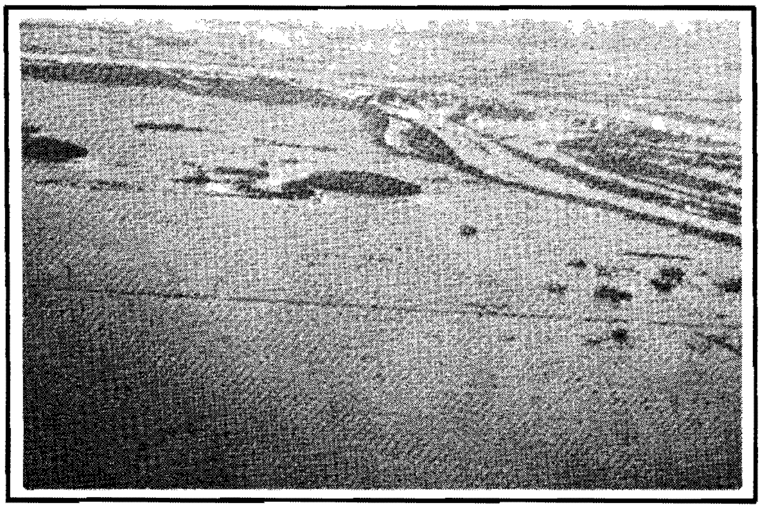
(ii) That financing for a port and the necessary land connections should be considered as an integral part of a Mutún export project;

(iii) That the port location be selected based on the needs of a Mutún export project, taking into account the risks associated with each alternative.

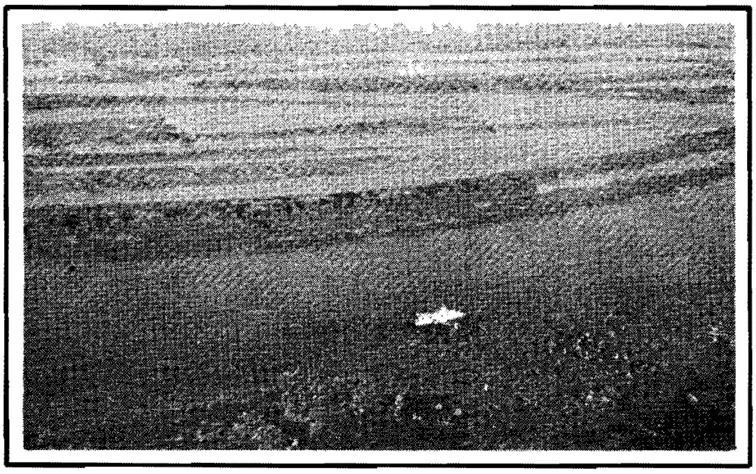
For the purposes of the ten year investment program presented in Chapter 18, a river port investment is shown starting in the mid-1980s, excluding the additional costs for land reclamation and rail connections required at Puerto Busch.

International Land Connections in Eastern Bolivia

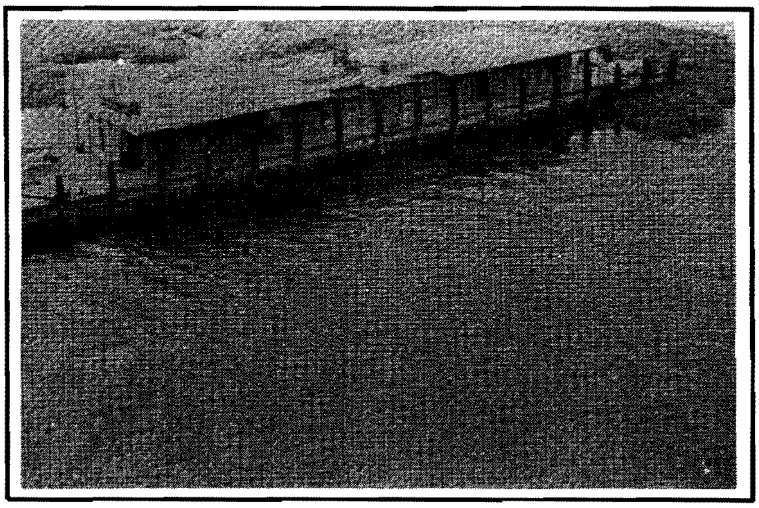
At present, Bolivia's connections with the countries on her eastern border are very limited. There is no road connection from the interior to Brazil, the sole access being by railroad from Santa Cruz to Corumbá. Connections with Paraguay consist of a small number of poor earth roads. Links to Argentina are of somewhat higher standard, with the rail connection to the Argentinian system through Yacuiba, and a gravel road of low quality in the same corridor. The thinly populated nature of the border regions means that they generate little transport demand, the main movements coming from international traffic to Brazil and Argentina. Rail offers the cheapest route to the important export markets for the products of the Santa Cruz region via the ports of Argentina and Brazil.



NEAR PUERTO ESPERANZA SHOWING THE LINE OF THE RAILROAD FROM CORUMBA TO SANTOS



THE REGION OF PUERTO BUSCH



THE TEMPORARY LANDING FACILITY CURRENTLY AT PUERTO BUSCH

THE PARAGUAY RIVER

A number of projects were considered, shown in Figure 15-3: the improvements and paving of the Santa Cruz-Yacuiba road to Argentina, the gravelling of the main link to Paraguay through Fortín Villazón, the construction of a road through the Tucavaca Valley and between Tunas and San José de Chiquitos, eventually linking Santa Cruz to the border, and the rehabilitation of the railroads linking Santa Cruz with Corumbá and Yacuiba.

Santa Cruz-Corumbá Road - This project has the nature of a development road, and as such received detailed treatment in Chapter 12. It was concluded that, while the potential for agricultural production in the region may be great, it must first be proven. Moreover, its realization depends on a substantial amount of migration to this very thinly populated region, a development which is expected to take several decades. As a result, only short sections of the road can be recommended at this time, which leaves the railroad as the sole long-distance means of transport in that corridor.

Santa Cruz-Corumbá Railroad - This 651 km long line, in service since 1958, provides a vital link between Santa Cruz and Corumbá in Brazil. It was, however, built to a relatively low standard and parts of it are now being rehabilitated. This was discussed in Chapter 13, where it was concluded that the entire line should be rehabilitated by 1990.

In December 1978, following a period of extremely heavy rains, serious damage was caused to the line in the mountainous section near Roboré, over a distance of 50 km. The line was out of operation for a period of nearly six months, while ENFE carried out emergency repairs at a cost of $b 25 million. In July 1979, a technical mission from the Japanese International Cooperation Agency (JICA) visited Bolivia and prepared a feasibility study (1) for the permanent restoration of the affected stretch of line, between Taperas and Roboré Stations, a distance of about 90 km.

The JICA Study considered five alternative solutions to the problem of restoring the line, which are shown in Figure 15-4. These ranged in cost from $b 607 million to $b 2,026 million (1980 pesos), and in scope from a rehabilitation of the existing track to the construction of a new 106 km long line, bypassing the dangerous area. The most expensive alternative

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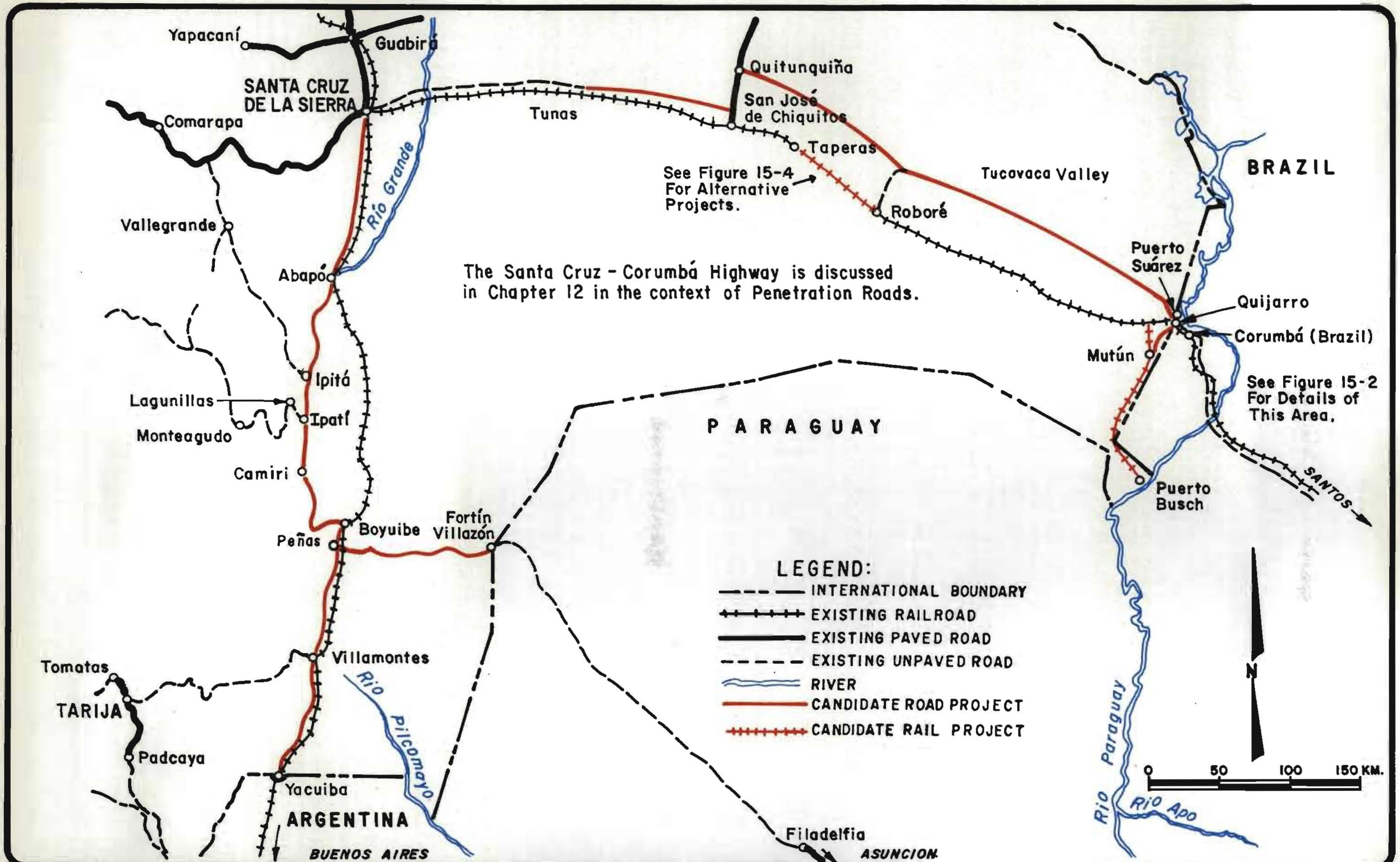
(1) Bolivian National Railways' Rehabilitation Program, Final Report, Volume 1, JICA, February 1980.

involved the construction of a 6.8 km long tunnel through Mt. Chochis. The initial conclusion of the JICA Study was that two alternatives should be studied in depth. These were the rehabilitation of the existing line, at a cost of $b 677 million (1980), and the construction of the bypass line at a cost of $b 607 million (1980). The benefits were assumed to be the same in each case (the extra operating time required by the long bypass line being offset by higher running speed). Thus, in the final evaluation, the less costly solution, i.e. a new 106 km long line between Taperas and Roboré, produced the highest rate of return and was thus recommended.

The National Transport Study made some observations on the methodology used in the justification of the detour line and also considered the possibility of other, less costly solutions. The rehabilitation alternative proposed by JICA would restore the line to a much higher standard than that found elsewhere on the system. A less ambitious rehabilitation scheme might cost about 20 percent less than that suggested by JICA -- that is to say $b 560 million (1980) or $b 400 million (1977) -- and would have the added advantage that, as a phased program of works, it could be spread over a period of years. It is recommended that this posibility be given careful consideration before any firm agreements are made regarding the railroad construction near Roboré.

It was mentioned before that no connection exist in this region, nor are recommended by this Study, between the Brazilian and Bolivian highway systems. It is known, however, that some demand exists to transport goods of relatively high value by truck from eastern Brazil to Santa Cruz and La Paz. To serve this limited but important traffic, it is recommended that ENFE introduce a regular piggy-back service between the Brazilian border and Santa Cruz. The service need not be of any great sophistication, requiring merely the addition of a few flat-bed wagons to the present train formations, responding to actual demand. It should, however, be a daily service and as such would be a valuable addition to the facilities available.

Santa Cruz-Yacuiba Road - Particular care needs to be taken in evaluating a road investment in a corridor where another mode (in this case rail) already exists with considerable unused capacity. The justification in this case, for paving or regravelling the roads between Santa Cruz and Yacuiba, is that there is already a substantial amount of traffic on this road, not travelling long distances, that does not find the services offered by the rail line either convenient or economic to use. From the results of the roadside interview survey on that road it was found that less than 10 percent of the tonnage passing through Ipatí had origins and destinations suitable for transfer to rail and for Villamontes the figure



CANDIDATE PROJECTS IN EASTERN BOLIVIA

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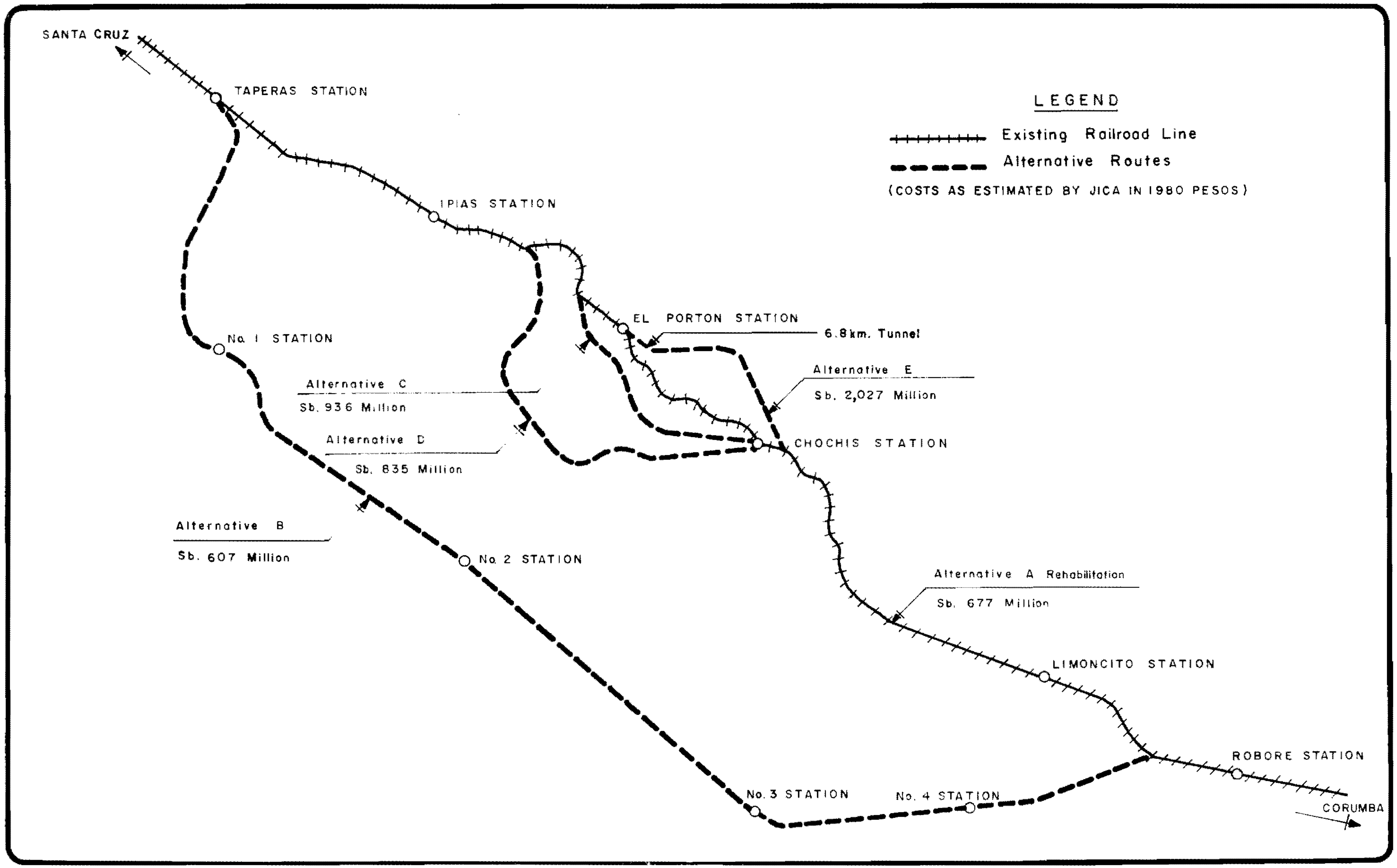
FIGURE 15–3



CANDIDATE RECONSTRUCTION PROJECTS FOR TAPERAS-ROBORE

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FIGURE 15–4

was only 5 percent. Much of the traffic on this road is associated with the largest town in the corridor, Camiri, which is larger than Yacuiba, Villamontes and Boyuibe together in terms of population,and this town is not served by the railroad. Thus one might see the modes serving different types of traffic, the rail providing vital service for long distance, especially foreign traffic; the road serving much more local movements, with little effective competition between them.

The freight volume in the corridor in the committed network, where the road is not paved, is about 520,000 tons per year north of Camiri and 400,000 tons south of Camiri for internal traffic. The rail share of this is about 210,000 tons per year north of Villamontes and 140,000 tons to the south. If the road were to be paved, as in the Test Network, the total tonnage in the corridor would rise by 25 percent of which a fifth would be diverted traffic and the remainder generated. The tonnage on rail would remain the same with the extra traffic going entirely onto the road. External traffic to and from Santa Cruz is allocated completely to rail in either case.

Costs of betterment with paving (see Chapter 11 for definition) in this corridor are relatively high -- about 40 percent higher than the costs shown in Table 11-7 of Chapter 11. Although betterment could be justified in the sections Santa Cruz-Abapó, severe budget restriction and other priorities lead to the recommendation that paving in this corridor should be postponed until the 1990s. Major gravelling is recommended instead (as described in Chapter 11) and this will substantially improve driving conditions in this corridor. Improvements should be phased based on individual feasibility studies, concentrating on improvements to help local traffic, rather than the completion of long sections of trunk road. These feasibility studies should take into account the role of the railroad in this corridor. The evaluations of this road are summarized by section in Table 15-5.

The design for a new paved road recently prepared for this route is not recommended within the next ten years.

<u>Santa Cruz-Yacuiba Railroad</u> - The bases for rail rehabilitation projects are discussed in Chapter 13. In the case of this line, with a length of 539 km and an estimated flow of 399,000 tons in 1989, the cost of rehabilitation was estimated at $b 464 million. The benefits were calculated as $b 30.8 million which give a rate of return of 6.6 percent in 1989 which is not sufficient to justify the project in that year. Some sections could be worth rehabilitation, but these must be selected based on detailed surveys of the line.

The Study did examine the possibility of a 45 km rail siding to Camiri. Construction costs were estimated at about $b 300 million and fixed costs of operation and maintenance at

Table 15-5

ROAD IMPROVEMENTS IN SANTA CRUZ-YACUIBA CORRIDOR

SECTION	1989 TRAFFIC (1) (vehicles/day)	TYPE OF IMPROVEMENT	APPROX. DATE	LENGTH (km)	COST OF PROJECT ($b million)	BENEFIT IN FIRST YEAR ($b million)	FIRST YEAR RATE OF RETURN (percent)
Santa Cruz-Abapó	536	major regravelling	1984	128	59	17.1	28.9
Abapó-Boyuibe	323	major regravelling	1987	217	119	22.9	19.3
Boyuibe-Villamontes	458	major regravelling	1987	107	47	9.0	18.9
Villamontes-Yacuiba	369	major regravelling	1984	104	47	5.5	11.[illegible]

NOTE: See Figure 15-3 for road section locations.

(1) Recommended Network flows.

$b 6.9 million per year. Cost savings by rail for Camiri traffic, otherwise transferring between road and rail at Boyuibe (63 km away), would be about $b 140 per ton. Even if all the forecast traffic to and from Camiri in 1989 (0.2 million tons) were to transfer to the new rail siding (which would be most unlikely), benefits less rail fixed costs would amount to only 6.5 percent of the investment cost in 1989. Hence a rail siding to Camiri cannot be recommended in the foreseeable future.

Connection to Paraguay - The road from Peñas, which lies on the main route between Santa Cruz and Yacuiba, to Fortín Villazón on the Paraguayan border (see Figure 15-3), is the only surface link for long-distance traffic between Bolivia and Paraguay. The road is 130 km long, of poor earth construction and carries very little traffic. The proposal is to gravel it at a cost of $b 18 million.

There is no possibility of justifying this investment at present-day traffic volumes, nor is the improvement likely to generate a significant amount of traffic. The road is a long way from any major generator, and has to be seen as a relatively small link in the road from Asunción to Santa Cruz and La Paz; it also is part of a branch of the Pan American Highway. For this reason, the project may be justified if and when growth of international traffic is stimulated.

The approach to the evaluation of the road was therefore to calculate the volume of traffic needed to give a 12 percent rate of return on the investment. Using the standard operating and maintenance costs developed by the Study, it was estimated that the minimum traffic volume should be about 50 vehicles a day. Whether this volume will be reached in the foreseeable future depends largely on developments in Paraguay. The 900 km long Trans-Chaco Highway from Asunción to Fortín Villazón is now paved as far as Filadelfia, some 350 km from the Bolivian border, and it is understood that Paraguay plans its further extension. It is suggested that the road improvement between Peñas and Fortín Villazón coincide with the extension of the Trans-Chaco Highway to the border.

The Guayaramerín-Porto Velho-Belem Corridor

Guayaramerín marks the only practicable trade route out of the entire north of Bolivia. The route proceeds through Guajará Mirim, on the Brazilian side of the Mamoré River to Porto Velho and Manaus, and thence down the Amazon to the Atlantic and beyond. The corridor is shown in Figure 15-5.

The importance of the route is that it offers potentially, if not actually, the cheapest means of exporting goods from the northern half of the country to destinations in Europe and the eastern United States, and equally of importing goods from those places. Most important, it provides a feasible outlet for meat from the Beni and thus opens up the prospect of large, highly profitable exports of beef to Europe.

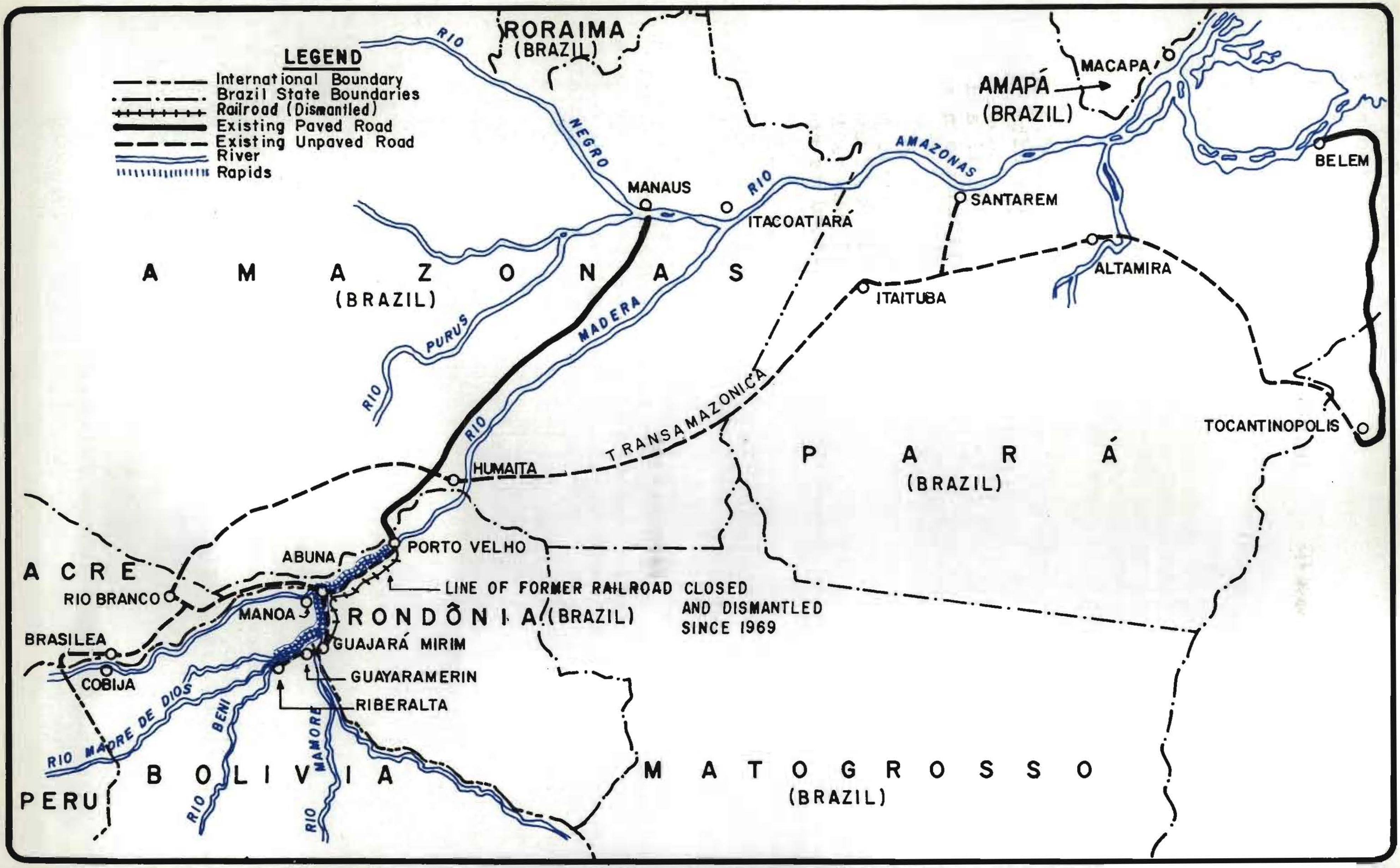
The distances from Guayaramerín to the main ports of the other continents are shorter than by other routes and are mostly by water, which is the cheapest form of transport. Obviously the journey inside Bolivia is important and the cost depends on the point of origin or destination within the country. However, Guayaramerín again has the advantage of cheap water transport on the Mamoré River.

At present the corridor is little used -- Guayaramerín has no road connection with the rest of the country apart from the road to Riberalta. It is connected to Trinidad and Puerto Villarroel by the Mamoré River but this serves effectively only a small part of the Beni. Guayaramerín is well located as a trading center but it cannot expect to prosper until it is better connected by road with the Beni generally and with the main centers of economic activity.

There are no port facilities, either at Guayaramerín or on the Brazilian side at Guajará Mirim. Nor is there any real case for them until traffic volumes increase or until containers are introduced on the river, which is not foreseeable for a long time. Bolivian traffic crosses the Mamoré on trucks by vehicle ferry which is operated free of charge by the Brazilians.

From Guajará Mirim the corridor proceeds through Porto Velho. There are two possible means of transport: road and river. The river, however, which becomes the Madeira after the confluence of the Mamoré and the Beni, is not navigable until just above Porto Velho. Most of it lies in Brazil and the Brazilians have no plans to make it navigable in the near future.

A railroad was built in 1911 to give Bolivia access to the Amazon, but was closed down in 1969, due to lack of use. A road was then built, employing most of the railroad as its foundation and using the same bridges. The railroad is now beyond any possibility of restoration.



THE GUAYARAMERIN-PORTO VELHO-BELEM CORRIDOR

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FIGURE 15–5

The road, then, is the only possible means of surface transport to Porto Velho. It is an earth road, wide, straight and flat, but in bad condition. It takes approximately 12 hours to travel the 330 km between Guayaramerín and Porto Velho. However the local government of the Brazilian State of Rondonia, in whose territory the road lies, has declared its intention to pave the road in 1981. Truck journey times should then diminish to about 6 hours.

From Porto Velho it is possible to cross the Madera by ferry and continue by road to Manaus, a further 800 km. The road is weakly constructed and carries weight restrictions of 5.5 tons per axle. Alternatively freight can be transported by river from Porto Velho, where there are two small ports, one with no facilities, the other with a small floating quay and two 1.5 ton cranes. There is no equipment for handling containers.

The Madera River is navigable from Porto Velho to the Amazon at Itacoatiara where boats may either transship or turn upstream to Manaus, which is a well equipped port visited by ocean-going ships, and transship there. However, since Itacoatiara possesses few facilities and attracts few ships, the normal practice is to use Manaus, despite the extra 400 km round trip.

Conclusions and Recommendations - The corridor lies mainly in Brazil. Within Brazil the needs of Bolivia are:

(i) A paved road from Guajará Mirim to Porto Velho; but as already stated, this is programmed for 1981.

(ii) Facilities for handling refrigerated containers at Porto Velho; these are clearly not needed yet but there is little possibility of building up meat exports until they are available. This is a matter that calls for negotiation between the two governments.

Within Bolivia the needs of both exporters and importers are:

(iii) Better access to the Mamoré at Puerto Villarroel and Trinidad by road from La Paz, Santa Cruz and Cochabamba, and by rail from Santa Cruz via the Río Grande.

(iv) Better road access to Trinidad and Puerto Siles by road from surrounding cattle country, both actual and potential.

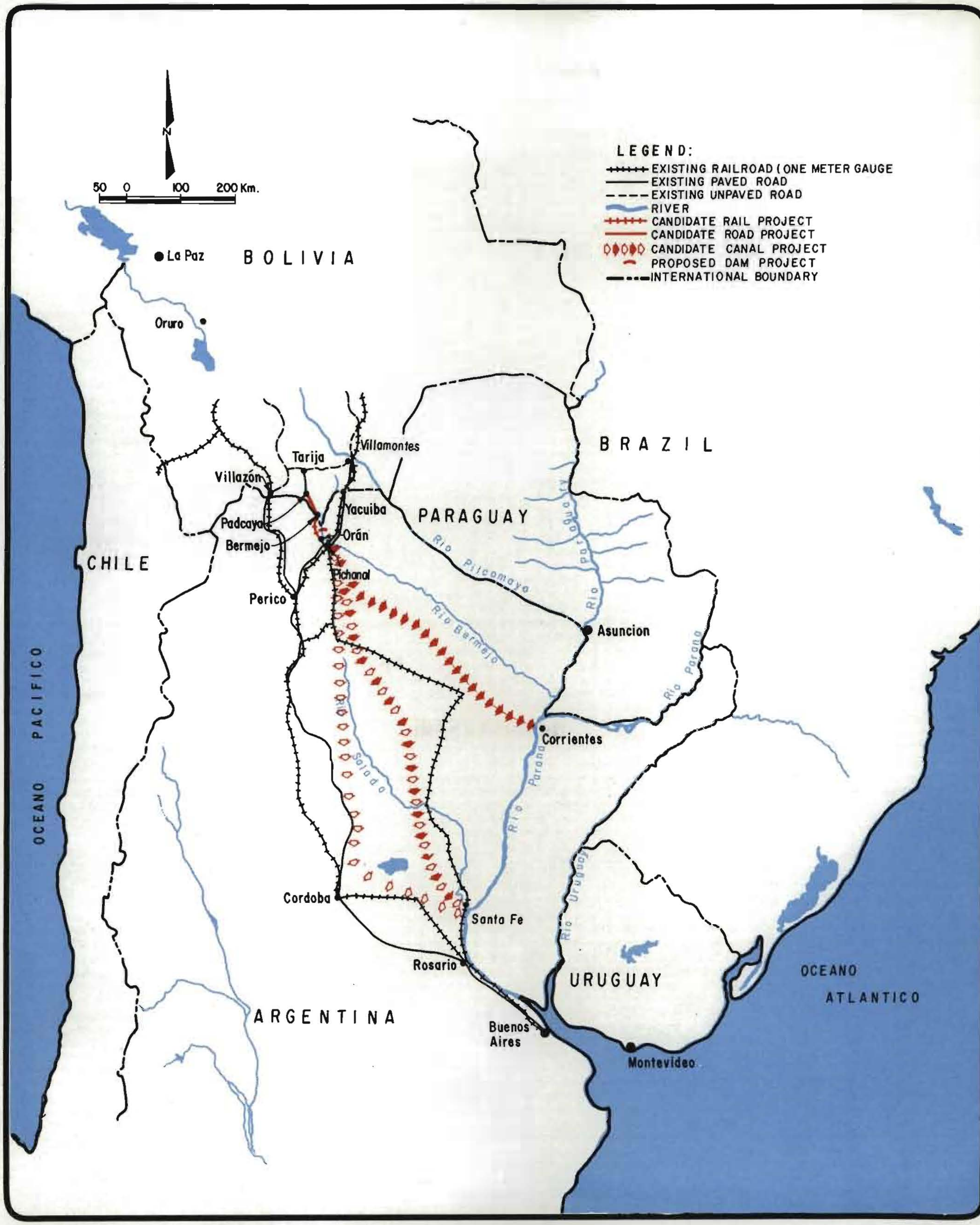
(v) Road access to Guayaramerín from potential cattle country nearby, and from Trinidad. A road to Trinidad would, of course, duplicate the Mamoré River to some extent, but it would not compete on price. The need for the road is partly for agricultural products, partly for consignments needing faster delivery and, largely, for passenger traffic. It is difficult to envisage the healthy development of Guayaramerin without road connection to the rest of the country; and equally it is difficult to believe in the development of the Beni without at least a rudimentary road network connecting town and country within the Beni itself.

Projects in Southern Bolivia and Northern Argentina

These projects are concerned with the connections between Tarija and Bermejo and northern Argentina and thus to the Argentinian ports of Rosario and Buenos Aires. The projects are shown in Figure 15-6 and consist of:

- Paving the road from Padcaya to Bermejo;
- Construction of a rail link from Bermejo to Orán in Argentina;
- Improvement of the River Bermejo, or construction of alternative canals.

Road Improvement Padcaya-Bermejo - The road from Tarija to Padcaya is already paved, as is the Argentinian road from Bermejo to the railhead at Orán. This project considers the paving of the intervening section which at the moment is a 159 km gravel road. The cost of new construction is estimated at $b 910 million and the traffic is forecast to grow from 82 vehicles per day in 1977 to 243 in 1989. (Betterment with paving is not an appropriate project here due to the difficult and unstable terrain). The net benefits for the new road calculated for 1989 are $b 75.5 million giving a first year rate of return of 8.3 percent. Thus the project cannot be justified during the coming decade but will be in the early 1990s. However, it is recommended that a major gravelling (see Chapter 11 for definitions) take place in the mid 1980s at a cost of $b 48 million with a rate of return of 15.8 percent. It is possible that some paving could be justified of short sections near the town of Padcaya and Bermejo, but this would first need a detailed local survey of construction costs and traffic.



CANDIDATE PROJECTS IN SOUTHERN BOLIVIA AND NORTHERN ARGENTINA

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FIGURE 15–6

Rail Link Bermejo-Orán - This rail line would be approximately 50 km long, almost wholly within Argentina, and has an estimated construction cost of $b 200 million. It would link Bermejo to Orán and thus to the whole Argentinian rail system and would probably attract much of the foreign trade traffic of both Bermejo and Tarija. If all of the traffic estimated for those two areas in 1989, about 137,000 tons, was assumed to use the railroad, the net benefit would be $b 5.5 million, or a 2.8 percent rate of return. This would rise to 4.5 percent by 1999. Thus the railroad is not economically justified from Bolivia's point of view in the foreseeable future, but should of course be used if Argentina were to construct it.

River and Canal Projects - These projects are again wholly within Argentina. The Bermejo River is not at present navigable for the first 600 km of its 720 km course to the confluence with the Paraná River. Argentina is however considering several schemes for the improvement of navigation in this area. Most important for Bolivia would be a dam on the Bermejo River at Zanja del Tigre, largely for irrigation and hydroelectric reasons, but which would also make navigation possible as far as Bermejo. Below this dam there are proposals for either the dredging of the Bermejo River or the construction of a canal to the Paraná River either at Corrientes or Santa Fé.

The Bolivian trade by itself could not hope to justify these schemes, but if Argentina should go ahead with them, Bolivia should try to be involved, in particular, in connection with the possibility of a system of locks to bypass the dam.

Land Connections to Peruvian Ports

The projects in this corridor, shown in Figure 15-7, for the most part involve substantial investment on the part of Peru, along with a lesser amount from Bolivia to permit successful operation. They share the basic aim of improving connections with the Peruvian port of Matarani. The port of Ilo is available at preferential tariffs, but the reluctance of Conference vessels to use this port, which lacks a breakwater and therefore is closed to shipping for about 15 days per year, means that for the immediate future Matarani will continue to be preferred by Bolivian clients. As noted earlier, cargo currently travels to Matarani port either over an extremely poor road or by a combination of road, rail and lake. Therefore, a subset of projects defined as the Lake Titicaca corridor are considered first, consisting of:

- Establish a rail roll on/roll off (RO-RO) facility and a bogie changing plant at Guaqui;
- Build a railroad link from Guaqui to Puno (175 km);
- Pave the road from Guaqui to Juli (93 km).

