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No. 52

THE STUDY ON DEVELOPMENT PLAN FOR THE NEW DELHI RAILWAY STATION IN INDIA

FINAL REPORT

EXECUTIVE SUMMARY

DECEMBER 1989

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

THE STUDY
ON
DEVELOPMENT PLAN
FOR
THE NEW DELHI RAILWAY STATION
IN
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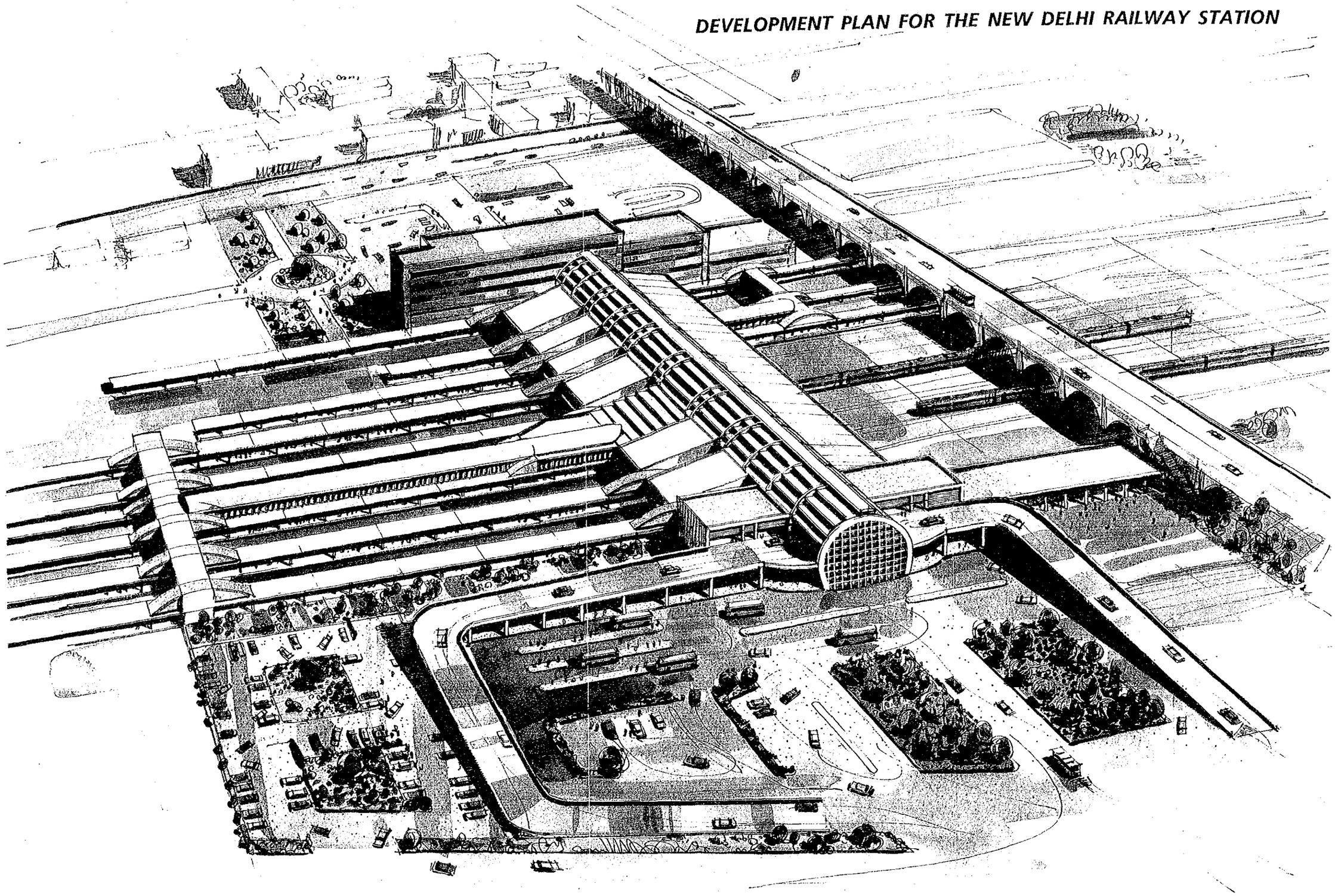

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EXECUTIVE SUMMARY

This is a summary of the Final Report of the JICA Study for the Modernization of the New Delhi Station (conducted Jan.-Nov. 1989).

The Project consists of two plans: First, a plan intending to make the routes clear to lead to New Delhi Station, by improving the line capacity of the sections involved (Master Plan). Second, a plan intending to make full use of New Delhi Station by improving its train handling capacity to the utmost and by drastically modernizing its quality of passenger service.

001 To give the conclusion first, the both plans have been verified to be technically feasible - as the result of the extensive study covering 200 km radius network around New Delhi, and as the result of the indepth investigation into the actual train operation works.

002 The Financial Internal Rate of Return (FIRR) was calculated at 12.1% and the Economic Internal Rate of Return (EIRR) at 19.5%, over the period 1990-2020, in case when the investment is suspended and the traffic increase depending on this investment is ignored as abandoned in the latter half of the project.

Viewed from standards generally accepted, these FIRR and EIRR are considered to be within a sound range and assure that this Project being economically/financially feasible.

003 Meanwhile, this Project consists of ordinary railway construction/reconstruction works. They do not contain any work that would necessitate specific environmental assessment procedures according to the laws and regulations now in force.

004 As to the opinion to the effect that the improvement of New Delhi would further increase the road congestion in the city centre, the Project took it fully into account; For example, the Meter Gauge (MG) goods and the passenger handling facilities at Delhi Main and other stations in the city center have been planned to be shifted to the suburbs. New Delhi station front plaza has been planned so that it would alleviate the road congestion around it.

005 The ultimate solution of the road congestion in the city center cannot be sought for in the construction of directional terminals in the suburbs. Because these measures would result only in giving rise to the equal or even additional road traffic from the periphery inward to the city center, or vice versa. Moreover, these measures would force a great inconvenience of the railway dependent public.

The ultimate solution of this problem lies nowhere than in the provision of a guided urban mass transit system such as LRT or underground system.

006 When the decision is made to implement the plan modernizing New Delhi Station itself (costing 1,431 million Rs), it is recommended that the plans improving the related sections (costing 1,641 million Rs) and the related terminals (costing 1,276 million Rs) be integrated with it, and executed in parallel. Otherwise, the cost effectiveness of the station modernization plan would be lost.

007 The first step of the Project, therefore, begins with the early decision to enlarge the scale of some of the ongoing projects. For example the section Jakhal-Samar Gopalpur should be included in the ongoing track doubling work. Then, the grade separation at Rampura Cabin in 1991. The modernization work of New Delhi Station itself will begin with the construction of three more platforms

in 1992. From technical reasons, the construction of the free passage will have to be performed concurrently with the platform work.

Hereunder are given the excerpts from the Report which support the above-mentioned conclusions.

CHAPTER 1 - INTRODUCTION

101 The Study has been conducted under the guidelines agreed between the Governments of India and of Japan, detailized by Northern Railway and the Study Team. They are as follows:

102 Geographical boundary of the study

1) 200 km radius circle

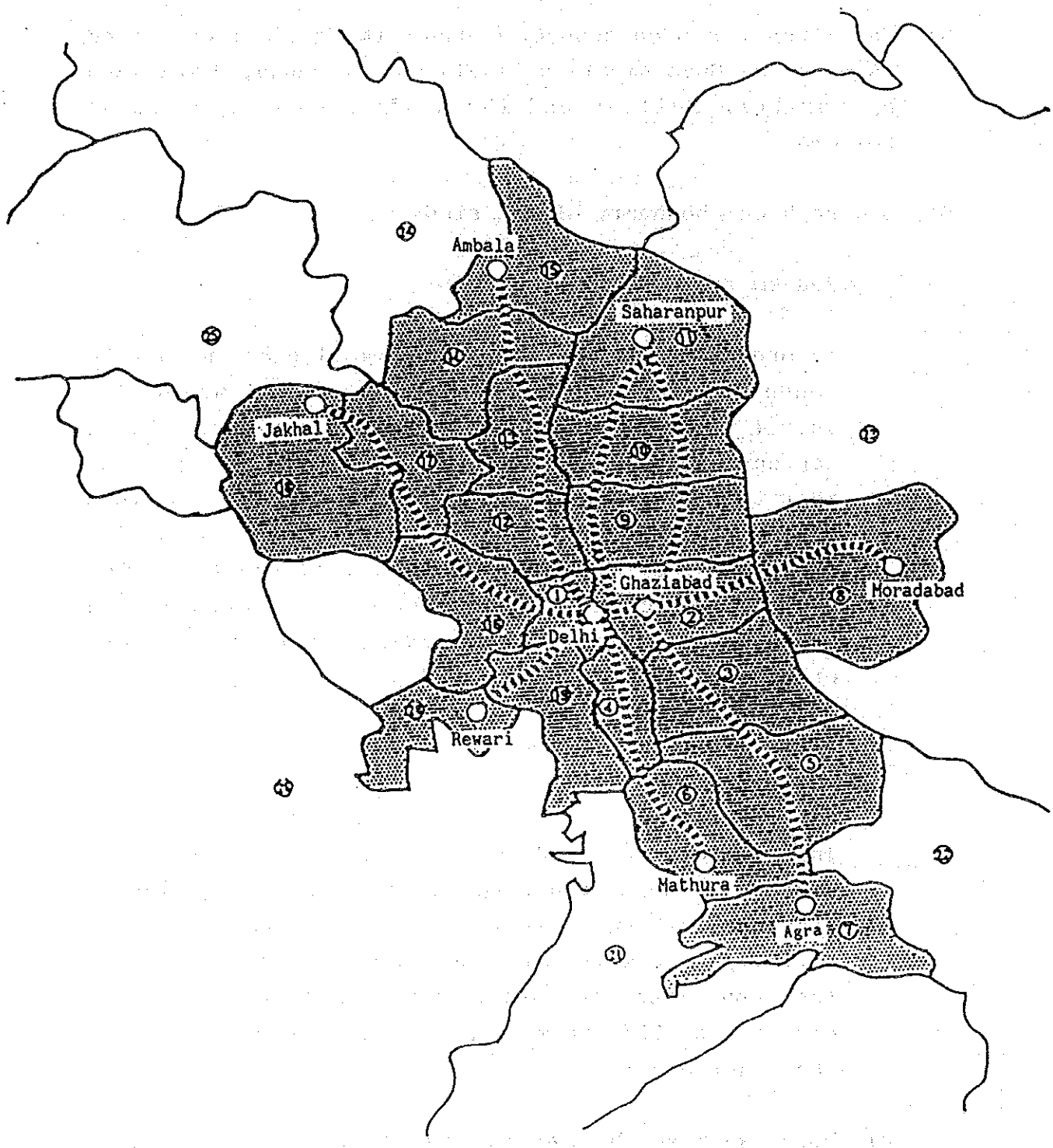
In order to evaluate a project, a simulation must be conducted of all the possible impacts it would give and it would be given, placing the project in an appropriate field of testing. It is for this purpose that the "Master Plan" study is conducted). For this Project, the field is chosen in a circular area with the radius of 200 kilometres around the New Delhi Station, since it is considered as an area within which the traffic flows involving New Delhi are more or less conclusive.