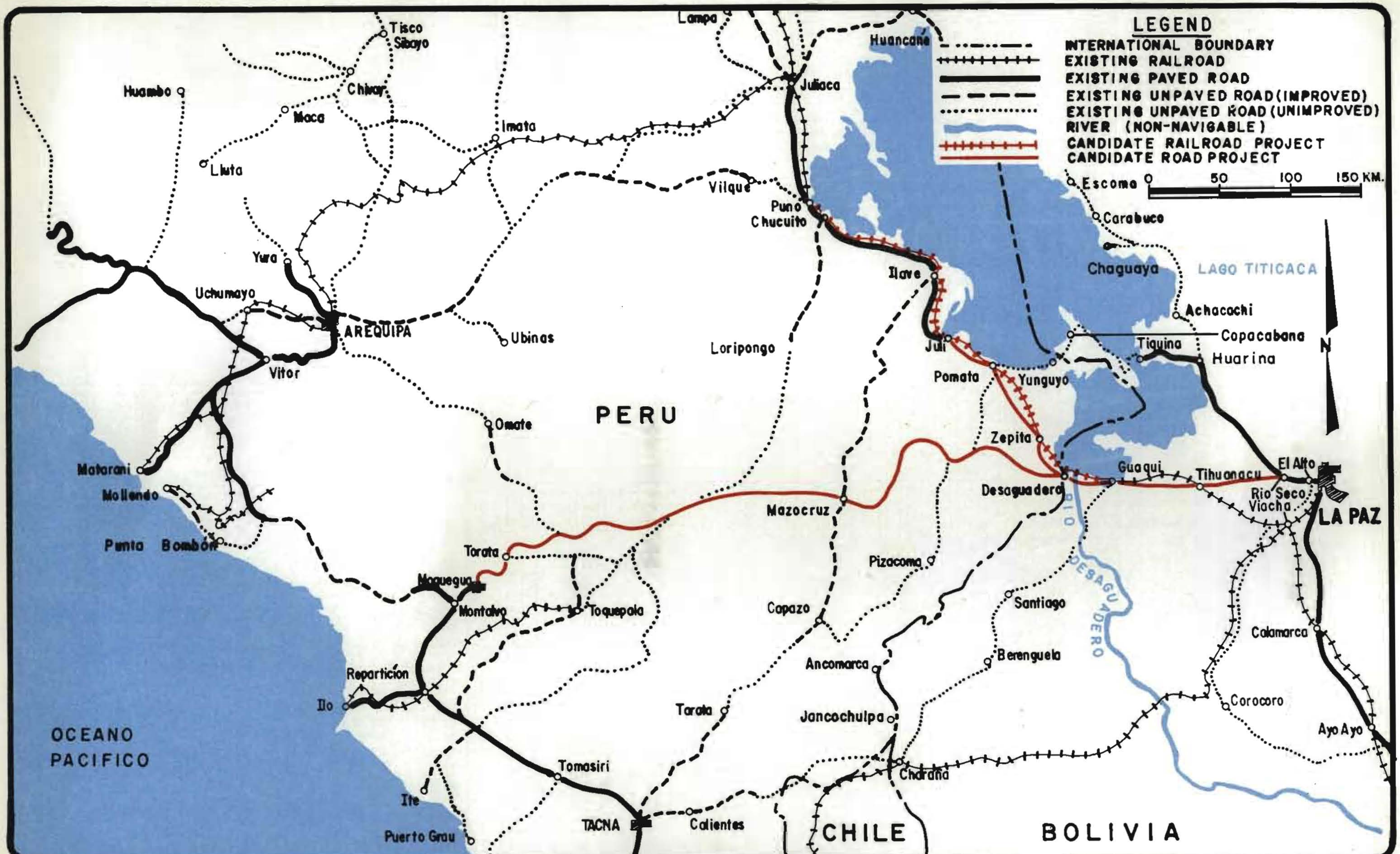
Improvements to Navigation on Lake Titicaca - The present facilities at the Bolivian port of Guaqui are primitive, requiring considerable time in port for the loading and unloading of goods. This may be one of the reasons for the remarkably low use of rail on the Bolivian side, but truck tariffs to Guaqui also appear to be below those of the present rail service.

An important project was defined involving the purchase of a new rail wagon ferry boat, similar to that already providing service between Puno and Chaguaya. This could be combined with new RO-RO rail facilities at Guaqui, to complement the existing ones at Puno, and a plant to change the rail wagon bogies between the Peruvian standard gauge and the Bolivian narrow gauge. Provision of these facilities would permit continuous rail operation between Matarani and the Bolivian interior. The main benefits would be decreased time in port by the lake boats and a lower overall cost since port handling costs would be much lower.

The economic feasibility of this project is highly dependent upon the volumes that may be expected to use the facility. In the evaluation, it has been assumed initially that Bolivia's policy regarding the use of seaports remains much the same as at present in terms of percent of total imports/exports passing through an individual port. Introduction of the new facilities would doubtless bring about a certain shift of traffic to rail. However, road would continue to offer certain advantages in terms of service, especially important for high value products. Construction of the rail interconnection Santa Cruz - Cochabamba would also affect the volumes passing through the corridor, as would possible changes in the access to Arica (discussed below). For these reasons, the feasibility of the projects was evaluated under a range of alternative volumes.

The total cost of the projects was estimated at $b 140 million. Future volumes are projected to range between 125,000 and 163,000 tons in 1989, and 260,000 and 355,000 tons in 1999.

Railroad Puno-Guaqui - This project is an alternative to the preceding one, since it would obviously replace the need for navigation between Guaqui and Puno. It is a long-standing idea, which would link the Peruvian and Bolivian railroad system. It involves construction of a 150 km stretch from Puno to Desaguadero in Peru, and of 25 km in Bolivia between Desaguadero and Guaqui. A railwagon bogie changing plant would also be required. The total cost of the project is estimated



CANDIDATE PROJECT LINKS WITH THE PERUVIAN PORTS

Wilbur Smith and Associates

FIGURE 15-7

at $b 782 million in 1989, 76 percent of which would be investments in Peru. As with the lake evaluation, a range of volumes was projected for this project.

Road Paving Guaqui-Juli - This project envisages betterment with paving (see Chapter 11 for definitions): it would involve some slight realignment and paving of a stretch of 23 km in Bolivia and similar work for a distance of 70 km in Peru, to Juli. The road from Juli to Puno is already built to a good standard with an asphalt surface. The total estimated cost for this project is $b 160 million. It is not though likely that construction of this road will divert much traffic from the overall rail/lake route since the route beyond Matarani will remain in poor condition and long-distance import traffic will probably continue to use the railroad. However it is quite likely that Bolivian export freight at present travelling to Guaqui by truck and then transferring to the lake, will now continue all the way by truck to Puno, avoiding the costs in time and port charges of using the lake. The volume of traffic projected for 1989 is 265 vehicles per day and for 1999, 600 vehicles per day.

Conclusions on the Lake Titicaca Corridor - The results of the economic evaluation on traffic forecasts are presented in Table 15-6, for the alternatives described above. It should be noted that the volumes, and therefore the benefits calculated, refer only to international traffic and that for any case involving construction of the paved road there are benefits to local traffic. These are estimated at $b 6.4 million for 1989 and $b 9.2 million for 1999.

The only project to exceed 12 percent in 1989 is the paving of the Guaqui-Juli road, which it does under all circumstances investigated. By 1999 the RO-RO ferry, the railroad, and the road and ferry combined also exceed 12 percent, but the railroad has a marginal rate of return over the road of only 8 percent. The additional inclusion of the ferry in 1999 has a marginal rate of return over road alone of 13.4 percent at the high traffic forecast.

Thus the recommendation for this corridor is that the 23 km road from Guaqui to Desaguadero be paved in the mid 1980's (see "Projects within Bolivia" below) and that negotiations be started with Peru for the extension of the Puno-Juli road to Desaguadero (70 km) at the same time. It should be noted that the Guaqui-Desaguadero road would also form part of the proposed road to Ilo discussed below and that this could ultimately be the more important route to Matarani. If the high traffic forecast is attained, then the provision of RO-RO facilities at Guaqui could also be justified by the end of the 1990's.

Table 15-6

COMPARISON OF ALTERNATIVES FOR INTERNATIONAL TRAFFIC IN THE LAKE TITICACA CORRIDOR

	ALTERNATIVE					
	Current Situation	Ro-Ro Ferry	Railroad Puno/Guaqui	Paved Road Juli/Guaqui	Road and Ferry	Railroad and Road
Investment in \$b million						
By Peru	-	-	596	128	128	724
By Bolivia	-	140	186	32	172	218
Total	-	140	782	160	300	942
High Traffic Forecast 1989						
Rail	-	-	212,000	-	-	140,000
Road	133,000	120,000	71,000	215,000	155,000	143,000
Ferry	150,000	163,000	-	68,000	128,000	-
Total	283,000	283,000	283,000	283,000	283,000	283,000
Low Traffic Forecast 1989						
Rail	-	-	184,000	-	-	122,000
Road	133,000	120,000	61,000	186,000	155,000	123,000
Ferry	112,000	125,000	-	59,000	90,000	-
Total	245,000	245,000	245,000	245,000	245,000	245,000
High Traffic Forecast 1999						
Rail	-	-	461,000	-	-	305,000
Road	270,000	260,000	154,000	468,000	295,000	310,000
Ferry	345,000	355,000	-	147,000	320,000	-
Total	615,000	615,000	615,000	615,000	615,000	615,000
Low Traffic Forecast 1999						
Rail	-	-	390,000	-	-	260,000
Road	270,000	260,000	130,000	396,000	295,000	260,000
Ferry	250,000	260,000	-	124,000	225,000	-
Total	520,000	520,000	520,000	520,000	520,000	520,000
Annual Net Benefits (\$b million)						
1989 High (1)	-	11.4	44.8	22.4	25.2	46.0
1989 Low (1)	-	10.4	40.8	21.0	23.0	41.6
1999 High (2)	-	35.4	96.8	47.0	65.8	99.0
1999 Low (2)	-	26.0	85.6	43.6	55.0	86.6
First Year Rate of Return (Percent) (3)						
1989 High	-	8.1	5.7	14.0 (18.5)	8.4 (10.5)	4.9 (5.6)
1989 Low	-	7.4	5.2	13.1 (17.1)	7.7 (9.8)	4.4 (5.1)
1999 High	-	25.3	12.4	29.4 (35.1)	21.9 (25.0)	10.5 (11.5)
1999 Low	-	18.6	10.9	27.2 (33.0)	18.3 (21.4)	9.2 (10.2)

(1) An additional benefit of \$b 6.4 million should be added to paved road projects for local traffic.

(2) An additional benefit of \$b 9.2 million should be added to paved road projects for local traffic.

(3) The figures in brackets include local traffic benefits.

If the Peruvians complete their section of the Puno-Guaqui railroad as far as Desaguadero as currently planned, then it will be well worthwhile for Bolivia to complete the short 23 km Guaqui-Desaguadero link. It is recommended that a design study for this project be undertaken immediately.

Road Improvement Desaguadero-Ilo - A further road project is the improvement of the road Desaguadero-Ilo. This project is at present being studies by the Peruvians; the current estimated cost is $b 2,200 million. Such an investment cost cannot possibly be justified on current expectations of future traffic in this corridor. However, an alternative project to improve the existing surfaces but without paving at a cost of $b 550 million, has been proposed by the Junta of the Andean Pact, which would permit all-year transport in this corridor. This would provide access not only to Ilo, but also from there by paved road, to Matarani in the north and Arica in the south. It is recommended that this revised plan should be given urgent consideration, since it could form the main road route from Bolivia to all the Pacific sea ports in Peru and Northern Chile.

Projects Within Bolivia - There are two major projects in the Peruvian corridor which are totally within Bolivia. These are the paving of the Río Seco-Guaqui-Desaguadero road (98 km) and the rehabilitation of the Viacha-Guaqui railroad (65 km).

The road is 98 km long and the cost of paving to betterment standards (see Chapter 11) is estimated at $b 134 million, including the cost of four bridges. The benefits to this project, for an opening date of 1986, are estimated at $b 26.1 million with a flow of 290 vehicles per day. This implies a 19.5 percent first year rate of return and so it is recommended that the project should go ahead. This road is discussed in more detail in Appendix 11G.

With regard to the rail rehabilitation, it is estimated that this would cost $b 56 million. At the highest 1989 forecast tonnage, the benefit would be $b 5.6 million giving a 10.0 percent rate of return. At the highest 1999 tonnage the benefit would be $b 7.5 million giving a rate of return of 13.4 percent. Thus the project is not justified by 1989, but may possibly be by 1999 at the highest growth rate.

Conclusions on Land Connections with Peruvian Ports - Thus it is recommended that the road from Rio Seco to Desaguadero be paved, and that support be given to the paving of Desaguadero to Juli and the construction of the low-cost road to Ilo, both the latter projects being in Peru. The rail rehabilitation and the RO-RO facilities at Guaqui should await further traffic growth. These conclusions are subject to the findings of the feasibility studies required for each recommended project.

Land Connections to Chilean Ports

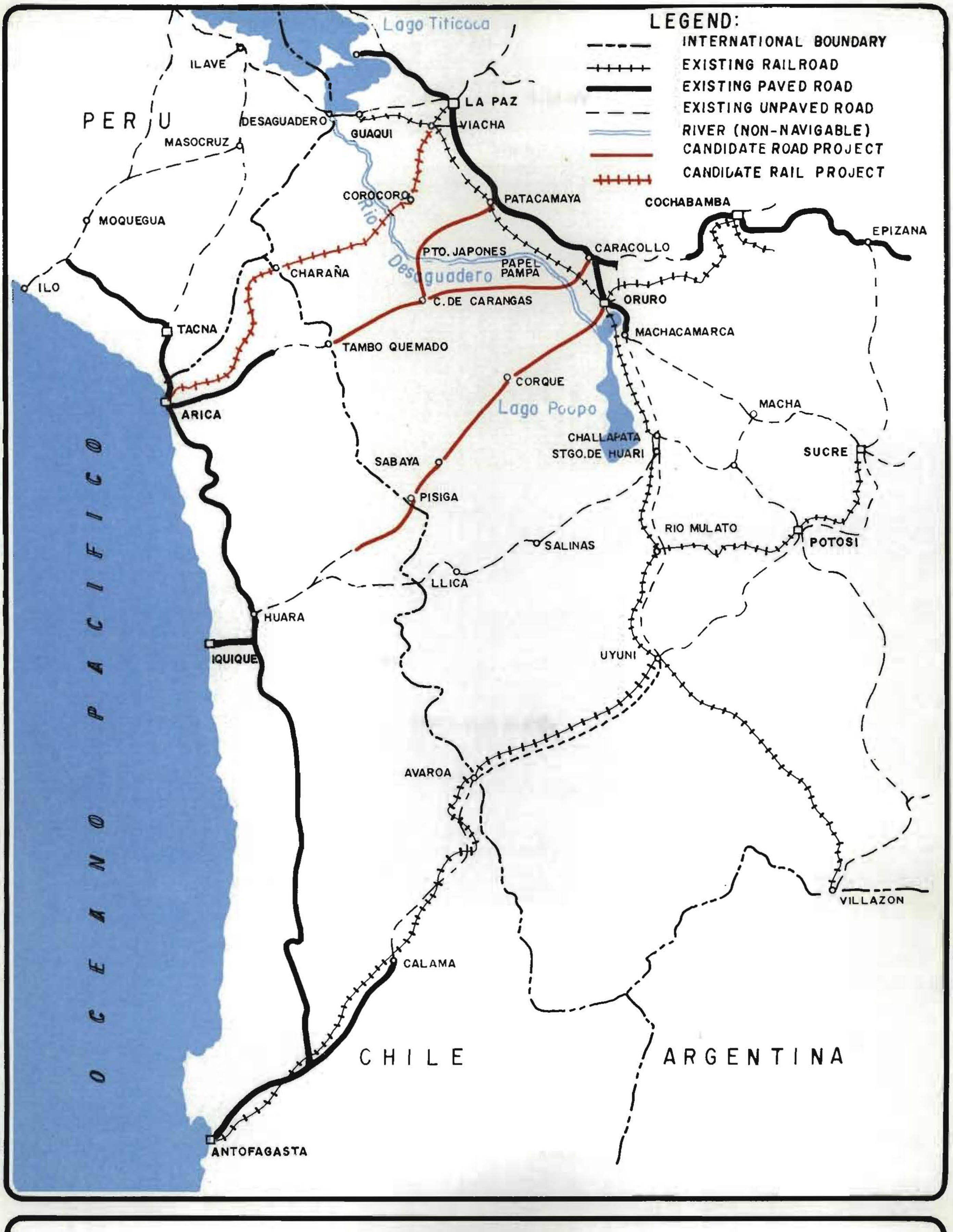
The projects in this region involve improving connections to the most conveniently placed port for La Paz -- Arica -- which are shown in Figure 15-8. The other major Chilean ports are Iquique and Antofagasta. The former handles little or no Bolivian cargo nor are there specific plans for it to do so; the latter is already adequately linked to Bolivia by the existing railroad. The corridor to Arica is served by two modes, road and rail: both operate under difficult conditions at present. The railroad is in extremely poor condition in both the Chilean and Bolivian sectors; the road connection via Tambo Quemado consists, for a quarter of its length, of rough earth roads impassable in the wet season, although there is an alternative route via Tacna in Peru. In 1977 the foreign trade in the Arica corridor totalled 138,000 tons of which 86,000 tons were by rail, and to Antofagasta 391,000 tons entirely by rail.

Road Improvements - The road connections to Arica evaluated were an improvement to the road Patacamaya-Puerto Japones-Carangas-Tambo Quemado (219 km) and also the improvement of a link from Caracollo, near Oruro, to Carangas. This latter link would allow more direct road access from Arica to much of the country but would require a 100 meter bridge across the River Desaguadero, which is already bridged on the alternative route at Puerto Japones. Also the traffic in the corridor is forecast to be only 180 vehicles per day in 1989, which is not enough to justify improving more than one route, and so attention was focused on the northern route from Patacamaya.

The only improvement found to be justified by projected traffic on the route was major gravelling. Costs were estimated at $b 85 million for the 219 km and benefits at $b 10.2 million in the year of opening (1987) giving an overall rate of return of 12.0 percent. The evaluations are summarized in Table 15-7. In addition, thirteen bridges totalling 290 meters and $b 36 million are recommended to cross the somewhat unstable river beds, where vehicle losses are not infrequent.

If the Arica railroad were to be closed, the volumes in this corridor would substantially increase and projects would be justified earlier or at a higher level.

For connections with Iquique and Antofagasta, two further roads to the Chilean border were considered from Oruro to Pisiga and from Uyuni to Avaroa at a cost of $b 60 million and $b 37 million respectively. Traffic volumes were extremely low. Neither road can be recommended during the next twenty years.



CANDIDATE PROJECT LINKS WITH THE CHILEAN PORTS

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FIGURE 15–8

Table 15-7

POSSIBLE ROAD IMPROVEMENTS PATACAMAYA-TAMBO QUEMADO

SECTION	LENGTH (km)	YEAR	COST ($b million)	BENEFIT ($b million)	FIRST YEAR RATE OF RETURN (percent)
Patacamaya-Pto. Japones	57	1987	23	2.6	11.1
Pto. Japones-Carangas	50	1987	20	2.6	12.9
Carangas-Tambo Quemado	112	1987	42	5.0	12.1

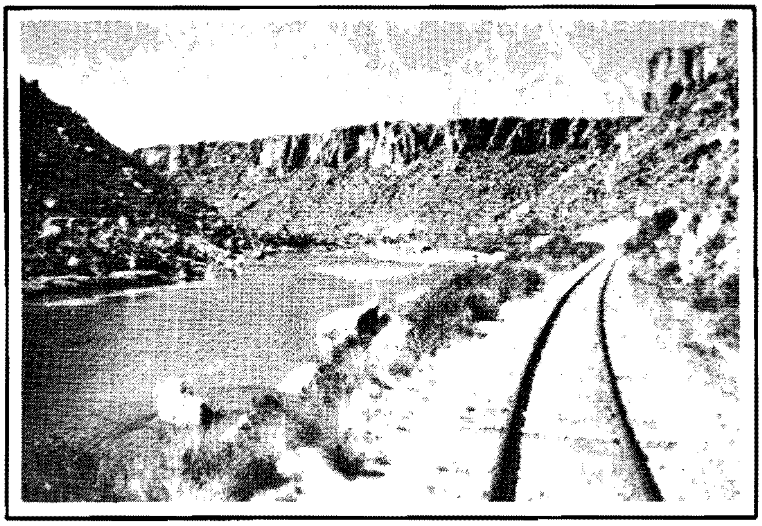
La Paz-Arica Railroad - In the peace treaty of 1904 following the War of the Pacific, Chile recognized Bolivian rights of transit through Chilean territory, and in the same treaty it was agreed to build the rail line now linking La Paz to Arica. Since then there have been numerous protocols and conventions on the railroad, the latest of which being in 1968. The de-facto situation at present is that Bolivia's imports on this line are limited to 7,000 tons per month, but at a tariff well below the cost of operation of the line. Two possibilities were considered, firstly that the line be rehabilitated and secondly that Bolivia take over operation of the line to remove the import limit.

The cost of rehabilitating the line (to the level of reconstruction -- see Chapter 13) from Viacha to the Chilean border at Visviri (near Charaña) was estimated at $b 164 million, but it was concluded that rehabilitation could not be justified, either now or at projected 1989 traffic volumes (see Chapter 13 for details). On the other hand, it was concluded that the line was well worthwhile keeping in operation and that maintenance standards should be raised to the "desirable" levels specified by ENFE (see also Chapter 13).

The current limit of 7,000 tons of imports per month imposed by Chile is clearly restricting the use of Arica Port and the Viacha-Arica railroad. One possibility, which Chile is apparently prepared to discuss, is that Bolivia should take over the entire line, both track maintenance and train operations. This would have the advantages of a single administration for the line. Although maintenance and operating costs on the Chilean section are difficult to predict for an all-Bolivian operation, it is expected that the line would be economically viable. If traffic volumes increased significantly, and this could well be the case with the lifting of tonnage restrictions and with an assured future, rehabilitation could be worthwhile, even though not justified at present traffic levels. Indeed, Chile once planned to rehabilitate their section of the line and much material for a rehabilitation can be observed along the track. Thus rehabilitation could possibly be justified at an early stage in the future growth of the line.

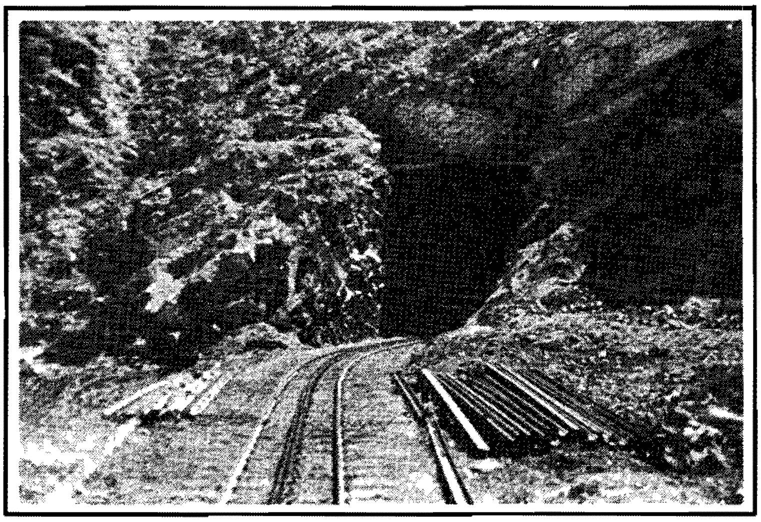
It is concluded, therefore, that this line is well worth keeping in operation, and this comment applies to both the Viacha-Charaña and to the Charaña-Arica sections. Rehabilitation is not justified at current volumes, but could be if volumes grew. This can only occur if the current tonnage restriction is removed.

It is noted that the gravelling of the Patacamaya-Puerto Japonés-Tambo Quemado road would not undermine the railroad operations. An alternative route to the railroad is highly desireable from the national viewpoint, and forecast traffic volumes justify



ON THE ALTIPLANO

THE STEEP GRADE IN CHILE
WITH CENTRAL RACK
(NOTE NEW RAILS READY
FOR REHABILITATION)



NEAR ARICA

LA PAZ-ARICA(CHILE) RAILROAD

improvements to the existing road by the reduction in vehicle costs brought about. Even with an improved rail operation, there will always be some cargo for which the speed and convenience of a truck will be overriding factors. For the great bulk of cargoes, however, the lower cost by rail will ensure the selection of that mode.

Use of Air Transport for Foreign Trade

The potential for international air freight is of special importance for Bolivia due to its landlocked situation. The use of air for cargo movement has been increasing rapidly in recent years throughout the world (over 10 percent growth per annum since 1972 in tons carried) not the least in developing countries: it is noticeable that virtually all countries that have shown large increases in exports of manufactures have also had very rapid growth in air freight exports. These have for the most part been in the area of labor intensive, relatively high - value manufactured goods, although there has also been considerable growth in recent years in the export of fruit, vegetables and flowers to the United States and Europe from Israel, Colombia and Kenya.

In May 1979, the Boeing Company produced a feasibility study for Bolivia, for the use of a Boeing 747-200 F which concluded that net earnings would be over $US 10 million per year on a total investment of $US 61 million. The only product that Bolivia at present produces in any quantity of sufficient value to justify the possible use of air freight is tin. While the potential for agricultural export using air exists, at present the production techniques and quality of product are not of sufficent standard to make an impact upon the world market.

In 1979, Bolivian production of tin was in the region of 30,000 tons and this volume is not considered likely to alter greatly in future years. The present value of tin on the world market is around $US 7.6 per pound, or approximately $US 15,500 per ton. The change in transport costs involved in switching the export of tin to air, assuming the tariffs used in the Boeing Study, would be in the region of an eight-fold increase: however, the additional cost would form a very small percentage of product value. The benefits to be gained from speed of delivery, and the ability to respond rapidly to fluctuations in world demand, make it very likely that it would be worthwhile exporting tin by air.

However, in the forecasts of earnings made in the Boeing Study, returns from the export of tin provided only 15 percent of income. About 80 percent of earnings were derived from the import, by air, of products from the United States and Europe. Some 15,000 tons were assumed to be imported at high tariffs (close to the existing rates), providing over $US 30 million income. The total air freight imports for 1978 and 1979 were 9,424 tons and 9,049 tons of which LAB handled 6,696 tons and 6,513 tons respectively. Thus, to achieve 15,000 tons, the service would have to take all existing freight, including that from LAB's Boeing 707, plus a substantial increase.

The viability of the entire operation therefore rests on the probability of the import cargo forecast being realized. While there is possibly a shortage of supply of air freight services to Bolivia at present, it is difficult to believe that the degree of diversion assumed in Boeing's study will occur simply as a result of the inauguration of this service on the part of LAB. If, assuming the same tariff levels, only half the diversion assumed takes place, and air imports from Europe achieve only 80 percent of predicted levels, the net profit of $US 10 million becomes a net loss of nearly $US 5 million, assuming a 10 percent escalation in costs.

The conclusion is therefore that this project cannot be recommended until a more detailed study with more reliable data has been carried out on the import volumes that are likely to travel by air. On the available evidence it does not seem worthwhile to conduct such a study in the near future.

Conclusions on International Transport Links

Imports and exports combined are expected to more than double by 1989 and more than triple by 1999, compared with the base year 1977. Therefore, several improvements are recommended to international transport links. The main foreign trade routes are currently by rail since the road connections with neighboring countries are either very poor or non-existent.

It is recommended that a port is built on the Paraguay River in order to export iron ore and pellets from Mutún as well as agricultural products from eastern Santa Cruz department. It is recommended that the financing of a port be linked to a Mutún export project, and that decisions on location, size, timing and land connections be left to the authorities responsible for the Mutún project.

Rehabilitation of the Santa Cruz-Corumbá railroad is recommended, including reconstruction of the section Taperas-Roboré which was badly damaged by floods in early 1979. It is recommended that this latter project, which would cost $b 400 million, is phased over the next ten years, although with most expenditure concentrated in the next six years. Only two 40 km sections of the Santa Cruz-Corumbá highway are recommended in order to start exploiting the agricultural potential of the Tucavaca Valley.

It is recommended that the Santa Cruz-Yacuiba road is subject to major gravelling at a cost of $b 273 million. Paving to the standard of betterment (see Chapter 12) could be justified for sections of this road but funding is unlikely to be available. Rehabilitation of the rail line in this corridor is not generally recommended, although it could be worthwhile in some sections.

It is considered that the Guayaramerín-Porto Velho-Belen corridor could be profitable exploited by Bolivia, particularly for exporting cattle products from the Beni to Europe. Improvements to this corridor, which lies mainly in Brazil, are programmed, including paving of the Guajará Mirim-Porto Velho highway. It is recommended that Bolivia negotiate with Brazil regarding the provision of refrigerated container handling facilities at Porto Velho.

Several projects proposed in Northern Argentina could be exploited by Bolivia if completed, including a rail line from Orán to Bermejo and various canal and river projects. None would be worth developing for Bolivian trade alone.

In the Lake Titicaca corridor, construction of the Guaqui-Desaguadero railroad is recommended at a cost of $b 186 million timed to coincide with completion of the Puno-Desaguadero railroad in Perú. Paving of the Río Seco-Desaguadero road is recommended to the standard of betterment at a cost of $b 134 million (with bridges) and encouragement should be given to the Desaguadero-Ilo and Desaguadero-Puno highway project in Perú.

It is concluded that the Viacha-Arica railroad is worth keeping in operation, but the low volumes of traffic (restricted by Chile to 7,000 tons per month) do not justify rehabilitation at the present time. Higher routine maintenance levels are recommended. As a complementary project, major gravelling and bridge building is recommended on the Patacamaya-Tambo Quemado highway at a total cost of $b 121 million.

On foreign trade by air, it is recommended that LAB expand their international and freight services by the purchase of an additional cargo Boeing 707. The proposal to purchase Boeing 747s for foreign trade is not recommended at the present time.

All recommended projects should be the subject of feasibility studies which should reconsider, where appropriate, the question of modal competition.

CHAPTER 16

ORGANIZATIONAL ASPECTS OF TRANSPORT

CHAPTER 16

ORGANIZATIONAL ASPECTS OF TRANSPORT

In this section of the report, the organization of the major transport modes is analyzed in order to establish the adequacy of the existing regulations in achieving the transport policy objectives as discussed previously. A number of recommendations are made to improve the situation.

The Transport Sector as a Whole

With the exception of the rail sector, which is discussed in Chapter 13, the various transport modes display similar characteristics in their organizational structure. Operation is in the hand of numerous small enterprises, with the possible intervention by the state as a controlling agent. Scheduled air passenger transport is dominated by a single carrier resulting from the technological and financial requirements of the mode and the need to operate internationally. However, numerous small operators have evolved to provide air cargo and air taxi services.

Overall responsibility of the direction of the transport sector lies with the Ministry of Transport, Communications and Civil Aeronautics (1), whose structure is shown in Figure 16-1. It is divided into eleven Directorates, two of which concern themselves with non-transport matters (mail and telephone). The Ministry also exercises control over autonomous state agencies such as the National Road Service (SNC) and the Railroad Company (ENFE).

Financial Situation - As discussed in Chapter 6, the financial conditions of the transport sector give reasons for concern. Road transport is in a difficult situation,partly because of an oversupply of trucking capacity. River transport is confronted with similar excess of supply, which has led to the voluntary restriction placed by operators on cargo size. In the air sector the national airline, LAB, faces a serious deficit, and the airport administration AASANA is unable to cover all its costs.

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(1) In October 1980, a new Aeronautics Ministry was created, which takes over from the Ministry of Transport the functions connected with air transport.

Overall one may conclude that the serious situation has come about partly as a result of a fundamental excess of supply within the transport industry; also, tariffs have been kept at the same level for many years (until 1979), while operating costs were rising. The objective of this chapter is to present the major problems of the modes and suggest mitigating measures that should be implemented.

Existing Regulations - Bolivia does not possess a General Law for the transport sector which considers the regulatory needs of each mode and controls competition. Nor is there a law for each mode regulating operations and protecting the rights of the users; existing legislation is patchy and lacks an overall focus.

General Law on Railroads - Passed in 1918, the general railroad law is an exception to the statement made above, although it has little influence now. Its original purpose was the control of railroad construction in the boom years. Today most of its provisions are obsolete as a result of the major changes that have taken place in the transport sector. From a legal viewpoint, the law ought to be revised, eliminating outdated sections and recognizing that, with one national railroad,there is no possibility of competition. As a point of interest, Article 78 of Chapter XII of the law extends its application to road projects and the provision of any transport services, be they by road, river or lake. Thus it is set out to be a general regulation for the whole sector, recognizing the need for joint legislation. Regrettably, no action in this direction has been taken since.

The Organizational Structure of Road Transport

The organization with overall responsibility for this sector is the General Directorate of Road Transport (DGTA)of the Ministry of Transport, which has the following main duties:

(i) To determine the national and international policy for the development of road transport;

(ii) To direct and regulate the provision of services and infrastructure within the sector;

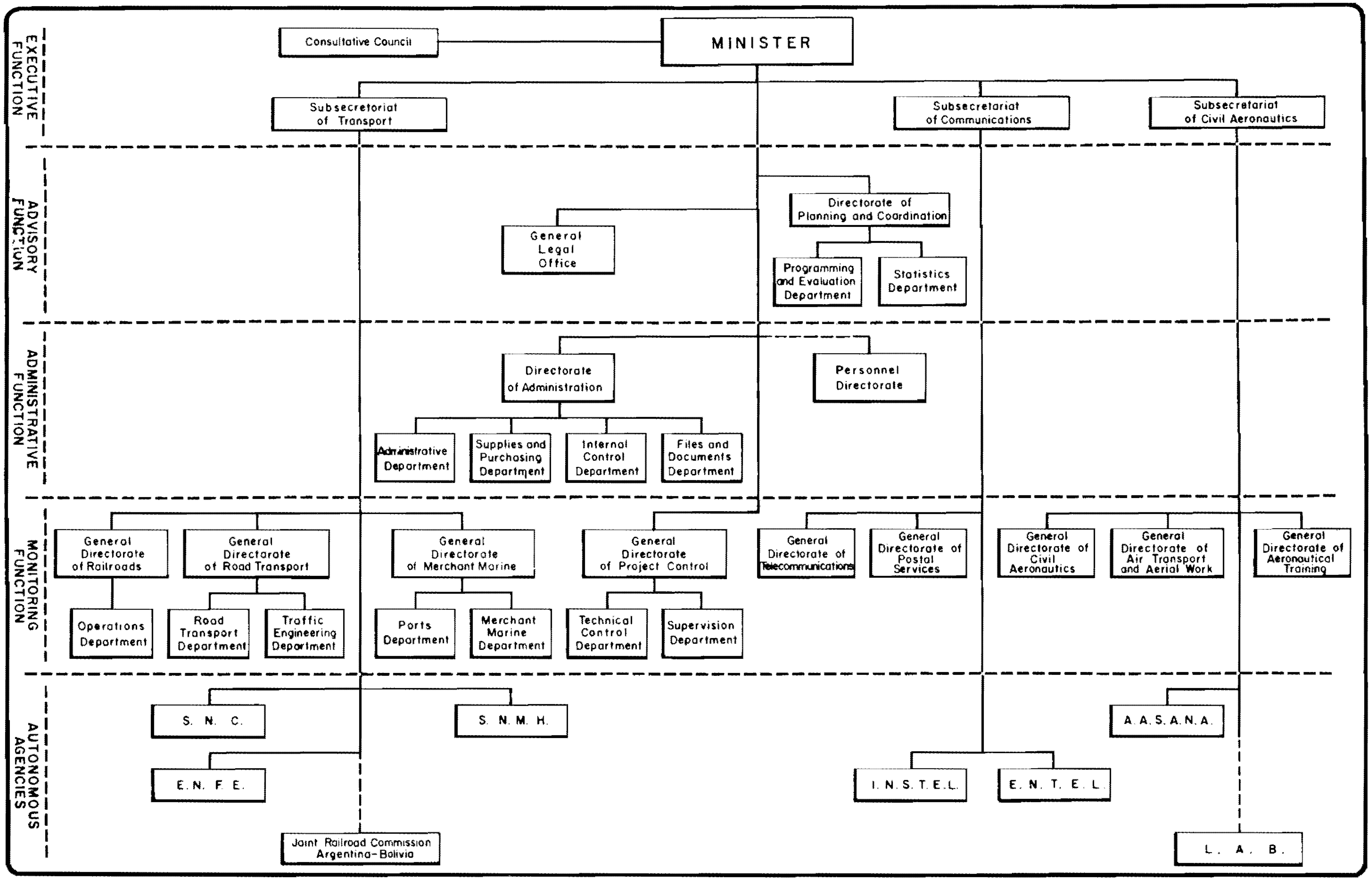
(iii) To promote coordination with other modes;

(iv) To propose safety standards;

(v) To propose the tariff system;

(vi) To maintain a register of transport companies;

(vii) To coordinate with the National Transit Service (SNT), a police force under the Ministry of the Interior.



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ORGANIZATION OF THE MINISTRY OF TRANSPORT, COMMUNICATIONS, AND CIVIL AERONAUTICS

FIGURE 16–1

At present, DGTA numbers only five persons, which is clearly inadequate to perform the tasks required of it. In effect, it has become a peripheral force, and power lies mainly in the hands of the operators, consisting of two basic groups: the companies (including cooperatives) and the drivers' syndicates.

The Syndicates - These represent operators, grouped according to the characteristics of their service, such as urban, interdepartmental, and interprovincial transport of passengers and freight. The existing legislation gives the syndicates a virtual monopoly of services, with the sole exception of international traffic and interdepartmental passenger traffic: to obtain an operating permit, one must be member of a syndicate. An important basic rule is that syndicate members may not own more than two vehicles.

Syndicates are grouped in departmental Federations, under the overall control of the Bolivian Confederation of Drivers; Figure 16-2 shows the organizational structure. In 1979, there were 130 professional syndicates, of which 44 concerned themselves with urban transport. In principle, once the requirements of an individual syndicate have been complied with, entry is without restriction. In practice, the Federations regulate access according to a number of criteria, including the perceived state of the local market for transport services. However, such regulation is not based on reliable data, nor is there any coordination between groups.

The monopoly enjoyed by the syndicates has given rise to a system of freight distribution among the members, which is similar to that of the French "Bureaux de Fret". Each departmental federation acts as a central collecting agency for goods produced in its region and distributes them among its members by a mutually agreed system, essentially based on a waiting list. Half of the available freight is reserved for drivers from other syndicates to be distributed in accordance with observed interdepartmental flows. The basic aim of the system is to avoid competition and to provide backhauls for truckers from other departments. However, it often occurs that trucks drive empty to other departments to collect return cargo, which is clearly inefficient.

In the case of some major clients, federations sign contracts for the exclusive provision of transport, dividing the business between their members as before. It is also possible for a client to contract an individual operator; in this case the federation must be informed of the agreement.

The Transport Companies - The technical definition of the term company, in this context, excludes the owners of one or two vehicles, restricting the term to the providers of international services (mostly freight) and interdepartmental passenger service. A total of 40 companies provide interdepartmental passenger transport, but only 24 of these are registered as required with the DGTA. International passenger service is provided by two companies, one Peruvian and the other a Bolivian syndicate. International freight transport is carried out by 13 firms, 8 of which are cooperatives.

Of particular importance in this sector are the Drivers' Cooperatives created under the General Cooperatives Law, and regulated by the National Cooperatives Institute (INALCO). From the standpoint of the Ministry, these are treated as normal companies.

Documentation - In order to operate, two main documents are required. The Route Sheet (Hoja de Ruta) is stipulated by the Traffic Code, and has to be presented as required along the route and delivered at the destination. It is used by the road police as a control device, without, however, providing the statistical information originally intended.

The Operating Permit (Permiso de Operación) is granted by the DGTA upon request from the Federation or company, and authorizes a particular vehicle for service.

The Regulation of Road Transport

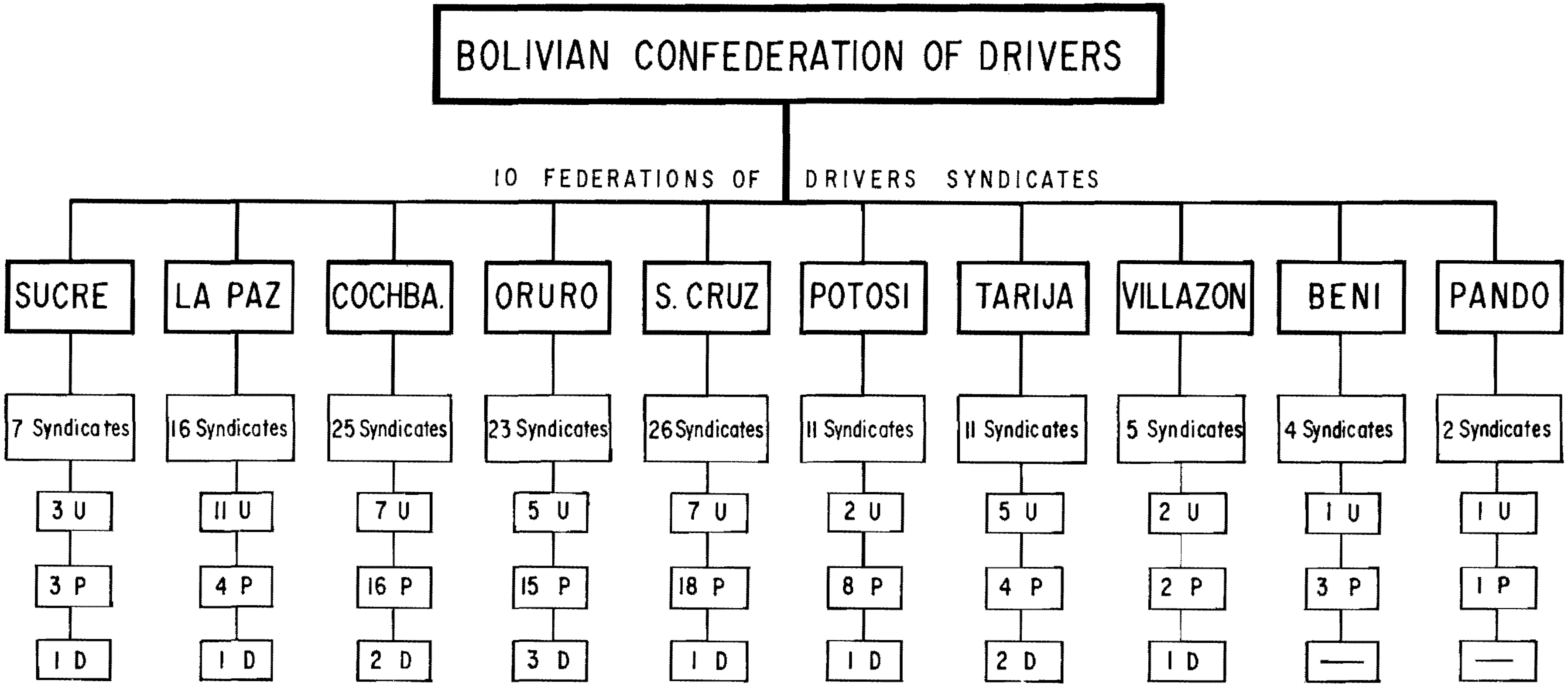
The legal dispositions regulating transport are described and analyzed in Working Paper 127. The main regulations are summarized in Appendix 16A. The principal legislation in this sector is Supreme Decree 10715 of February 1, 1975, which is based on the provisions of Ministerial Resolution 49/71 of April 21, 1971 and the regulations dated December 5, 1972. It establishes the basic rules which have determined operations in recent years. The fundamental provisions are:

(i) Public road transport is under the jurisdiction of the Ministry of Transport;

(ii) The Ministry has the power of inspection and control of both public and private road transport;

(iii) The law establishes definitions of public and private services;

(iv) Operating licenses are issued by the Ministry of Transport;



LEGEND:
- U Syndicates for Urban Transport.
- P Syndicates for Transport between Provinces.
- D Syndicates Transport between Departments.

NOTE: Covers Transport of both passengers and freight.

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ORGANIZATION OF PUBLIC ROAD TRANSPORT (1979)

FIGURE 16–2

(v) The Law restricts the operation of urban and interprovincial passenger services and of interprovincial and interdepartmental freight services to drivers' syndicates, which have to be affiliated with the Bolivian Confederation of Drivers;

(vi) The operation of interdepartmental passenger and of international passenger and freight services may be authorized for syndicates or companies.

Law Decree 11/48 of October 26, 1973 made the Route Sheet compulsory. Other regulations charge the Ministry of Transport with the control of vehicle imports, maximum permissible axle weights and vehicle sizes, bilateral conventions on international transport, ability to regulate tariffs, and various vehicle taxes.

Analysis of the Existing System - As discussed in Chapter 2, a strong case can be made for the State to intervene in the organization of road transport. However, the question must be asked whether the existing system in Bolivia is achieving its aims, and whether it is operating efficiently. It is evident that substantial improvements are possible, for a number of reasons:

(i) A general transport policy is lacking upon which particular regulations could be based;

(ii) Existing laws are inadequate to deal with all the problems that arise in road transport;

(iii) In particular, there are no provisions to establish a system of own-account transport;

(iv) The Ministry of Transport lacks the power to promote new services or to modify the existing ones in the public interest;

(v) The definition and classification of services is incomplete;

(vi) The technical vehicle standards are regulated inadequately;

(vii) There are no defined criteria to establish and revise tariffs;

(viii) There is no compulsory insurance covering passengers and cargo;

(ix) There is no system of regular vehicle inspection.

Of particular importance is the keeping of a Register of Transport Companies: the definition of bodies who must be registered should be expanded to include all organizations offering services, not simply those who call themselves companies.

Turning to the actual operations, the overriding observation is that the lack of an effective presence on the part ot the Ministry of Transport (in the form of DGTA) has led to a situation where control effectively lies in the hands of the syndicates. These obviously act in their own interests, defending their effective monopoly and limiting their members to a maximum of two vehicles. The principal observations on the road transport operations are as follows:

(i) The frequent stops required to check Route Sheets, deal with local customs levies, etc. have a negative impact on productivity, especially in those cases where routes are closed at night;

(ii) The Route Sheet is not used, as it might be, to obtain statistical data on cargo and passenger flows;

(iii) There is no effective vehicle inspection by the Ministry of Transport and no coordination with the National Transit Service to enforce existing regulations;

(iv) The DGTA, mainly for lack of personnel, is failing to exercise its designated functions, such as controlling services, promoting new ones, establishing an insurance system and maintaining a register of firms;

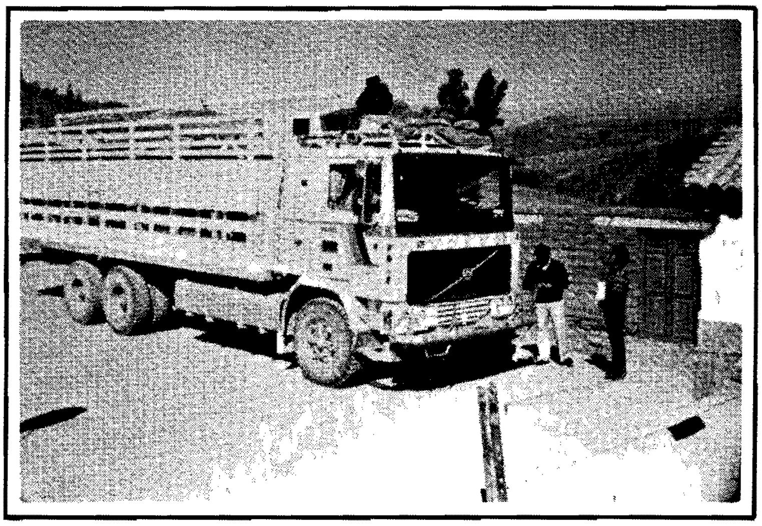
(v) There are no technical and economic requirements to become a trucker;

(vi) Passenger transport services are of poor quality in many areas and often do not meet demand;

(vii) Freight transport does not operate economically, with very low rates of vehicle utilization; with tariffs higher than would be necessary with more efficient operation, thus permitting inefficient operators to stay in business; and with restrictions on vehicle ownership which prevents the growth of larger firms and the resulting economies of scale.

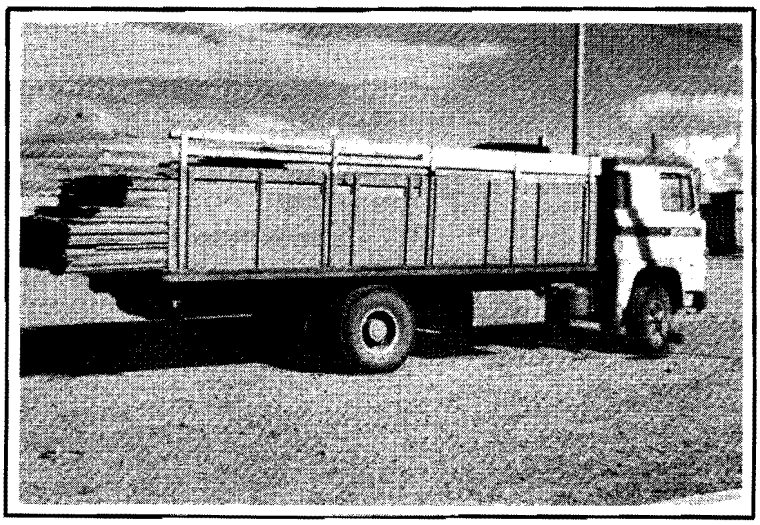
The overall effect of the existing monopoly in the freight sector is to create imbalance between demand and supply in many areas of the country and to raise freight tariffs to a level higher than they need be.

NEAR SUCRE



CARRYING PASSENGERS AND THEIR GOODS

SINGLE REAR-AXLE TRUCK WITH CAPACITY GREATER THAN LEGAL AXLE LOADS PERMIT



TRUCK TRANSPORT

Alternatives Considered - A number of alternative courses of action have been evaluated, in order to achieve better regulations and a more efficient organizational structure of road transport. These range from a complete freedom of competition to complete government control, and also include the continuation of the present system.

Regulation of operations should be defined within the framework of a Basic Law for Motor Transport which would establish the appropriate dispositions needed for successful operation of the sector. Such a law should cover the following aspects:

- The responsibilities of the Ministry of Transport;
- Definition and classification of road transport services, types of operators and their rights and obligations;
- Regulation of access to the road transport industry;
- Specification of vehicle characteristics for each type of service;
- Register of firms and operating permits;
- System of approval and revision of tariffs;
- Insurance system;
- System of vehicle inspection with sanctions.

Turning to the organizational structure of road transport, six alternatives have been analyzed:

0 Minimum regulation of the sector.

1 Continuation of the present system.

2 Continuation of the present system, but with far greater intervention by the Ministry of Transport. The Ministry would become effective in controlling access to the industry and would have the power to impose the provision of services where necessary.

3 Revocation of Supreme Decree 10715, abolishing the privileged legal position of the road transport syndicates.

4 Creation of a National Transport Company, which would then operate in competition with the syndicates.

5 Nationalization of the entire road transport sector.

These six alternatives were evaluated according to a rating system, whereby relative scores were given for the following eight criteria: (i) economic efficiency, (ii) service quality, (iii) service to isolated communities, (iv) avoidance of monopolistic behavior, (v) optimized use of available vehicles, (vi) consideration of syndicate pressures, (vii) provision of employment, (viii) likelihood of strikes. The evaluation, which is described in Working Paper 146, resulted in the recommendation of Alternative 2 (to be possibly followed by Alternative 3) as will be discussed in the next section.

Conclusions on Road Transport - To bring about the needed improvements, it is recommended to implement Alternative 2, at least initially. If it proves to be impossible to obtain the desired results through this measure, serious consideration should be given to the repeal of Supreme Decree 10715, defined above as Alternative 3.

Thus, a major effort is required by the Ministry of Transport to expand the capacity of DGTA so it can perform its duties. Also, the existing legal provisions should be revised and expanded to assure that entry to the road transport industry and the registration of transport companies be effectively controlled by DGTA; those dispositions of Ministerial Resolution 49/71, which are in contradiction with these objectives, should be repealed. In addition, an Interministerial Commission should be set up to reconcile the responsibilities of the DGTA and the National Transit Service, with specific reference to the use of the Route Sheet, the vehicle inspection system, the introduction of compulsory insurance, and removal of the present road check points erected by various entities.

It will take some time for DGTA to build up its capacity to effectively control access to the road transport industry. On the other hand, there are now far more trucks in the country than needed to serve current demand, a situation which was not prevented by the syndicates' own control of access to the industry. In view of this, it is recommended that the import of trucks be prohibited at least during 1981 to avoid a further uneconomic drain on the country's foreign reserves. By 1982, DGTA should be in a position to perform the functions recommended, whereupon the somewhat rigid import restrictions could be lifted.

In the long term, the legislation discussed above should be integrated within a General Law of Transport to be developed by the Ministry of Transport with the involvement of the Ministry of Interior.

Vehicle Registration - The only national register at present is that of the National Transit Service (SNT). Registration is also required by municipalities when license plates are issued. Figure 16-3 shows the registry forms in use; a detailed discussion of the issues related to vehicle registration is contained in Working Paper 127a.

The National Transit Code states that "vehicles and legal acts relating to them shall be noted in the Transit Register". This contains data on:

(i) Characteristics of the vehicle;

(ii) Details of ownership, sales, and financial information;

(iii) Court orders limiting vehicle ownership;

(iv) Accidents.

The register serves a useful purpose for the traffic police in tracing thefts, accidents, etc. The register is maintained manually, by number of license plate; an alphabetical listing is also kept. A major problem is the lack of knowledge concerning vehicles taken out of service, which are not deregistered.

Another central register used to be maintained to facilitate collection of vehicle tax. This function has now been handed over to the major municipalities. Imported vehicles are registered only at the point of entry, with no central register.

The Municipal Authorities of the departmental capitals maintain a register of vehicles existing in their department. The registers for La Paz and Santa Cruz are being computerized.

The Ministry of Transport is required by law to maintain a register of transport companies: this has been interpreted to refer only to organizations registered as companies for tax purposes, and thus contains only the operators of international, and of interdepartmental passenger services.

As a result of this dispersion of controls, it is virtually impossible to arrive at a credible estimation of the existing vehicle fleet in the nation.

Table 16-1 shows the national vehicle fleet for 1978, as used by the Ministry of Transport in their "Emergency Plan 1980" Table 16-2 shows the estimation made by the National Transit Service for 1979. It indicates that the data for the departments of Oruro, Beni, Pando and Tarija are incomplete. Thus, information

Table 16-1

NATIONAL VEHICLE FLEET ESTIMATED BY MINISTRY OF TRANSPORT

December 31, 1977

TYPE OF VEHICLE	LA PAZ	SANTA CRUZ	COCHABAMBA	ORURO	POTOSI	TARIJA	CHUQUISACA	PANDO	BENI	TOTAL
Automobiles	11,680	3,587	4,978	982	854	485	393	2	39	23,000
Heavy trucks	5,449	5,196	5,473	2,213	1,580	1,580	1,608	2	42	23,143
Vans	5,414	3,083	4,294	1,151	1,046	732	613	6	147	16,486
Jeeps	2,683	2,740	917	259	166	195	138	1	133	7,232
Landrovers and similar	2,900	703	1,471	448	148	116	111	1	11	5,909
Buses	2,907	650	651	440	225	95	50	-	1	5,019
Official Vehicles	4,102	745	853	157	148	287	280	-	48	6,620
Motorcycles	8,038	4,943	6,063	982	287	531	543	24	1,003	22,414
TOTAL	43,173	21,647	24,700	6,632	4,454	4,021	3,736	36	1,424	109,823

NOTE: Obsolete vehicles are generally not deregistered.

SOURCE: El Plan de Emergencia 1980 (Emergency Plan 1980), Ministry of Transport, Communications and Civil Aeronautics. No adjustments were made, even though some totals do not add up.

MINISTERIO DEL INTERIOR
DIRECCION NAL. DE RECAUDACION

SERVICIO NACIONAL DE TRANSITO

$b. 100.-

Nº 007174

REGISTRO NACIONAL DE VEHICULOS

1.— Lugar de empadronamiento .... Fecha de inscripcion ....
Marca .... Clase de vehiculo .... color .... modelo .... año ....
Nº Motor .... Nº de chasis .... Medida de llantas ....

2.— Capacidad de carga .... Nº de asientos .... Capac. pasajeros ....
Potencia HP .... Kilometraje .... Nº matrícula anterior ....

3.— Vehículo dedicado a: .... Presta servicios como ....
Tipo de servicio que presta .... Tipo de vehículo ....

4.— Valor en $b. .... En $us. .... Fecha que comenzó su uso ....
Propietario anterior ....

5.— Propietario actual .... Nacionalidad ....
Natural de .... Edad .... Carnet de Identidad Nº ....
Estado civil .... Profesion ....
Domicilio .... Garaje ....

6.— Obligaciones en favor de: ....
Archivo Nº .... Año .... Orden judicial de embargo ....
....

7.— Nº de placa .... Marca .... Propietario .... Telf. Nº ....

Dirección General de la Renta Interna
BOLIVIA

Precio $b. 2.50

53650

Registro Nacional de Vehículos Automotores

Distrito ____________ Marca ____________ Modelo ____________ Clase vehículo ____________
Clase Servicio ____________ Color ____________ Peso Kilos ____________ Cap. Ton. ____________
Valor Renta ____________ Valor CIF. ____________ Aduana ____________
Nº Motor ____________ Nº Chasis ____________ Nº Póliza Import. ____________ fecha ____________
Importado por ____________ con C. I. ó Padrón ____________
Propietario anterior ____________ con C. I. ó Padrón ____________
Domicilio ____________ Nº ____________ Teléf. Nº ____________

Propietario actual ____________ C. I. ó Padrón ____________
Nacionalidad ____________ Profesión u Ocupación ____________
Fecha de Transferencia ____________ Domicilio ____________ Nº ____________
Teléf. Nº ____________ Casilla ____________ Placa anterior: ____________
Placa nueva ____________ Placa actual: ____________

VEHICLE REGISTRATION FORMS

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FIGURE 16–3

Table 16-2

NATIONAL VEHICLE FLEET ESTIMATED BY NATIONAL TRANSIT SERVICE
December 31, 1979

TYPE OF VEHICLES	LA PAZ	SANTA CRUZ	COCHABAMBA	ORURO (1)	POTOSI	TARIJA (1)	CHUQUISACA	PANDO (1)	BENI (1)	TOTAL
Automobiles	13,615	3,977	5,840	1,080	904	645	496	2	39	26,598
Heavy trucks	6,184	5,402	6,085	2,347	1,719	1,677	1,267	2	42	24,725
Vans	5,971	3,281	5,115	1,221	1,203	743	640	6	147	18,327
Jeeps	3,917	2,931	1,375	310	224	204	173	1	133	9,268
Landrovers and similar	3,656	805	1,849	495	162	118	119	1	11	7,216
Buses	3,434	758	855	497	255	100	51		1	5,951
Official Vehicles	4,906	783	904	168	166	297	294		48	7,566
Motorcycles	10,388	5,984	8,322	1,479	397	718	812	24	1,003	29,127
TOTAL	52,071	23,921	30,345	7,597	5,030	4,502	3,852	36	1,424	128,778

(1) The data for Pando and Beni are for December 31, 1976. For reasons unknown to the General Directorate of the National Transit Service, data for 1977, 1978 and 1979 were not submitted. With regard to Oruro department, data are lacking for the months of July, September and December 1979. Moreover, Tarija data for 1979 were not submitted, for reasons unknown to the General Directorate.

NOTE: Obsolete vehicles are generally no deregistered.

SOURCE: National Transit Service.

that is vital for the efficient operation of DGTA is unreliable; also much of it is not included among data recorded by the National Transit Service, such as:

- Capacity of trucks and buses
- Vehicle fleet by operator or transport company
- Operating permit associated with each vehicle.

The recommendations relating to the question of vehicle registration are as follows:

(i) The register kept by the National Transport Service should be computerized;

(ii) The necessary measures should be taken to improve the system of reporting by individual departments;

(iii) The National Transit Service should be notified of vehicles taken out of service;

(iv) Vehicles which have been imported illegally should be the object of a campaign for registration;

(v) The DGTA register of firms should include all transport enterprises with operating permits;

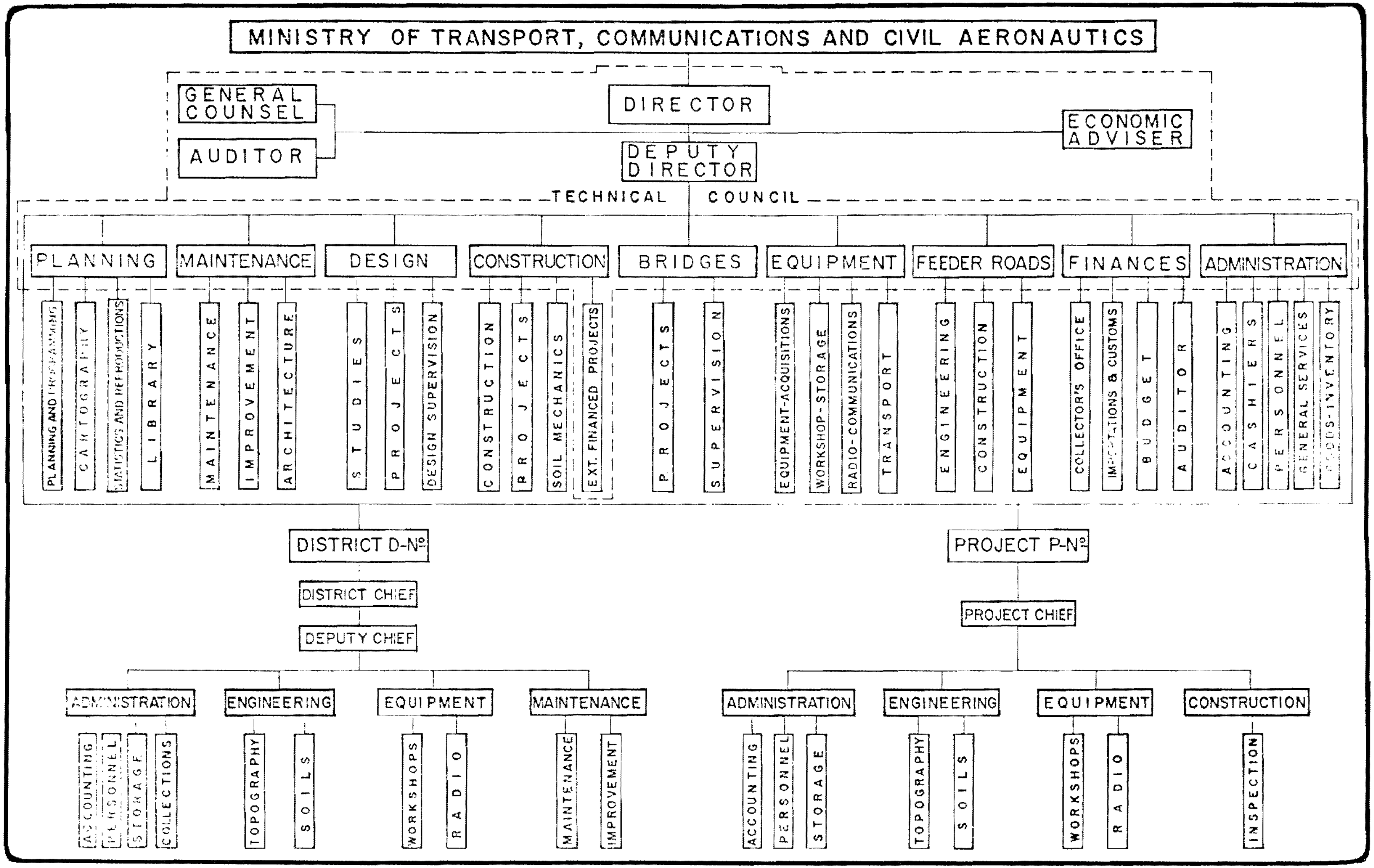
(vi) The DGTA must be given adequate personnel to carry out its functions.

Administration of Roads and its Financing

The planning, construction, maintenance and administration of roads in Bolivia are the responsibility of the National Road Service (Servicio Nacional de Caminos - SNC), an autonomous body under the tutelage of the Ministry of Transport and Communications. SNC was established by Supreme Decree 6684 of February 21, 1964; in 1979 over 5,000 persons were employed by the organization.

Figure 16-4 describes its internal organization, consisting of nine major departments. Throughout the country there are 10 district offices responsible mainly for maintenance and improvement of the network. These districts are divided in their turn into subdistricts (residencias).

Detailed design of major projects is usually carried out by consultants under the supervision of SNC's Design Department. This often follows economic feasibility studies which are usually also carried out by consultants. Several of the roads currently under construction or otherwise committed, such as La Paz-Cotapata-Santa Bárbara, Quillacollo-Confital-Caihuasi and Chimoré-Yapacaní, have been subject to such studies. The same applies to several candidate projects discussed in this report, practically all of which had been found economically feasible; in many cases, these earlier conclusions have not been confirmed by the findings of this present Study.



ORGANIZATION OF THE NATIONAL HIGHWAY SERVICE

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FIGURE 16–4

Once the road designs are ready, SNC's Construction Department prepares the specifications for construction and supervision of works, as well as the related contract documents. The bidding process usually takes about one year.

Analysis of Existing Organization - SNC faces a number of problems relating to its internal organization: there tends to be a lack of coordination between departments, and there is a certain duplication of the functions of Director and Deputy Director. For this reason a revised structure is proposed to increase interdepartmental contact and relieve pressure from the Deputy Director. Three new subdirectorates are proposed, each of which would oversee the work of several departments. They are as follows:

- Planning and Design Subdirectorate
- Construction and Maintenance Subdirectorate
- Administrative Subdirectorate

The Construction and Maintenance Subdirectorate would consist of the existing Departments of Maintenance, Equipment, Bridges, Construction and Feeder Raods. The Finance and Administration Departments would come under the Administrative Subdirectorate. The Planning and Design Subdirectorate would include the existing Departments of Planning and Design and would also incorporate the functions of the Economic Advisor. In addition, it is suggested that consideration be given to the creation of a Studies and Investigation Department, under the same Subdirectorate. The aim of this new Department would be to perform certain basic road research relevant to Bolivian conditions, and to strengthen SNC's capability in conducting or supervising economic feasibility studies.

The coordination between central and district offices requires revision as well. At present the system is highly centralized with requests for vehicle spares, for example, being channelled through the central office in La Paz with the result that delays can become immense. For example, equipment availability in the Beni was as low as 40 percent owing to lack of spare parts. The District Chiefs find most of their time taken up with administrative matters and have very limited powers of independent action. Technical responsibility falls largely upon the Deputy District Chiefs creating many of the same problems experienced in the central organization.

It is therefore recommended that the Districts be given more power in financial matters, and that they be re-organized in a similar fashion as the central office. Three subunits are suggested for each district, dealing with (i) maintenance, (ii) engineering and construction and (iii) administration.

The Financial Base of SNC - The main source of funds is the Central Treasury, complemented by external loans, and also direct road user tolls. The latter, paid by users of roads that have permanent maintenance, are based on a rate of 0.02 pesos per vehicle-kilometer. In recent years however, as shown in Table 16-3, the costs of collecting this tax have steadily increased until they absorb nearly all the receipts. Thus, the net revenue from this source amounts to only 0.2 percent of SNC's total income, presented in Chapter 6. In consequence, SNC is faced with two alternative courses of action: either the rate at which the tax is charged is raised significantly, or the system is abandoned. For reasons in addition to purely financial arguments, such as the user costs in lost vehicle time and the difficulty of controlling the collection of high tolls, it is recommended that the present system be abandoned. An alternative system of vehicle taxation is discussed in Chapter 17.

The Organization of the Air Sector

Because of the international nature of its operations, the air transport sector displays different characteristics from the other modes regarding its organization and regulation. International standards apply equally to operations within the country in many cases. The basic legislation affecting air transport is the following:

(i) Chicago Convention on Civil Aviation (1944),which established uniform standards for air transport operations, jurisdiction and administration;

(ii) Creation in 1967 of the National Airport Administration (Administración de Aeropuertos y Servicios Auxiliares a la Navegación Aérea - AASANA), separating its functions from the national airline, LAB;

(iii) Creation in 1972 of the National Aeronautics Council, reporting directly to the Presidency;

(iv) Creation in 1972 of the Subsecretariat of Civil Aeronautics;

(v) Creation in 1974 of the General Directorate of Air Transport and Aerial Work;

(vi) Creation in 1978 of the General Directorate of Aeronautical Training;

(vii) Creation in 1980 of a new Aeronautics Ministry, taking over from the Ministry of Transport all functions related to Civil Aviation.

Table 16-3

SNC TOLL RECEIPTS AND COLLECTION COSTS

YEAR	AMOUNTS IN MILLION PESOS Receipts	Costs of Collection	RATIO OF COLLECTION COSTS TO RECEIPTS (%)
1975	7.6	4.3	57
1976	8.3	4.8	58
1977	9.0	5.9	66
1978	9.6	7.4	77
1979	9.8	8.5	87

The regulations of major concern are (i) the Chicago Convention which governs Lloyd Aéreo Boliviano's international traffic and operations at the international airports of La Paz, Santa Cruz and Cochabamba, and (ii) the Aeronautics Code which combines the relevant legislation in the sector with general policy statements and international agreements.

Analysis of Air Sector Organization - Figure 16-5 depicts the overall organization of air transport, prior to the creation of a new Aeronautics Ministry in October 1980. The National Aeronautics Council is the supreme body in the sector with broadly defined responsibilities. These include:

(i) Advising the Supreme Government and the central administration on aviation activities;

(ii) Coordinating the country's human and financial resources in the aeronautics field, and providing coordination between the civilian and military sectors;

(iii) Controlling and executing the national aviation policy;

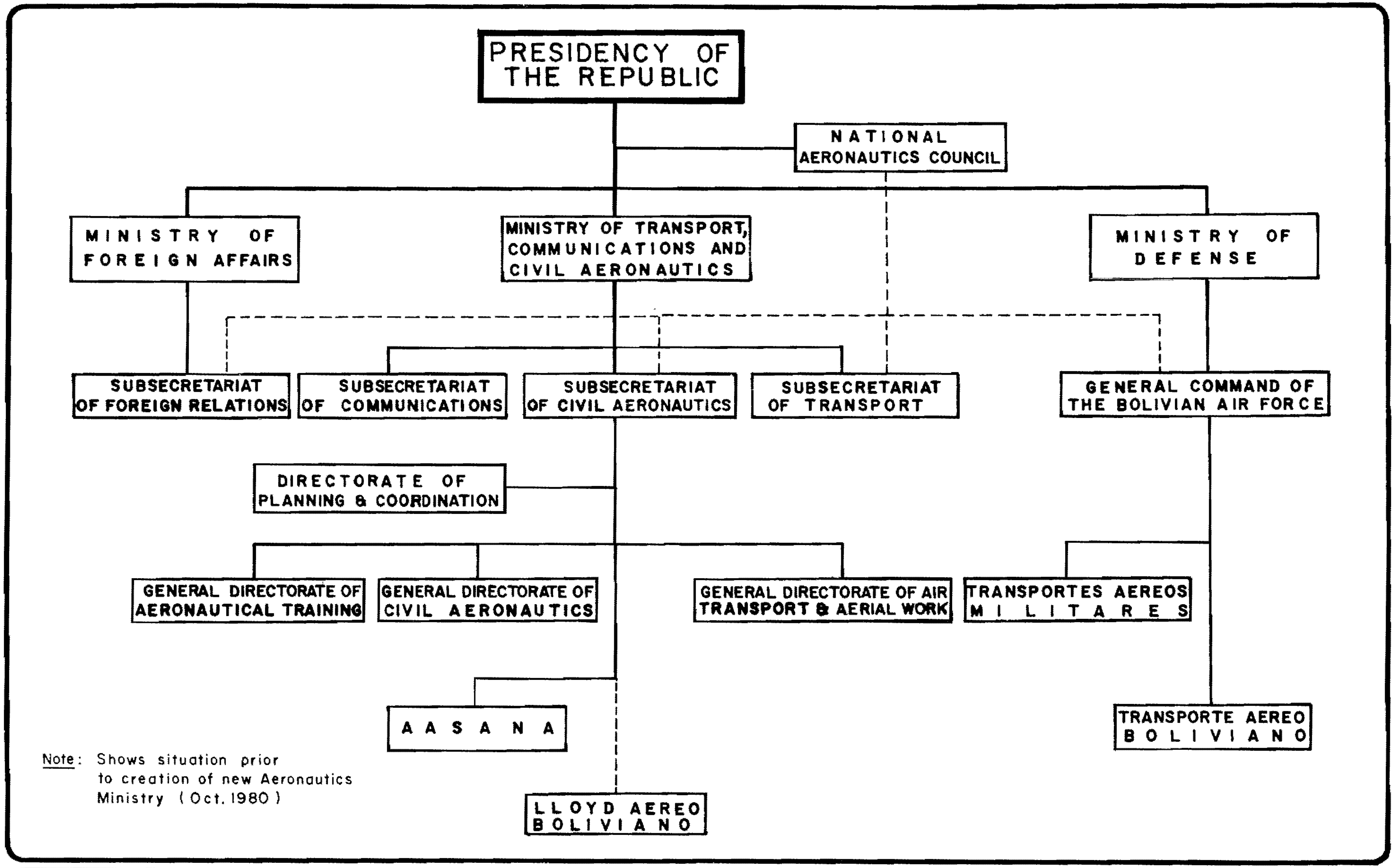
(iv) Judging all aspects of aviation projects and other activities of general interest to national aeronautics.

Within the Ministry of Transport, control of the air transport sector lay with the Subsecretary for Civil Aeronautics, who supervised three General Directorates: (a) Civil Aeronautics, (b) Air Transport and Aerial Work, and (c) Aeronautical Training.

AASANA - The National Airport Administration is an operationally autonomous organization, responsible for the construction, maintenance and operation of airports, as well as the provision of communications and meteorological services needed for air navigation. At present the organization lacks sufficient resources to adequately perform all its tasks, such as the adequate supervision of consultants, by whom much detail design work is done.

Air Transport Services - The national airline (Lloyd Aéreo Boliviano - LAB), which is 98-percent State owned, is the principal passenger carrier. It provides links between all major population centers, and to some isolated areas. It is also developing an important international operation. The structure of its internal organization appears adequate.

Transportes Aéreos Militares (TAM) has the double function of providing logistical support to the army units throughout the country and also serving isolated communities not reached by LAB or any other transport mode. However, TAM also operates some of the same trunk routes as LAB, an activity which can be considered



ORGANIZATION OF AIR TRANSPORT

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FIGURE 16–5

to contribute to LAB's financial problems. TAM is not required to pay airport fees directly to AASANA, and in addition sometimes uses military airfields for its passenger services. Moreover, a different insurance schedule is applied to TAM operations.

Non-scheduled air freight services, both domestic and international, are offered by another Armed Forces organization, Transportes Aéreos Bolivianos (TAB). In addition, domestic services are provided by 25 companies dedicated to freight transport, principally meat from the Beni. These are grouped in the Association of Private Air Transport Firms (ADEPTA) to defend their common interests regarding such items as tariffs and taxes. Approximately 140 operators of air taxis are grouped into regional organizations.

Conclusions on Air Transport Organization - The recent creation of the Aeronautics Ministry will most likely affect the powers and duties of the National Aeronautics Council. It appears desirable that the forthcoming administrative changes include the formation of a consultative council with representation from all the entities interested in air transport, such as AASANA, LAB, TAM, ADEPTA, and the Directorates of Civil Aeronautics and of Air Transport and Aerial Works. This council would be consulted before any new operating permits are issued, or before major investments by the State enterprises are approved.

The technical capabilities of AASANA need to be strengthened, mainly by keeping and attracting competent staff through higher salaries. In the meantime, more construction and installation supervision should be subcontracted to consultants where appropriate, as it is apparent that AASANA's capabilities in this sphere are limited.

TAM should be required to make the same payments as LAB for its commercial operations, at least in those areas where there is direct competition between the two airlines. Also it should not be allowed to compete directly with LAB at greatly subsidized tariffs.

Organizational Structure of Water Transport

The land-locked situation of Bolivia and the physical peculiarities of the several waterways that are not connected with each other mean that each area requires specific treatment. The organization of water transport is discussed in Working Paper 147, and the analysis is summarized in the following paragraphs. The current legislation on water transport is summarized in Appendix 16B and is discussed below.

Current Legislation - Supreme Decrees 12683 to 12685, passed on July 18, 1975, establish the basic navigation policy. As shown in Figure 16-6, the Bolivian Navy (FNB) is in overall charge of navigation through the General Directorate of Port Captaincies (DGCP).

However, commercial water transport is regulated by the General Directorate of the Merchant Marine (DGMM), an organ within the Ministry of Transport. To complement this the FNB is empowered to operate services to isolated regions without seeking commercial gain. DGMM must approve petrol movements by FNB as well as routes, frequencies, timing and tariffs of regular cargo services. It is also responsible for planning port construction.

The FNB, on the other hand, is responsible for the national register of boats, inspection of vessels and navigational controls, lights, etc.