2) Outer and inner circles

The 200 km radius circle area is divided into the inner circle area and outer circle area. The inner circle is identified with the Delhi Area a jurisdiction of Northern Railway. It is for reasons of the affinity in traffic pattern observed in the area, and the convenience in information logistics. The outer circle area lies between the 200 km radius circle and the inner circle.

3) More exactly, the two circles are defined as follows:

"Delhi area (inner circle)" means the railway lines/sections whose outer ends are demarcated by the


Ambala
Saharanpur
Jakhal
Ghaziabad
Moradabad
Delhi
Rewari
Mathura
Agra

stations enumerated below:
Ghaziabad, Tuglakabad, Bijwasan(MG), Shakur Basti, Holambi Kalan and Behta Hazipur.

"Related area (outer circle)" means the railway lines/sections (connected with the Delhi area) whose outer ends are demarcated by the stations enumerated below:
Tundla, Moradadad, Saharanpur, Ambala Cant, Jakhal, Mathura and Rewari (MG).

103 Time boundary of the Study

1) Target year

The target year of the Project is set at 2010. For a project of this nature and scale, 10 years' period (target year 2000) is considered empirically as too short and 30 years (2020), too long.

2) Earlier Period and Later Period

The project period is divided into Earlier Period (from now to 2000) and Later Period (from 2000 to 2010). This classification is made according to the difference in nature of the investment planning for each period. The difference is referred to in the subsequent paragraph.

3) On the other hand, the economic/financial analyses are made covering the period 1990-2020.

104 Investment policy

1) Earlier Period

For the Earlier Period, the investment is planned to the extent that it can be verified of its feasibility

and cost effectiveness, within the scope of work and the geographical boundary of the Study. They are chosen from among the Action Plan of the Northern Railway on the one hand and on the other, they were newly proposed by the Team in addition to the Action Plan.

2) Later Period

For the Later Period, the investments are tentatively proposed to meet with the increasing traffic volume predicted for the period. They include the construction of a new "Delhi avoiding line" costing Rs 4 billion, the quadrupling of tracks of Mathura and Tundla lines, etc.

Their feasibility and cost effectiveness must be verified, amongst all, whether or not the train operability in the areas exterior to the 200 km radius circle could be matching with the upgraded traffic capacity within the circle. But this can not be verified in this study for the following reasons.

--- The objectives of these investments contain the elements deviated from that of the Project.

--- The geographical boundary of such study must be enlarged in such a manner as to cover the traffic flows not necessarily involving New Delhi.

The investment plans proposed for the Later Period should not be considered, therefore, as having been led out of a solid policy, but they are proposed tentatively presupposing that their cost effectiveness might be verified by separate studies.

CHAPTER 2 - SOCIO-ECONOMIC FRAMEWORK AND DEMAND FORECAST

SOCIO-ECONOMIC FRAMEWORK

201 Population within the boundary of the Study

Years	1985	1990	1995	2000	2005	2010
Million persons	44.0	50.0	56.2	62.4	68.9	75.2
Growth rates %	2.7	2.6	2.4	2.1	2.0	1.8

202 Economic Active Population within the boundary of the Study

Years	1985	1990	1995	2000	2005	2010
Million persons	12.6	14.5	16.6	19.0	21.4	24.0
Growth rates %	2.7	3.0	2.8	2.7	2.4	2.2

203 GDP of the boundary of the Study

Years	1985	1990	1995	2000	2005	2010
Rs 1000 crores	4.5	5.8	7.3	9.4	12.0	15.3
Growth rates %	4.8	5.0	5.0	5.0	5.0	5.0

DEMAND FORECAST

204 Forecasting Method

The region was divided into 20 zones and so-called Four-Step Method was selected and applied. The data used were collected from the relevant directorates of IR and NR.

205 Assumptions taken and to be noted

Schedule speeds of the trains were assumed to be the same as at present except in the sections: Delhi/New Delhi --

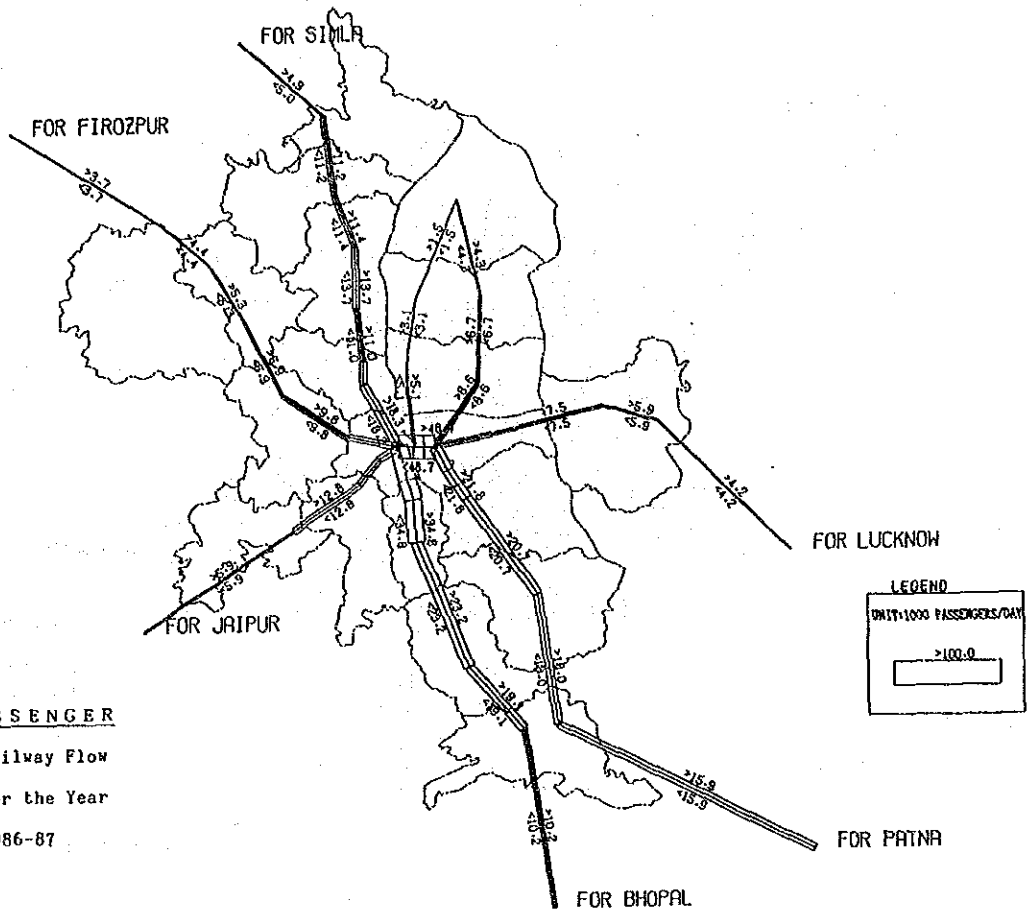
Tundla, Delhi/New Delhi -- Ambala and Delhi/New Delhi -- Mathura, where improvement in speed was taken into account. The construction of Express Highway was not considered.

The fare/rate system was assumed to be similar to the present, but the fare/rate level was assumed to rise* proportionally to the GDP's, in estimating the modal split.

* Note: This assumption of rise in fare/rate level is not taken in the financial analysis.

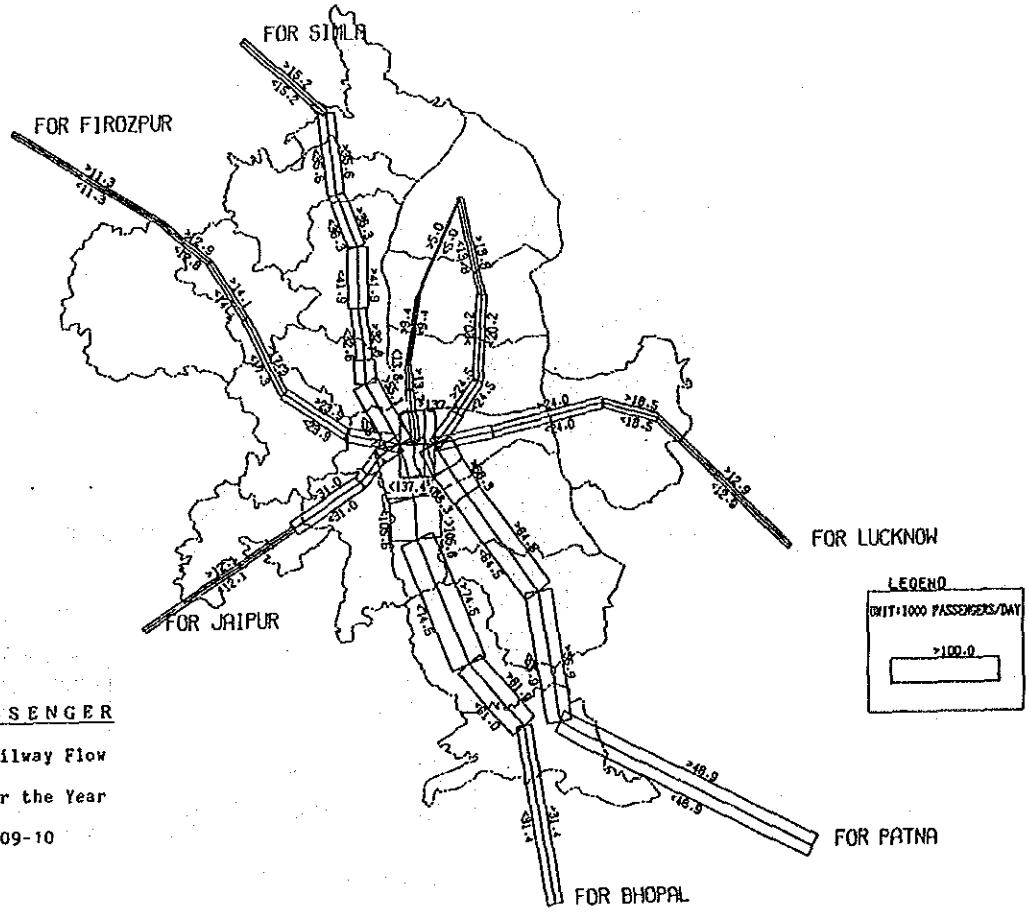
206 Results are as shown in Fig. 2.3.4 - 2.3.7.