Analysis of Water Transport Regulations - There is a clear imbalance in the regulatory powers granted to the DGMM and the FNB which is revealed in the Navigation Law, which devotes 127 articles to the responsibilities of the FNB and only one to those of the DGMM. The only real power lying with the DGMM is the approval of tariffs, but in practice the data required for its calculations, such as movement statistics and registration of vessels, rest with the Navy. The other responsibilities given to the DGMM are impractical, such as the authorization of foreign boats to carry coastal traffic.

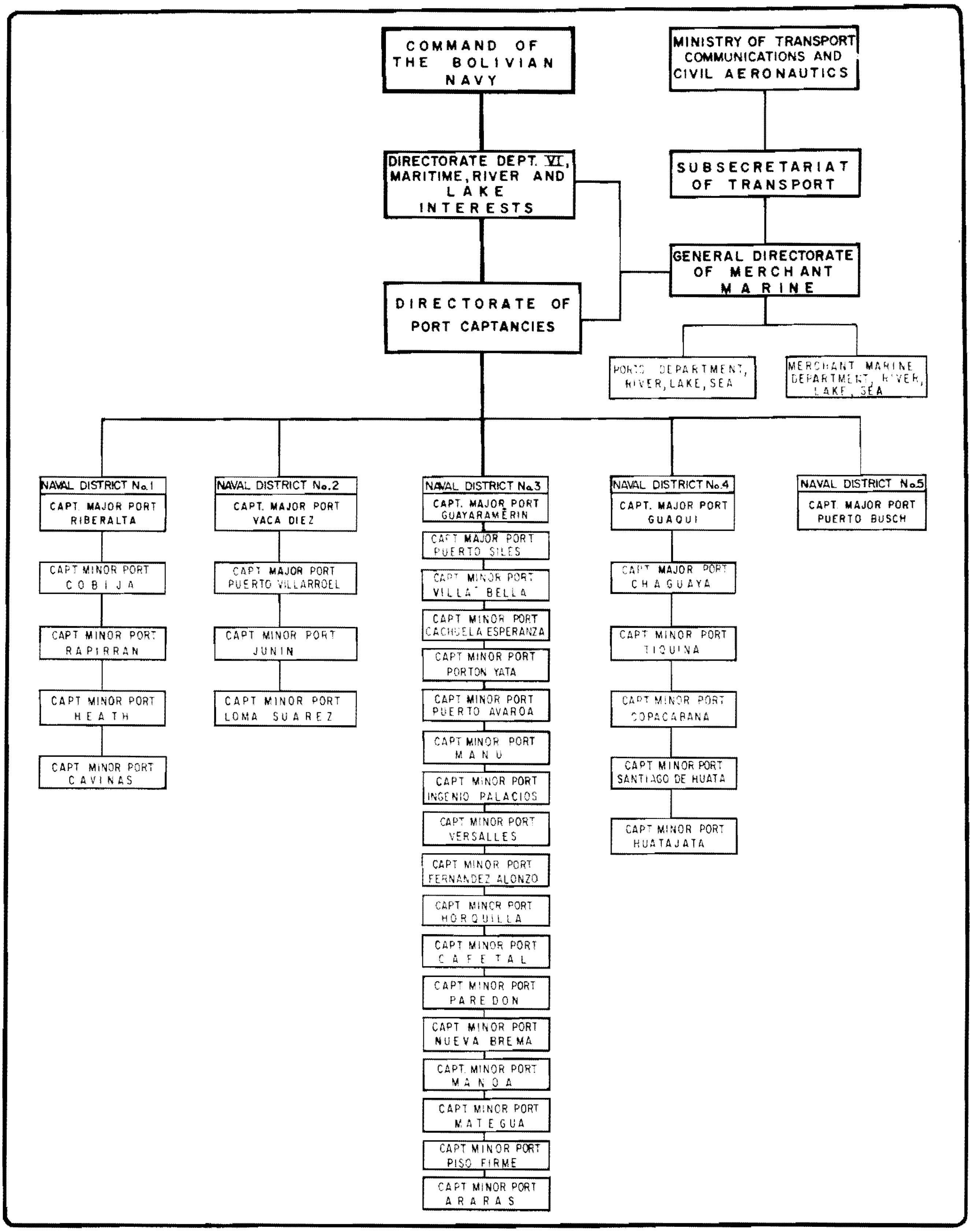
Organization of Structure of River Transport - The most important internal river system is that of the Ichilo-Mamoré which has two operators' associations: the Association of River Operators, and the Transporters Association of the Beni, which is an off-shoot of the former organization.

Both associations operate boats of 150-200 ton capacity. Other operators, not organized in any form, use smaller boats. As with the road syndicates, one of the aims of the organizations is to avoid competition -- as a countermeasure to the low level of demand for river transport, they have imposed a limit of 150 tons per shipment, which is clearly inefficient from a purely economic viewpoint.

The Bolivian Navy appears to be running a commercial operation carrying petroleum products. For this purpose it owns four tanker vessels with a capacity of 250,000 liters each.

Organization of Lake Transport - Lake transport between Puno and Bolivian ports is operated by the Railroads of Southern Peru. The port of Guaqui is operated by ENFE, with AADAA controlling the warehousing. The zone is under the overall control of the Captaincy of the Bolivian Navy, who authorizes movements of shipping and controls navigation of the lake.

Organization of Maritime Transport - Bolivia possesses an expanding shipping line, LINABOL, which operates in association with foreign companies. The use of the Chilean, Brazilian and Argentinian ports and the access to them, are the subject of several bilateral conventions. It is one of the functions of DGMM to oversee all these commercial activities.



ORGANIZATION OF RIVER TRANSPORT

Wilbur Smith and Associates FIGURE 16–6

A Ports Commission has also been created as a high level advisory body, presided over by the Subsecretary for Foreign Relations. It was made up of public and private entities with an interest in ocean traffic. However, it lacked a permanent structure and has not operated for several years.

Conclusions on Water Transport Organization - The overall conclusion is that an unacceptable degree of conflict exists between the functions of the DGMM and the FNB to the detriment of the efficient operation of the sector. The following action is therefore recommended[2]:

(i) Abolition of the DGMM, transferring its responsibilities to the FNB;

(ii) Integration of the former powers of the DGMM regarding lake and river transport with those of the DGCP;

(iii) Creation of a permanent secretariat for the Ports Commision as a consultative body;

(iv) Delegation of the responsibility for river ports to the local level, in most cases to the appropriate departmental development corporations.

Conclusions on Organizational Aspects of Transport

The main observation is the need for a more active participation by the Ministry of Transport in the regulation of road transport. The financial situation of all modes is serious, with the level of economic activity failing to generate sufficient transport demand to meet the supply in both infrastructure and services. In general, the level of regulation is insufficient, with strong operators' organizations acting in their own interests and apparently often to the users' detriment.

The resulting recommendations for each mode are as follows:

Road Transport - Regulation of road transport is weak and poorly implemented, basically because of lack of resources on the part of the crucial bodies. To remedy the situation, the following is recommended:

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(2) On January 8, 1981, Supreme Decrees 17918 and 17919 established a new Subsecretariat of Maritime, River and Lake Interests. A commission was subsequently formed to define the functions of this new Subsecretariat which is under the control of the Ministry of Defense. The Study's recommendations were slightly modified to take account of the new development.

(i) Restructure the General Directorate of Road Transport (DGTA) of the Ministry of Transport, increasing its resources and creating regional offices;

(ii) Form interministerial commission including representatives of DGTA and National Transit Service (SNT), to establish procedures on subjects of common interest such as the sharing of statistical data, implementation of vehicle inspection and insurance system, and removal of toll stations on highways;

(iii) Where in the public interest, DGTA to impose the provision of truck transport if not sufficiently furnished by the syndicates;

(iv) DGTA to impose minimum safety and service levels on buses and passenger services;

(v) DGTA to determine a rational tariff system related to real operating costs, with a system for updating as required;

(vi) DGTA to draw up a register of transport companies, operating permits and commercial vehicles, with annual revision;

(vii) DGTA to be charged with issuing operating permits; as a first step, it should clearly define the criteria for granting access to the profession;

(viii) DGTA to determine the number and type of permits that should be issued annually on the basis of a level of observed demand for services;

(ix) As interim solution,no permits are to be issued in 1981 for the importation of road transport vehicles;

(x) Establish a system to process the statistics at present contained on the Route Sheet;

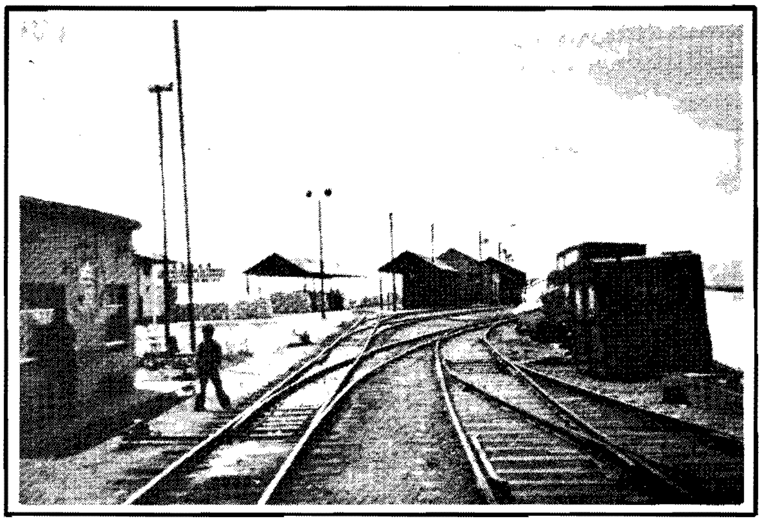
(xi) Establish an efficient vehicle inspection system with adequate sanctions to ensure compliance;

(xii) Abolish the Tránsito system, except on specific roads where tolls are appropriate (such as the Autopista), replacing lost revenues through indirect taxation of users;

(xiii) Introduce compulsory insurance for cargo and passengers;

GENERAL VIEW

RAIL LINES ONTO THE QUAY



RAIL TO BOAT TRANSFER

GUAQUI PORT , LAKE TITICACA

(xiv) Introduce compulsory third-party insurance for all vehicles circulating on public roads;

(xv) Computerize vehicle registry kept by SNT and establish procedures for regular reporting and updating;

(xvi) Regularize the status of illegally imported vehicles;

(xvii) Compile and publish the currently valid transport legislation;

(xviii) Revise the existing legislation and draw up new regulations to achieve the above;

(xix) Reinforce the organizational structure of SNC to improve performance.

Many of the above recommendations aim at controlling the monopolistic tendencies inherent in the current structure of the road transport industry, as discussed earlier in this chapter. If the suggested measures do not bring about the desired results by 1983, the repeal is recommended of those parts of Supreme Decree 10715 which limit road transport to syndicate members affiliated with the Bolivian Confederation of Drivers; at the same time, competition should be gradually introduced by granting operating permits to independent drivers, cooperatives and companies.

Air Transport - In the reorganization of this sector which is likely to follow the recent creation of an Aeronautics Ministry, a consultative council should be formed which combines representatives of government, airport administration and air transport operators. The National Airport Administration (AASANA) should be strengthened and TAM's commercial operations should be brought onto the same base as those of LAB.

Water Transport - The main conclusion is that the organization and control of the water sector has not been clearly defined in the past. However, government has now taken steps to correct this situation with the formation in early 1981 of the new Subsecretariat of Maritime, River and Lake interests under the Ministry of Defense. In addition, the Study recommends that the administration of the ports of the northern river system should be delegated to the departmental level.

CHAPTER 17

FUTURE TARIFF POLICY AND FINANCIAL PROSPECTS

CHAPTER 17

FUTURE TARIFF POLICY AND FINANCIAL PROSPECTS

A description of current or recent tariffs was given in Chapter 5 and an account of the financial position of the transport industry in Chapter 6. Now, having studied the future development of the economy and the transport system, it is desirable to consider the financial outlook for the industry and its component parts, and to examine the related question of tariff policy. The complex issue of tariff policy will be discussed first, to establish certain objectives and principles. Then the financial and economic implications will be considered of the possibilities and advantages to modify the existing transport tariffs.

Objectives of Tariff Policy

Tariffs serve three purposes. First, they are a means whereby producers may recover their production costs and make a profit. Secondly, since profit is the difference between tariffs and costs, they are an incentive to maximize productivity, especially if they are determined by competition between producers. Thirdly, they are the mechanism whereby consumers exercise their purchasing power and thus dictate the allocation of scarce resources between different products and services. If this latter mechanism is to induce an optimal allocation of resources, i.e. one which maximizes the satisfaction of consumers' wants, subject to the distribution of purchasing power and certain other conditions, the price of a product must equal or bear a close relationship to the opportunity cost of the resources consumed as a consequence of the purchase of that product. This raises a difficult question: what is the relevant cost, and hence the "efficient" price, of the product? But the important point to recognize is that the efficient price is not necessarily the one that will achieve the other tariff objectives of recovering production costs and encouraging productivity. There may be a conflict between economic efficiency and financial self-sufficiency.

In many sectors of the economy this problem does not arise: the average cost of production is easily calculated and satisfies all three objectives. But the transport sector is more complex, for three reasons. First, the structure of transport costs is itself complex; transport infrastructure is very long-lasting, indivisible and costly; once it has been built it often possesses more capacity than is needed and costs very little to use. Secondly, transport is a service; it cannot be stored and it has to be produced when and where it is wanted. This greatly exacerbates the problem of surplus capacity because, even to provide for a small amount of traffic, an extensive infrastructure is necessary, which lies underutilized all or most of the time. Thirdly, there are technical difficulties in charging users directly for the use of roads, which not only makes it difficult to implement an efficient tariff policy on the roads but also has important effects on other modes in competition with the roads.

The consequence of these special characteristics of the transport sector is that the opportunity cost of producing transport services varies greatly. It rises far above average cost when there is congestion and falls far below average cost when the volume of traffic is below the capacity of the system. In Bolivia the latter situation is almost universal.

Transport tariffs consist naturally of two parts: a tariff for the vehicle, be it train, plane, bus or boat, and a tariff for the infrastructure, i.e. the track, airport, road, port, etc. The problems of vehicle tariffs are very different from those of infrastructure tariffs. A few paragraphs of explanation may be helpful.

Vehicle Tariffs - There is relatively little difficulty in determining efficient tariffs for vehicles in interurban service. On the roads and rivers, where all public services are provided by private operators, there is the possibility of leaving the operators free to set their own tariffs. Government intervention is only necessary if there is positive evidence that freedom from control is failing, or would fail, to achieve the objectives of tariffs. The main reasons for this are:

(i) Monopoly. If one or a group of operators are able to impose excessively high tariffs and prevent other operators from entering the industry and charging less, there is a case for breaking the monopoly or, failing that, controlling prices.

(ii) Excessive competition. When there is competition in the transport industry, operators usually object that there is too much competition and that they cannot make a reasonable profit. This may be true if new operators enter the industry without a proper knowledge of the costs or the demand, and drive down load factors and possibly tariffs. Such a situation is not likely to last, but it may last long enough to justify intervention. But intervention could be limited to control of entry; it need not include tariffs.

(iii) Social reasons. Government may wish to help certain classes of the population or certain communities by giving them cheap transport services. This may be achieved by tariff control and a compensating subsidy to the operators.

These general remarks may apply to all modes of transport. Railroad operations are, of course, a State monopoly, as are most internal air passenger services. But other transport services, by air, road and river, are in the hands of small private operators, though not always in effective competition. Each mode will be considered separately later.

Infrastructure Tariffs - The big tariff issues concern the infrastructure. The basic problem is simple: once a road, railroad or airport has been built, no matter what it cost or why it was built, the resource cost of using it is small until such time as the volume of traffic begins to impose pressure on the capacity of the infrastructure, causing delays, which are costly and can mount sharply. Until these capacity limits begin to push up system costs, there is a disadvantage in charging traffic more for using the infrastructure than the real costs of operation and wear-and-tear attributable to its use; the disadvantage is simply that a higher charge discourages use of the system, whose potential benefits are therefore lost to those who would have been willing to pay the lower tariff.

But if the lower tariff -- i.e. the efficient price -- is charged, there is also a disadvantage insofar as the full costs of building and maintaining the infrastructure are not recovered. Other sources of finance must be found, which may undermine the incentive effect of the profit motive. Alternative sources of finance may also carry disadvantages. The ideal source might be the general sales tax, or a value-added tax, but there may be political difficulties in raising it.

The solution to the problem could lie anywhere between a minimum tariff policy, setting all tariffs equal to marginal cost, and a full cost-covering policy, but even within the latter policy it would be possible to charge low (marginal cost) tariffs for some services and higher tariffs (above average cost) for others. The best solution is that combination of tariffs and other sources of income which minimizes the sum of the economic losses caused by inefficient prices and the disadvantages caused by the use of other sources of income.

This sort of solution calls for a knowledge of marginal costs and demand elasticities, neither of which are easy to estimate; it also calls for judgment of the consequences of raising income from sources other than tariffs. In particular it is necessary to consider the effects of a tariff policy for one mode of transport on other modes.

The General Approach

Before looking at each mode separately, it is desirable to determine a general approach to the overall tariff situation. Bolivia presents an extreme picture, repeatedly seen in this Study, of an underutilized transport system. Roads and railroads are often very costly to build, because of the terrain; yet where they have been built they are almost invariably little used. The busiest roads outside towns carry only about 800 vehicles a day and the busiest railroad lines only six to eight trains a day. The busiest airports receive three or four planes an hour during the day, most of which are small private planes.

For this reason there is an obvious attraction in charging tariffs that cover only the marginal maintenance and operating costs attirbutable to the traffic, in order to place no unnecessary discouragement on the growth of traffic and on the economic activity that it reflects. But it does not always follow that low tariffs will lead to more traffic. It is necessary to consider separately each class of traffic, i.e. each commodity and each origin-destination movement, and to judge the elasticity of demand with respect to the tariff level. When demand is highly inelastic, there is no case for charging low tariffs; on the contrary it may be reasonable to charge tariffs above average cost in order to help offset the deficit on other, low-tariff traffic.

It is proposed therefore that a main aim of tariff policy should be to charge low tariffs for infrastructure where this might encourage traffic, but on no account should the tariff be less than the marginal costs attributable to the traffic. With roads, rivers and airports the responsibility for infrastructure is quite separate from that for transport services and the question of charging for the infrastructure arises automatically, but with the railroads the same body, ENFE, is responsible for both infrastructure and services, and there is no separate charge for the infrastructure. It is desirable that rail infrastructure be separately costed (as it is) and that rail tariffs be clearly divided, for the benefit of management, into an infrastructure component and a service component. This makes it easier to devise a rational tariff policy for the railroads and also facilitates coordination of road and rail policies.

This approach to infrastructure tariffs could lead to deficits, although this is not the expectation of the Study, except possibly for airports. If deficits are incurred, though, they must be met in a way that is less damaging than higher tariffs. It may be assumed that some contribution from Treasury funds would be forthcoming because such contributions are already being given. But additional contributions should be sought within the transport sector, on the guiding principle that their impact on production and trade should be minimal.

Another important principle concerns the coordination of competing modes. It is desirable that, where there is a choice between two modes, the difference in their tariffs should equal the difference in their marginal costs, so that whatever policy is adopted, the difference in marginal costs exercises its influence on modal choice.

Railroad Tariffs

The biggest conflict between economic efficiency and financial self-sufficiency arises with ENFE. This is because marginal operating costs are typically only 25 to 35 percent of total costs. The low level of marginal costs is due largely to the fact that all lines, stations and other facilities are operating far below their capacity. Much rolling stock, particularly for passenger traffic, is also underutilized. Consequently additional traffic can be accommodated anywhere on the system at a relatively small addition to ENFE's costs. But if all tariffs were set equal to marginal cost there would be little or no revenue to cover fixed costs.

If, on the other hand, tariffs are set equal to average costs which, however they are defined, are three or four times as high as marginal costs, some traffic will move by road instead of rail, even though the resource costs of so doing are much higher, and other traffic will fail to appear because the higher tariffs will render the trade unprofitable. This cannot be in the national interest.

The attractions of a "low-tariff" policy, i.e. a policy whereby some tariffs are deliberately set below average cost, are particularly strong in Bolivia because of the great need to stimulate the development of natural resources and to promote the required migration of population. The growth of manufacturing is also highly dependent on cheap transport to widen the domestic market and thus obtain economies of scale. But a low-tariff policy carries with it the need to secure alternative sources of finance and to ensure financial discipline in the railroad management.

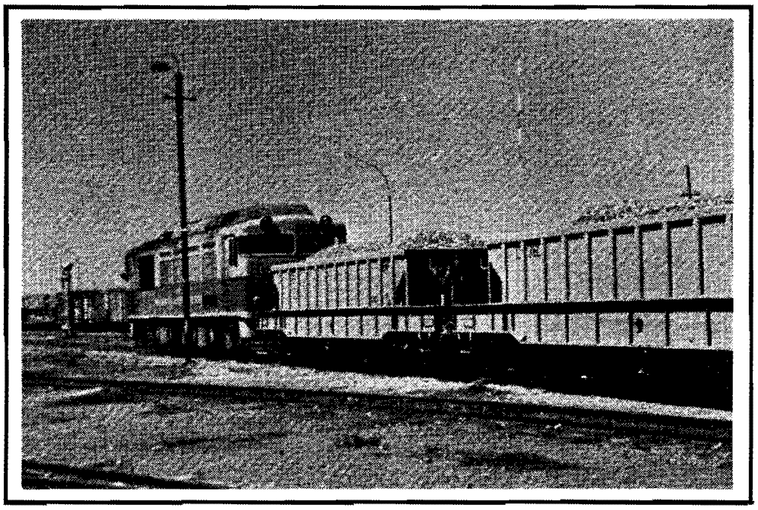
Alternative Sources of Finance - In order to cover the deficits caused by a low-tariff policy, additional income may be sought both within the organization and from the government. The principal possibility within the organization is to charge higher tariffs to traffic that is insensitive to the tariff level, in order to subsidize the low-tariff traffic. Another method used in some countries is for the railroad company to make profits from other activities such as catering, retail shops, hotels, tourism and property investment in order to help finance its railroad activities. In all these cases the railroad company is in effect using its monopoly power to extract abnormal profits with which to finance its unremunerative operations. This would seem to be an innocuous solution to the problem.

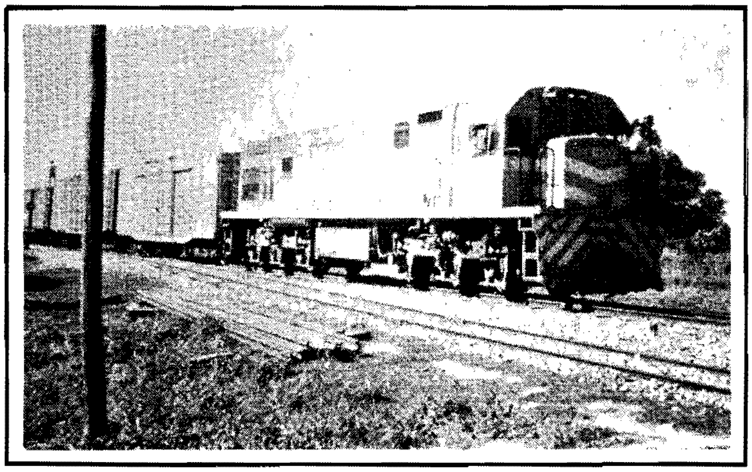
Government finance normally comes from general taxation and it is difficult to be sure just what is the marginal source of such funds. Is it income tax, corporation tax, value-added tax, customs duties or what? In principle, the ideal source of funds to finance a subsidy is probably the value-added tax or a sales tax. It can be shown theoretically that, if tariffs are equated to marginal cost and are financed by a small, proportional increase in all taxes, consumer satisfaction -- in its conventional meaning -- will be higher than if all tariffs are equated to average cost. The sales tax in Bolivia stands currently at 8 percent on certain goods and services and raised $b 503 million in 1979.

In practice, estimates presented later in this chapter demonstrate that ENFE could be self-financing using the principle of cross-subsidation discussed in the first paragraph of this section, so that additional government finance would not be required.

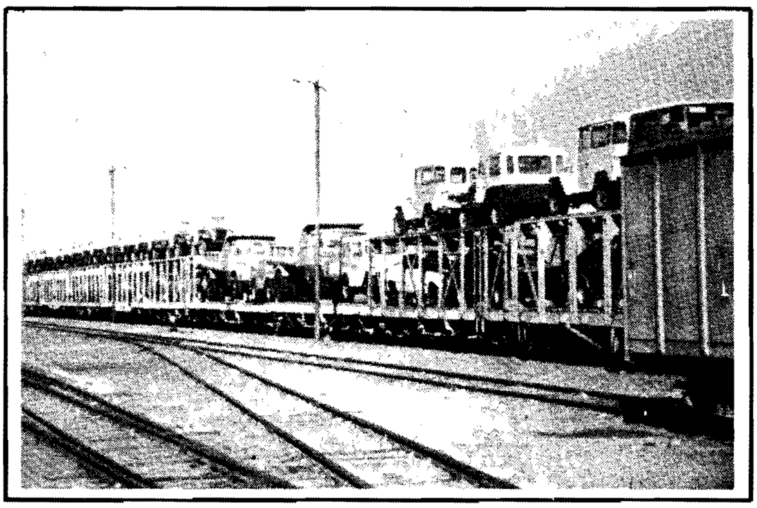
Financial Discipline - It is widely observed that the need to recover costs exercises a powerful discipline on the managment of an enterprise, although this does not always apply to enterprises that enjoy a monopoly. It is argued that subsidies remove this discipline and encourage waste and weak management. But this argument depends on the way in which the subsidy is given. If subsidies are "open-ended", either explicitly or implicitly, they may have this effect. If they are given in the form of payments for services rendered or as infrastructure grants, they need not have any adverse effect.

BALLAST WAGONS AT VIACHA





SANTA CRUZ - CORUMBA LINE



IMPORTS FROM ARICA

RAIL FREIGHT TRANSPORT

It is therefore recommended that, if subsidies are given to ENFE, they should be in the form of a bonus per ton carried of specific goods on specific routes, and similarly for passengers; or, if desirable, they should be grants for specific capital improvements. There should be no change in the policy goal that ENFE should earn sufficient revenue to cover current expenditure including the servicing of capital.

It is important, of course, that subsidies, if they are given, be given in a way that is proof against abuse either by the customers of the railroad company or by the company itself.

Demand Elasticities - There are clearly strong arguments for and against a low-tariff policy. A practical approach to the question is to restrict the offer of low tariffs to that part of the traffic where there is most to be gained, i.e. to those commodity movements where low tariffs might bring a substantial volume of new traffic to the railroads, either by diversion from the roads or by generated trade. It is therefore necessary to consider the demand elasticities with respect to rail tariffs of all relevant commodity movements.

A complete study of demand elasticities would require data that are not available to the Study; it is a task for the marketing department of ENFE. All that can be attempted here is a broad preliminary analysis. The objective is two-fold: to identify traffic that is highly elastic and which therefore merits low tariffs, and also to identify highly inelastic traffic which could be subjected to higher tariffs to help finance the former.

Demand elasticity is related to the length of journey: the longer the journey on land the more likely is it to be made by rail. The ratio of value to volume is also relevant: high-value traffic is less likely to be lost to the country -- it may be lost to the railroads -- by an increase in tariffs, and vice versa. The type of commodity is also relevant: heavy bulk cargo is likely to be strongly attached to the railroads and not easily lost by an increase in tariffs. For these and other reasons it is desirable to consider the traffic in great detail, but as a preliminary analysis, it was divided into ten commodity groups and the main corridors of movement.

It is particularly important to distinguish international and domestic traffic. About 80 percent of rail freight traffic in 1977 was international and was confined to five frontier crossings - Avaroa, Charaña, Quijarro, Yacuiba and Villazón.

Table 17-1 shows the imports and exports in 1977 through these five points, divided into ten commodity groups. An analysis was made to determine the volume of imports and exports originating or terminating outside South America. About 47 percent of imports and 76 percent of exports were in this intercontinental category, the great majority using the ports of Antofagasta (via Avaroa) and Arica (via Charaña). All this intercontinental traffic is likely to be insensitive to rail tariffs. The remaining traffic through Avaroa and Charaña mostly uses the two ports for shipment from Argentina, Venezuela and other South American countries. Only 12 percent of this traffic is with Chile and that part with Antofagasta has no road alternative. In effect all traffic through Avaroa and Charaña can be regarded as strongly attached to the railroad.

Similarly all traffic through Quijarro is captive to the railroad since there is no road; also, distances are long. Most of the traffic consists of imports from Brazil, largely manufactures from Sao Paulo but including agricultural produce from nearer areas.

Traffic through Yacuiba and Villazón consists largely of foodstuffs traded with Argentina, both imports and exports. This traffic could be sensitive to rail tariffs. Most of the remaining, non-food traffic is presumably with Buenos Aires and strongly attached to the railroad.

It would appear then that the great majority of ENFE's international traffic faces little or no competition from the roads. The cost of rail transport within Bolivia is generally only a small part of the total cost of the goods being transported. Hence there is no reason to expect that lower tariffs would lead to a significant increase in this traffic, except possibly on the line to Guaqui, nor that higher tariffs would provoke a serious loss of traffic. There may be some exceptions but the conclusion must be valid for the great majority of ENFE's international traffic. When freight rates were raised in January 1975, by 120 percent on food and 68 percent on other commodities, the volume of traffic increased and the previous year's operating loss of $b 93 million was turned into a profit of $b 67 million. In July 1978 freight rates were raised again by 15.9 percent. Traffic fell slightly in 1979 but recovered in 1980. These facts confirm that international freight demand is generally inelastic.

This is an important conclusion because it raises the possibility of increasing tariffs on external traffic in order to subsidize internal traffic. A special test made on the computer model threw light on the demand elasticities of internal traffic. These elasticities were calculated for each of the twelve principal freight-carrying lines and are summarized in Table 17-2.

Table 17-1

RAIL IMPORTS AND EXPORTS, 1977

	COMMODITIES IN THOUSAND TONS										
IMPORTS	Agricultural	Mineral	Petroleum	Food	Textiles	Wood,Paper	Chemicals	Bldg.Materials	Metals	Vehicles	TOTAL
Avaroa	91.3	1.2	17.9	12.4	0.9	1.8	10.4	46.6	22.7	11.9	217.1
Charaña	21.7	0.2	6.1	6.2	1.1	7.3	7.7	0.5	8.5	11.2	70.5
Quijarro	21.2	0.4	0.2	3.0	1.8	3.3	4.0	52.6	24.3	14.9	125.8
Yacuiba	3.2	1.0	0.1	25.1	0.2	0.1	3.5	3.4	16.2	8.3	61.1
Villazón	6.0	0.1	1.4	47.3	0.3	1.6	4.6	1.0	11.3	3.7	77.2
	143.4	2.9	25.7	94.0	4.3	14.1	30.2	104.1	83.0	50.0	551.7
Percent outside South America	69	31	6	11	47	53	69	26	41	62	47
EXPORTS											
Avaroa	1.7	158.3	-	10.7	-	3.2	-	-	0.4	0.1	174.4
Charaña	-	13.3	-	1.6	-	-	-	-	0.1	0.2	15.2
Quijarro	9.8	3.3	2.0	1.1	-	3.6	4.6	-	0.1	-	24.5
Yacuiba	3.3	-	0.1	33.6	-	28.0	-	-	0.2	0.2	65.4
Villazón	0.2	14.8	-	-	-	0.1	-	-	-	0.2	15.3
	15.0	189.7	2.1	47.0	-	34.9	4.6	-	0.8	0.7	294.8
Percent outside South America (all modes)	49	88	-	74	-	54	18	-	100	40	76

SOURCES: INE and ENFE.

Table 17-2

DEMAND ELASTICITIES OF INTERNAL RAIL FREIGHT TRAFFIC

COMMODITY GROUP	AVERAGE DEMAND ELASTICITY [1]
Agricultural	1.75
Mining	1.31
Food	1.69
Textiles	2.54
Wood, Paper	2.32
Chemicals	2.37
Building Materials	1.35
Metals	0.98
Vehicles	0.76
All	1.31

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(1) The elasticity of demand is the power to which the ratio of costs, in situation A over situation B, is raised to give the ratio of flows in situation B over situation A.

In mathematical terms:

$$\frac{q'}{q} = \left(\frac{c}{c'}\right)^{e}$$

where, q = Flow in situation A
q' = Flow in situation B
c = Cost in situation A
c' = Cost in situation B
e = Elasticity of demand.

The test was made with 1989 socio-economic data and the 1989 Test Network. The estimated elasticities were derived from diversion curves over a wide range of tariffs and proved quite high, with an overall average of 1.31. The conclusion is that lower tariffs could generate a substantial volume of traffic in all groups.

Passenger Fares - For some years ENFE has adopted a low-tariff policy for passengers. In general, passenger demand is believed to be relatively elastic and, with growing competition from buses and aircraft, is likely to become increasingly so.

Passengers form a small part of ENFE's operation and contribute little towards fixed costs. Although the volume of passenger traffic continues to rise, there are doubts about the long-term prospects of rail passenger transport on the Andean System, as discussed in Chapter 13. For the time being, the low-tariff policy should be continued, with tariffs little higher than long-run marginal costs. Probably, passenger fares on the Andean System should be revised, as it is doubtful whether they are covering variable operating costs at the present time.

ENFE's Financial Position - In Chapter 6 it was shown that in 1979 ENFE was in a poor financial position. There was a modest deficit on current operations, the precise amount being unknown, and an overall deficit of about $b 250 million after inclusion of interest and taxation. Outstanding debts amounted to $b 3,180 million, to be repaid over 40 years.

The future prospects of the railroads, however, contain some favorable points. Traffic is growing and is forecast to continue to do so. The cost structure of the rail system is made up of low variable costs and relatively high fixed costs so that any growth in freight traffic produces a large contribution to net revenue (this is not so with passenger traffic because fares barely cover variable costs). Furthermore it was shown that most of ENFE's current freight traffic is insensitive to tariff levels, so the deficit could in principle be eliminated by a simple increase in tariffs, as it was in 1975.

Projections of ENFE's freight operating costs and revenues in 1989 were made, in 1977 pesos, using the committed network, i.e. excluding the proposed interconnection. Two computer projections were made, one with a continuation of current tariffs, the other with a low-tariff policy in which tariffs on all internal traffic were approximately equal to 1989 variable costs but below this level for some lightly utilized lines. Tariffs on external traffic were maintained at present levels (1977) for both calculations. The results are shown in Appendix 17A for each line and are summarized for the whole system in Table 17-3. They show a profit in each case, of $b 391 million with high tariffs and $b 205 million with low tariffs. But the volume of internal traffic increases nearly threefold as a result of the low tariffs.

This is an extreme case of low-tariff policy and is not recommended. With rather higher tariffs on both internal and external traffic, profits could approach the levels calculated assuming current (high) tariffs.

In order to quantify this, a further computer test was made combining the recommended transport system with what was termed a "medium" tariff policy, in which rail internal tariffs were set at 1.5 times variable cost. The rail results for this medium policy are also shown in Table 17-3, assuming external tariffs to remain at present (1977) levels. The result of such a policy would be approximately a doubling in internal traffic (compared with current tariffs), and in profits, to mid-way between the results for the low and the high tariff policy. The increase over low tariff policy profits occurs entirely on the Andean System. If it was felt important to raise total profits to the high tariff policy levels, this could be brought about by an increase in external tariffs of about 12.5 percent, combined with the medium tariff policy for domestic traffic (with perhaps even the low domestic tariff policy on the Eastern System). A tariff structure in this range would be an appropriate starting point for ENFE in the work of formulating a new commercial policy.

<u>Conclusion</u> - At present, ENFE tariffs are related to estimates of average total cost. These estimates include substantial, arbitrary allocations of fixed costs. Tariff-fixing takes account of size of load, distance, loadability of cargo and dangerous cargoes. Discounts may be made in order to secure traffic in the face of competition. The general goal of tariff policy is stated to be "the interest of the company" but the interpretation of this goal has not been made clear. In any event ENFE is currently reviewing its tariff policy. The time may be opportune, therefore, to offer suggestions on this subject.

The reason why this chapter has placed so much emphasis on the importance of marginal cost in the determination of tariffs is that there is a possible conflict of interest between the community and the railroad company. It is in the public interest that tariffs should reflect marginal cost, when demand is sensitive to the tariff level; it is not necessarily in ENFE's interest. But what is ENFE's interest, other than to serve the public interest? ENFE is not a profit maximizing body but it is expected to cover its costs. Its task, as a public corporation, is to serve the public but at the same time to be financially self-sufficient. A low-tariff policy does not help ENFE to achieve financial self-sufficiency and may therefore be resisted by ENFE management.

Table 17-3

PROJECTIONS OF ENFE'S OPERATING COSTS AND REVENUES, FREIGHT TRAFFIC, 1989
(in 1977 pesos)

ANDEAN SYSTEM	HIGH-TARIFF POLICY	MEDIUM-TARIFF POLICY	LOW-TARIFF POLICY
Ton-km (millions):			
Internal	196.2	324.1	414.8
External	400.3	400.3	400.3
Total	596.5	724.4	815.1
Revenue ($b million):			
Internal	123.4	203.9	179.6
External	460.3	457.3	457.6
Total	583.7	661.2	637.2
Costs ($b million):			
Fixed	275.1	275.1	275.1
Variable	212.1	306.1	362.9
Total	487.2	581.2	638.0
Profit ($b million):	96.5	80.0	- 0.8
EASTERN SYSTEM			
Ton-km (millions):			
Internal	211.8	392.9	481.2
External	388.7	388.7	388.7
Total	600.5	781.6	869.9
Revenue ($b million):			
Internal	186.5	131.9	152.2
External	387.4	387.8	385.4
Total	573.9	519.7	537.6
Costs ($b million):			
Fixed	157.2	157.2	157.2
Variable	121.9	156.7	175.0
Total	279.1	313.9	332.2
Profit ($b million):	294.8	205.8	205.4
Combined System-profit ($b million):	391.3	285.8	204.6

There is thus a political problem, which is common in public enterprises. It is the government's responsibility to ensure that the tariff policy of a state-owned industry is both in the public interest and consistent with the financial obligations of the industry.