Traffic growth both in passengers and goods is remarkable especially in directions Mathura and Calcutta, both in passenger and goods.



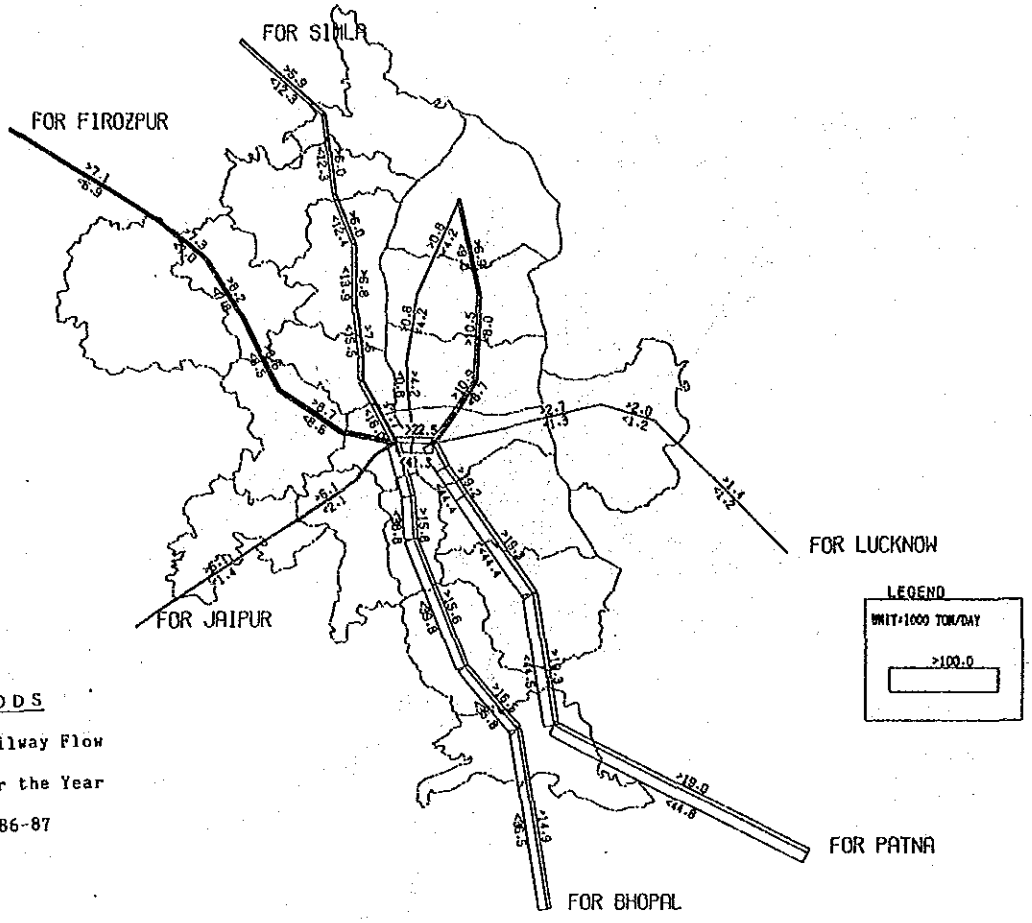
PASSENGER

Fig. 2.3.4 Railway Flow for the Year 1986-87



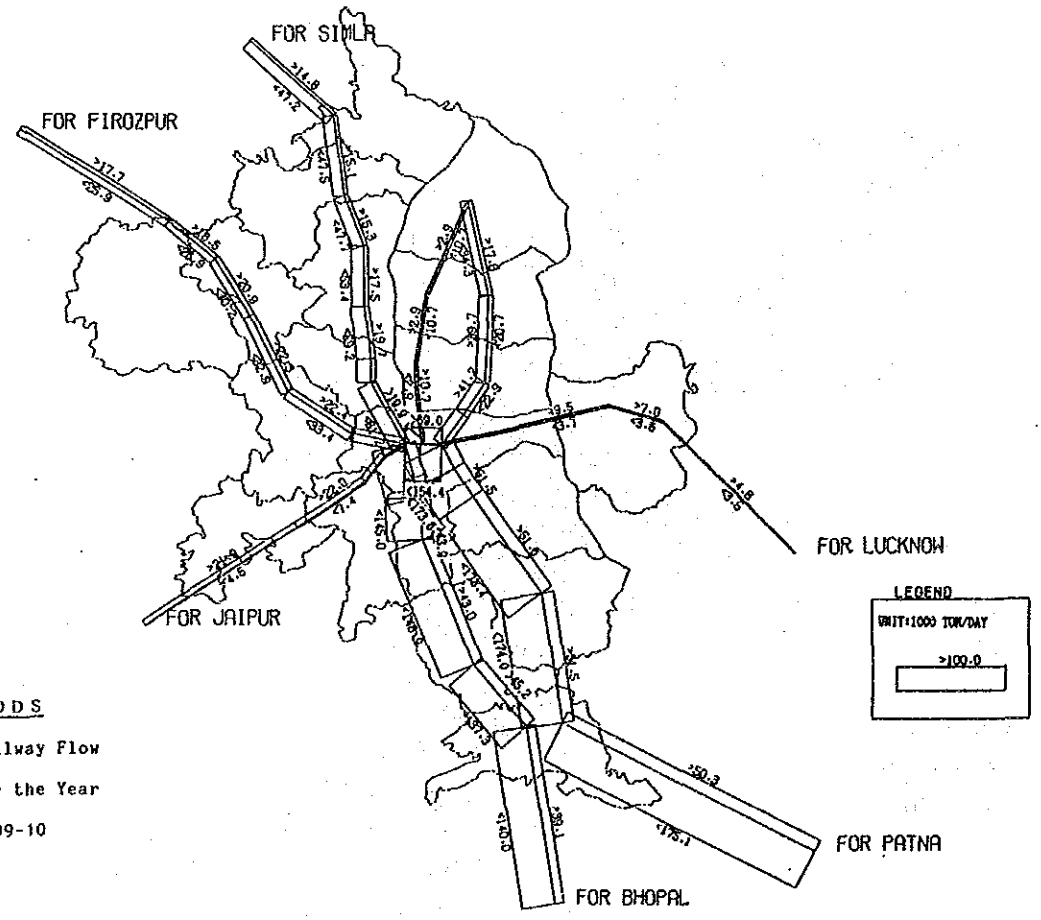
PASSENGER

Fig. 2.3.5 Railway Flow for the Year 2009-10



GOODS

Fig. 2.3.6 Railway Flow for the Year 1986-87



GOODS

Fig. 2.3.7 Railway Flow for the Year 2009-10

CHAPTER 3 - BASIC TRANSPORTATION PLANNING

301 Objectives

The objectives of the transportation planning in this study are:

(1) to identify the number of trains to be treated at the Delhi/New Delhi Stations, and

(2) to ascertain if it will be possible to deal with them in these stations.

302 Method

For the first objective, the estimation was conducted in the following manner:

(1) The required number of trains to be operated in the lines/sections of the region with a 200 km radius from New Delhi was sought for. It was obtained by dividing the sectional traffic volume (persons/tons) by the load per train (persons/tons). The sectional traffic volume was estimated by the demand forecast results, and the load per passenger train was determined considering the Action Plan to lengthen the train formation. The load per goods train was estimated at the same level as at present.

(2) Then, the line capacity of the relevant lines/sections was sought for. It was determined according to the line capacity improvement envisaged in the Action Plan for the period up to 1994-95, and for the period up to 2000, it was determined according to the Team's improvement plans additional to the Action Plan (See Chapter 4).

(3) For the period after 2000, a planning was made conceptually (See 104, subparagraph 2).

(4) Based upon the train operation plans thus obtained for the period up to 2010, the number of trains to be dealt with at Delhi Main and New Delhi were counted. As the result, it was estimated to increase from the present 177 to 248 in 2000 and 364 in 2010, one way per day.

Table 3.5.2-6 Number of Incoming or Outgoing Passenger Trains to Delhi and New Delhi in 2009-10

Station	1.Nov.1988	1994-1995	1999-2000	2004-2005	2009-2010
New Delhi	100	118	140	172	199
Delhi	77	94	108	136	165
Total	177	212	248	308	364

The above Table presupposes that some trains now originating/ teminating at Delhi Main will pass through Delhi Main and will be dealt with at New Delhi. Also it presupposes that MG arrival/departure lines at Delhi Main will be modified for Broad Gauge (BG) suburban trains use.

303 Terminal capacity

For the second objective of the Study, the capacity of the platforms, washing/stabling lines and the arriving/ starting lines of the Delhi/New Delhi stations were investigated. It is found out that it will be possible to

cope with the predicted traffic demand up to 1994-95, with the existing and already planned (by Indian Railways) facilities, but in and after 1999-2000, measures should be taken.

304 Number of trains exceeding the arrival/departure line capacity of Delhi, New Delhi

The incoming or outgoing trains are estimated to reach 364 per day in 2009-10, while the capacity stays at 260. Accordingly, 104 trains will have to be suspended.

Table 3.5.2-9 Number of Incoming or Outgoing Trains in Delhi Area

			For GZB	For TKD (For NDLS)	For DLI DSA	For NDAZ	For SSB	Total
Total	Demand	A	131	111	37	43	39	(364) 361
	Terminal capacity	B						△ 104 (260)
	Line capacity	C	△ 33 (98)	△ 28 (83)	-	△ 20 (23)	-	△ 81 (283)
	C - B	D						△ 23

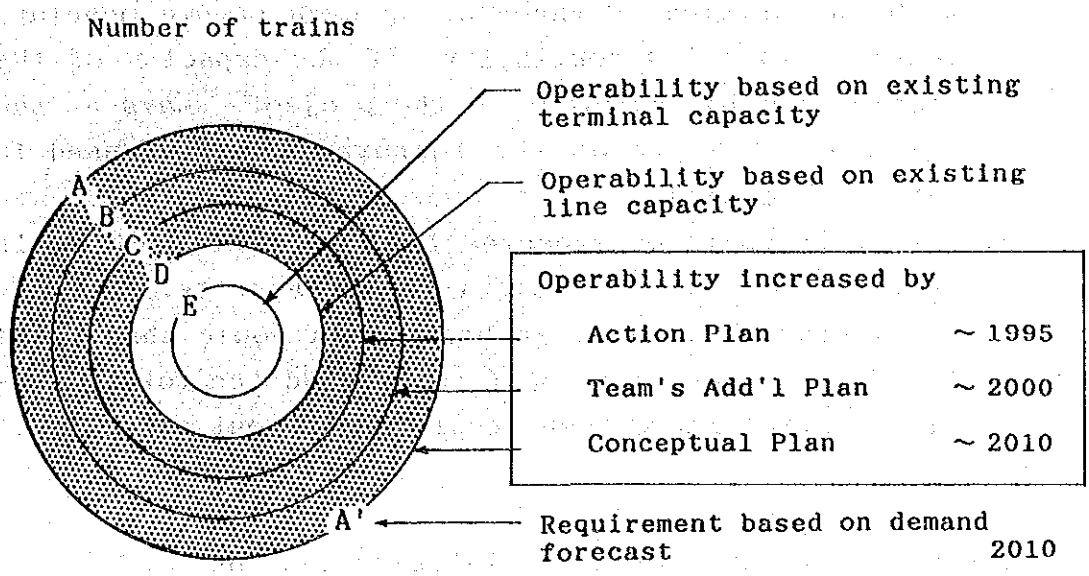
Note 1: "Total" is the total of Delhi Main and New Delhi.

Note 2: Figures in parentheses include the parcel trains and holiday trains.

305 Conclusion

364 trains will be incoming or outgoing in Delhi area, of which 81 will be suspended at the border of the outer and inner circle, due to the limited line capacity in the outer circle. Out of these 81 trains, 33 of them will be treated at Ghaziabad, 28 at Tuglakabad and 20 at Holambi Kalan. The remaining incoming or outgoing trains will, therefore, be 283. But the total of the capacity treating them at Delhi and New Delhi is limited at 260. So 23 suspended. They have to be dealt with at inner terminals by improving these terminals such as Anand Vihar.

CHAPTER 4 - RAILWAY FACILITIES, THEIR ACTUAL STATUS AND IMPROVEMENTS



401 Chapter 3 (Para 3-5 of the Report) and Chapter 4 deal with the difference between the requirement for, and the operability of the trains. The difference in the operable numbers of trains that lie between the requirement (circle A') and the present operability (circle E) must be filled up by some measures. The measures to fill the gap between circles D and E was dealt with in Chapter 3 and, the gap between C and D is already known (Action Plan). Measures to fill the gap between B and C and between A and B are the questions.

402 Team's Additional Plan for increasing the line capacity during the Earlier Period for the Related Section (1989-2000) (gap: B-C)

The improvement plans for the Earlier Period are proposed, selecting the line capacity increasing projects, based on the following criteria:

(1) Where a considerable difference is already observed between the number of trains required and the number

of trains operable, in the lines/sections in question.

(2) Where it is considered that the on-going projects might be critically checked, or even become meaningless, or lose its continuity, if the capacity of the line or section relevant to the projects stays at the existing level or at the improved level planned in Action Plan, and

(3) Where, it could be expected that, if the section in question is improved of its line capacity, the sections connected to it in Delhi area could absorb the traffic increase arising from it, and the total line-wise service improvement would prove cost effective.

Line Capacity Improvement of Related Sections

The additional improvement works to be made in the Earlier Period are as shown in Table 4.2.1 below.

Table 4.2.1 Additional Improvement Plan of Related Lines/Section by 2000

Section	Existing Facilities	Improvement Plan
Ghaziabad ~ Tundla 183.8km	Double tracked, Electrified Absolute Block System	Modernizing Signalling System
Naya Azadpur~ Ambala 188.2km	Double tracked, Non-Electrified, Absolute B. System	Modernizing Signalling System
Shakurbasti ~ Rohtak 59.7km	Double tracked, Non-Electrified, Absolute B. System	Modernizing Signalling System
Rohtak~ Jakhal 129.1km	Single tracked, Absolute B. System, Non-Electrified	Track Doubling
Palwal~ Mathura 83.4km	Double tracked, Electrified Absolute B System	Modernizing Signalling System
Patel Nagar ~ Rewari 74.7km	Double (partially Single tracked), Non-Electrified Absolute B. System	Track Doubling Modernizing Signalling System

(See Fig. 5.5.1)

403 Team's Plan for increasing the line capacity during the Later Period for the Related Sections
(2000-2010) (Gap: A-B)

The improvement plans for the Later Period are proposed. It should be noted, however, that, the proposal was made under the presupposition that these projects would become cost-effective, without being hampered by the inadequancy of the line capacity of the related sections located out of the 200 km radius circle.

Table 4.2.2 Additional Improvement Plan of Related Lines/Section by 2010

Section		Improvement Plan
Ghaziabad ~ Khurja	32.5km	Additional track : 3 tracks
Khurja~ Tundla	121.3km	Track Quadrupling
Khurja~ Palwal~ Rewari~ Photak	210.5km	New 'Delhi Avoiding Line'
Tuglakabad~ Palwal	39.4km	Additional track : Quadrupling
Palwal~ Mathura	83.4km	Track Quadrupling
Ghaziabad ~ Hapur	37.0km	Track Doubling
Murad Nagar ~ Meerut City	29.5km	Track Doubling
Holambi Kalan ~ Ambala	177.0km	Electrification

(See Fig.5.5.1)

404 Line Capacity Improvement of Sections within Delhi Area

Earlier Period

The transportation plan presupposes the improvement in traffic capacity of some bottleneck sections within Delhi area. They are as shown in Table 4.3.1. In planning them, however, effectiveness was one of the key criteria. Namely, even if these sections within the Delhi area are improved, it will not become effective un-

less the sections in the outer circle are improved. Therefore the improvement within the area is justified only when the improvement of the exterior area is supported by a higher investment priority. Otherwise the improvements within the area would not prove effective.

Later Period

The amount of the investment required to increase the line capacity of the sections in Delhi area would be tremendous, if the same traffic pattern is to be observed in coping with the increasing traffic demand in this area after 2000.

It is therefore necessary to by-pass the goods traffic by way of the new line (new "Delhi Avoiding Line") to ease the line capacity within the area. It is also necessary to build some satellite terminals in the periphery of Delhi area to ease the traffic pressure, which will be referred to in the next chapter.

Table 4.3.1 Improvement Plan of the Bottlneck Section within Delhi Area

Section, Places	Planned Improvement
Entry to NDLS from direction Tilak Bridge	Modify the track layout from 3 track routes to 4 track routes to enable using platforms at the same time with New Delhi Station improvement
Rampura Cabin(D.A.L.)	Eliminate surface crossing of D.A.L.with Main Line
Rampura Cabin ⌣ Naya Azadpur	Double the track, as well as electrify the section
New Delhi/Delhi ⌣ Subzi Mandi/D.Kishanganj	Eliminate the surface crossing of MG and BG tracks
Tilak Bridge ⌣ Shahibabad	Quadrupling the track, and construct a grade separation at "B" Panel
Tuglakabad⌣Lajpat Nagar ⌣Nizamuddin	Improve Turnouts
Section of Absolute Block System	Improve to Automatic Block System

405 Relationship with the New "Delhi Avoiding Line"

Rampura Cabin work may become unnecessary when the new Delhi Avoiding Line is completed. But its construction will be no earlier than 2000. The total avoidable losses arising from the restriction in train operation at Rampura Cabin would certainly surpass the cost of eliminating the surface crossing suspended until 2000. The elimination should be expedited.

CHAPTER 5 - FUNCTION ASSIGNMENT TO TERMINALS IN DELHI AREA

501 Now the number of trains getting in/out of Delhi Main and New Delhi is known. And how many of them these two terminals can deal with, is also known. Next issue is what to do with those trains which these terminals cannot treat. Solutions are in three alternatives:

1 - Improve the both terminals
2 - Improve either one of the terminals
3 - Shift certain train handling works from these terminals to other terminals.

502 Alternative 1 is too expensive. Furthermore, this would add more road congestion in the city centre. Alternative 2 and 3 must be taken. A main passenger terminal of a city would lose its raison-d'-être if it is located remote from the city centre. It would not be so, however, in case of auxiliary passenger terminals or goods terminals. They can fulfill their roles at locations remoter from the city centre, if and when fast and frequent transportation can be provided from their locations to the city centre. The renewal of the roles of the terminals in Delhi area often means, therefore, to study the possibility of dispersing some part of the station's train handling functions to remoter places. The functions can be divided into four categories: Namely, handling of 1) MG passenger trains, 2) MG goods trains, 3) BG goods trains and 4) BG passenger trains.

503 MG Passenger Terminals

(1) Alternatives

Delhi Station is equipped with facilities to deal with the MG passenger trains. And the MG tracks cross with BG tracks at two places west of Delhi Station, causing a serious bottleneck for the train

operation of the area. The situation will be worsened in future not only in terms of train operation but also in terms of operational safety, as the number of trains will increase. Moving Delhi's MG passenger handling function to the suburbs is a must. Three solutions are considered.

Case 1: Relocate Delhi MG passenger function to Bijwasan where a new MG passenger terminal will be built.

Case 2: Delhi Station will be grade-separated i.e. reconstructed to a two floored building (given another elevated or underground floor) and its MG passenger facilities will be moved to this new floor.

Case 3: Modify Patel Nagar Station on the Ring Line into an MG passenger terminal and move Delhi's MG passenger functions to it.

(2) Evaluation

1) Case 2 may offer an high level of convenience to the MG passengers but the investment cost will reach a tremendous amount and the construction work is complicated and difficult. Case 2 cannot be considered as a feasible alternative. Therefore Case 1 and 3 are compared.