It is recommended that ENFE's tariff policy for freight should move toward lower rates for internal traffic where this can be expected to attract a substantial volume of new traffic, taking a long-term view of the prospects. The rates should not go lower than long-run marginal costs, but that leaves room for large reductions. Rates should be reduced in steps and should not be allowed to generate a greater demand than can be met with the available rolling stock; but of course the fleet should be expanded as fast as possible to meet the demand.

These tariff reductions would naturally reduce the contribution of existing traffic to the recovery of fixed costs. New traffic will, by definition, cover its marginal variable costs (which will generally be close to average variable costs) and may also contribute towards fixed costs, if the tariff is higher than marginal costs.

On the basis of estimates presented in Table 17-3, revenues would be higher under the medium tariff policy when compared with the current (high) tariff policy. If revenues were to fall, though, two methods are proposed for meeting the losses. First, tariffs could be raised on those classes of external traffic that appear most inelastic. It is assumed that full-cost tariffs would normally be charged. Increases above full cost should be concentrated on imports and in particular on consumer goods of relatively high value. The advantage of this cross-subsidization approach is that it maintains intact the principle of financial self-sufficiency. But if government aid is required, an alternative is proposed which is a bonus on specific commodities and routes where lower tariffs are desirable. The bonus should be a specific payment for each ton carried in excess of a stated volume, i.e. the bonus should be paid on the marginal traffic only, in order to give maximum incentive to ENFE to attract such traffic.

Road User Charges

If the choice between different modes is to be soundly based on a comparison of opportunity costs, the tariffs charged for their use must all be computed on the same principles. Since this is technically impossible for private transport, i.e. private cars, trucks and aircraft, there arises an insoluble problem in obtaining a rational balance between public and private transport. But this problem is of little consequence in Bolivia, particularly outside the cities, because there are few people with private vehicles.

The main goals of tariff policy on the roads are the same as on the railroads except that the question of financial self-sufficiency does not arise, because there is no corporate body like ENFE charged with the responsibility of running the road system as a commercial operation. Since vehicle owners pay their own operating costs which, unlike those of the railroads, are normally far higher than the relevant infrastructure costs, and pass them on to their customers, the problem of road user charges resolves into two quite separate issues: first, the taxation of vehicles as a charge for using the roads, and secondly, the question of controlling the tariffs charged by bus and truck operators.

Vehicle Taxation - It is economically desirable that vehicles should be charged directly for the costs they impose on the community when they use the roads (i.e. the marginal costs) but it is impossible in practice to know with any precision what these costs are, or to charge directly for them. Road charging systems therefore have to be very rough and ready. Nevertheless, it is important that road users be forced, by means of appropriate taxes, to give due weight to the considerable costs they cause when they use the roads.

What are these costs? They are of three kinds. First, the vehicle damages the road, which has to be repaired. Secondly, with growth of traffic, there comes a point when it is cheaper to upgrade the road, in order to reduce maintenance costs, than to continue with it as it is; hence there is a cost of minor improvement. Thirdly, with further growth of traffic, the capacity of the road comes under pressure, giving rise to costs in the form of either congestion or major construction to provide more capacity.

The marginal cost of using the roads therefore consists, in Bolivia, of the cost of road maintenance associated with a marginal increase in traffic of a given kind, plus the cost of road improvements attributable to a marginal increase in traffic. In practice this can best be estimated by taking the variable road maintenance costs (i.e. those dependent on the volume of traffic) and a normal level of expenditure on road improvement, and allocating this sum among the types of traffic using the roads. Between 1977 and 1979 these expenditures were estimated as follows:

	ROAD EXPENDITURES IN MILLIONS OF CURRENT PESOS		
	1977	1978	1979
Variable Maintenance (1)	58	67	83
Improvement	332	344	387
	390	411	470

(1) Following experience in the United Kingdom, it is assumed that a quarter of road maintenance costs are variable with the volume of traffic. Fixed maintenance costs will be discussed later.

Further sums of $b 602 million in 1977, $b 919 million in 1978 and $b 841 million in 1979 were spent on new roads. If it could be assumed that these new roads were true additions and not simply improvements to the existing network, then the figures given above ($b 390 million, $b 411 million and $b 470 million) would be the costs that should have been charged to road users in 1977, 1978 and 1979.

It was shown in Table 6-2 that road users paid $b 309 million in 1977, $b 392 million in 1978 and about $b 590 million in 1979. It might be said therefore, that overall the charges were in reasonable balance, in aggregate. However, the validity of the above assumption on new road construction will be reexamined later in this chapter. First, the question will be discussed, how road user costs were distributed between different classes of vehicle.

The taxes paid with regard to vehicles are customs duty, annual tax, fuel tax and taxes on oil, tires and spare parts. Table 17-4 gives estimates of the average payments made in 1977 and 1979 by the six vehicle types used in the Study. Since customs duty is paid only once during the lifetime of the vehicle it has been divided by the average life of the vehicle in years.

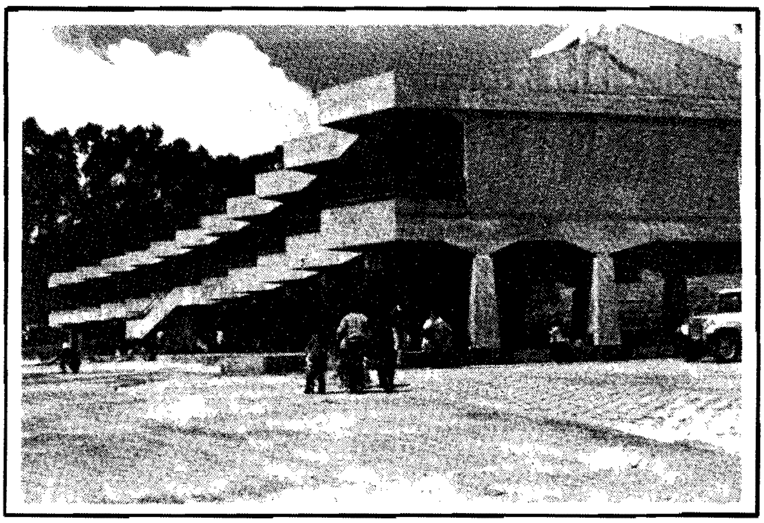
By far the largest tax in 1977 was the customs duty on vehicles. It should be understood that in the table this item has been treated as an annual charge spread over the life of the vehicle, using the 1977 or 1979 prices. Moreover, a large proportion of vehicles enter the country without paying customs duty, both legally and illegally. One cannot therefore expect to reconcile these figures with the annual tax receipts by government.

In 1979, average road user charges rose with inflation but fuel prices and taxes remained the same until the end of the year when very large increases were introduced, more than doubling the tax on gasoline and quadrupling that on diesel. These changes will transform the magnitude and composition of road user charges in 1980.

Apart from the magnitude of vehicle taxation, there is the question of the type of tax. As a charge for using the road, the tax should be related as closely as possible to the incidence of road use. Fuel tax is thus good for this purpose; annual tax and, still more, customs duties are not efficient taxes for private vehicles but may be quite efficient for public vehicles where they enter into the tariffs charged for the use of vehicles. This will be discussed later.

INTER - DEPARTMENTAL BUS
NEAR COCHABAMBA

INTER - PROVINCIAL BUS
IN THE YUNGAS VALLEYS



BUS STATION AT SUCRÉ

BUS TRANSPORT

Table 17-4

AVERAGE ROAD USER CHARGES IN PESOS, 1977 AND 1979

1977	JEEP	26-SEAT BUS	36-SEAT BUS	SMALL TRUCK	MEDIUM TRUCK	LARGE TRUCK
Customs duty including fees	4,973	13,442	34,466	3,117	4,226	10,429
Annual tax (1)	3,360	795	1,790	410	605	1,520
Fuel tax	1,065	7,202	1,317	2,087	2,765	834
Oil tax	87	588	1,060	170	224	671
Tires tax	462	5,490	7,408	784	2,236	4,008
Spare parts tax	161	1,910	2,576	272	778	1,394
Total	10,108	29,427	48,617	6,840	10,834	18,856
1979						
Customs duty including fees	5,875	16,305	40,637	3,725	5,109	12,292
Annual tax (1)	3,360	795	1,790	410	605	1,520
Fuel tax	1,065	7,202	1,317	2,087	2,765	834
Oil tax	87	588	1,060	170	224	671
Tires tax	564	6,698	9,038	956	2,728	4,890
Spare parts tax	201	2,388	3,220	340	972	1,742
Total	11,152	33,976	57,062	7,688	12,403	21,949

(1) Excluding municipal tax.

Road Maintenance Costs - As stated above, the marginal costs caused by the use of road vehicles consist of two parts: the direct damage they cause to the road, which has to be repaired, and the investment in road improvement attributable to the growing volume of traffic.

It has been found that the damage done to unpaved roads is about the same per vehicle-kilometer for all classes of vehicle, and the cost in Bolivia is estimated at 0.20 pesos on earth roads and 0.16 pesos on gravel roads. On paved roads the damage is related to the number of equivalent axles, the average cost being estimated at 0.024 pesos per equivalent axle per vehicle-kilometer. Equivalent axle values are estimated typically as follows:

VEHICLE CLASS	NUMBER OF EQUIVALENT AXLES	COST PER VEH-KM ($b)
Jeep	0.01	.0002
26-seat bus	0.40	.010
36-seat bus	1.47	.035
Small truck	0.11	.003
Medium trucks:		
5.4-7.2 tons	0.25	.006
7.3-9.4 tons	0.73	.018
Large trucks:		
9.5-11.3 tons	1.66	.040
11.4-13.6 tons	3.40	.082
13.7 + tons	5.00	.120

Data are available showing the amount of travel on paved, gravel and earth roads in 1977, by vehicle type. Applying the above unit costs, the total damage costs imposed by each class of vehicle can be calculated, as in Table 17-5. Dividing by the number of vehicles in each class, one obtains the average cost attributable to each vehicle. Unfortunately data on the vehicle population are extremely poor and the figures used are crude estimates based on incomplete data.

Road Improvement Costs - Road improvements are justified by the savings in operating costs received by the vehicles using the road. These savings are greater, per vehicle-km, for some vehicles than others. They tend to occur in the following proportions, taking the savings to a jeep as equal to 1:

Table 17-5

ROAD MAINTENANCE COSTS ATTRIBUTABLE TO DIFFERENT CLASSES OF VEHICLE, 1979

	JEEP	26-SEAT BUS	36-SEAT BUS	SMALL TRUCK	MEDIUM TRUCK	LARGE TRUCK
Size of Fleet	40,000	3,000	1,600	18,000	15,000	5,000
Total kilometrage (millions) on:						
Paved roads	121	64	26	43	69	108
Gravel roads	54	13	8	26	52	63
Earth roads	36	5	2	19	4	15
Total	211	82	36	88	125	186
Total Cost ($b000) Caused on:						
Paved roads	24	640	832	129	690	7,560
Gravel roads	8,640	2,080	1,280	4,160	8,320	10,080
Earth roads	7,200	1,000	400	3,800	800	3,000
Total	15,864	3,720	2,512	8,089	9,810	20,640
Average cost per vehicle ($b):	397	1,240	1,570	449	654	4,128

NOTE: These estimates give a total variable maintenance cost of $b 60.6 million in 1979 which is less than the $b 83 million estimated earlier from the expenditure figures. Of course there is no reason why expenditure in any one year should equal the cost of damage done to the roads. Other possible explanations are that the kilometrage figures are underestimated, because data on local traffic is very weak, or that the percentage of maintenance expenditure classed as variable with traffic has been overestimated.

Jeep	1.00
26-seat bus	1.35
36-seat bus	2.44
Small truck	0.89
Medium truck	1.03
Large truck	2.22

A rational allocation of road improvement costs to individual classes of vehicle is to divide the costs by the weighted annual kilometrage of each class, the weights being the proportions given above. This gives the following results:

	PERCENT	COST PER VEHICLE, 1979 ($b)
Jeeps	20	2,100
26-seat buses	11	15,400
36-seat buses	9	23,625
Small trucks	8	1,867
Medium trucks	12	3,360
Large trucks	40	33,600
	100	

Adding together the costs attributable to variable road maintenance and road improvement, one can compare the marginal cost per vehicle with the total tax paid in 1979, as follows:

	COST PER VEHICLE ($b)	TAX PER VEHICLE ($b)		
		Direct	Indirect	Total
Jeeps	2,497	1,917	9,235	11,152
26-seat buses	16,640	16,876	17,100	33,976
36-seat buses	25,195	14,635	42,427	57,062
Small trucks	2,316	3,553	4,135	7,688
Medium trucks	4,014	6,689	5,714	12,403
Large trucks	37,728	8,137	13,812	21,949

It must be repeated that the figures for tax per vehicle only apply to those vehicles paying full tax. A large number of vehicles, possibly more than half, do not pay customs duties or annual tax. The direct taxes are those related directly to use of the vehicle, i.e. taxes on fuel, oil, tires and spare parts, and may be compared with the direct costs caused by using the roads. The comparison suggests that the large trucks pay substantially less than their costs while other vehicles pay appreciably more.

Other Costs of the Road System - The variable costs of the road system, to which the discussion has so far been confined, comprise only about one third of the total costs. Fixed maintenance costs account for about 15 percent and new construction a little over 50 percent. These costs have to be covered. It is normal in a growing economy, particularly where road transport is in an early stage of development, that a part of these costs, especially construction costs, is borne by the whole community as an investment for posterity. But it is also normal that some of these costs, and especially the fixed costs of road maintenance, are borne by road users. There is, however, no accepted way of determining just how big this contribution should be. Roads, if properly maintained, will last indefinitely and will benefit many future generations. The division of their capital cost between present road users and the State is a matter for political decision. There is certainly a case for charging road users for the fixed costs of maintenance and also for the construction costs of those new highways which reduce travel costs in the corridors already served by roads. As was discussed in previous chapters, most new road investment recommended for the 1980s will in fact be for major improvement schemes which will reduce operating costs for road users.

These expenditures were not charged to road users in recent years. Although the fuel tax increases of late 1979 have gone some way towards covering them, this may have been more than offset by the reduction in customs duties decreed in October 1980. The current road user tax situation is unclear and requires further analysis in the light of the recent changes. However, in the previously discussed period 1977-1979, users paid only 30 to 40 percent of all road expenditures, if it is accepted that only true development road investments should be paid from other sources. It therefore appears that substantial increases in road user taxation are warranted.

The payment by road users of these additional costs is best obtained through indirect taxes that have the minimum deterrent effect on the use of the roads, particularly their use for productive purposes. Purchase tax or customs duties on private vehicles (both cars and trucks) can be recommended for this role, and annual taxes on private vehicles are also unlikely to produce adverse economic effects. Taxes on buses, though socially less desirable, are similarly unlikely to affect economic development.

The current transito toll system is not considered a useful mean of charging for road use. In Chapter 6, it was seen that less than one percent of the income required for highway financing came from these tolls, which in any case barely covered the costs of collection. Of course, tolls could be raised, but this would immediately increase problems of control and accounting, very much so if Transito tolls were to provide a significant source of income. Moreover, with increases in traffic, the Transito system will become a significant source of delay and an impediment to free travel. It is therefore recommended that the system be abolished (see also Chapter 16). It is suggested in Chapter 11 and Appendix 11A that the transito stations could be converted to vehicle weigh stations, to enforce vehicle axle loading laws.

Test of Possible Taxation Policy - A possible road user taxation policy was postulated, and tax revenues for the period 1981-1990 were compared with the costs of highway investment and maintenance for the recommended Investment Plan for that period. The tax rates were used as inputs to the calculation of road tariffs in the 1989 Recommended Network Test which provided the traffic flows used in the final evaluations.

It was found that tax income in the period would be quite close to total highways costs with the following tax rates.

			1977 TAX
Fuel Tax	:	rising to 20 percent by 1990	-36 percent(subsidy)
Lubricant Tax	:	rising to 20 percent by 1990	- 6 percent(subsidy)
Tire Tax	:	15 percent	about 10 percent
Vehicle Tax	-	Medium Bus: 20 percent	21 percent
	-	Large Bus: 25 percent	11 percent
	-	Small Truck:20 percent	15 percent
	-	Medium Truck:25percent	14 percent
	-	Large Truck:30 percent	12 percent

Vehicle tax includes tax on spare parts. While jeeps would be subject to taxation, it was assumed that this would be a part of light vehicle taxation, revenues from which would more likely be assigned to urban transport investment.

The final result is as follows (all in 1977 pesos):

Tax Revenue 1981-1990	- Tires:	$b 2,364 million
	- Fuel:	8,208
	- Lubricants:	1,207
	- Vehicles:	7,571
	- Spare Parts: (10 percent of vehicles)	757
		$b 20,107 million

Highway Investment Program 1981-1990 $b 21,048
Highway Investment less Penetration Roads: $b 18,536

(The penetration road program is the only part of the road investment program concerned with opening up new regions rather than improving existing routes. Hence, investment totals are shown with and without these routes).

Clearly, a more sophisticated policy is required than outlined here. For example, there is scope to vary taxes within the heavy vehicle group in order to encourage tandem rear-axle trucks, which do less damage to the road. Also, it may not be desirable to penalize renewal of worn-out tires by such a tire tax as postulated in these calculations. However, the general feasibility of a set of taxes to cover highway investment costs is clearly demonstrated by this exercise.

Conclusions on Vehicle Taxation - In relation to the situation prevailing from 1977 to 1979, the overall revenues from road user taxation should be increased substantially. The one class of vehicle that appears particularly undertaxed is large trucks, which are paying little more than half their marginal costs, whereas the tax on medium trucks is about three times their marginal costs. Small trucks are also paying over three times their marginal costs. There is no reason to criticize the relative level or form of taxation on jeeps, automobiles and buses.

It is therefore recommended that customs duties and annual taxes should be substantially increased on large trucks, to become effective following the moratorium recommended in Chapter 16 on all imports of commercial vehicles. An appropriate scale of new taxes needs to be worked out for different truck sizes, with significantly lower rates for vehicles with tandem axles due to their lesser impact on pavement deterioration.

In addition to the proposed general increase, these recommendations amount to a restructuring of the scale of taxes on trucks so that the scale is much more heavily weighted against large trucks and less heavily against small and medium trucks. In short, large trucks are giving rise to higher costs of road maintenance and improvement than they are paying for, and the opposite is true for small and medium trucks. While the advantages of large trucks are not in dispute, the present scales of taxation appear to over-encourage their use to an extent that is not in the economic interest of the country.

Tariffs for Road Transport - The economics of intercity road transport, for both passengers and goods, lead naturally to an industry composed of many small operators. This tendency is found everywhere. Where the volume of demand for their services is high enough to support more than one or two operators, a state of competition tends to arise because, if operators try to collude to charge excessive tariffs, it is easy for other operators to enter the market and undercut the aspiring monopolists. One common complaint is that the entry of too many operators tends to lead to excessively low tariffs and low load factors, rendering the business unprofitable. This situation, if true, clearly cannot last; supply is bound to find a level where profits, even if low, are acceptable. This regime has the advantage of ensuring customers cheap transport and a highly competitive service.

In Bolivia these tendencies are found, as in other countries, but the force of competition is suppressed by law. Truck operators are not permitted to expand their fleets, which must severely repress the spirit of enterprise in the industry. Operators not only form syndicates but are forced by law to do so, since an operator can only work within a syndicate. Local monopolies are thus created by law. In order to contain the natural tendency of the syndicates to charge excessive tariffs, control on tariff levels is imposed by the central government.

This system of organization has serious disadvantages. It imposes a sharing out of work between members, thus reducing the incentive to give good service, and it leads to various inefficiencies resulting from State supervision of tariffs. Truck operations can be quite complex and, because the short-run marginal costs of operating a truck are considerably below average costs, the operator may sometimes be keen to carry freight cheaply in order to increase vehicle utilization and thus reduce his average costs and increase his profits. At other times, for various reasons, he may not be willing to work unless a relatively high tariff is paid. A system of free tariff negotiation, based on competition, offers advantages to both operator and customer. Tariff control eliminates these advantages because it imposes a rigidity and excessive uniformity of tariffs on the industry.

Given a system of syndicates, however, control must be exercised over maximum tariffs -- and the syndicates will frequently ensure that the maximum is also the minimum. The State is faced with the continuing problem of determining what these tariffs should be. This is a difficult task. The only way of trying to do it is to examine the records of annual costs and revenues of a sample of operators. Given the very small scale of the operations, their records will not be accurate: the authorities will never know the true profits being made. In any event, given rigid tariff controls, some movements will be more profitable than others and the favored members of the syndicate will tend to get the most profitable traffic, so that a rigid set of tariffs will lead to higher profits for some than for others, regardless of their efficiency.

These difficulties are greatly exacerbated in times of high inflation. There is no way in which tariff control can possibly be efficient. Inevitably the industry will fluctuate violently between highly profitable periods, immediately after a tariff increase, and unprofitable, or less profitable, in periods immediately before the next increase.

Conclusions on Road Tariffs - If it is impossible for the government authorities to know the true state of profits in the localized transport industries, both trucks and buses, it is certainly impossible for the Study team too, even if there were resources to make a thorough, nationwide investigation. It would be entirely spurious for the Study to suggest that tariffs are currently too high or too low, either generally or in particular parts of the country. It must be realized that the costs and revenues vary considerably from one area to another.

Some recommendations, however, can be made on tariff policy, if not on the levels of tariffs. In Chapter 16 it was proposed that modifications in the regulatory system should be made with a view to the possible abolition of the syndicates' monopoly power. This would permit a freer tariff policy. As a move in this direction it is proposed that a system of fork tariffs be introduced, i.e. a system where maximum and minimum tariffs are set. Syndicates should be prohibited from interfering with members' tariffs provided they do not deviate from the permitted range. This range may vary in extent from one route to another. As and when a state of healthy competition is attained in particular areas, the range of the fork may be widened until eventually it becomes irrelevant.

For as long as monopoly exists, however, tariff controls are indispensable. With inflation, a regular review of tariffs should be made, based on the submitted accounts of the local operators or a sample of them. As roads are improved, it is imperative that the lower operating costs resulting therefrom be reflected in lower tariffs; otherwise the benefits of the improvements will not be passed on to consumers and the road's developmental potential will not be realized.

With buses, although the same principles apply, less flexibility in tariffs is possible since published fares must be available to passengers. This does not mean, however, that some freedom should not be given to operators to fix their tariffs and to introduce discount schemes and surcharges if they wish. If there is no competition, maximum fares must be set. If there is competition, a range of tariffs should be permitted, allowing operators to offer different levels of service with correspondingly different tariffs if they so wish, thus providing passengers with more choice.

Air Transport Charges

As described in Chapter 5, the charges of the National Airport Administration (AASANA) are in the form of landing fees, air navigation charges, aircraft parking charges and passenger airport taxes. It is desirable that these tariffs be based on the same principles as advocated above for rail and road tariffs. With airports, however, the marginal costs of accommodating air traffic tend to be much higher, relative to average costs, than with railroads and roads. This is because a comparatively small volume of traffic, in terms of passengers and freight tons, is needed before expenditure is required for improvements to the runway, to accommodate larger planes, and for airport buildings, navigational aids, maintenance facilities, etc. An examination of AASANA's records shows that the four busiest airports out of 33 in all, account for 72 percent of the costs and handle 89 percent of passengers and 78 percent of freight.

There is little economic case, therefore, except at the smallest airports, for a tariff policy that fails to recover costs of operation, maintenance and routine improvements. At the very small airports, of minimum capacity, temporary subsidies may be desirable while traffic is building up to a level sufficient to support full-cost tariffs. In particular, airports serving development areas merit temporary subsidies to permit tariffs to be set at a level which will eventually be self-financing when sufficient development has occurred;

and in these cases the airport might be expanded beyond minimum capacity while still receiving subsidy.

Airports that may justify economic subsidies of this kind include Riberalta, Puerto Suárez, Apolo, Roboré and an airport in the San Joaquín region. There is also a clear case for social subsidies at certain airports. This is obviously a political decision. Candidates for such subsidies might include Cobija, Guayaramerín, San Matías, Ixiamas, Santa Ana de Yacuma, San Borja, San Ignacio de Velasco and Ascensión de Guarayos. When an airport has passed the stage of being a development project there is no good reason why further investment should be committed before it is commercially justified.

In Chapter 6, AASANA's financial position was shown to be highly unsatisfactory. In 1978, income fell short of operating costs by 15 percent and there was no contribution to depreciation and interest. It seems probable that some of AASANA's past investment was premature and/or that tariff levels have been too low.

In approaching AASANA's financial problem, one fact is of dominant importance: charges to AASANA comprise only 6 percent of LAB operating costs and probably less of those of long-distance foreign air services using Bolivian airports. An increase of one third in AASANA's charges would amount to only 2 percent of airline operating costs. It is clear that AASANA could thus become financially viable without any difficulty.

It should also be pointed out that airports possess a unique opportunity to make large supplementary profits on services to passengers. Their passengers comprise the highest income groups, including many foreigners, and while waiting in the airport they are a captive market for the sale of food, drink, souvenirs, duty-free articles, reading matter and other articles, all at inflated prices. Further profits are obtainable from car parks, car rental companies and other services.

There is absolutely no good reason why AASANA should not cover its normal operating costs and service the capital costs for routine, small-scale investments. Large projects, however, such as the new Viru Viru airport, cannot be expected to be paid from general AASANA revenues. Assistance from other financial sources is also needed for economic and social subsidies to small airports, as mentioned above.

Conclusions on AASANA Charges - It is recommended that a small number of airports including Riberalta, Puerto Suárez, Apolo and Roboré be assigned economic development grants in order to reduce airport charges. The government may also wish to give social subsidies towards the cost of maintaining small airports in remote parts of the country. These subsidies, as well as the costs related to the Viru Viru project, should properly be paid to AASANA from Treasury funds. Still, it seems that a general increase in airport charges is also required to put the organization into a position of financial viability.

Before raising its charges, it is desirable that AASANA should attempt to identify the costs associated with different classes of aircraft. A statistical analysis was made to determine the runway costs, aircraft servicing costs, air navigation costs, passenger and freight handling costs and administration costs attributable to different classes of aircraft. This is reported in Appendix 5D and also Working Paper 35b. A thorough analysis of this kind should be carried out by AASANA and used as a basis for its various charges. At present, foreign aircraft and passengers are being charged heavily, and this might be justified by the high costs of handling them, or a political decision to discriminate against foreign traffic. But it is desirable that the actual costs occasioned by this and other types of traffic should be known as accurately as possible.

Lloyd Aéreo Boliviano - Tariff policy for LAB presents few theoretical problems. There is no infrastructure and not much competition on domestic routes. The normal goal should be that each route should cover its total costs. This means that the total annual cost of operating the route, including depreciation and interest payments, should be divided by the expected number of passengers. If there are peaking problems, special fares could be introduced to even the flow of passengers, and special discount schemes could be devised to attract new passengers in order to raise load factors.

Exceptions must be made for certain routes serving development areas or remote communities, as already mentioned in connection with airports. The case for subsidizing services to development areas is strong because in Bolivia these areas may never develop at all without reasonably frequent services at normal tariffs and these can only be provided by means of subsidy until the traffic volume has built up sufficiently to cover the cost of the service. It should be emphasized that these subsidies are needed to provide good frequencies, not subnormal tariffs.

The case for subsidizing social routes is again a political one, but from an economic viewpoint, it is relevant to compare the cost (and benefit) of a subsidized air service with that of a new road. There can be little doubt that, for passenger traffic, a subsidized air service to Cobija, Riberalta and San Matías as examples, would be more beneficial and less costly than a road, which, on account of the distance, would be rarely used. The effect on goods traffic would be different, of course, and it is necessary to consider whether roads to these outlying places would in fact generate a significant amount of goods traffic.

Leaving aside these special development and social routes, the remaining domestic routes call for rationalization of tariffs and a general increase. LAB has said that over the years numerous tariffs have been modified for special reasons, giving rise to a somewhat inconsistent pattern of tariffs today. There is a need to review and revise the costing of each route to ensure the appropriate allocation of costs among the forecast passengers using the route.

Secondly, as shown in Chapter 6, LAB failed by 12 percent to cover its costs in 1979; since then fuel and other costs have risen substantially. An increase in fares to remedy this situation was made in early 1981, but this was the first increase since 1973. No details were available in time for analysis by the Study. As a general rule, future tariffs should be kept in closer relationship with costs than has been done in the past.

Conclusions and Recommendations

The following summarizes the findings and recommendations of the Study with regard to tariff policy.

General Approach - The main aim of tariff policy in Bolivia should be to charge low tariffs for infrastructure where this might encourage traffic, but on no account should the tariff be less than the marginal costs attributable to the traffic. Where demand is highly inelastic, it is reasonable to charge tariffs above average costs in order to offset the deficit on other, low tariff traffic.

To ensure coordination between competing modes, the difference in their tariffs should equal the difference in their marginal costs, thereby exercising an appropriate influence on modal choice.

Railroad Tariffs - A lower tariff policy, charging somewhere between marginal costs and the currently charged average costs is recommended in order to encourage fuller use of the railroad system. Higher tariffs should be imposed on traffic insensitive to the tariff level (principally international traffic), in order to subsidize low tariff traffic (principally domestic traffic).

The policy goal of ENFE earning sufficient revenues to cover current expenditures, including the servicing of capital, should continue. Estimates by the Study indicate that this should still be possible, even with lower tariffs for some domestic traffic. If it does become necessary to provide subsidies, they should be in the form of a bonus per ton carried of specific goods on specific routes, and similarly for passengers; or as grants for specific capital improvements.

To carry out this tariff policy, the marketing department of ENFE should make a complete study of demand elasticities of all relevant commodity movements. Using the findings of this study, ENFE should reduce tariffs for internal traffic in steps expanding the fleet as necessary as soon as demands begin to approach the capacity of available rolling stock.

Road User Charges - These include the taxation of vehicles as a charge for using the roads. Marginal costs of road use in Bolivia consist of variable road maintenance and improvements associated with marginal increases in traffic. Comparisons of the level of direct taxes on vehicles (fuel, oil, tires, spare parts) with marginal costs of road use by vehicle class using 1979 values indicate that large buses and trucks pay substantially less than their costs, while small and medium trucks pay appreciably more.

However, these marginal (variable) costs are less than one third of total road system infrastructure costs; fixed maintenance costs account for about 15 percent and new construction over 50 percent. If it is accepted that present road users should pay for full maintenance costs and the construction costs of new highways which reduce travel costs in corridors already served by roads, substantial increases in road user taxation are warranted, particularly for large trucks and also for both small and large buses. The payment of these additional costs by road users, with minimum deterrent effect on road use, should be achieved by increases in purchase tax or custom duties. The current Tránsito toll system is considered as unsuitable for the collection of road charges, and it is recommended that it should be abolished.

Tariffs for Road Transport - This focuses on the question of controlling tariffs charged by bus and truck operators. In Bolivia, truck operators are not permitted to expand their fleets and by law must join syndicates. To control the tendency of syndicates to charge excessive tariffs, the central government controls tariff levels. This system eliminates free tariff negotiation based on competition, and imposes an undesirable rigidity and excessive uniformity of tariffs.

Modifications in the regulatory system are proposed (see Chapter 16) to reduce the syndicates' monopoly power, thereby permitting a freer tariff policy. A system of fork tariffs, i.e. a system where maximum and minimum tariffs are set, should be introduced. When a state of healthy competition is attained, the range of the fork may be widened until eventually it becomes irrelevant.

As roads are improved, the lower operating costs must be reflected in lower tariffs so that the benefits will be passed on to consumers and full developmental potentials realized.

While the same principles apply to buses, published fares reflecting maximum rates must be available to passengers. Where there is competition, a range of tariffs should be permitted, facilitating development of different levels of service and thereby providing passengers with more choice.

Air Transport Charges - Marginal costs of accomodating air traffic tend to be much higher, relative to average costs, than with railroads and roads. A comparatively small volume of traffic, in terms of passengers and freight tons, requires improvements to the runway, airport buildings, navigational aids, maintenance facilities, etc. Therefore, tariffs should recover costs of operation, maintenance and routine improvements, except at very small airports where temporary subsidies may be desirable until traffic growth is sufficient to cover full-cost tariffs. Such subsidies should be provided at Riberalta, Puerto Suárez, Apolo, Roboré and an airport in the San Joaquín region.

Where airports provide the only access to a region, social subsidies are in order. Candidates for such subsidies include Cobija, Guayaramerín, San Matías, Ixiamas, Santa Ana de Yacuma, San Borja, San Ignacio de Velasco, Ascensión de Guarayos and Fortín Ravelo.

An increase of one third in AASANA's charges would amount to only 2 percent of airline operating costs. AASANA charges should cover normal operating costs and service capital costs for routine small-scale investments. A general increase in airport charges to generate the necessary revenues is needed and is recommended. The increased charges should be based on a thorough analysis of runway, aircraft servicing, air navigation, passenger and freight handling and administration costs attributable to different classes of aircraft. Large projects, such as the new Viru Viru airport, and economic and social subsidies should come from government treasury funds.

Lloyd Aéreo Boliviano - Each route should meet its total annual costs including operations, depreciation and interest payments. Special fares should be introduced to even out passenger flow during peak periods, and discount fares used to raise load factors. LAB indicates historic tariff adjustments have resulted in some inconsistencies; the revised full-cost rate structure should reflect the appropriate allocation of costs among forecast passengers using each route.

Subsidies for certain routes serving development areas or remote communities should be designed to increase frequency of service; they should not reflect subnormal tariffs.

With continuing increases in fuel and other costs, a flexible tariff policy is recommended to keep costs and tariffs in close relationship.

CHAPTER 18

INVESTMENT PROGRAM

CHAPTER 18

INVESTMENT PROGRAM

The purpose of this chapter is to bring together all the recommendations on investment in infrastructure and equipment made in earlier chapters, notably Chapters 11 to 15, and present an investment program for the period 1981 to 1990. An outline plan for the 1990s is also discussed. The reasoning behind the recommendations are not repeated here: for these details, it is necessary to consult the appropriate chapter.

The recommendations on investment were developed within the framework of a likely budget for transport investment in the next decade. This aspect is reviewed first, and then the recommended investment program is presented by mode. A more detailed listing of recommended projects is included in Chapter 20.

All costs are quoted in 1977 pesos when \$ US 1 = \$b20. Due to inflation, the value of the peso has declined so that approximately \$b 1 (1977) = \$b 1.6 (1981). Also, the exchange rate has changed so that in 1981, \$ US 1 = \$b 25.

Investment Budgets

A discussion was presented in Chapter 8 of the rationale for defining a budgetary framework, within which to formulate an investment program. It was argued that funds are not unlimited and that the sums likely to be available for future investment can be predicted, based on past trends and the likely future growth of the economy. It was also argued that the share of total investment to be allocated to transport could also be estimated based on past trends, and that a transport study (as opposed to a study of total investment for all sectors) could not reasonably exceed the estimates so made, even if worthwhile projects were found. The transport budget so derived includes funding from foreign loans and, since there are limits to the number of such loans that the country can safely contract, the possibility of special loans for particular transport projects could not be taken as an argument for increasing the transport budget. Chapter 8 concluded by presenting a high and low estimate of the sums likely to be available for inter-urban transport investment in the period 1981 to 1990, assuming that the transport sector would receive 30 percent and 20 percent respectively of total public investment funds.

Table 18-1

COMMITTED TRANSPORT INVESTMENTS, 1981-1990

(millions of 1977 pesos)

MODE	ITEM	1981 1983	1984-1986	1987-1990	TOTAL
Rail	Rehabilitation program	250	-	-	250
	Yapacaní-Río Grande (1)	330	220	-	550
	Design Study: Motacucito-Puerto Busch	9	-	-	9
	ENFE General	50	100	400	550
	Subtotal	639	320	400	1,359
Air	Air Navigation and Communications Equipment Plan	200	-	-	200
	Santa Cruz (Viru Viru)	1,150	140	-	1,290
	Tarija	50	-	-	50
	Trinidad	70	-	-	70
	Cobija	60	200	-	260
	Potosi	50	-	-	50
	Puerto Suárez	250	-	-	250
	Riberalta	200	227	-	427
	AASANA General	40	40	60	140
	Subtotal	2,070	607	60	2,737
Highways (2)	Basic Road Maintenance - 3 districts (3)	257 (4)	257 (4-part)	342	856
	- remainder	385	385	514	1,284
	Deferred Maintenance, 3 districts (3) (4)	143	28	-	171
	Remainder of Pilot Maintenance Project (4)	222	11	-	233
	Feeder Roads (with USAID) (5)	155	-	-	155
	Current Construction	1,454	291	-	1,745
	Cotapata-Santa Bárbara	200	1,200	200	1,600
	Confital-Caihuasi	200	400	-	600
	Chimoré-Yapacaní	900	860	200	1,960
	SNC General	40	100	100	240
	Subtotal	3,956	3,532	1,356	8,844
	TOTAL	6,665	4,459	1,816	12,940

(1) Under the supervision of COMIXTA.

(2) See Appendix 18A for details.

(3) The three districts are: La Paz, Cochabamba and Santa Cruz.

(4) Part of the Pilot Maintenance Study financed by the World Bank, starting March 1981.

(5) Indicates completion of the first project only.

A certain amount of investment in transport is already committed -- that is to say, financing is assured and, in most cases, construction is underway. These commitments restrict the amounts available for additional expenditure, particularly in the early period. Committed investments total nearly $b 13,000 million, of which over $b 6,600 million are committed for the period 1981-1983. The committed investments are summarized in Table 18-1.

The major committed expenditures are for new road projects which account for nearly half the total commitment. The first phase of the USAID feeder road program is also taken as committed (although USAID is currently suspended). Routine (basic) road maintenance is taken as committed, although the Study evaluated projects to increase spending on this item. The committed highway investments are specified in more detail in Appendix 18A. Other important projects, committing relatively large sums, are the new airports at Santa Cruz (Viru Viru) Cobija, Riberalta and Puerto Suarez, the railroad from Yapacaní to Río Grande and the railroad rehabilitation program (Phase III).

These committed sums are compared below with the total transport budgets estimated previously. A medium budget is also considered, and the budgets have been allocated to three periods within the decade.

PERIOD	HIGH BUDGET	MEDIUM BUDGET	LOW BUDGET	COMMITTED
		(millions of 1977 pesos)		
(Percent Public Investment)	(30%)	(25%)	(20%)	-
1981-1983	8,460	7,060	5,640	6,665
1984-1986	9,600	8,000	6,400	4,459
1987-1990	15,560	12,970	10,370	1,816
Total	33,620	28,030	22,410	12,940

The committed sums represent a very large proportion of the low budget, exceeding the sums available for the first period and reaching 92 percent of the low budget for the first and second periods combined. Clearly, an investment program based on the low budget would be very restricted, particularly in the first six years.

Enough projects were justified which would, when combined with committed projects, account for the sums available under the high budget. This implies that transport sector investment could account for 30 percent of all public investment in the next ten years. Therefore, the basic investment program presented in this chapter assumes that the high budget will be available. However, in the discussions of the investment program for each mode, priorities are indicated in the event that only the medium, or even the low, budget is available.

Before discussing the investment program by mode, two further points are discussed: the treatment of maintenance costs and the treatment of Lloyd Aéreo Boliviano (LAB) investments in new aircraft.

Treatment of Maintenance Costs - In the analysis of past transport investments, and therefore also in the proposed Investment Program, the total expenditures of SNC are included under Highway Transport, since all SNC activities are concerned with either investment in maintenance or investment in infrastructure. These two items are competing for the same investment funds and it is a specific requirement of the Study to examine the balance between them.

In the case of air, rail and water transport, much of the costs of the entities (ENFE, AASANA, etc.) are concerned with operations of services. Maintenance activities are included in operations and are somewhat difficult to disentangle in a completely satisfactory manner. The costs of operations, and therefore of maintenance, are not included in the analysis of past investments. In projecting investment by these modes, though, the funds for additional maintenance (necessary to raise maintenance standards) have been included in the program, since this requires diversion of funds from infrastructure investment.

Treatment of LAB Aircraft Investments - Investments in new aircraft for LAB have been excluded from the Investment Program, since such investments can usually be financed commercially (that is to say, without aid from international development agencies) on the basis of projected revenues, and are therefore treated quite differently from other government investments. It is noted that in 1978, heavy investment by LAB in new passenger jets, caused total transport investments to reach an unprecedented 35 percent of public investments, compared with about 30 percent if LAB aircraft were excluded.

Railroad Investment Program

The recommended railroad investment program is shown in Table 18-2. As previously mentioned, three of the items are considered committed. These are the rail line from Yapacaní to Río Grande, now under construction and expected to be finished in 1985, the track rehabilitation program for 1981 to 1983, a design study for Motacucito-Mutún-Puerto Busch and general ENFE expenditure for stations, freight yards and marshalling facilities. This last item has been increased for the last part of the decade, when freight traffic is expected to build up.

The largest item of additional investment recommended by the Study is the acquisition of new equipment to carry the forecast increase in freight. To some extent, these purchases will depend on the rate of increase in freight traffic. However, it is essential that demand be anticipated adequately, so that lack of rail equipment does not discourage this growth.

Table 18-2

RECOMMENDED RAIL INVESTMENTS, 1981-1990
(millions of 1977 pesos)

ITEM	1981-1983	1984-1986	1987-1990	TOTAL
Committed Projects				
Rehabilitation Program (third phase)	250	-	-	250
Yapacaní-Río Grande	330	220	-	550
Design Study: Motacucito-Puerto Busch	9	-	-	9
ENFE General	50	100	400	550
Subtotal	639	320	400	1,359
New Projects				
New Equipment	200	700	1,400	2,300
Track Maintenance (additional)	120	100	0	220
Taperas-Roboré reconstruction	150	150	100	400
Mutún-Motacucito	-	-	183	183
Guaqui-Desaguadero	-	-	186	186
Design Studies: Guaqui-Desaguadero	4	-	-	4
Interconnection	-	-	200	200
Rehabilitation Program(fourth phase)	-	300	700	1,000
Subtotal	474	1,250	2,769	4,493
TOTAL	1,113	1,570	3,169	5,852

The second major item is investment in track rehabilitation, which is recommended by the Study to continue at about the current pace. The investments for 1981 to 1983 include the completion of the current program, and the funds for the remainder of the decade will finance a further 1,070 km. Associated with this is a sum for increased track maintenance which is recommended for unrehabilitated lines. This is in addition to current maintenance, included in normal ENFE operating costs (not considered here).

Reconstruction is needed of that part of the Santa Cruz-Corumbá line near Roboré which was badly damaged by floods in January 1979. This is recommended as a program of improvements on the existing alignment, which can be phased over the entire period 1981 to 1990, but with most of the expenditure in the first six years 1981-1986.

Investment in two new lines are tentatively recommended; one from Mutún to Motacucito (near Quijarro), the timing of which depends upon the build-up in production at Mutún; and one from Guaqui to Desaguadero, which depends upon the Peruvians completing the line from Puno to Desaguadero. For the latter project, a design study is recommended immediately.

On the basis of the analyses conducted in this Study, the rail interconnection is not recommended for the 1980s, although it could possibly be justified economically for the early 1990s. However, further studies are recommended of the potential for transit traffic and of a possibly lower cost alignment via Villa Tunari. If these further studies demonstrate the economic feasibility of this project at an earlier date, then the rail interconnection could be brought forward, perhaps into the late 1980s. It must be recognized, though, that this is an extremely expensive project, and to build even one third of the interconnection in the late 1980s would cost about $b 4,000 million pesos. This would mean that other projects totalling an equivalent cost would have to be postponed.

A design study for the interconnection is included in the investment program at a cost of $b 200 million for the late 1980s. It is possible that this could be a gift from Brazil, in which case, these funds could be assigned to the actual construction of this project (albeit a small contribution).

In the event of budget limitations, priority should be given to increased track maintenance and purchases of new equipment. The very severe low budget would require the postponements of most of the fourth phase of the rehabilitation program, part of the Taperas-Roboré reconstruction and all new construction to the 1990s. The medium budget would permit about two-thirds of the fourth phase of the rehabilitation program and most of the Taperas-Roboré project in the 1980s, but new projects would still have to be postponed to the 1990s.

Highway Investment Program

The details of the recommended highway investment program are shown in Table 18-3, and the recommendations on new or improved roads are illustrated in Figure 18-1.

A large part of the Highway Investment Program is for already committed highway projects, which total $b 7,500 million in the first six years out of a total highway expenditure of about $b 12,000 million. The major committed projects are for paved roads between Oruro and Cochabamba, between Chimoré and Yapacaní (opening up a new route between Cochabamba and Santa Cruz) and from La Paz into the Yungas. Important committed projects for unpaved roads include two highways to Trinidad from Santa Cruz and from La Paz. There are also other committments to continued highway maintenance. Highway commitments are presented in more detail in Appendix 18A.

New roads recommended by the Study include Las Carreras - Iscayachi (59 km -- gravel) for 1981-1986 and Machacamarca-Challapata (96 km -- paved) for 1984-1986. The final link in the Cochabamba-Trinidad road from Eteramazama to San Ignacio de Moxos (272 km -- gravel) is recommended for 1987-1990. It is also recommended that the proposed Santa Bárbara-Bella Vista and San Borja-Trinidad roads be redesigned using lower design standards to reduce estimated costs. On this basis, they can be justified for the 1980s and are thus included in the investment program, allowing $b 300 million for San Borja-Trinidad (228 km) to be spent throughout the period 1981-1990 and $b 1,250 million for Santa Bárbara-Bella Vista (99 km) in 1987-1990.

New penetration roads and associated feeder roads are also recommended in northern and eastern Bolivia, totalling 1,610 km. The two major routes recommended are Trinidad-Guayaramerín and Rurrenabaque-Ixiamas-Chivé-Cobija. It is recommended that these roads be built to keep pace with the development of the region opened up, and priorities are given in Chapter 12.

Improvements are also recommended to some 5,000 km of the existing road system. Of highest priority are rehabilitation and overlaying of 820 km of existing paved highways which have been allowed to deteriorate badly, and much of this work should be carried out in the first three to six years. Major gravelling of 3,642 km of unpaved road is also recommended, which includes provision of adequate drainage and a good gravel surface. Betterment is recommended for 632 km of higher volume unpaved roads. This is defined as improvement on the existing alignment and includes widening to 7 meters, better drainage, improvement of severe curves and provision of a 6-meter pavement.

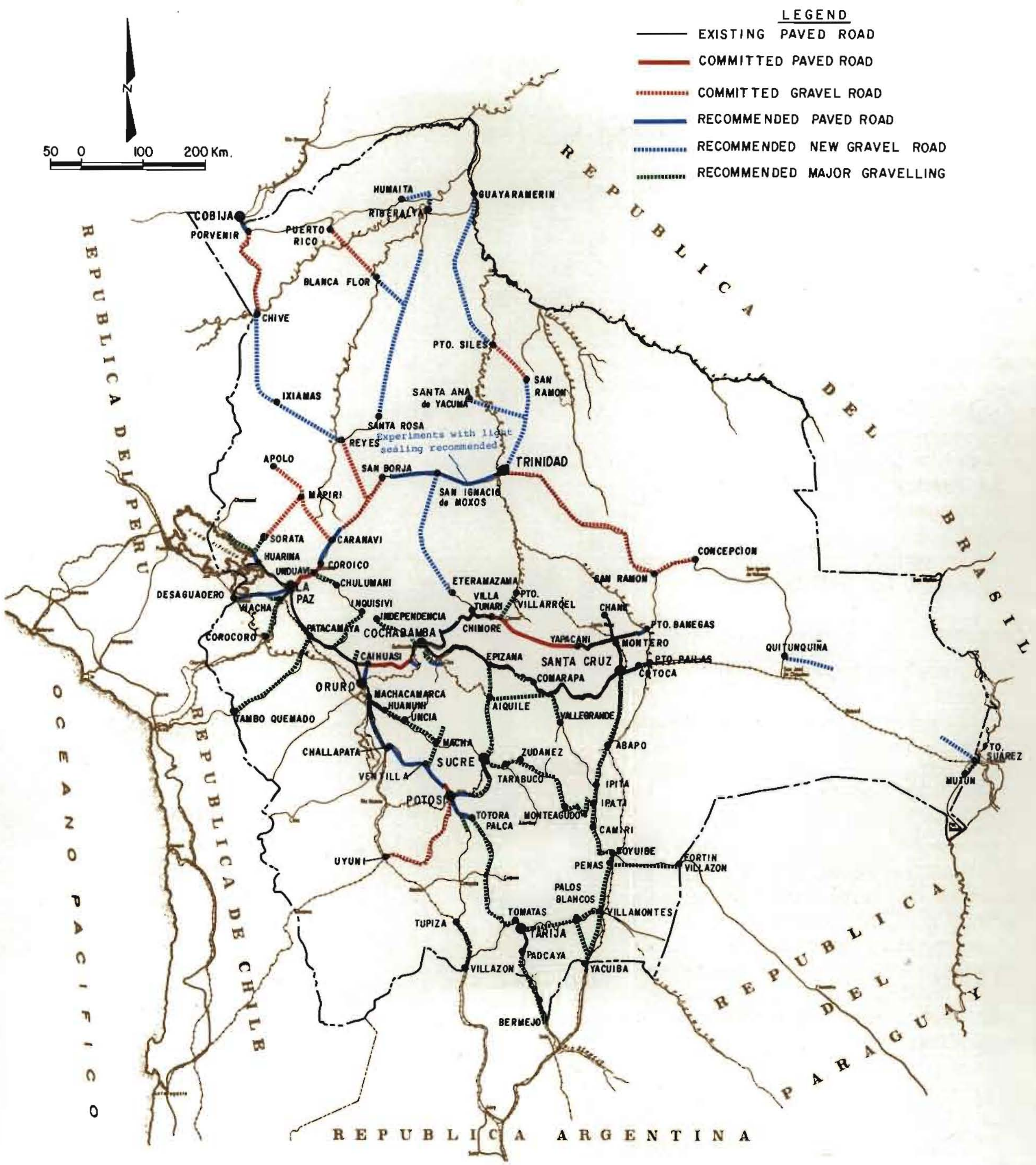
Table 18-3

RECOMMENDED HIGHWAY INVESTMENTS, 1981-1990

(millions of 1977 pesos)

ITEM	1981-1983	1984-1986	1987-1990	TOTAL
Committed Projects				
Basic Road Maintenance - 3 districts (1) (2)	255	255	340	850
- remainder	387	387	516	1,290
Deferred Maintenance, 3 districts (1) (2)	143	28	-	171
Remainder of Pilot Maintenance Project (2)	222	11	-	233
Feeder Roads (with USAID)	155	-	-	155
Current Construction	1,454	291	-	1,745
Cotapata-Santa Bárbara	200	1,200	200	1,600
Confital-Caihuasi	200	400	-	600
Chimoré-Yapacaní	900	860	200	1,960
SNC General	40	100	100	240
Subtotal	3,956	3,532	1,356	8,844
New Projects				
Additional Road Maintenance	191 (3)	383	1,058	1,632
Feeder Roads	-	200	300	500
Bridges (except projects listed below)	150	150	187	487
Santa Bárbara-Bella Vista (incl.bridges)	-	-	1,250	1,250
San Borja-Trinidad (including bridges) (4)	70	70	160	300
Eteramazama-San Ignacio (including bridges)	-	-	1,116	1,116
Machacamarca-Challapata (including bridges)	-	439	-	439
Las Carreras-Iscayachi (including bridges)	90	90	-	180
New Penetration/Feeder Roads	199	736	1,577	2,512
Improvements to Santa Cruz-Cochabamba	83	135	-	218
Other paved road improvements	61	426	280	767
Unpaved road improvements - Betterment	74	425	552	1,051
- Major gravelling	123	313	878	1,314
Río Grande Bridge	-	-	130	130
Axle Load Measurement Program	6	2	2	10
Design Studies	31 (5)	117 (6)	150	298
Subtotal	1,078	3,486	7,640	12,204
TOTAL	5,034	7,018	8,996	21,048

(1) La Paz, Cochabamba and Santa Cruz.
(2) Part of the Pilot Maintenance Study.
(3) Of which 33 can be taken as committed with the Pilot Maintenance Project.
(4) Including $b 3 million for two motorized pontoons for the Mamoré River crossing west of Trinidad.
(5) Plus $b 29 million included in Pilot Maintenance Study.
(6) Plus $b 4 million included in Pilot Maintenance Study.



ROADS RECOMMENDED FOR THE 1980s

Wilbur Smith and Associates

FIGURE 18–1

A program of bridge building is recommended in addition to the bridges required for the new highway projects specifically listed in Table 18-3. Over 100 additional bridges are recommended, of which one third are replacements for existing inadequate bridges. In addition, a bridge over the Rió Grande at Puerto Banegas near Santa Cruz is recommended for the period 1987-1990.

The investment plan includes an allowance to continue work on existing feeder roads at about the same pace as at present.

A large increase in road maintenance expenditure (in addition to paved road overlaying and rehabilitation) is recommended, with a gradual build up to the higher recommended levels during the first three to six years, under the supervision of the Pilot Maintenance Study (which started March 1981). Linked with the plans for improvements to existing paved roads and for better road maintenance, is a program for enforcement of vehicle axle loading regulations.

In the event of stricter budget limitations, it is recommended that priority be given to paved road rehabilitation and overlaying, to the upgrading of road maintenance and to the axle load enforcement program. With the very restrictive low budget, much of the program for new penetration and feeder roads, as well as three major projects for the last period -- Santa Bárbara-Bella Vista, Eteramazama-San Ignacio and the Río Grande bridge -- would have to be postponed until the 1990s. All other programs would be delayed and could not be completed as set out in the program presented. In total, only about half the program for new projects could be completed with the low budget.

With the medium budget, the projects Santa Bárbara-Bella Vista and Eteramazama-San Ignacio, together with about one third of the program for new penetration and feeder roads, would have to be postponed until the 1990s. The rest of the program could be completed in the 1980s, although much would be delayed until later in the decade than programmed under the high budget.

Air Investment Program

The recommended investment program is shown in Table 18-4. The largest single expenditure is for completing the new airport at Santa Cruz (Viru Viru), which is committed. Also committed are the new airports at Cobija, Riberalta, and Puerto Suárez and improvements at Potosí, Tarija and Trinidad. The most important committed project, from the point of view of improving aviation throughout the country, is the Air Navigation and Communications Equipment Plan.

Table 18-4

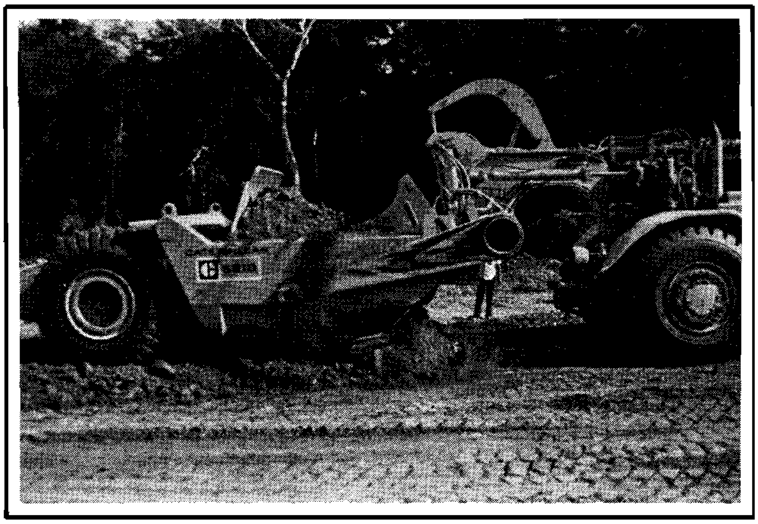
RECOMMENDED AIR INVESTMENTS, 1981-1990

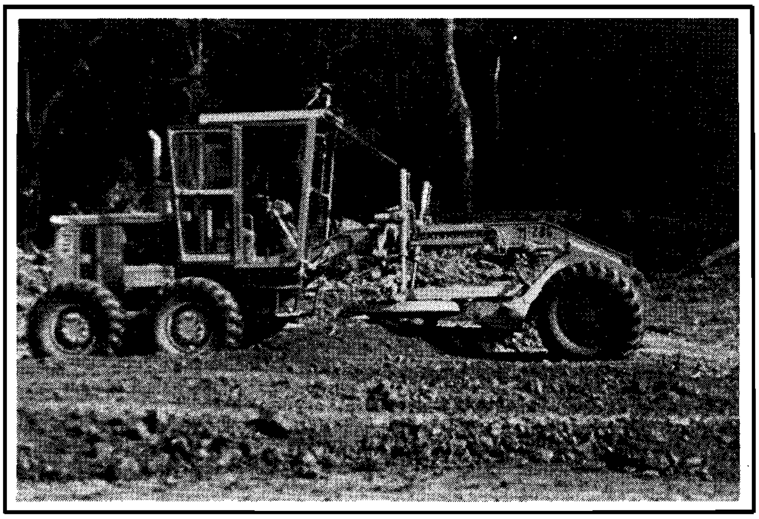
(millions of 1977 pesos)

ITEM	1981-1983	1984-1986	1987-1990	TOTAL
Committed Projects				
Air Navigation and Communication Equipment Plan	200	-	-	200
Santa Cruz (Viru Viru)	1,150	140	-	1,290
Tarija	50	-	-	50
Trinidad	70	-	-	70
Cobija	60	200	-	260
Potosí	50	-	-	50
Puerto Suárez	250	-	-	250
Riberalta	200	227	-	427
AASANA General	40	40	60	140
Subtotal	2,070	607	60	2,737
New Projects				
Additional Airport Maintenance	29	66	106	201
La Paz	-	-	590	590
Cochabamba	90	-	1,200 (1)	1,290
Airport Rehabilitation Plan (16 airports)	100	150	-	250
Design Studies	5	12	20	37
Subtotal	224	228	1,916	2,368
TOTAL	2,294	835	1,976	5,105

(1) 85 percent of the total project - the remainder is for completion in the early 1990s. (This project was not evaluated by the Study -- see Footnote 5 in Chapter 14).

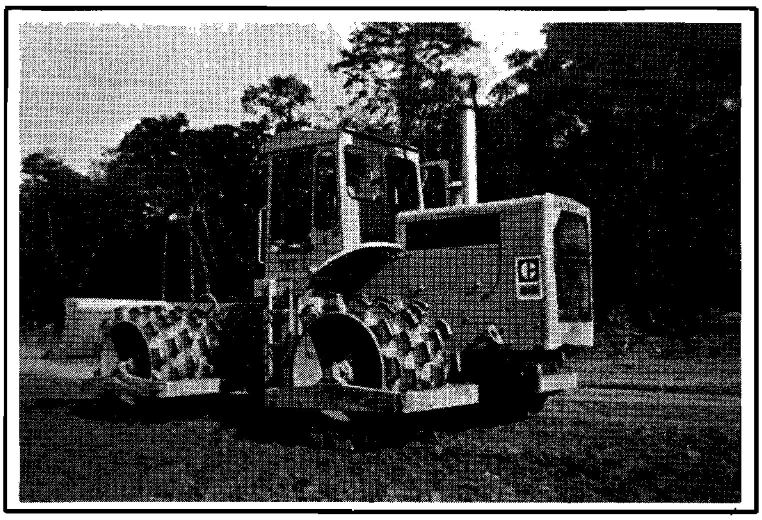
DUMPING MATERIAL





GRADING

COMPACTING



ROAD CONSTRUCTION IN THE BENI
(SANTA CRUZ-TRINIDAD)

The most important new project is for an airport rehabilitation plan, designed to improve conditions at sixteen small airports for F-28 jet and F-27 turboprop operations.

At Cochabamba, two projects are included. The first is a runway extension in the first period, recommended for safety reasons. In the last period, a large sum is tentatively included for the construction of a new runway and terminal at the existing airport, which may be required for safety reasons. However, this latter project should only proceed following a definite decision to postpone the proposed relocation of Cochabamba Airport to Santa Lucia for at least twenty years. (1).

The projects at La Paz and Potosí are to make substantial improvements to the existing airports. Proposals to relocate either of these airports would have to be subject to detailed feasibility studies.

In the event of budget restrictions, priorities should be given to the Airport Rehabilitation Plan and to improved maintenance. Under the low budget, the new runway and terminal at Cochabamba and part of the improvements at La Paz, would have to be postponed until the 1990s. Under the medium budget, only the Cochabamba project would have to be postponed. In both cases, the remaining new projects would be delayed to later in the decade than programmed for the high budget.

Water Transport Investment Program

Details of the recommended investment program are given in Table 18-5. There are no committed projects.

The main project is for a port on the Paraguay River. An initial development is included in the period 1984-1986 and an extension in the period 1987-1990. The timing of the different stages of this project depends upon the rate of development of a Mutún based iron ore or iron pellet export project. Funds are also allocated for the purchase of river barges in the last period. The location of the Paraguay River port has yet to be decided. Investments are shown for the port investment only, and do not include the additional costs of the rail link from Mutún to Puerto Busch or for land reclamation, both required for the Puerto Busch alternative.

The remaining projects for water transport are for the purchase of boats and equipment for clearing obstructions in the Ichilo-Mamoré river system, and for the purchase of equipment for four small ports on this river system.

Under the low budget, the second stage of the Paraguay River Port and the related barge purchases, would have to be postponed until the 1990s. Under the medium budget, no changes would be necessary to the water transport program.

(1) This project was not evaluated by the Study. See footnote 5 in Chapter 14.

Table 18-5

RECOMMENDED INVESTMENTS FOR WATER TRANSPORT 1981-1990

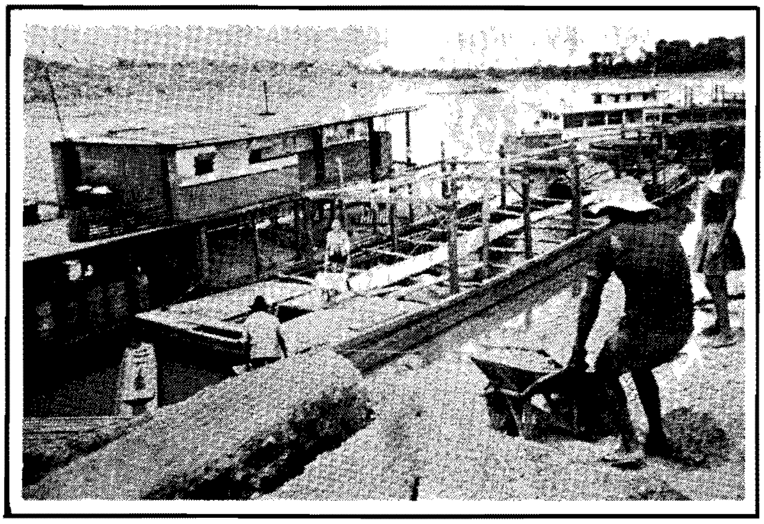
ITEM	1981-1983	1984-1986	1987-1990	Total
		($b million)		
Paraguay River Port	-	200	400 (1)	600
River Fleet	-	-	1,000 (1)	1,000
Port Improvements (2)	6	-	-	6
Mamoré River Cleaning	20	-	-	20
TOTAL	26	200	1,400	1,626

(1) Timing of the second stage of the Paraguay River port and the river fleet depend upon growth of Mutún traffic.

(2) At Puerto Villarroel, Trinidad, Guayaramerín and at the terminal of the new rail line from Yapacaní at Río Grande.

LOADED BARGES

TRUCK TO BARGE TRANSFER



LOADING AGGREGATE
BY HAND LABOR

PUERTO VILLARROEL
ICHILO RIVER

Summary of the Recommended 1981-1990 Investment Program

Table 18-6 summarizes the recommended 1981-1990 investment program and compares with the estimated low, medium and high budgets for transport investment. Total recommended expenditure on transport investment is $b 33,631 million in the ten years 1981-1990, approximately the total estimated to be available under the high budget. This would imply that transport obtains 30 percent of the funds estimated to be available for public investment in this period. It is perhaps unlikely that such a high sum will be available and so project priorities have been indicated in the preceeding pages in the event that only the medium or even the low budgets will be available.

Some projects in the later period are dependent on special factors, such as the rate of development of Mutún, the need to build another runway at Cochabamba airport and on whether the Peruvians complete the Puno-Desaguadero railroad. Therefore, there is some flexibility in the last period. The main problems are likely to be felt in the first two periods when the high budget for transport is definitely desirable.

Of the total program, the largest share is for highways which would account for 63 percent of total spending, similiar to the 64 percent average of non LAB transport investments for the past seven years. Of the highway share, over 40 percent is already committed. About 17 percent of investments are allocated to rail, which is considerably less than the 29 percent average for ENFE and COMIXTA for the past seven years. The share of air infrastructure investments doubles from 7 percent in the past seven years to 15 percent. Water transport, which previously accounted for almost no investment, takes 5 percent of the total.

Transport Projects for the 1990s

It is not possible, nor very desirable, to be specific in recommending projects for a period starting in ten years time. There are so many uncertainties on such matters as the general growth of the economy, the likelihood of discovering new resources (particularly of minerals and hydrocarbons) and the pace of development of transport infrastructure in the 1980s. Also, changes in the world outside may have a strong influence on the development of Bolivia, but are impossible to predict with any certainty. It is possible, though, to indicate in general terms transport projects which could become necessary in the 1990s, if the country continues to develop on the lines set out in this report. That is the object of this section.

Table 18-6

SUMMARY OF 1981-1990 TRANSPORT INVESTMENT PROGRAM

(Millions of 1977 pesos - percentages in brackets)

	MODE	1981-1983	1984-1986	1987-1990	TOTAL
Committed	Rail	639 (10)	320 (7)	400 (22)	1,359 (11)
	Water	0 (0)	0 (0)	0 (0)	0 (0)
	Air	2,070 (31)	607 (14)	60 (3)	2,737 (21)
	Highway	3, 956 (59)	3,532 (79)	1,356 (75)	8,844 (68)
	TOTAL	6,665 (100)	4,459 (100)	1,816 (100)	12,940 (100)
Projects	Rail	474 (26)	1,250 (24)	2,769 (20)	4,493 (22)
	Water	26 (1)	200 (4)	1,400 (10)	1,626 (8)
	Air	224 (13)	228 (4)	1,916 (14)	2,368 (11)
	Highway	1,078 (60)	3,486 (68)	7,640 (56)	12,204 (59)
	TOTAL	1,802 (100)	5,164 (100)	13,725 (100)	20,691 (100)
Total	Rail	1,113 (13)	1,570 (16)	3,169 (20)	5,852 (17)
	Water	26 (1)	200 (2)	1,400 (9)	1,626 (5)
	Air	2,294 (27)	835 (9)	1,976 (13)	5,105 (15)
	Highway	5,034 (59)	7,018 (73)	8,996 (58)	21,048 (63)
	TOTAL	8,467 (100)	9,623 (100)	15,541 (100)	33,631 (100)
BUDGET	High	8,460	9,600	15,560	33,620
	Medium	7,060	8,000	12,970	28,030
	Low	5,640	6,400	10,370	22,410

Budget Restraints - The economic situation in the 1990s is likely to be easier that is expected for the 1980s and consequently, more funds should be available for investment. Estimates were presented in Chapter 8 of possible non-urban transport budgets, which range from a pessimistic estimate of $b 28,500 million to an optimistic estimate of $b 75,800 million (expressed in 1977 pesos). Thus at least as much money should be available in 1990s as is expected in the 1980s, with the probability that there will be very much more. At this stage, projects can be identified which would cost a total of about $b 53,000 million to implement, and so it is not thought that budget limitations will be very stringent in the 1990s.

Railroads - The major contents of a railroad investment program for the 1990s are outlined below:

ITEM	COST ($b millions)
Rail Interconnection (Cochabamba-Santa Cruz)	11,400
Track Rehabilitation	2,000
Rail Equipment	5,000
General	1,600
Total	20,000

The major investment would be in the rail interconnection. It is emphasized that this is not a recommendation of the Study. since more studies need to be completed, particularly on international transit traffic. However, an optimistic view can be taken that the likely volumes of traffic, and revenues therefrom, will be sufficient to justify this line. It is also noted that further studies of this project may result in an economic justification for the late 1980s. However, financial restrictions would probably make it difficult to complete much of the project in the 1980s, and the bulk of expenditure would almost certainly occur in the 1990s.

Although track rehabilitation does not appear to be well justified at current traffic volumes, the situation would be quite different if rail freight volumes grow as predicted by the Study. Therefore, it is assumed that rehabilitation of the remainder of the rail system will be necessary in the 1990s. Similarly, the item for equipment requirements has been based on freight traffic forecasts by the Study.

Highways - The major items of a possible highway investment program for the 1990s are shown below:

ITEM	LENGTH (km)	COST ($b million)
Betterment	3,600	9,400
Overlaying existing pavements	2,500	2,500
Major gravelling	2,500	1,500
New penetration and feeder roads	1,500	2,000
Existing feeder roads	-	1,500
Bridges	10,000 (1)	1,600
Road maintenance (Additional to current)	-	5,000
Total		23,500

(1) Length in meters

This investment program implies a large increase in the length of paved roads, more than doubling the length of road expected to be paved by 1989, which itself represents almost a doubling of the paved system today. By the end of the 1990s, it can be expected that the main roads from La Paz to Bermejo, Santa Cruz to Yacuiba and Potosí to Epizana will be completely paved. It is also suggested that the gravel roads to Trinidad, currently under construction or recommended by the Study, could also be paved, as well as the road from Trinidad to Guayaramerín, and Riberalta. This would produce a dramatic change in the accessibility of these remote regions compared with today.

Two obvious gaps in the paved road system envisaged for the year 2000 would be the link from Tarija to Villamontes and the Uncía-Sucre-Ipatí road. In both cases, construction costs would be very high due to the difficult terrain, and forecast traffic volumes (made assuming that the roads would be paved) do not warrant more investments than the major gravelling recommended for the 1980s, apart from a section of betterment from Sucre to Padilla. Clearly though, this cannot be a final decision and the potential for these two routes must be re-examined nearer the time. A factor which could influence the decision on Uncía-Sucre-Ipatí would be international interest in completing the Pan-American highway, of which this road forms a part.

The 1,500 km of penetration and feeder roads would complete the priority system shown in Chapter 12, and also the link Nacebe-Humaitá (in Pando). Other penetration roads could be built, but much depends on the success of migration and rural development schemes associated with these roads. It is recommended that the success of schemes undertaken in the 1980s should be carefully monitored, before committing further investment.

The road maintenance program for the 1980s is assumed to continue. It is expected that all paved roads in place in the late 1980s will require overlaying at some time in the 1990s.

Air Transport - The major elements of a possible investment program for the air sector are as follows:

ITEM	ESTIMATED COST ($b million)
New Airports	6,000
LAB and AASANA general	1,500
Total	7,500

Most of the identified costs refer to new airport construction, including runway paving at San Ignacio de Velasco, Yacuiba, San Borja and Santa Ana de Yacuma, and for possible airport relocation for Cochabamba, La Paz, Oruro, Trinidad and Potosí. Airport relocation would generally be justified on urban planning grounds rather than on any lack of capacity or other problems at the airports themselves. The exception is Potosí where relocation could be required for safety reasons.

If relocation of Cochabamba airport does prove to be necessary, then the recommendation for the 1980s to build a new runway and terminal at the existing site should not go ahead. Therefore the alternatives for Cochabamba must be thoroughly evaluated before commitments are made to the 1980s investments.

Water Transport - The major elements of an investment program for water transport are shown below:

ITEM	COST ($b million)
Paraguay River Port (third stage)	300
River Fleet	1,500
Lake Titicaca RO-RO Facility	200
Total	2,000

The third stage of the Paraguay River Port and the river fleet -- barges to take iron ore -- will depend on the rate of expansion at Mutún. The last item, RO-RO facilities on Lake Titicaca at Guaqui, will depend on whether or not the Peruvians extend their railroad from Puno to Desaguadero. If they do, then clearly the new lake facility will not be required.

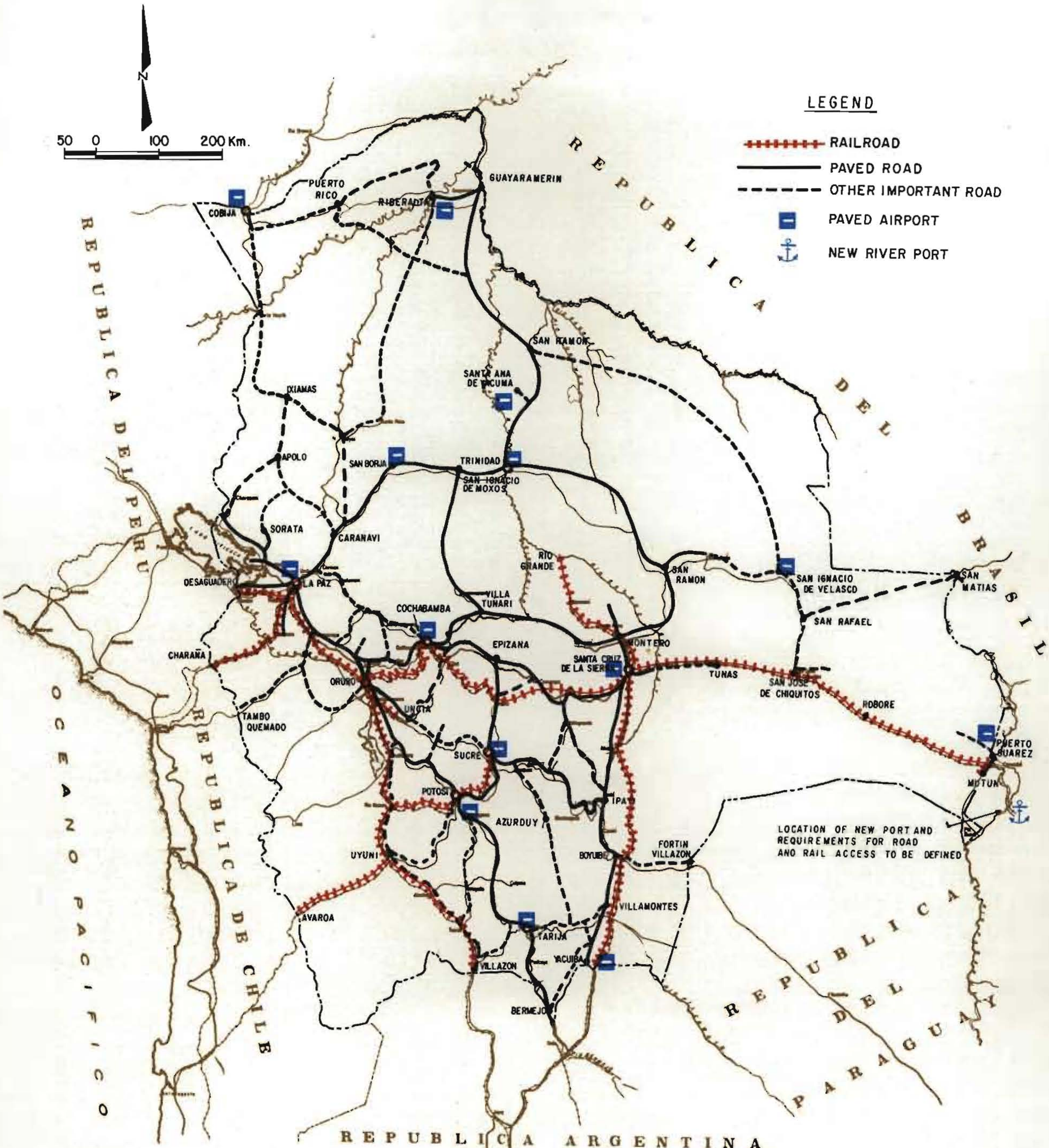
Summary of Possible Investments in the 1990s - The table below summarizes the possible investments for the 1990s by mode:

MODE	TOTAL INVESTMENT ($b million)	PERCENT
Rail	20,000	38
Highway	23,500	44
Air	7,500	14
Water	2,000	4
Total	53,000	100

In addition to these investments, it may also be worthwhile to extend the YPFB petroleum products pipeline system from Villamontes to Tarija in the 1990s, at an estimated cost of $b 650 million for a 4-inch line.

Under such a program, the expenditure on all modes would increase from the 1980s. A change from previous patterns of investment would be the large switch from highways to rail, brought about mainly by the inclusion of the rail interconnection in this program. Possibly more could be required for highways to develop more penetration roads. For example, the development of penetration roads and associated feeder roads to open up the potentially rich agricultural area of the Tucavaca valley would cost an additional 900 million pesos, and completion of all the penetration roads evaluated in Chapter 12 would cost $b 6,000 million beyond the $b 2,500 million included in the investment plan for the 1980s, and the $b 2,000 million included in the outline plan for the 1990s. Implementation of more penetration and feeder road projects than so far recommended or suggested, should depend on the success of the recommended schemes in spurring economic development in their areas of influence.