2) The roles MG Line service plays in Delhi area are, for one, to provide long distance passenger trains, and for another, to provide Delhi area dwellers the commuter service to and from the city center. From this viewpoint an MG terminal in Delhi should be;
   a) located as near as possible to the business centers of the city
   b) providing good transportation access to the business centers of the city.

c) providing good transportation access to the stations where the long distance service for other places are offered (i.e. New Delhi/ Delhi stations).

Patel Nagar is better located than Bijwasan in view of 1) above, and in view of 2) too, as Patel Nagar is on Ring Line, the provision of EMU service will be much easier than in Case 1. Moreover, Patel Nagar is near to Patel Road where an LRT Project is being considered. If it is realized, it would be connected to the station. Patel Nagar will become one of the best served points in the Delhi's urban railway network.

For the above reasons, Case-2 - Patel Nagar, is recommended. The required cost is approximately 174 millions Rs.

504 MG Goods

Meter Gauge goods trains reaching/leaving Delhi area are dealt with at three stations: D. Lahori Gate, Sarai Rohilla and Shakur Basti.

(1) Lahori Gate

MG goods handling at D. Lahori Gate had better be abolished. It is the world's trends that small goods stations are jointed together to form a larger terminal where the goods handling jobs are mechanized.

(2) Shakur Basti

Most of the goods at Shakur Basti is dealt with by sidings.

According to the Team's view, the goods handling at Shakur Basti can be kept as it is for the time being.

(3) Sarai Rohilla

As to Sarai Rohilla, two cases should be evaluated.:

1) Case 1: Sarai Rohilla (Goods) Remains as it is.
The passenger train operation back-up facilities for Patel Nagar cannot be built here. Therefore the Alternative Patel Nagar (4.1.3) becomes impossible.

2) Case 2: Sarai Rohilla (Goods) is moved to Bijwasan
If Sarai Rohilla (Goods) is to be moved to somewhere else, the place cannot be other than to Bijwasan.

(4) Evaluation

Case 1 requires the least investment, but for the same general reasons as given in case of Lahori Gate, the Team considers that Case 2 should be recommended. The required cost is approximately 280 million Rs.

505 BG Goods

Considering the trends in congestion of the roads reaching the terminal, the Team recommends that the BG goods handling at New Delhi (Goods) should also be relocated to somewhere else. As to the place to which it could be moved, two cases are considered:

- Case 1: D. Kishanganj, Naya Azadpur or other existing goods terminal in Delhi area.
- Case 2: Holambi Kalan to be newly constructed.

Evaluation

It is a matter of policy rather than the matter of technical comparison, whether or not either of the two cases be selected. The Team recommends for Case 2 - moving New Delhi BG Goods to Holambi Kalan, because it would encourage the modernization of railway goods handling. Another reason supports Case 2: It is the recent development of the industrial lots quite near to the existing Holambi Kalan station.
Provided that the railway offers good service to the shippers, this would justify the relocation of New Delhi (Goods) to Holambi Kalan to a considerable degree.

506 BG Passengers

All these modifications in the roles of the existing terminals have been proposed to achieve one thing - to deal with more BG Passengers in Delhi area.

Next issue is to best allocate the BG passenger trains among the existing terminals in Delhi area.

(1) New Delhi's eligibility

From the viewpoints not only of the railway transportation efficiency but also of the city planning of the Delhi area, two options are conceivable in dealing with the increasing number of trains and passengers flowing into the area.

A. Accept them at one of the selected existing railway terminals in the city centre of Delhi area, which, the terminal, will be adequately improved and fully utilized.

B. Divide and accept them at some existing or new directional terminals, which will be selected

avoiding the city centre, where new passenger facilities will be created or improved.

The option A is recommended. The reasons are as follows:

1) At present, the New Delhi Station is the core of the railway network of the Delhi area. As such, it is and will be dealing with most of the Mail/Express trains. Option A will be the least demanding option for the convenience of the passengers, because it is not necessary for the users to change the present travelling behaviors.

2) The New Delhi Station will have enough space for the additional passenger facilities if its goods handling is shifted to somewhere else. Option A will make the required investment minimal because the existing facilities could be utilized. While the Delhi Station is limited in this flexibility.

3) The New Delhi's east front plaza is in good conditions and ready in space for further improvement of access to the Ring Road. The examples of the improvements are; expansion of the plaza toward the Ajmeri Gate side, grade separation of car-access space, etc. When these improvements are done, Option A will not worsen the congestion of the city centre.

4) When other conditions are the same, the most efficient way of handling trains is to deal with as many of them as possible at a single station. Option A will provide it.

507 Viability of the Solution

Based upon the above-mentioned concept, the utmost improvement and utilization of New Delhi as the BG passenger terminal in Delhi area will be made. How many

years could the improvement keep being effective?

(1) Requirements and acceptability

Table 5.4.1 shows the numbers of BG passenger trains to be dealt with at New Delhi and Delhi.
On the other hand, Table 5.4.3 shows the largest scale of improvements possible to be realized at New Delhi Station. There, the facilities are planned at a scale the largest possible within the available space. The space was considered "available", assuming that New Delhi BG goods would be moved to Holambi Kalan, and D. Lahori Gate MG goods would be abolished.

(2) Durability

Since the required number of trains increases (Table 5.4.1), the limit will be reached in Delhi Main in the year 2000. Its capacity is as shown in Table 5.4.2.
New Delhi will accept these trains which will overflow Delhi Main. But even if the utmost improvement is made to New Delhi (Table 5.4.3), the limit will be reached in New Delhi before 2005.

Table 5.4.1 Number of Trains Handling in Delhi Area

Station	Year	Arrival	Depart.	Switch B.	Through	Total
New	1988	26	26	11	63	126
Delhi	1995	34	34	11	73	152
	2000	56	56	11	73	196
	2005	88	88	11	73	260
	2010	115	115	11	73	314
Delhi	1988	27	29	23	40	119
	1995	30	32	23	56	141
	2000	34	36	23	56	149
	2005	57	57	23	56	193
	2010	86	86	23	56	251
Total	1988	53	55	34	103	245
	1995	64	66	34	129	293
	2000	90	92	34	129	345
	2005	145	145	34	129	453
	2010	201	201	34	129	565

Table 5.4.2 Number of Trains to be dealt with at Delhi Main

	1988	1995	2000	2005	2010
Arrival	27	30	34	34	34
Departure	29	32	36	36	36
Turn-Back	23	23	23	23	23
Through	40	56	56	56	56
Total	119	141	149	149	149

Table 5.4.3 Largest Possible Improvements at New Delhi Within Available Space

Tracks	Existing Facilities		Possible Facilities	
	Number	Length in number of coaches acceptable	Number	Length in number of coaches acceptable
Platforms	11	15 to 22	16	26
Washing Lines	9	9 to 21	16	26
Stabling Lines	7	varying length	8	26
Sick Lines	2	varying length	8	12

Table 5.4.4 Number of Trains to be dealt with at New Delhi

	1988	1995	2000	2005	2010
Arrival	26	39	67	73	73
Departure	26	39	67	73	73
Turn-Back	11	11	11	11	11
Through	63	73	73	73	73
Total	126	162	218	230	230

508 Directional Terminals

Some directional terminals will have to be planned, for one thing, considering the limitation in the terminal capacity of New Delhi and for another, considering the limitation in the line capacity for certain line/sections within Delhi area leading to New Delhi.

The number of trains which will have to be dealt with at terminals other than Delhi Main and New Delhi, is shown in Table 5.4.5.

Table 5.4.5 Direction-wise Numbers of Trains to be dealt with

Four terminals must be improved (or constructed) to deal with trains of three directions.

(1) Ghaziabad

Ghaziabad must be strengthened to deal with the passenger trains of the directions Tundla, Hapur and Meerut, since there will be problems in the line capacity to bring them from these directions to New Delhi.

The improvements of Ghaziabad include 3 arrival/departure lines and 16 washing/stabling lines.

Approximate Cost Rs 189 million

(2) Anand Vihar

For the same reason, a new terminal will be constructed at Anand Vihar, with 2 arival/departure liens and 11 washing/stabling lines.

Approximate Cost Rs 266 million

(3) Tuglakabad

Tuglakabad must be improved to deal with the passenger trains of the direction Mathura.
The improvements will include the construction of
2 arrival/departure lines and
13 washing/stabling lines

Approximate Cost Rs 125 million

(4) Holambi Kalan

Passenger handling facilities must be added to Holambi Kalan Goods Terminal (which will have been completed by 1995), to deal with the passenger trains of the direction Ambala.
The additional facilities will include
2 arrival/departure lines and
9 washing/stabling lines

Approximate Cost Rs 171 million

509 Sequence of Terminal improvements

Earlier Period

To recapitulate the terminal location plans above described, the sequence of the improvement works will be as follows:

(1) Construct the washing lines and stabling lines at Nizamuddin, as currently planned and practised.

(2) Construct a passage line from Tilak Bridge to Nizamuddin, at the same time as (1) above.

(3) Move the passenger-car maintenance work now being made at New Delhi to Nizamuddin.

(4) Construct two platforms in the space in New Delhi yard where the present passenger-car maintenance facilities are removed by (3) above.

The above-mentioned steps (1) through (4) are already being executed. The steps below are to follow them.

(5) Move the New Delhi goods facilities to Kishanganj and other existing cargo stations.

(6) Build washing/stabling lines in the space thus created in New Delhi. The construction at New Delhi of four platforms, the improvements of the station buildings and of station front plaza are to follow.

(7) Construct a BG goods terminal at Holambi Kalan.

(8) Construct a goods terminal at Bijwasan, to deal with the loading/unloading of MG goods and to deal with the transshipment MG-BG.
Move the MG goods facilities at D. Lahori Gate and Sarai Rohilla to Bijwasan.

(9) Improve Patel Nagar as an MG passenger terminal, move there the MG passenger handling now being made at Delhi Main.
Construct the maintenance facilities for MG passenger trains at Sarai Rohilla.

The above-mentioned steps (5) through (9) should be completed by 1999-2000.

Later Period

(11) Construct additional platforms at New Delhi Station and build washing/stabling lines at D. Lahori Gate where the MG goods passenger facilities will have been removed.

(12) Improve and construct passenger terminals at Ghaziabad, Anand Vihar, Tuglakabad and Holambi Kalan to deal with the trains increasing after 2000.