Figure 18-2 summarizes the main features of the transport system which could be in place by the year 2000.



A POSSIBLE TRANSPORT SYSTEM FOR THE YEAR 2000

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FIGURE 18–2

CHAPTER 19

FUTURE TRANSPORT PLANNING

CHAPTER 19

FUTURE TRANSPORT PLANNING

Together with several short-term recommendations on transport policy, the principal product of this Study has been the definition of an investment program for the transport sector. This program reflects basic assumptions regarding the country's economic development, a most complex matter which cannot be predicted with certainty. The likelihood exists, therefore, that some of the analyses and conclusions will have to be updated in the light of unforeseen developments or decisions.

The need for review of plans is by no means unique to Bolivia, but is a general feature of medium and long-term transport planning. Thus, planning must be seen not only as the development of an initial action program, but also as a continuous activity of providing the facts and figures required by those who have to make the country's decisions.

Use of Comprehensive Transport Planning

The decision makers face a difficult task, particularly with regard to transport investment. There are five competing modes, each with an organization demanding from central government its share, and maybe more, of the country's scarce financial resources. It was mentioned before that for road and rail alone, projects suggested in the past would cost about five times as much as Bolivia can afford to spend in the next ten years on transport investments. Similarly, the nine departments have differing views how these resources should be distributed among the regions. While such pressure on government is natural, it is important to ensure that investment decisions are made in the interest of the country as a whole, rather than just responding to the pressures of a particular transport mode or geographical region.

The methods employed in comprehensive transport planning address this very question. Projects of all modes are analyzed together, using the same criteria of economic evaluation. A transport model of the type used in this Study predicts future flows embracing all relevant transport services and thereby assessing the competitive position of each mode in each particular corridor throughout the country.

In contrast, a standard feasibility study usually centers on only one mode in one particular corridor and tends to justify the transport investment it investigates. The comparison of several such studies, to determine which of the examined projects deserves the highest priority, is normally difficult because of the differences in the methods and criteria employed. This does not mean that detailed feasibility studies of transport infrastructure projects are wasted efforts; they are often required to investigate details of the function and the planned construction of the transport facility, after the overall priorities are established, and before construction plans are prepared.

Establishing the overall priorities in a scientific manner will benefit the economy as a whole. Especially in a country with a large foreign debt and a limited investment budget, it is vital that these investments be made wisely, generating benefits which will make later investments possible, and thereby aiding the country's development.

It is sometimes stated that any transport investment would be useful, and that the country should therefore move ahead with building roads, railroads and airports without wasting time and money on studies. Nothing is further from the truth; this report demonstrates how many bad investments might be made, thereby preventing more useful projects from being built. A glaring example of past misinvestment is the railroad construction to the Yungas: new investments were made as late as the 1950s, and only a decade later the rail line was abandoned for lack of use.

Apart from providing the data to make sound investment decisions, comprehensive transport planning can also benefit other aspects of transport policy, both national and international. The establishment and updating of a data base on transport costs, flows and other characteristics related to the movement of goods and persons is required for any government agency that must negotiate with transport operators about tariffs, or with foreign governments about transit rights, improved transport connections or possible credits for investment projects.

It was mentioned before that comprehensive transport planning is a continuing process. The present Study has launched this process, and it is important that the momentum of scientific transport planning be maintained. The remainder of this chapter deals with this subject.

Planning for Transport in Bolivia

Great economic benefits can be derived from a relatively small investment in an advisory group engaged in comprehensive transport planning. In the past, this function had been assigned to the Directorate of Planning and Coordination (DPC) in the Ministry of Transport, Communications and Civil Aeronautics. Partly as a consequence of many staff changes and partly because of the day-to-day demands made on its senior professionals by other sections in the Ministry of Transport, the Directorate of Planning and Coordination has been less effective than was envisaged at its creation. Its actual functions are limited largely to the establishment of annual budgets, the registry of construction companies and the keeping of some basic statistics, without however providing much analysis. To remedy this absence of effective planning and coordination between the various transport modes, this Study now proposes the creation of a new National Transport Center (CNT) to take over the function of long-term planning from DPC. Before discussing the possible activities of the proposed Center, the planning functions of other entities are reviewed, including those of DPC.

Directorate of Planning and Coordination - Created in 1970, DPC was assigned a mixture of tasks, ranging from long-term transport planning to short-term budget programming for the Ministry of Transport. Among the other functions are those to keep a variety of statistics and a registry of construction companies, to monitor the implementation of transport projects, to coordinate between the various transport modes and to advise on transport matters to be included in international agreements.

At present, DPC consists of 17 employees, of whom 5 are university graduates. The two top positions of DPC are filled by officials who also have other responsibilities within the Ministry and who therefore can spend only part of their effort in directing the directorate. Moreover, DPC has in recent years lost several of its professional staff. Some of these transferred in 1978 to the counterpart team of the National Transport Study, which then effectively took over DPC's function of long-term transport planning.

It is now recommended that the functions of DPC be directed more to the short-term planning needs of the Ministry of Transport and that long-term planning be left to the proposed National Transport Center (CNT).

The proposed organization for DPC is shown in Figure 19-1; its staff would amount to 19 employees including the Director.

The suggested functions are described below:

- Elaborate the annual operating budgets for the transport and communications sector and make the necessary adjustments or updates to the medium and long term financial plans, based on the criteria and priorities recommended by the National Transport Center.

- Present the annual budgets to government for approval and perform the necessary administrative procedures to put them into force.

- Draft the texts for regulations, legal dispositions or policy measures proposed by CNT.

- Monitor the implementation of the plans, programs and policies approved for the transport sector.

- Propose the revision or modifications of international agreements regarding transport, or the signing of new ones.

- Coordinate the participation of the transport and communications sector in meetings concerning integration or international aspects.

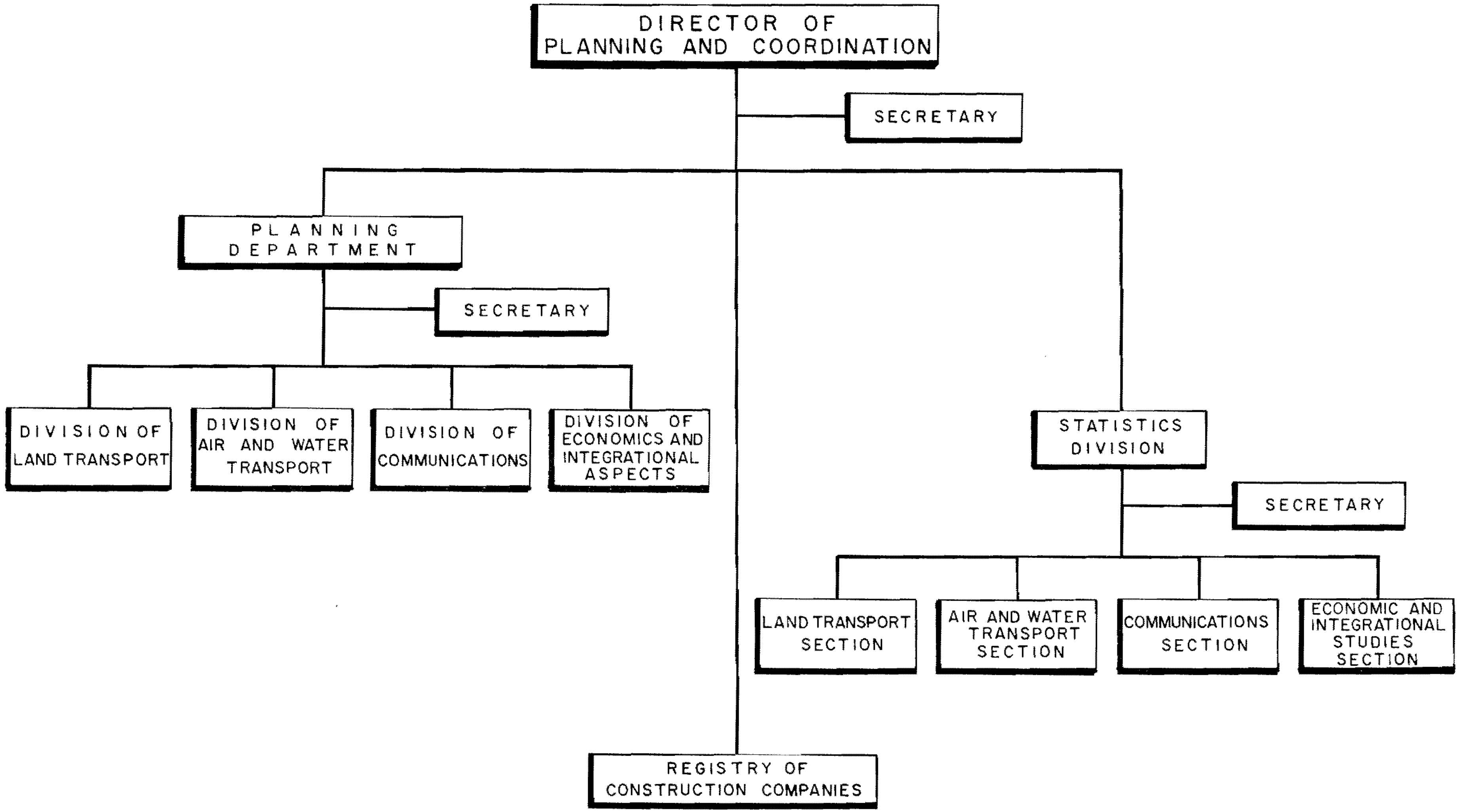
- Process statistics relative to transport and communications; issue and distribute bulletins.

- Keep a register of the construction companies that will allow, in a reliable manner, their technical and economic certification.

Planning Departments of the Transport Agencies - The autonomous state transport companies and entities, such as SNC, ENFE or LAB, have their own planning departments. It is important that their functions be set within an overall framework of planning responsibilities. The assignment of responsibilities must be clearly defined, not only to avoid the duplication of effort among the various agencies, but also to ensure that no gaps exist in the planning process.

The functions suggested for the planning departments of autonomous transport entities are as follows:

- Maintain an inventory of all candidate projects of the transport mode being considered, ranging from conceptual ideas to those which are in the implementation phase.



PROPOSED ORGANIZATION OF D.P.C.

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FIGURE 19-1

- Elaborate and process data which will permit further project analyses, taking into account alternative solutions, both within the mode and on a global level of the transport sector.

- Propose construction standards for each project, including their justifications.

- Estimate the construction costs for each project and document the methods followed and assumptions made.

- Make and update traffic flow projections for projects under consideration.

- Perform all other functions that are specific to the entity.

As examples of these specific functions, the following discusses the responsibilities established for two of the principal agencies under the Ministry of Transport.

National Road Service - SNC's planning department has the following specific functions, extracted from the statute approved by Ministerial Resolution No. 2544 of July 4, 1979.

- Elaborate a national and regional road plan, considering the construction of new roads and the improvement of existing roads, based on a study of the economic and financial aspects of their use and maintenance.

- Carry out studies and prepare statistics needed for the formulation of possible adjustments of the road plan.

- Define and supervise road feasibility studies carried out by consultants, and conduct the necessary negotiations.

- Ensure that the formulated plans be consistent with government policy.

National Railroad Company - ENFE's planning department has been created through Company Disposition No. 18/57 in compliance with Article 9 of the Law for the National Planning System, approved by Supreme Decree No. 11848 of October 3, 1974. It has the following functions:

- Conduct research on the supply and demand of railroad transport.

- Formulate and update the short, medium and long-term plans.

- Evaluate periodically the implementation of plans, programs and projects.

- Give advice to ENFE's other departments in the definition of projects.

- Elaborate and keep up-to-date the inventory of ENFE's projects, evaluate them periodically and establish priorities for their financing.

- Assist in the elaboration of ENFE's budget.

- Provide the necessary standards and criteria to guide and coordinate the preparation of statistics.

- Guide and coordinate the studies on operating costs and tariffs.

- Guide and coordinate the studies on general aspects of the national economy.

- Program the technical assistance for the company.

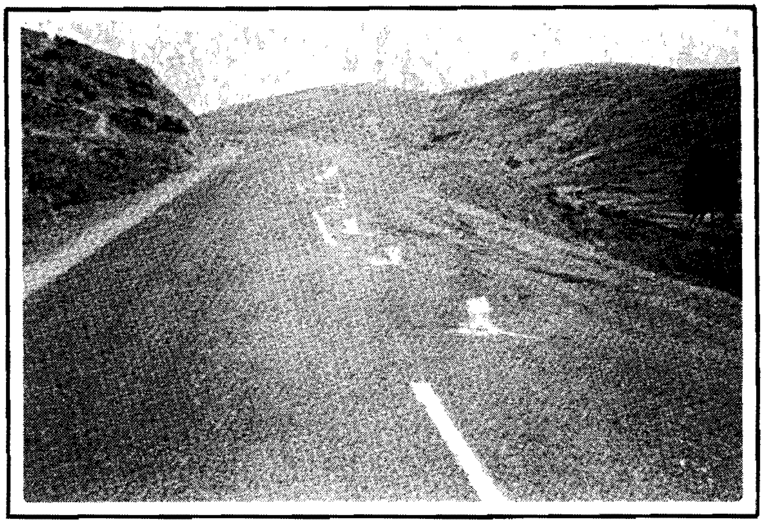
- Establish and maintain a data file on the national economy.

The National Transport Center - Experience shows that the establishment of DPC as a mere Ministry Directorate was an inadequate solution to medium and long-term transport planning. It is therefore proposed to create a new autonomous entity under the Ministry of Transport and Communications to perform this function.

The main purpose of this entity, which could be named "National Transport Center" (CNT), would be to give scientifically derived advice to the decision levels. Among CNT's specific functions, the following can be mentioned:

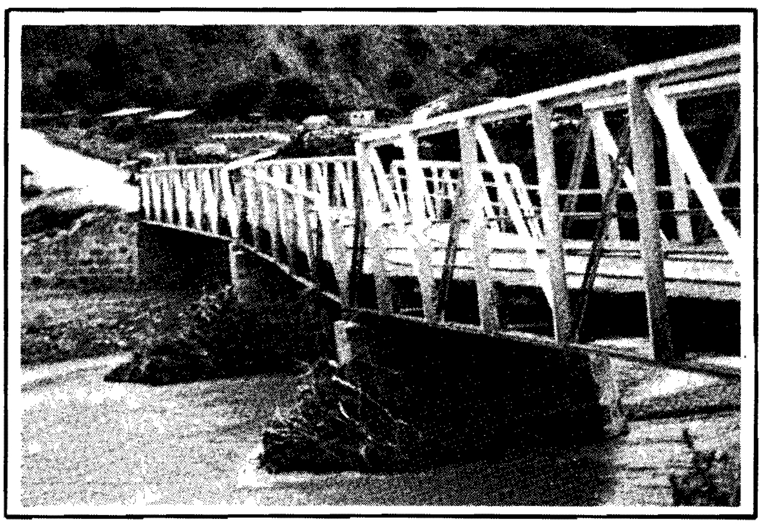
- Provide technical coordination on transport priorities between the Ministry of Transport, the recently created Aeronautics Ministry, and the Subsecretariat of Maritime, River and Lake interests, established in January 1981 under the Ministry of Defense.

- Prepare a timetable for the implementation of this Study's recommendations regarding investments and regulatory measures.



HUARINA - TIQUINA

COCHABAMBA - SANTA CRUZ



MIZQUE BRIDGE NEAR AIQUILE
(MARCH, 1979)

EROSION AND SUBSIDENCE

- Monitor the achievement of the recommendations formulated by this Study.

- Determine the requirements of statistics and their way of presentation, based on recommendations formulated by this Study in coordination with the National Statistics Institute (INE) and the transport organs as well as the establishment of the outlines of data flows and the adequate provision of information.

- Update periodically the National Transport Study, making the complementary studies and investigations.

- Based on information received from model agencies, prepare five year investment plans for the consideration of the Minister of Transport.

- Participate in or give advice to transport analyses to determine Bolivia's interests which are to be represented in international negotiations.

- Analyze development strategies and regional and national plans, and their impact on the transport investment plan.

- Analyze socio-economic parameters and developments in foreign trade and the impact of changes on transport.

- Study transport measures to provide regional integration within the context of the Andean Pact, Cuenca del Plata and others.

- Study the required transport measures to promote, within the country's economic realities, the process of national integration.

- Suggest special studies in areas where new developments are likely to generate significant changes in traffic flows.

- Participate in, or give advice to, those regional development projects which have a major effect on transport.

- Prepare publications on transport matters, especially those related to a global view of this sector.

- Investigate the application of new transport technologies, especially those that are compatible with the level of development in the country.

- Give ad-hoc advice to government on matters relating to transport policy.

It is thought at this stage that, at least initially, the National Transport Center would have a relatively small staff, consisting of about ten professionals plus supporting personnel, selected from this Study's counterpart team. The functions to be performed would be in line with the organization chart shown in Figure 19-2, although CNT's staff would have to be flexible and have the capability to perform several functions within the center.

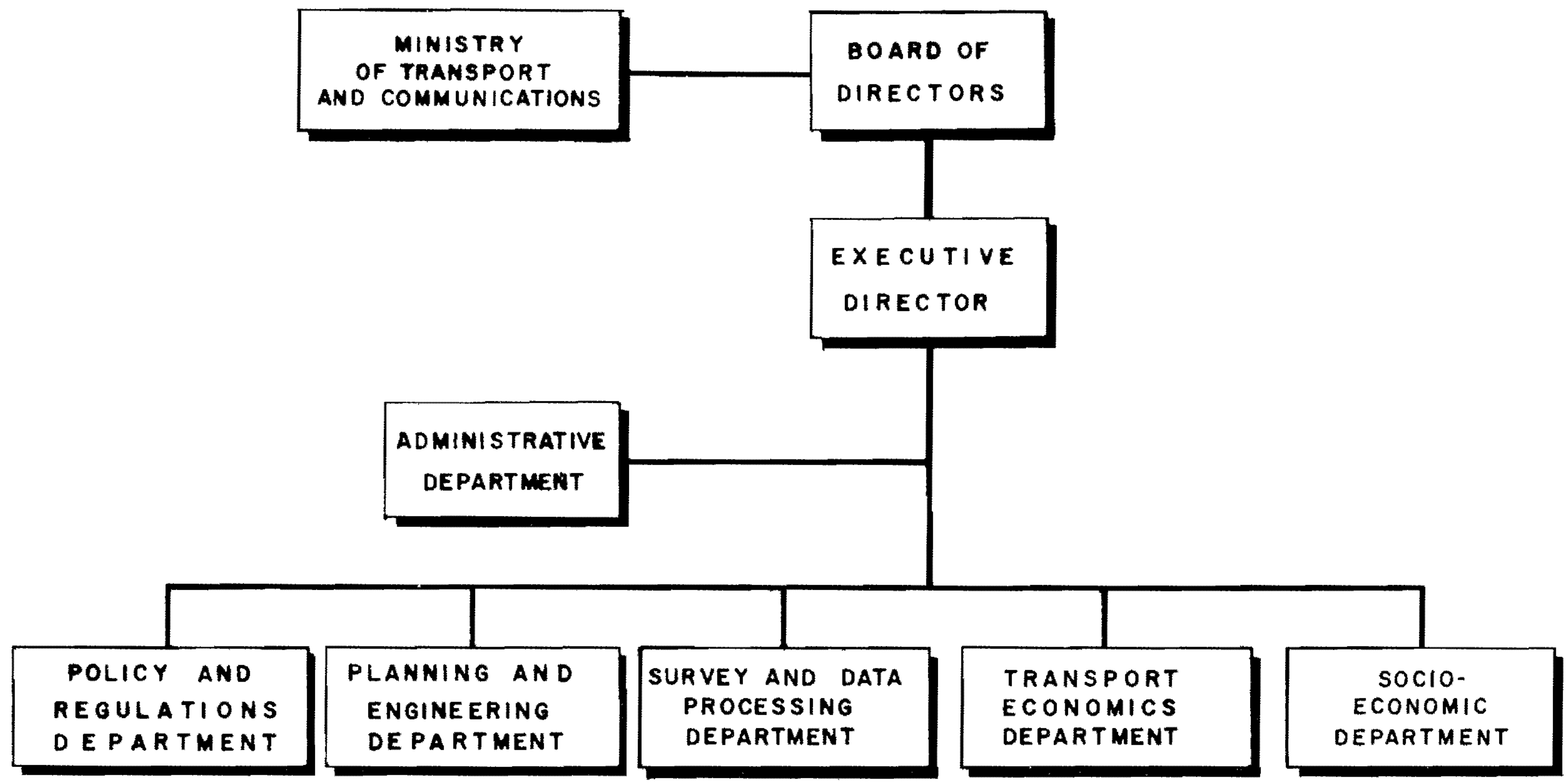
Phase II of National Transport Study

The initial two years of the continuing transport planning activities have already been laid down in the Project Document signed by the Bolivian Government and the United Nations Development Programme. Defined as Phase II of the National Transport Study, the work will be conducted primarily by Bolivian professionals, with the technical participation of two expatriates, an engineer and an economist. The initial activities of this group will be centered around the implementation of the recommendations contained in this report. This is likely to require additional analyses to answer questions related to particular Study recommendations, tasks which are very similar to the updating of the Study's findings, mentioned before.

It is proposed that the work defined under Phase II of the Project Document be already conducted within the framework of the National Transport Center (CNT). At the time of writing this report, the size of CNT and the professional capabilities of its members have not yet been decided, and it is therefore not possible to define a detailed work program for 1981 and 1982. The next section describes those tasks that must be achieved during this time, while the section thereafter outlines certain additional activities which would be beneficial to the country but which may have to be abandoned or postponed depending on the work capacity that will be given to CNT.

Principal Tasks - The most important initial activity of CNT concerns the implementation of the recommendations summarized in Chapter 20 of this report. With regard to proposed infrastructure improvements, numerous documents have to be prepared and decisions made before the first bulldozer starts work. Thus, upon approval of this Study's recommendations, CNT should set up -- in coordination with the relevant Government Agencies -- detailed timetables for the implementation of each project. These would consider the following:

- Additional feasibility study where required
- Approval of recommendations made in that study
- Financing plan for project
- Preparation of final designs and construction specifications
- Review and approval of documents for construction contract
- Letting of construction contract
- Construction
- Definition and letting of other associated contracts.



PROPOSED ORGANIZATION OF
THE NATIONAL TRANSPORT CENTER

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FIGURE 19–2

Associated with this task is the clear assignment of responsibilities connected with the above steps. These would be established based on guidelines received from the Minister of Transport, and CNT would act as overall coordinator, monitoring the progress of project implementation and preparing brief monthly reports to the Minister.

Where further feasibility studies are required, the Terms of Reference would be prepared in close coordination between CNT and the relevant government agencies. As appropriate, CNT would also monitor progress and technical content of these studies. In certain cases, CNT could be called upon by government to prepare small studies themselves.

Among the recommended infrastructure projects, at least the following will require more detailed studies before final design plans are prepared:

- Rail interconnection Santa Cruz-Cochabamba
- Rail line Motacucito-Mutún
- Rail line Guaqui-Desaguadero
- Rail passenger services to zones not otherwise served by ground transport
- Port on the Paraguay River
- New airports at La Paz and Cochabamba, to be considered as urban planning projects
- High-grade gravel surfaces for selected airports
- Road Santa Bárbara-Bella Vista
- Pilot project of road betterment with paving and associated analyses.

Depending on their urgency, the Terms of Reference for these studies should be prepared, or reviewed where they already exist, either in the first or second year of Phase II. On those projects for which the preparation of construction documents can proceed, CNT should periodically review the basis for their justification. Should there be a major departure from the assumptions inherent in Phase I of the Study, any project could still be stopped or postponed before its construction is fully committed.

With regard to the Study's recommendations on tariff and regulatory policies, CNT should also prepare a timetable for their implementation, and then monitor its fulfillment. Very importantly, it should develop an action program to gradually change ENFE's tariffs as recommended in Chapter 17. In addition, it should follow up on the reorganization and strengthening recommended for the Ministry of Transport's Dirección General de Transporte Automotor. It should also review progress achieved in the procedural improvements recommended for the vehicle register, maintained by the Servicio Nacional de Tránsito.

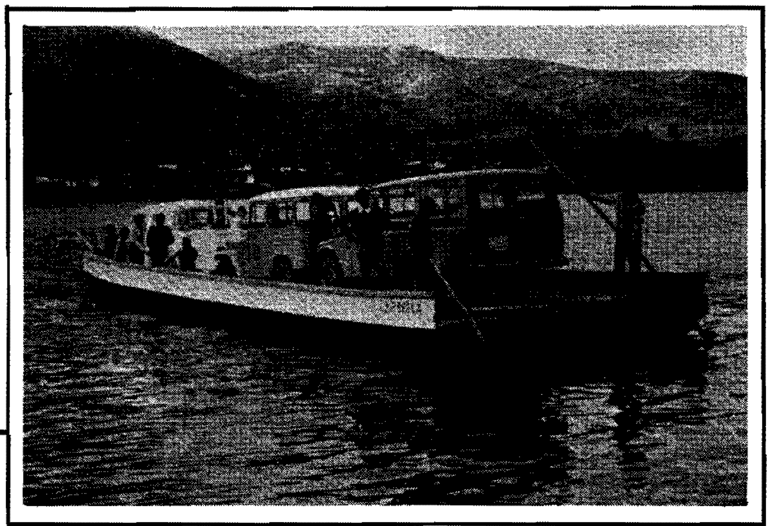
Another important function of CNT, during Phase II and beyond, will be to give continuing advice to the Minister of Transport. To some degree, this can be achieved in the preparation of monthly reports, but in addition such advice may have to be given on an ad-hoc basis. The knowledge of transport matters acquired by CNT's team during Phase I of the Study makes them specially qualified for this function. As a complement, further analyses -- including applications of the transport model -- may be required during Phase II to respond to particular problems.

Additional Tasks - Any of the activities outlined earlier for CNT could logically be included in the Terms of Reference for Phase II. However, these must be weighed against CNT's initial staffing with a view that they do not exceed its capacity; in any case the principal tasks defined in the preceding paragraphs must receive priority.

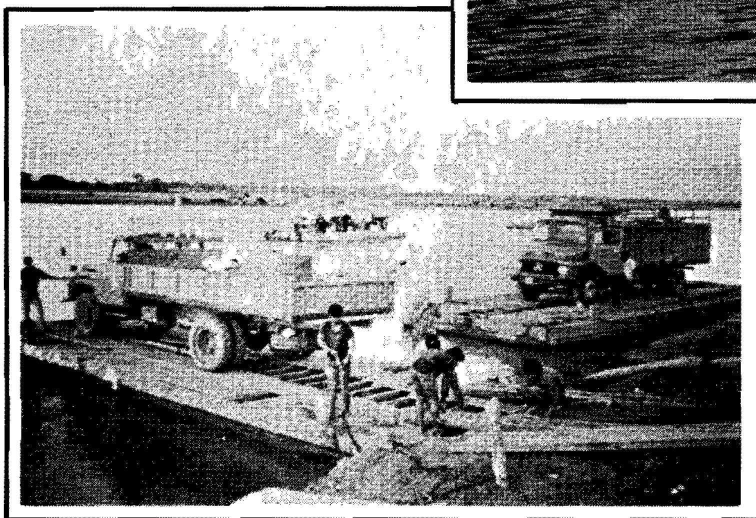
With the transport model, Bolivia has now a useful tool to assess the transport implication of new planning policies. Thus, CNT could make a valuable contribution to the Ministry of Planning and other government entities in their overall economic planning for the country.

CNT could also give advice on data collection procedures, with a view of creating a regularly updated data bank for the transport sector, in coordination with the National Statistics Institute (INE) and the Directorate of Planning and Coordination of the Ministry of Transport. The transport data collected during Phase I should be regularly updated, which requires a particular effort in the case of road transport because of its dispersed nature. In addition to SNC's traffic counting program and the recommended updating of the vehicle register, it is proposed to conduct at least every two years a sample roadside interview survey to monitor trends in vehicle loadings, cargo carried, trip lengths, and origin-destination patterns. While these surveys might best be under the direction of SNC, their design should be closely coordinated with CNT.

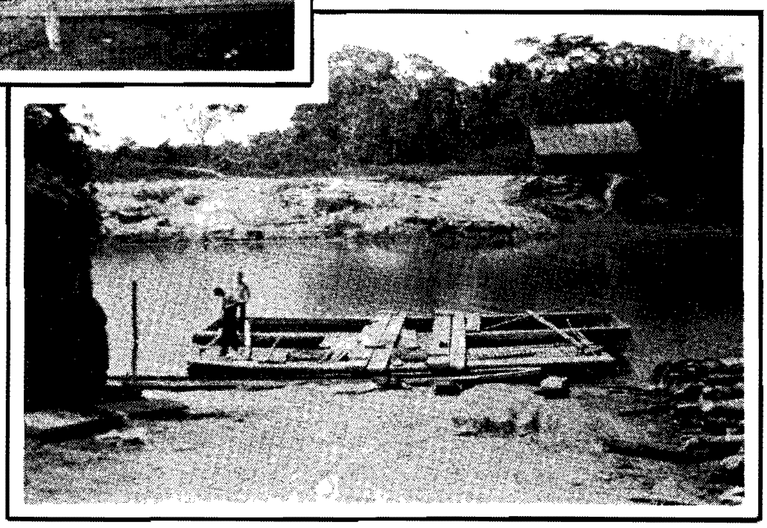
Integration with Other Studies - The United Nations Economic Commission for Latin America (CEPAL), in response to a resolution passed at its April 1979 conference, has set up a project to improve transport conditions of South America's two landlocked countries, Bolivia and Paraguay. This project will commence in early 1981 and will be staffed, for its Bolivian operation, by one expatriate transport economist and several local counterparts. Some arrangements have already been made to organize CEPAL's project within the framework of CNT which would, in fact, provide the local counterpart team.



AT TIQUINA ON LAKE TITICACA



AT PUERTO BANEGAS ON THE RIO GRANDE



IN BENI DEPARTMENT NEAR SAN BORJA

VEHICULAR FERRIES

It can be expected that other transport projects may be funded by international organizations. Normally, these stipulate a local counterpart team; it is proposed that this be integrated with CNT, similar to the project on landlocked countries. Very preliminary discussions in this direction have already taken place, concerning a study of the international transport corridors in the Amazon basin, sponsored by the Institute for Latin American Integration (INTAL).

Reports - It was already proposed in this section that CNT prepare monthly reports (in Spanish) to the Minister of Transport, advising him on the progress achieved with the implementation of this Study's recommendations. As appropriate, these reports should make specific proposals on how to deal with delays and other problems that are certain to occur.

In addition, more elaborate reports should be prepared every six months, also describing progress achieved and problems encountered with the implementation of the Study's recommendations. These reports would be published in both English and Spanish and would be distributed to the appropriate government agencies as well as the World Bank and the United Nations Development Programme.

The first of these reports should -- besides reporting on implementation progress -- contain a detailed work program for the remainder of Phase II. Morever, it should contain the timetables for the implementation of the Study's recommendations, as discussed earlier in this section.

In Phase I, about 60 working papers were published to document technical details of the Study. Many further working papers exist in draft form, while outlines have been prepared for others still. It is proposed that CNT continue publishing these working papers during Phase II at a rate which is commensurate with its staffing.

Future Use of the Transport Model

An important product of this Study has been the development of a computerized transport model together with a group of staff trained in its use. This model is capable of a wide variety of uses during the coming years.

In the first instance, there is the use of the model as it stands. This could be required for a range of reasons involving changes of socio-economic data or transport plans. For example, the Study has assumed that the Mutún iron works will be operational by 1989. If it should become clear in the future that this is not so, which would also affect the related developments in Santa Cruz and Cochabamba, then it could be useful to use the model to estimate the impact on transport flows.

Indeed, monitoring of trends in population, GDP and goods production over the next few years may show that the Study's forecasts have been overly optimistic or pessimistic. This again would require the use of the model. For reasons of time, the model has only been run completely for the most likely 1999 development pattern, and it would add greatly to the knowledge of future transport if it could also be run for the other two patterns.

With respect to transport plans, it is certain that ideas will be proposed in the near future, possibly as a result of this report, for new transport facilities, which will require evaluation. An example here could be an alignment for the rail interconnection radically different from those tested by the Study. The use of the model in the manner described above could prevent the misallocation of resources which might result from following a fixed plan based on assumptions that are no longer valid.

A second possibility is that the methodology developed could be applied in different ways. Thus regional models could be built to provide more detailed information on smaller areas of the country. The basic form of the model would probably be unchanged but the number of zones in the region would be increased and more network links included. The results would show more accurately local flows on links and provide information on links not currently included in the main transport networks.

CHAPTER 20

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 20

CONCLUSIONS AND RECOMMENDATIONS

This Report is the result of two years of detailed study of the Bolivian transport system and of its ability to respond to the transport demands of the next twenty years. The overall conclusion concerning the policy that should be pursued to the best advantage of the country as a whole, is that efforts should be directed not so much towards massive investment in new infrastructure but towards improving and increasing the use of the facilities that already exist. Bolivia possesses a substantial amount of infrastructure, but as has been demonstrated, the level of utilization, almost everywhere, is very low. This is as true of the roads as of the railroads, and similarly the airport system could support a far greater level of movements without encountering capacity constraints.

Thus the recommendations contained within the body of the Report have been aimed at encouraging higher levels of use of existing investments. Encouragement takes three forms -- through a rationalized and coordinated set of tariffs, through removal of organizational obstacles which impede development, and through investment in infrastructure. This last is devoted principally to an upgrading of the present facilities, although some additional links are considered, mainly in the as yet underdeveloped regions of the country.

In order that the investment plan proposed by the Study should be realistic, account has to be taken of the money that is likely to be available to the transport sector during the 1980s and 1990s. To this end, past budget allocations have been analyzed and it has been shown that transport has accounted for between 20 and 30 percent of overall spending in recent years. The recommended investments, therefore, have been selected to correspond to a range of possible future budgets from a "low" of 20 percent of overall spending, to a "high" of 30 percent, during the 1980s. In the 1990s the economy as a whole is expected to grow considerably, and the budget constraint is of less importance.

It is against this background of limited investment potential in the 1980s, and a general policy objective of increasing the use of existing infrastructure, that the main conclusions and recommendations of the Study are now presented.

Future Tariff Policy

Given the underutilization of current infrastructure, there is an obvious attraction in charging tariffs that cover only marginal transport costs, in order to place no unnecessary discouragement on the growth of traffic and on the economic activity that this reflects. It is proposed therefore that a main aim of tariff policy should be to charge low tariffs where this might encourage traffic. On no account, however, should the tariff be less than the marginal costs attributable to the traffic. This approach could lead to deficits on infrastructure costs on roads, railroads and perhaps airports, but it is recommended that these be met in a way more beneficial to the economy than high transport tariffs.

At present, ENFE freight tariffs are related to estimates of average total cost, including substantial arbitrary allocations of fixed costs. It is recommended that ENFE's tariff policy for freight should move towards lower rates for domestic traffic where this can be expected to attract a substantial volume of new traffic in the long term. The rates should not fall below long-run marginal costs and should be reduced in stages as ENFE's capability to handle the traffic increases. Two methods are proposed for meeting any shortfall in revenue: (i) tariffs should be raised on inelastic traffic, notably external, and, if this cross-subsidization is not sufficient, (ii) a bonus should be paid by government for each ton over a stated minimum volume for a particular commodity and route.

For rail passenger traffic it is thought that the current tariffs do not in all cases cover the marginal cost of the traffic. It is recommended that in these cases they should be raised so as to do so.

Road freight traffic, is at present in the hands of truckers' syndicates, and under the circumstances, a government-fixed tariff is essential. It has been proposed that modifications to the regulations be made to control better the syndicates' power and to permit a freer tariff policy. The policy recommended is that of forked tariffs, i.e. a system of maximum and minimum tariffs between which operators may set their tariffs.

With buses, the same principles apply, although less flexibility in tariffs is possible since published fares must be available to passengers. However, some freedom should be given to operators to fix their own tariffs and to introduce discount schemes and surcharges if they wish.

For airports, the marginal costs of accommodating traffic tend to be much higher relative to average costs than with railroads and roads. Thus there is little economic case for a tariff policy which fails to recover costs of operations, maintenance and routine improvements, and it is recommended that AASANA raise its charges to do so. Exceptions would be made for airports in development areas, airports where social subsidies are justified, and major new airports such as Viru Viru.

The normal goal for LAB, which has no infrastructure and not much competition on internal routes, should be that each route should cover its total cost. As LAB did not cover its costs in 1979, this would imply a general increase in fares. Exceptions could be made on some routes for developmental or social reasons.

Transport Infrastructure

The recommendations on transport infrastructure (beyond what is already committed) are listed below by mode, giving, where appropriate, the scale of the project and the recommended timing and cost. The Investment Plan as a whole is discussed in Chapter 18.

It is emphasized that all these recommendations are subject to the findings of detailed feasibility studies, which should include analyses of costs, benefits and modal competition for each individual project.

Railroads - Four projects are recommended as follows:

	LENGTH (km)	DATE	COST ($b millions 1977)
1. Mutún-Motacucito	26	1987-1990	183
2. Guaqui-Desaguadero	25	1987-1990	186
3. Taperas-Roboré improvements	90	1981-1990	400
4. Track rehabilitation	1,070	1984-1990	1,000

The first project depends on the speed with which the Mutún iron production expands, and the second project depends on when the Peruvian line from Puno to Desaguadero is completed. A design study is recommended for Guaqui-Desaguadero immediately. A study is also recommended of the rail system interconnection towards the end of the 1980s.

Although the rail interconnection is not recommended for the 1980s on the basis of the evaluations made by this Study, it is recommended that further investigations are conducted -- of a more northerly alignment via Villa Tunari, and of the potential for transit traffic. If these studies prove favorable, the priority for the interconnection can be advanced.