510 Investment Amount and Schedule

The above-mentioned terminal improvements and the line capacity improvements (chapter 4) altogether, the investment amount and schedule are charted as shown in Table 5.5.1 (P.36~ 38). The works include those for the related sections and those for removing the bottleneck points in Delhi area.

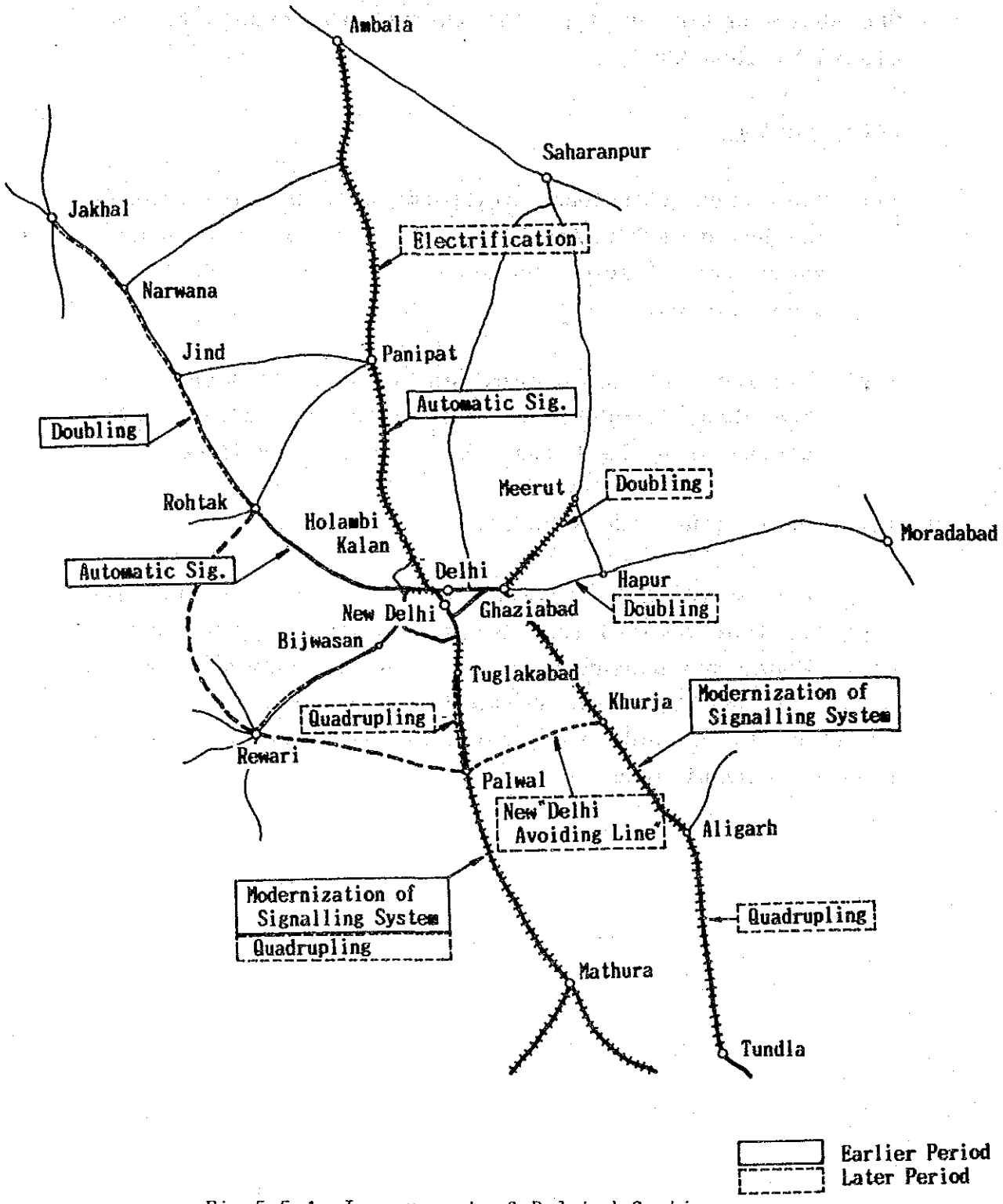


Fig.5.5.1 Improvement of Related Section

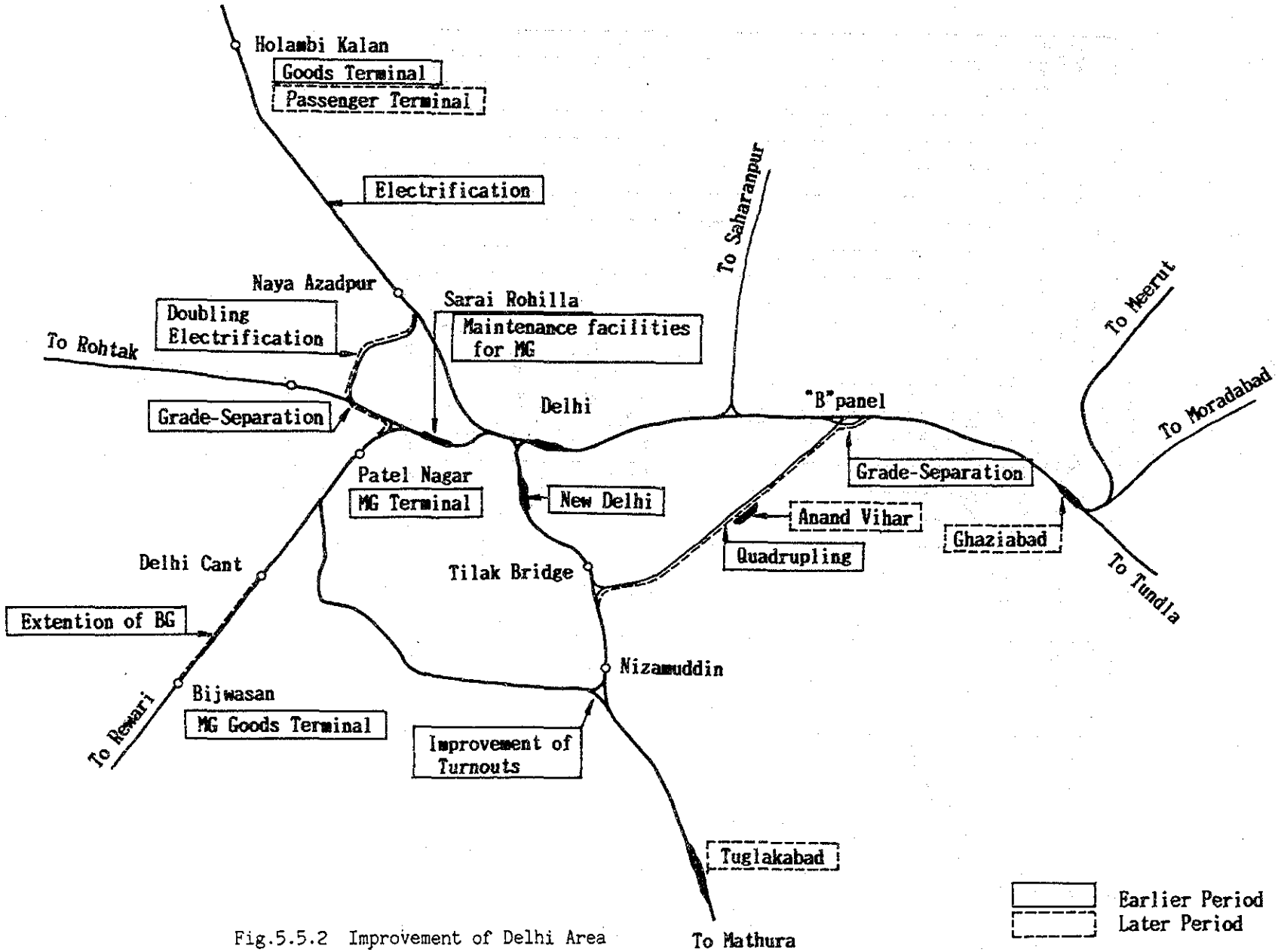
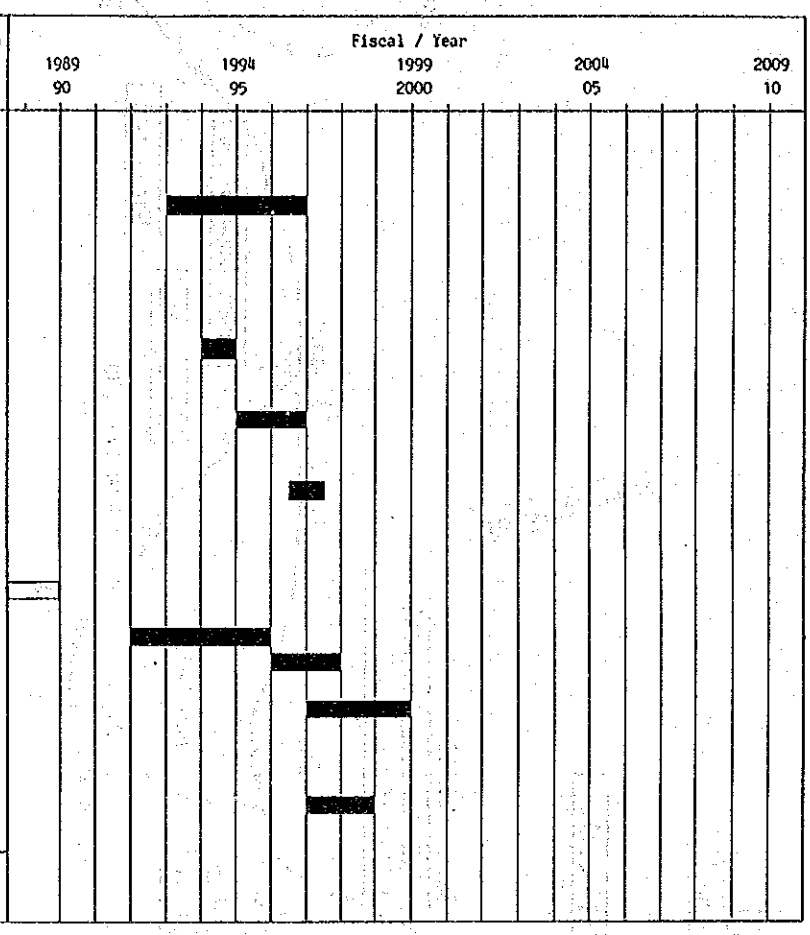


Fig.5.5.2 Improvement of Delhi Area

Table 5.5.1 Investment Schedule

Improvement Section/Terminal		Construction Cost (Million Rs)
Earlier Period		
Relevant Section		
· Ghaziabad ~ Tundla	Modernization of Signalling System, including improvement turnouts and OHE etc.	690
· Delhi ~ Holambi Kalan	Electrification	69
· Naya Azadpur ~Ambala	Automatic Signalling	185
· Shakur Basti ~Rohtak	Automatic Signalling	94
(Rohtak ~Jakhal Doubling)		
-Rohtak ~Samar Gopalpur, Kinana ~Barsola, Ghaso~Jakhal		
-Samar Gopalpur ~ Kinana		195
-Barsola~Ghaso		104
· Palwal ~Mathura	Modernization of signalling system	192
· Patel Nagar ~Rewari	Automatic Signalling	112
Sub total		1641



Note : "Doubling," "Tripling," "Quadrupling," mean Track doubling, Track tripling and Track quadrupling, respectively.