Air - The following projects are recommended:

	DATE	COST ($b millions 1977)
1. Cochabamba - runway extension	1981-1983	90
2. Cochabamba - new runway and terminal (1)	1987-1990	1,200
3. La Paz - improvements to El Alto	1987-1990	590
4. Airport Rehabilitation Plan (16 small airports)	1981-1986	250

It is recommended that the Airport Rehabilitation Plan be initiated with a detailed survey, conducted with expert assistance.

Water - Three projects are recommended as follows:

	DATE	COST ($b millions 1977)
1. Ichilo-Mamoré - river cleaning	1981-1983	20
2. Port improvements at Villarroel, Trinidad, Guayaramerín and at the terminus of the new rail line under construction from Yacapaní to the Río Grande	1981-1983	6
3. New port on the Paraguay River (2)	1984-1990	600 (2)

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(1) If justified for safety reasons. Costs included in the program represent 85 percent of the project, the remainder being designated for the 1990s.

(2) For two of three stages, but excluding the additional cost of a railroad from Mutún to Puerto Busch and for land reclamation, both associated with a port location at Puerto Busch.

Highways - Many highway projects are recommended, and they are listed below by category:

	LENGTH (km)	DATES	COST ($b million 1977)
Penetration Roads (3) -			
Trinidad-San Ramón	191	1981-1990	761
Guayaramerín-Pto.Siles	215	1981-1990	543
Santa Rosa-Riberalta(4)	270	1981-1986	22
Tumupasa-Ixiamas	45	1984-1986	210
Riberalta-Humaitá	50	1984-1986	116
Tucavaca Valley (5)	80	1984-1986	187
Ixiamas-Chivé	219	1987-1990	673
Other new roads (including bridges) -			
Machacamarca-Challapata	96	1984-1986	439
Las Carreras-Iscayachi(6)	59	1981-1986	180
Eteramazama-San Ignacio de Moxos	272	1987-1990	1,116
Santa Bárbara-Bella Vista (7)	99	1987-1990	1,250
San Borja-Trinidad(7)(8)	228	1981-1990	300

(3) Also implies construction of associated feeder roads -- length shown are for penetration roads only, but costs are total cost.

(4) Only justified if construction can be continued at the current very low costs.

(5) Recommended as two sections of 40 km each, starting from Puerto Suárez and Roboré.

(6) New section of 42.4 km required between El Monte and Tres Cruces.

(7) Timing dependant on reducing costs from current estimates.

(8) Completion of partially built road, including costs of motorized pontoons for the Mamoré River crossing west of Trinidad.

		LENGTH (meters)	COST $b millions 1977
Bridges (9) - (other than for new roads)	Villamontes-Yacuiba (9 bridges)	146	17
	Boyuibe-Villamontes (7 bridges)	150	23
	Pto.Banegas-San Ramón (1 bridge)	74	7
	Río Seco-Desaguadero (4 bridges)	238	25
	Machacamarca-Uncía (5 bridges)	280	32
	Quillacollo-Independencia (3 bridges)	90	13
	Mataral-Vallegrande (2 bridges)	66	5
	Sucre-Padilla (1 bridge)	15	3
	Epizana-Sucre (2 bridges)	180	12
	Camargo-Tomatas (8 bridges)	136	17
	Santa Cruz-Boyuibe (2 bridges)	350	87
	Potosí-Camargo (11 bridges)	225	27
	Potosí-Tarapaya (1 bridge)	40	4
	Pto.Japonés-Tambo Quemado (4 bridges)	85	9
	Patacamaya-Pto.Japonés (9 bridges)	205	27
	Replacement of Existing bridges(34 bridges)	1,327	179
	Río Grande at Pto. Banegas(1 bridge)	1,500	130

(9) Dates dependent on feasibility studies and timing of other improvements.

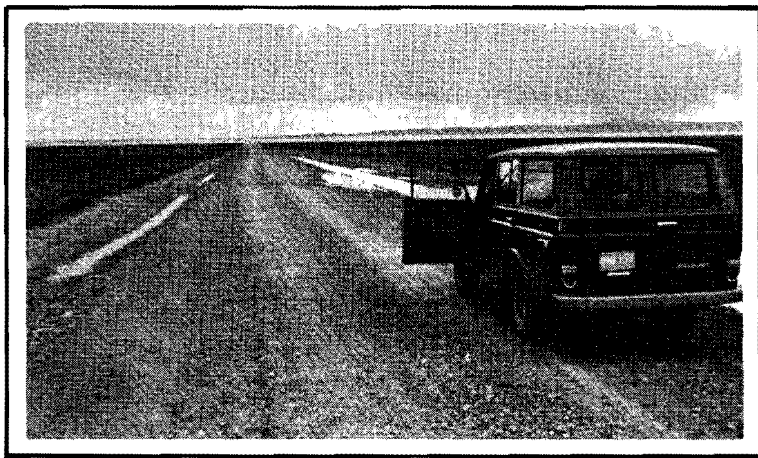
	LENGTH (meters)	DATE	COST ($b millions 1977)
Paved Road Rehabilitation -			
Comarapa-Jorochito	120	1984-1986	135
Guabirá-Yapacaní	68	1984-1986	197
Guabirá-Pto.Banegas	54	1987-1990	161
Guabirá-Chané	41	1987-1990	119
Paved Road Overlaying -			
Cochabamba - Epizana	126	1981-1983	83
El Alto-Patacamaya	85	1981-1983	61
Patacamaya-Oruro	122	1984-1986	87
Oruro-Machacamarca	31	1984-1986	23
El Alto-Viacha	20	1984-1986	17
Cochabamba-Villa Tunari	124	1984-1986	102
Betterment with paving -			
Santa Cruz-Cotoca	18	1981-1983	27
Cobija-Porvenir	30	1981-1983	47
Sacaba-Villa Tunari (part) (10)	29	1984-1986	23
Trinidad-Pto.Almacén	14	1984-1986	30
Huarina-Achacachi	19	1984-1986	23
Río Seco-Desaguadero	98	1984-1986	109
Machacamarca-Huanuni	22	1984-1986	29
Potosí-Cucho Ingenio	38	1984-1986	72
Potosí-Sijllani	59	1984-1986	86
Pulquialto-Sucre	29	1984-1986	53
Oruro-Caihuasi	39	1987-1990	54
Challapata-Ventilla	94	1987-1990	192
Ventilla-Tarapaya	85	1987-1990	178
Cucho Ingenio-Totora Palca	31	1987-1990	46
Punata-Arani	8	1987-1990	9
Cliza-Punata	11	1987-1990	12
Tarata-Cliza	11	1987-1990	12
Parotani-Capinota	25	1987-1990	35
Km 87-Puerto Banegas(11)	9	1987-1990	14

(10) Paving a section which was never paved in the original construction.

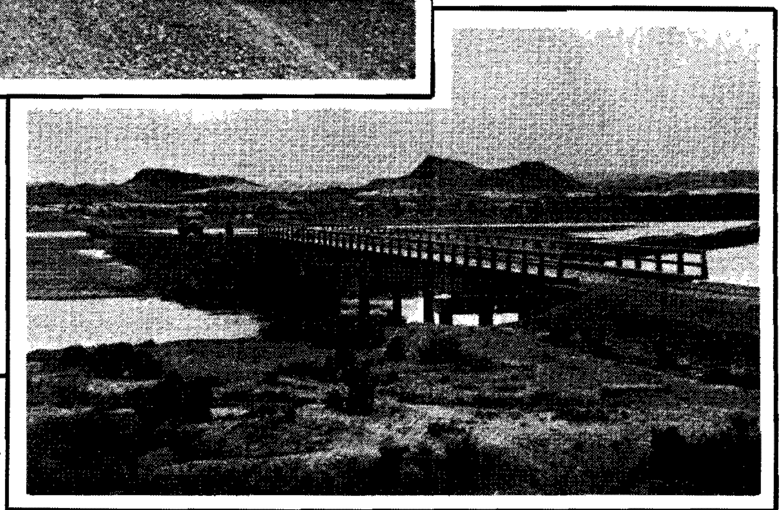
(11) On the Guabirá-Puerto Banegas road. Timing should coincide with the construction of the Río Grande road bridge at Puerto Banegas.

Major gravelling projects are specified by region, as follows:

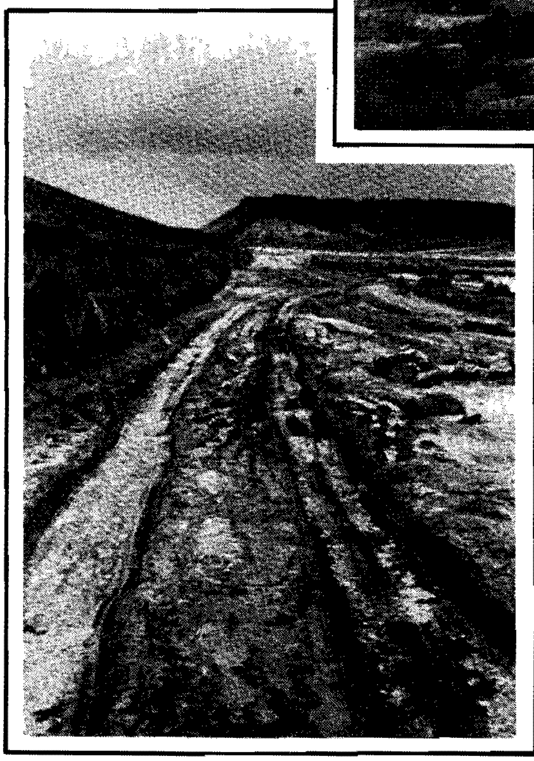
	LENGTH (km)	DATE	COST ($b million 1977)
Western Bolivia -			
Oruro-Toledo	39	1981-1983	12
Achacachi-Warisata	15	1984-1986	5
Achacachi-Ancoraimes	36	1984-1986	13
Viacha-Kapiri	13	1984-1986	4
Warisata-Sorata	38	1987-1990	10
Tiquina-Copacabana	42	1987-1990	13
Viacha-Corocoro	73	1987-1990	25
Patacamaya-Tambo Quemado	219	1987-1990	85
Yungas Valleys -			
Unduavi-Chulumani	67	1981-1983	22
Quillacollo-Sta.Helena	56	1984-1986	19
Inquisivi-Panduro	107	1984-1986	37
Santa Helena-Independencia	93	1987-1990	26
Caracollo-Colquiri	37	1987-1990	15
Southern Bolivia -			
Tomatas-Iscayachi	51	1981-1983	17
Las Carreras-Camargo	74	1981-1983	26
Padcaya-Bermejo	159	1984-1986	48
Villamontes-Yacuiba	104	1984-1986	47
Santiago de Huari-Challapata	13	1987-1990	5
Totora Palca-Camargo	117	1987-1990	43
Tarija-Villamontes	249	1987-1990	68
Boyuibe-Villamontes	107	1987-1990	47
Peñas-Fortín Villazón	130	1987-1990	18
Tupiza-Villazón	92	1987-1990	39
Cruce San Lorenzo-San Lorenzo	3	1987-1990	2
Palos Blancos-Campo Pajoso	83	1987-1990	27
Cochabamba Region -			
Angostura-Cruce Santivañez	5	1984-1986	2
Cruce Santivañez-Tarata	13	1984-1986	5
Aguirre-Chaco	19	1987-1990	5
Oruro-Sucre-Ipatí corridor -			
Sucre-Tarabuco	64	1981-1983	26
Tarabuco-Zudañez	45	1984-1986	17
Huanuni-Uncía	56	1984-1986	19
Ventilla-Macha	39	1984-1986	13
Uncía-Macha	89	1987-1990	24
Zudañez-Padilla	78	1987-1990	31



NEAR PATACAMAYA



PUERTO JAPONES



NEAR THE FRONTIER WITH CHILE

THE ROAD TO ARICA(CHILE)

PATACAMAYA-TAMBO QUEMADO

	LENGTH (km)	DATE	COST ($b million 1977)
Padilla-Ipatí	229	1987-1990	81
Sijllani-Pulquialto	72	1987-1990	29
Central Region -			
Siberia-Comarapa	50	1984-1986	11
Sucre-Epizana	238	1987-1990	102
Aiquile-La Palizada	137	1987-1990	32
Mataral-Vallegrande	53	1987-1990	20
Santa Cruz Region -			
Santa Cruz-Abapó	128	1984-1986	59
Cotoca-Puerto Pailas	25	1984-1986	14
Abapó-Boyuibe	217	1987-1990	119
Others -			
Mutún-Quijarro	44	1981-1983	20
Río Ivivigarzama-Pto.Villarroel	25	1987-1990	12

Road Maintenance and Organization of SNC

The Study has confirmed the findings of the 1978 World Bank mission, that road maintenance standards need to be substantially upgraded.

On paved roads, patching should be intensified from current negligible levels and routine surface dressing introduced. For gravel roads, better graded gravel should be used, together with watering and compacting techniques. With these improvements, frequency of grading on gravel roads could be reduced from current levels. On the other hand, more intensive grading and spot gravelling is required on earth roads.

It is assumed that this basic policy will be introduced over the next four years under the supervision of the Pilot Maintenance Study (started March 1981). It is also expected that more detailed analyses during the Pilot Maintenance Study will lead to changes in the details of the program for specific regions.

Regarding organization, it is recommended that SNC's central office be reorganized to promote interdepartmental contact and better managerial control. Three new subdirectorates are proposed, each of which would oversee the work of several departments. They are as follows:

- Planning and Design Subdirectorate
- Construction and Maintenance Subdirectorate
- Administrative Subdirectorate

The Construction and Maintenance Subdirectorate would consist of the existing departments of Maintenance, Equipment, Bridges, Construction and Feeder Roads. The Finance and Administration Departments would come under the Administrative Subdirectorate.

The Planning and Design Subdirectorate would include the existing Departments of Planning and Design and would also incorporate the functions of the Economic Advisor. In addition, it is suggested that consideration be given to the creation of a Studies and Investigation Department, under the same subdirectorate. The aim of this new department would be to perform certain basic road research relevant to Bolivian conditions, and to strengthen SNC's capability in conducting or supervising economic feasibility studies.

Program of Highway Studies

A program of studies to be initiated in the next three years is recommended as follows:

Penetration Roads:	Rurrenabaque-Ixiamas-Guarayos-Chivé Trinidad-San Ramón-Puerto Siles-Guayaramerín Puerto Suárez-Quitunquiña
Pilot Betterment Studies:	Río Seco-Desaguadero Challapata-Ventilla
Betterment:	Santa Cruz-Cotoca Cobija-Porvenir Trinidad-Puerto Almacén Huarina-Achacachi Machacamaraca-Huanuni Potosí-Cucho Ingenio Potosí-Sijallani Sucre-Pulquialto
Major Gravelling:	Unduavi-Chulumani Oruro-Toledo Camargo-Las Carreras Iscayachi-Tomatas Sucre-Tarabuco Mutún-Quijarro
Paved Road Rehabilitation:	Comarapa-Jorochito Guabirá-Yapacaní
New Highways:	San Borja-Trinidad Machacamarca-Challapata (to find ways of reducing costs from present design)
Others:	Axle Load Measurement Program.

HOLE PREPARED FOR PATCHING

COMPACTING THE PATCH

ROAD PATCHING OPERATIONS

These studies should re-consider, where appropriate, the question of modal competition between road and rail.

Organization of Road Transport

It is apparent that the present organizational structure of the road transport industry has led to the concentration of power in the hands of the operators syndicates. This in turn has contributed to an even distribution of service throughout the country and a generally inefficient utilization of the truck fleet.

It is recommended that government presence in this sector be strengthened by reinforcing the General Directorate of Road Transport (DGTA) of the Ministry of Transport, through an increase in its manpower and the creation of regional offices. The DGTA, and not the synidicates should be responsible for determining the number of operating permits to be issued annually, on the basis of observed demand for service. If insufficient service is provided in a particular area, the DGTA should impose its provision in the public interest. As an interim measure in the reorganization of the sector it is recommended that no further road transport vehicles should be permitted to be imported during 1981.

The SNC and Transito toll system now costs as much to operate as it procures in revenues, while imposing costly delays on road users. It is recommended that it be abolished except on some specific roads (such as the La Paz autopista). It is recommended that revenues for road improvement and maintenance be obtained from revised fuel and tire taxes and higher import duties.

More emphasis should be placed on the enforcement of axle load limits. It appears possible that some transito stations could be converted into permanent weighing stations; these would be supplemented by spot checks throughout the road system, using movable scales.

There is a lack of reliable data concerning the size and nature of the vehicle fleet in the country. The present register maintained by SNT should be computerized and regular reporting and updating procedures introduced. Insurance should be made compulsory for cargo and passengers carried on public services; consideration should be given to the introduction of compulsory third-party insurance for all vehicles circulating on public roads.

Rail Transport

The main recommendation on rail is that a major change is made in tariff policy in order to make rail transport more attractive for domestic freight. Tariffs for most domestic traffic should be set somewhere between marginal costs and the currently used average costs. Tariffs for external traffic, and for similarly inelastic domestic traffic, can be continued at current levels, or even raised slightly. Exact tariff levels will depend upon more detailed studies by ENFE's costing department.

It is expected that the tariff policy change will result in a large increase in freight movements. This will require new equipment and, above all, adequate planning to ensure that equipment purchases and commercial policy are harmonized.

It is recommended that track rehabilitation benefits be re-examined for the mountain lines, and that rehabilitation priorities suggested in this report be revised accordingly. It is also recommended that levels of track maintenance for unrehabilitated lines be raised to the levels considered "desirable" by ENFE, in order to prevent further track deterioration.

Further studies are recommended of the rail interconnection. In particular, potential international transit traffic, and the likely revenues they would generate must be identified more securely. It is also recommended that a more northerly alignment via Chimoré to Yapacaní be investigated.

It is recommended that a rail "piggy-back" service be started on the Santa Cruz-Corumbá line to transport trucks to and from Brazil.

Fare levels on the Andean passenger services should be assessed and if, as suspected on the limited data available, revenues are not covering variable operating costs, then fares should be raised immediately.

It is recommended that both the Cochabamba-Aiquile and the Potosí-Sucre lines be considered for closure. In the latter case, closure may be avoided if the new tariff policy results in a large increase in freight traffic and if the considerable tourist appeal of this line could be profitably exploited.

Improvements in operation are required, and it is recommended that a detailed review be made of the causes of the rather unsatisfactory performance of the past three years, particularly with regard to equipment maintenance and availability.

Better integration of the Andean and Eastern systems is recommended at the management level. Some functions relating to overall policy should be more centralized, while other aspects which have to do with day-to-day operation and commercial exploitation could be usefully decentralized.

Air Transport

There are three major recommendations in the Air Sector. The first is that the much delayed Air Navigation and Communication Equipment Plan (a committed project) is implemented immediately, without further adjustments. The second is that an Airport Rehabilitation Plan is initiated, concentrating on sixteen of the smaller airports, to permit operations by F28 passenger jets and F27 passenger turboprops. Related to the latter, it is recommended that levels of infrastructure maintenance are raised at all AASANA airports.

The other main recommendations concerning the air sector relate to improvements in current operational practices. Within the non-regular air sector, it is most important that major improvements be made in current maintenance procedures. The financial state of non-regular airlines does not permit replacement of the fleet, but with better maintenance the extremely poor accident record of the sector should be substantially improved. An expanded inspection system on the part of the DGAC is needed to enforce the maintenance standards, but this also implies increased training facilities, for both inspectors and mechanics. It is also recommended that a review is made of tariff levels, and of the licensing of non-regular operators.

In the general aviation sector, it is recommended that much stricter control be exercised over the operation of air taxis. The present practice where private operators offer occasional commercial services must be eliminated -- anyone offering such a service should be registered as a commerical operator and both the plane and the pilot subjected to more rigorous tests of "airworthiness". Enforcement should be through the issuing of licenses to operate, subject to annual renewal.

LAB's plans to extend jet service to a number of new communities is endorsed. However, the major effort needs to be devoted not to the development of new routes, but to the improvement of service on existing routes, particularly those designated as secondary. It is recommended that when LAB selects candidate aircraft to replace the ageing F27 fleet, serious consideration be given to the Dash-7 plane, in addition to the two F28 passenger jets on order, as well as to the possibility of introducing a mixed fleet by including a smaller plane (such as the Twin-Otter). This would give greater operational flexibility and permit economic operation on new routes for which a 50-seat aircraft would be too large. It is recommended that LAB study the expansion of its scheduled freight operations with the purchase of a second B-707 cargo aircraft.

AASANA's financial position is such that it cannot meet the financial burden imposed upon it by major airport investments such as those at Viru Viru, Cobija, Riberalta, Puerto Suárez and the proposed new terminal and runway at Cochabamba. It is strongly recommended that AASANA should not be made responsible for such investments.

River Transport

Apart from air, river currently provides the only means of access to large parts of northern Bolivia. Roads are now being built to several of these zones, and trucks are starting to carry some of the goods previously transported on the river. At the same time, however, more people are moving in, generating economic activity which in turn increases overall transport demand. Therefore, the demands for river transport in northern Bolivia are expected to remain relatively stable.

On the other hand, substantial growth is anticipated in the two external river corridors that could be used to export some of Bolivia's production. One of these is the Paraguay River in the east, the other the Madera River in the north; both of these are only accessible through ports located in Brazil.

The Madera river port of Porto Velho is separated from Bolivia by a long stretch of rapids, but can be reached over a 330 km road which will be paved in the near future. The long-term export potential from northern Bolivia is very promising, including meat in refrigerated containers. It is suggested that in negotiations with Brazil, Bolivia give attention to the improvement of port facilities at Porto Velho and to their use for Bolivian cargo.

On the Paraguay River, current mineral exports from Mutún have to pass through the Brazilian port of Corumbá. As an initial step to put this transport, which as a strong growth potential, into Bolivian hands, it is recommended to build a port in Bolivian territory. In the selection of a Paraguay River Port site, it is recommended that the following principles are followed:

(i) A new river port in Bolivian territory should be built only if it is needed for a major export project based on the iron ore resources at Mutún (although it could then be used for general foreign trade);

(ii) That financing for a port and the necessary land connections should be considered as an integral part of a Mutún export project;

(iii) That the port location be selected based on the needs of a Mutún export project.

At the same time as building a port, arrangements should be made to build up a river fleet to serve the demands generated by the exports from Mutuñ.

On the Mamoré river system, fallen and embedded tree trunks cause delay and danger to navigation. It is recommended that a project be initiated to remove these obstructions, first in the section from Trinidad to Guayaramerín, then in the section from Puerto Villarroel to Trinidad. Once the railroad currently under construction north of Yapacaní reaches the Río Grande, simple port facilities should be provided at that location to permit the transfer of goods between river barge and rail. It is also recommended that some equipment is provided at the Ports of Villarroel, Trinidad and Guayaramerín to aid maintenance of the river bank, and cargo transfer operations.

With regard to the administration and maintenance of river ports in the Amazon basin, it is recommended that this responsibility be given to the local development corporations. These would then provide the equipment (such as bulldozers) as needed to maintain the ports and make possible small-scale improvements. They would also furnish -- where appropriate -- simple loading devices such as conveyor belts. All other government responsibilities concerning river transport should be transferred to the Bolivian Navy, including those currently assigned to the Ministry of Transport's General Directorate of the Merchant Marine.

Pipelines

If an agreement is reached about the sale of natural gas to Brazil, this will automatically imply the construction of a major gas pipeline from the Santa Cruz area to the eastern border. Similarly, the building of further gas pipelines for the internal market will depend more on YPFB's distribution strategy than on transport considerations.

Oil pipelines, on the other hand, especially those used for the transport of refined petroleum products, compete directly with other transport modes. However, the existing network is already quite extensive, and the evaluation revealed no need for additional product pipelines until the 1990s.

Transport Investment Plan 1981-2000

The object of the investment plan is to bring together the projects for each mode into a program for the whole country within the estimated budget limits. The projects which make up the plan have been listed in earlier sections of this chapter. The expenditures and budgets for each period considered, which were discussed in detail in Chapter 18, are summarized in Table 20-1.

Table 20-1

SUMMARY OF RECOMMENDED TRANSPORT INVESTMENTS

(millions of 1977 pesos)

PERIOD	INVESTMENT Rail	Road	Air	Water	Total	BUDGET (1) Low	Medium	High
1981-1983	1,113	5,034	2,294	26	8,467	5,640	7,060	8,460
1984-1986	1,570	7,018	835	200	9,623	6,400	8,000	9,600
1987-1990	3,169	8,996	1,976	1,400	15,541	10,370	12,970	15,560
Sub Total	5,852	21,048	5,105	1,626	33,631	22,410	28,030	33,620
1991-2000 (2)	20,000	23,500	7,500	2,000	53,000	37;530	46,890	56,340
Total	25,852	44,548	12,605	3,626	86,631	59,940	74,920	89,960

(1) Budgets for inter-urban transport investment.

(2) Budgets for 1991-2000 correspond to Development Pattern C. With Development Pattern A, a low budget of $b 28,500 million is estimated. With Development Pattern D, a high budget of $b 75,800 million is estimated. See Chapter 8 for details.

The recommendations follow the high budget, but it is recognized that these sums are unlikely to be available. Therefore, recommendations are made in Chapter 18 on project priorities in case only the low or medium budgets apply.

Access to Foreign Markets

Further substantial expansion of agricultural production in Bolivia requires new markets if it is to be worthwhile. These can only be outside the frontier, either in adjoining countries or further afield, such as the United States and Europe. Transport costs play a critical role in the profitability of such production. For this reason it makes good sense for Bolivia to develop first those areas of potential production which are close to cheap export routes. The most promising routes are undoubtedly the northern corridor through Guayaramerín-Porto Velho to Manaus and Belem, and the Paraguay River.

Successful exploitation of these routes depends on close cooperation with Brazil through whose territory the traffic would have to pass; this is to be taken into account in future negotiation with that country.

Similar bi-lateral talks are recommended over the Peruvian corridor: priority should be given to obtaining Peruvian agreement regarding the paving of the road from Juli to Desaquadero. Much could be done to improve the flow of traffic in this corridor if agreement could be reached with Peru to reduce the number of checks and control points presently imposed on Bolivian trucks using this route. It is recommended that this be pursued as a prime objective.

Similarly, if transit traffic is to be encouraged, steps should be taken to reduce the burden of paperwork at present involved in passing such traffic through Bolivia.

Regarding improvements to existing links to ocean ports that do not require infrastructure investment, it is recommended that a rail "piggy-back" service be instituted on the Santa Cruz-Corumbá line. The service, which need not be elaborate, merely requiring the addition of a few flat-bed wagons to existing trains, should increase traffic in this corridor at minimal cost.

Future Long-term Transport Planning

The recommendations contained in this report are the result of considerable analytical effort by a comparatively large team of Bolivian and foreign professionals. Following a detailed study of the national economy and of its potential for development, a global view was taken of the entire transport sector to establish the priorities within it. This comprehensive approach -- and the use of objective criteria of economic evaluation -- now provides the basis for decisions on transport policy and investment, which are in the interest of the county as a whole rather than merely responding to sectoral or regional pressures.

However, the presently formulated transport plan will require updating in the future, as unforeseen developments take place or as the Nation's priorities change. Transport planning is a continuing process which has been launched in Bolivia with this Study. To reap the full benefit from the investment made in it, the continuing transport planning process must now be firmly established.

To achieve this, the creation of a National Transport Center has been proposed, as an autonomous agency under the Ministry of Transport. Its staff would be made up from members of this Study's counterpart team who have now acquired knowledge of the comprehensive transport planning science. It would be unfortunate indeed if this accumulated knowledge were dispersed and thereby, at least partly, lost to the country.

This has been the experience with the Ministry of Transport's Directorate of Planning and Coordination, which was formed on the recommendations of a previous comprehensive transport study. One of its principal functions was to perform medium and long-term transport planning, but this has not been achieved in reality. Partly this may have been due to the pressures of day-to-day problems inside the Ministry, that needed immediate solution, thus diverting attention from the seemingly less urgent issue of long-term planning. Another reason may have been the difficulty to attract and keep the sufficient qualified staff needed for the Directorate to perform the planning functions assigned to it. Learning from this past experience, the National Transport Center is now proposed as an autonomous agency.

The principal task of the Center would be to provide technical coordination in the planning of transport priorities both with regard to possible investments and changes in regulatory measures. It would ensure that an adequate up-to-date base of transport data be kept and would update the findings of this Study, as required. These activities would provide the Center with the backround to give, on a continuing basis, ad-hoc advice to the Minister of Transport.

The first two years of continuing transport planning have already been defined as Phase II of this Study. Emphasis should now be placed on implementing the recommendations contained in this report, i.e. the preparation of detailed timetables, terms of reference and proposed assignments of responsibilities. On the success of Phase II, in firmly establishing the National

Transport Center as an effective advisory group, will depend on the quality of the future decisions that will be made in the transport sector. Wisely made decisions will help to generate economic gains and thus spur development. The nation will be the beneficiary.

Most Urgent Needs

Undoubtedly the most pressing need is the immediate creation, as an autonomous body, of the National Transport Center based upon the counterpart staff of this Study. Without such a body, the accumulated knowledge and experience of the existing team will be lost, and the vital long-term transport planning process, initiated by this Study, will fail to materialize.

Regarding the individual modes, the most urgent requirement in the rail sector is raising of the standards of track maintenance to the recommended levels. Work should also begin with priority on the improvements to the Roboré-Taperas section of the Santa Cruz-Corumbá line. Slightly longer-term priorities are the initiation of studies of potential transit traffic, to examine the justification of the rail interconnection. In organization, the strengthening of the ENFE Commercial Department is urgent in order to implement the recommended tariff policy.

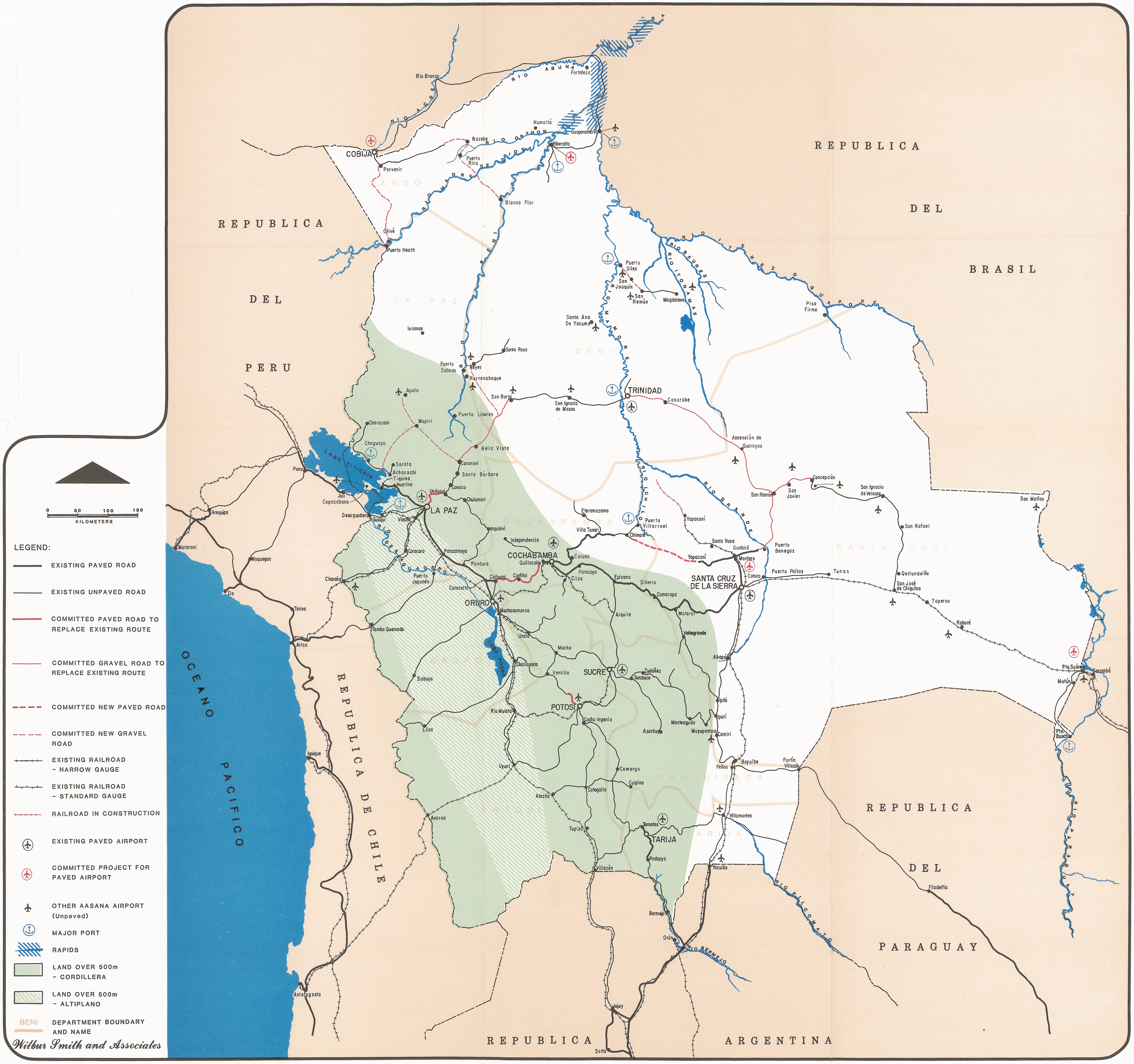
In the organization of the road sector the most urgent need is for a strengthening of the powers and resources of the General Directorate of Road Transport (DGTA) and the banning of truck imports in 1981. Regarding actual road construction and maintenance, highest priority should be given to the upgrading of maintenance standards and practice. The rehabilitation of existing paved roads should take precedence over other operations.

In the area of water transport the most urgent need is for the initiation of detailed engineering studies of a new port on the River Paraguay and the associated link to the Mutún complex.

The air sector has two urgent projects that should take precendence over all others for this mode. The first is the implementation of the Air Navigation and Communication Equipment Plan, which requires the earliest possible purchase and installation of the equipment funded under the 1978 World Bank loan. The second is the initiation of an Airport Rehabilitation and Maintenance Plan. It is suggested that this project might be the subject of special study, similar in scope, but smaller in scale, to the World Bank Pilot Maintenance Study for highways. Also, the extension of the runway at Cochabamba Airport is a priority project on safety grounds.

TABLE OF ABBREVIATIONS

$b	Bolivian Pesos- $US 1.00 = $b 25.00 (1981) - $US 1.00 = $b 20.00 (1977)
ADT	Average Daily Traffic
AADAA	Customs Administration
AASANA	National Airport Administration
ADEPTA	Association of Private Air Transport Firms
COMIBOL	National Mining Company
COMIXTA	Bolivian-Argentinian Joint Commission
CNT	National Transport Center
CEPAL	Economic Commission for Latin America
CODETAR	Tarija Department Development Corporation
COFADENA	National Development Corporation of the Armed Forces
CORDEBENI	Beni Department Development Corporation
CORDECO	Cochabamba Department Development Corporation
CORDECH	Chuquisaca Department Development Corporation
CORDECRUZ	Santa Cruz Department Development Corporation
CORDEOR	Oruro Department Development Corporation
CORDEPANDO	Pando Department Development Corporation
CORDEPAZ	La Paz Department Development Corporation
CORDEPO	Potosí Department Development Corporation
DGCP	General Directorate of Port Captaincies
DGMM	General Directorate of Merchant Marine
DGTA	General Directorate of Road Transport
DGTTA	General Directorate of Air Transport and Aerial Works
DPC	Directorate of Planning and Coordination
ENFE	National Railroad Company
FNB	Bolivian Navy
GNP	Gross National Product
GEOBOL	Bolivian Geological Service
GDP	Gross Domestic Product
HDM	Highway Design and Maintenance Standards Model
IBRD	International Bank for Reconstruction and Development (The World Bank)
IBTA	Bolivian Institute of Agricultural Technology
IDB	Interamerican Development Bank
INE	National Statistics Institute
INALCO	National Cooperatives Institute
INTAL	Institute of Latin American Integration
IRR	Internal Rate of Return
LAB	Lloyd Aéreo Boliviano
LAC	Líneas Aéreas Canedo
LAI	Línea Aérea Imperial
LPG	Liquid Petroleum Gas
LINABOL	Bolivian Shipping Line
MTCCA	Ministry of Transport, Communications and Civil Aeronautics
NPV	Net Present Value
NTS	National Transport Study
SHN	Hydrographic Service of the Navy
SN	Structural Number (Used in Road Pavement Design)
$\overline{SN}$	Modified Structural Number
SNC	National Road Service
SNT	National Transit Service
TAM	Transportes Aéreos Militares
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
YPFB	National Hydrocarbons Company


REPUBLICA DEL BRASIL
REPUBLICA DEL PERU
REPUBLICA DE CHILE
REPUBLICA DEL PARAGUAY
REPUBLICA ARGENTINA
OCEANO PACIFICO
LA PAZ
COCHABAMBA
SANTA CRUZ DE LA SIERRA
ORURO
SUCRE
POTOSI
TARIJA
TRINIDAD
COBIJA
LAGO TITICACA
LAGO POOPO
RIO ABUNA
RIO ORTHON
RIO MADRE DE DIOS
RIO BENI
RIO MAMORE
RIO ITONAMAS
RIO BAURES
RIO ITENEZ O GUAPORE
RIO GRANDE
RIO ICHILO
RIO DESAGUADERO
RIO PILCOMAYO
RIO BERMEJO
RIO PARAGUAY
PANDO
LA PAZ
BENI
COCHABAMBA
SANTA CRUZ
CHUQUISACA
TARIJA
0 50 100 150
KILOMETERS
LEGEND:
EXISTING PAVED ROAD
EXISTING UNPAVED ROAD
COMMITTED PAVED ROAD TO REPLACE EXISTING ROUTE
COMMITTED GRAVEL ROAD TO REPLACE EXISTING ROUTE
COMMITTED NEW PAVED ROAD
COMMITTED NEW GRAVEL ROAD
EXISTING RAILROAD - NARROW GAUGE
EXISTING RAILROAD - STANDARD GAUGE
RAILROAD IN CONSTRUCTION
EXISTING PAVED AIRPORT
COMMITTED PROJECT FOR PAVED AIRPORT
OTHER AASANA AIRPORT (Unpaved)
MAJOR PORT
RAPIDS
LAND OVER 500m - CORDILLERA
LAND OVER 500m - ALTIPLANO
BENI DEPARTMENT BOUNDARY AND NAME
Wilbur Smith and Associates