Table 5.5.1 Investment Schedule

Improvement Section/Terminal		Construction Cost (Million Rs)
Delhi Area		
· Rampura Cabin ~Naya Azadpur	Grade-separation, Doubling	116
	Electrification	33
· Tilak Bridge ~ Sahibabad	Quadrupling Grade-separation at "B" panel	330
· Delta area at Nizamuddin	Improvement of turnouts etc.	11
· Delhi Area Absolute Block section	Automatic Signalling	39
Therminal		
· Nizamuddin (PhaseⅡ)	Washing & stabling line	—
· New Delhi (Phase Ⅰ)	2 platform faces	—
· Holambi Kalan	Goods facilities for New Delhi	258
· Bijwasan	MG goods facilities	280
· Patel Nagar (including maintenance facilities at Sarai Rohilla)	MG passenger fa-	174
· Delhi	(BG facilities at MG)	35
· New Delhi (Phase Ⅱ)	3 Platform faces Washing & Stabling lines	333
· New Delhi (Final phase)	New station building including passenger information	1098
Sub total		2707
Total (5 Years each)		4348

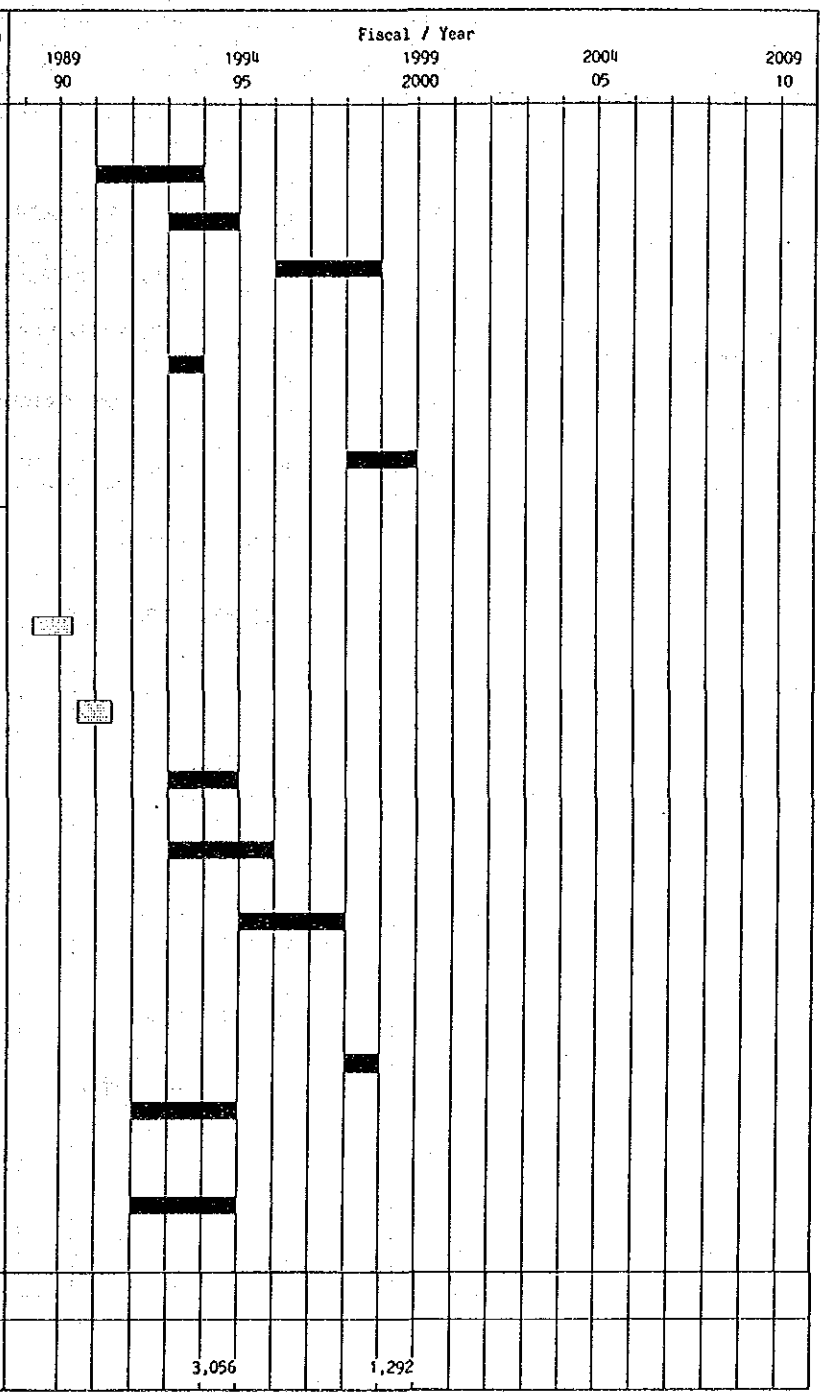


Table 5.5.1 Investment Schedule for Later Period Projects

Improvement Section/Terminal		Construction Cost (Million Rs)	1997 98	1998 99	1999 -2000	2000 -01	2001 -02	2002 -03	2003 -04	2004 -05	2005 -06	2006 -07	2007 -08	2008 -09	2009 -10
Later Period Section															
· Ghaziabad ~Khurja	Tripling	360													
· Khurja~Tundla	Quadrupling	2340							Tripling		Quadrupling				
· Khurja~Palwal Rewari~Rohtak	New "Delhi Avoiding Line"	3850							New line						
· Tuglakabad ~Palwal	Quadrupling (3→4track)	440													
· Palwal ~Mathura	Quadrupling	1610			Tripling			Quadrupling							
· Ghaziabad ~Hapur	Doubling	210													
· Murad Nagar ~ Meerut City	Doubling	170													
· Holambi Kalan ~Ambala	Electrifi-cation	530													
Terminal															
· New Delhi Station	Platform & Washing/Stabling. Tracks station building	125													
· Holambi Kalan	Passenger Facilities	171													
· Anand Vihar	Passenger Facilities	266													
· Tuglakabad	Passenger Facilities	125													
· Ghaziabad	Improvement of Passenger Facilities	189													
Later Total		10,386													

CHAPTER 6 - IMPROVEMENT PLAN FOR NEW DELHI STATION

601 Requirements in Planning New Delhi Station Improvement

(1) The space of D. Lahori Gate must be assigned to passenger car washing/stabling lines of New Delhi.

(2) The existing station buildings and platforms etc., must be utilized as much as possible.

(3) The track layout must be modified so that the use of the main line tracks might least compete between the on-service trains and out-service trains. ("On-service trains" mean the trains in commercial service. "Out-service trains" means those being shifted to/from washing/stabling lines)

(4) The track layout must be modified so that a platform might be used for trains of various directions. The track connection between the platforms and the arriving/starting lines must be so designed.

(5) The new platforms to be built must be designed so that they could deal with 26 car trains. The same with the washing/stabling lines.

(6) Part of the car washing works must be mechanized.

(7) Investments for improving luggage handling must be minimized, in consideration of the probable changes in method of their transportation in future.
But their moving lines must be separated from those of the on-platform passengers at the places where luggages will cluster.

(8) No large scaled commercial development of the station will be planned (as agreed in the Interim

Report. But see 606 (4)).

(9) The station building layout must be designed so that the moving lines of station users might not interrupt each other. The same with the moving lines of cars gathering at the station front plaza.

602 The Planned Track Layout of New Delhi Yard

A conceptual design is shown in Fig. 6.2.1.

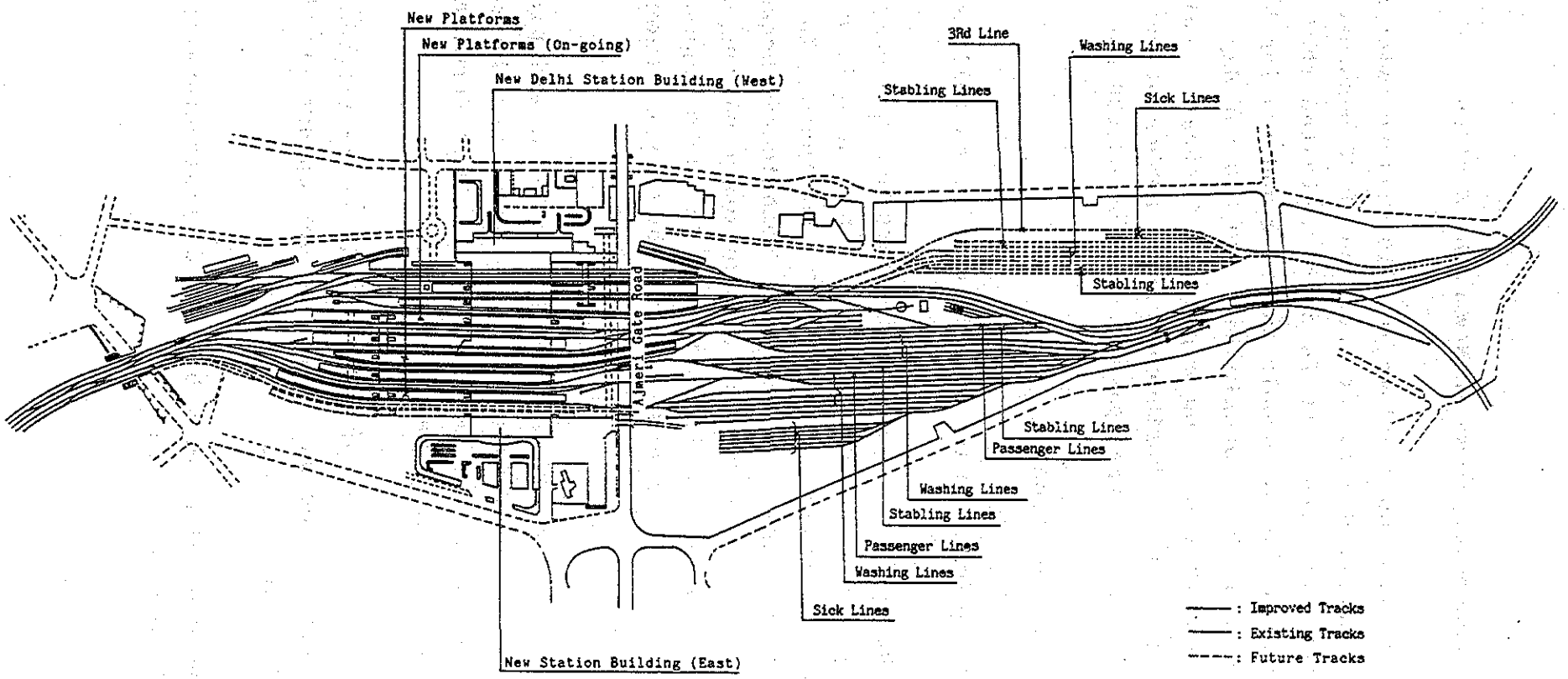


Fig.6.2.1 New Delhi Station Conceptual Plan

603 Future Passenger Flows in New Delhi Station

Passenger transport volume in 2010 will be twice as large as at present, due to the increase of 76 passenger trains of longer consists. It is also estimated that in 2010 the total number of people entering and leaving New Delhi Station will be approximately 500,000 per day, with the maximum number of people passing through a gate being 20,000 per hour. Furthermore, the number of pedestrians who will use the free passage will be 60,000 per day.

604 Passenger Flow Problem

The main problems have been identified as follows:

(1) The moving lines of passengers are too complicated. On the platforms, these lines have to avoid the parcels/luggage stacked here and there. In the concourse, they get even more complicated because they crisscross with the lines of other passengers bound for different directions. On the overpasses they also intermingle with pedestrians (nonrailway users).

(2) Passengers stagnate on the concourse and platforms, due to insufficient space. Actually, the space per person should be designed in this terminal to be larger than normal.

(3) The locations of certain service facilities are not easy to find and there are not enough public signs indicating them.

All these problems must be solved by structurally improving the entire station.

605 Station Building Planning

There are three major aims of the improvements:

(1) Separate the flow of non-passengers (i.e., pedestrians) using the free passageway from the passengers getting on/off trains.

(2) Lay out appropriately the passenger facilities in full respect of the improved moving passenger lines.

(3) Secure more space per person than normal in designing the passenger facilities of this terminal.

606 Main Features of Renewed New Delhi Station

(1) Free Passage

A free passage for non-passengers, of a steel structure with width of 30 metres is built crossing the station above the platforms.

On both sides of the passage are placed the waiting rooms, ticketing offices and shops. The total width of the structure including these facilities is 85 metres.

(2) West Gate Building (Management Facilities)

West Gate Building --- improved

- RC structured
- four floored
- 5,000 m^2

The West Gate building is reconstructed of its main concourse and atrium to be connected to the free passage.

(3) East Gate Building --- rebuilt

- RC structured
- four floored (one basement and three floors on ground)
- 3,000 m^2

East Gate will be the main entry to the station in future. Outside the Gate, an approach deck is built to

lead to the Sale/Flow Facilities through the free passage. Departing passengers will use this passage and the arriving passengers will use the ground level concourse. The flows of departing passengers and arriving passengers, along with the relevant flows of buses and taxi, will be thus separated.

The East Gate building itself is used as below mentioned;

1st Basement- machines, equipments, a power substation and ticket storage rooms

Ground floor - passenger exit, maintenance staff offices, luggage acceptance

1st floor ---- passenger entry, shops

2nd floor ---- up-graded retiring room

(4) A far sighted policy should be decided by the top management whether the building should remain four stories, as planned in this study, or be a high rise building in future. The foundation of the East Gate building should be planned accordingly.
(See Fig 6.3.1)

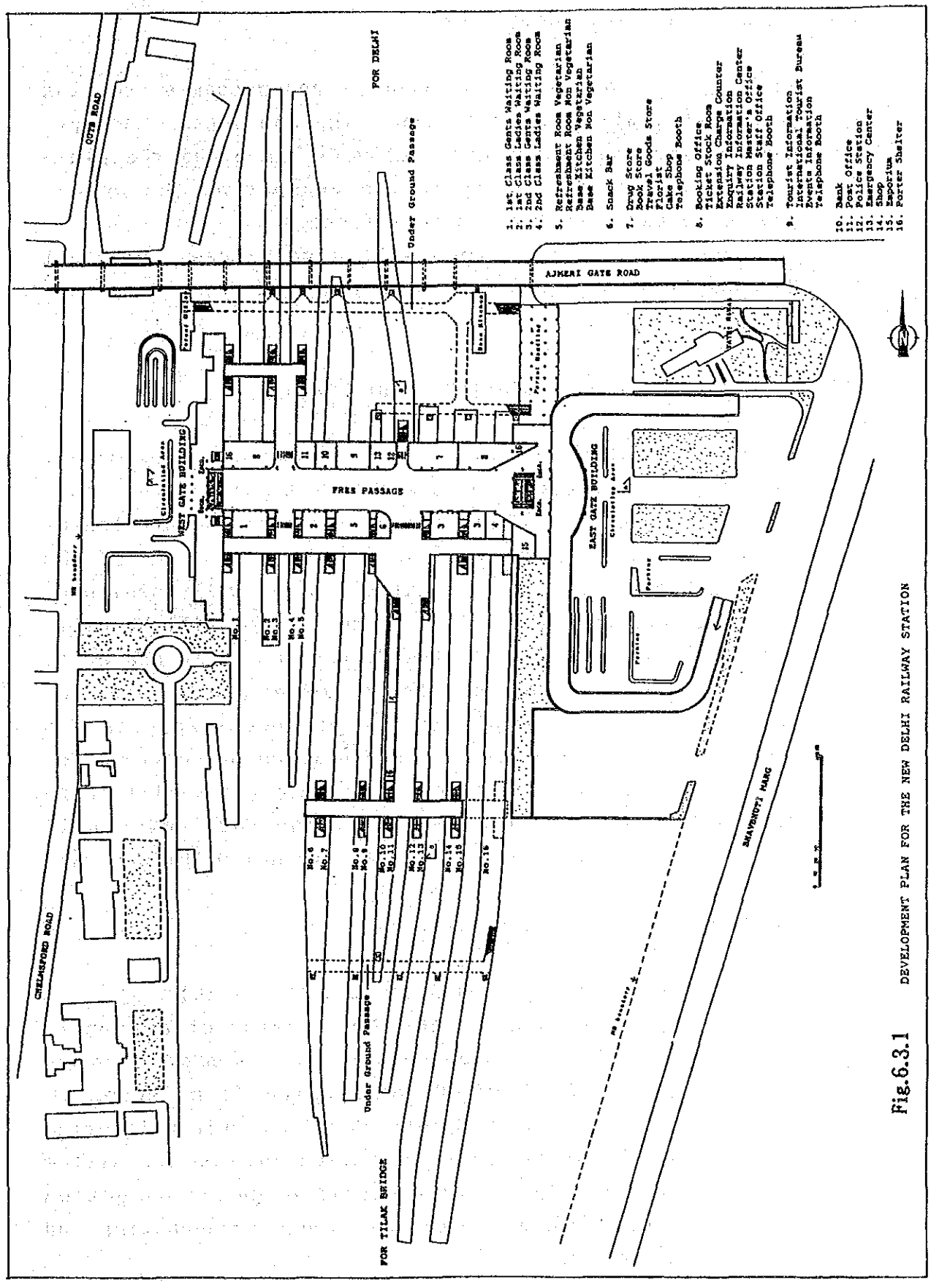


Fig.6.3.1 DEVELOPMENT PLAN FOR THE NEW DELHI RAILWAY STATION

607 Luggage Handling Facilities

For luggage handling, two underground passages crossing the tracks, will be built connecting the luggage acceptance office, sorting place, delivery place and the platforms. Lifts will be installed connecting the underground passages to the platform level.
Both ends of each platform will have slopes. Platform No.16 will be assigned for connecting the two underground passages.

608 Improvement Plan of Station Front Plaza

The west side of the station has a plaza of approximately 20,000 square meters. But there is a temple at the western edge, which makes the access/egress to the station by bus difficult. On the other hand, the east side of the station has a plaza that is extensive and well furnished. It is assumed that this side of the station will be utilized more by passengers in the future, as it is nearer to the Ring Road. When platforms for exclusive use for buses, double-deck structures for car access/egress and other facilities providing a good balance of services for all the transport modes, the East Gate plaza will function better than West Gate Plaza. The East Gate will become better suited as the gateway to New Delhi Central.

609 Passenger Information Facilities

(1) Passenger Information Control System (PIC)

a) The functions of the PIC consist of automatic broadcasting and automatic indication of information. The flow of information is as shown in Fig. 6.4.3-1. PIC collects the required information from the train operation information system and from the train's position/number detection system, and controls the timely broadcasting and indication.

b) A tape-recorded announcement system will be connected either to the train operation information system or to the operation of the track circuit.

c) In case of operational abnormalities, PIC outputs not only the information on train delays but also all other kinds of information required at a station.

d) The system prepares for two methods of activating the indicators and TV screens. By the first method, the system works under the control of the Center, instructions being given directly from CTC & PIC, and patternized indications are output. By the second method, the system will be activated manually to output the particular texts which are unavailable among the prepared indications.

(2) Automatic indicators (departure train signs, etc.)
Movable indicators of departure trains are planned to be introduced. It is recommended that the static indicators be introduced in the future.

(3) Available Seat Indication System

(4) Simultaneous notification equipment

(5) Train operation information indicators
Train operation information indicators will be installed in the dispatcher's office and certain stations' operation staff rooms.

610 Investment Timing for New Delhi Improvement

(1) From the viewpoint of transportation planning, it would do building platforms and washing/stabling lines, step by step, as the number of trains increases. The investment timing can be rather long-ranged.

- Construction of 2 more platforms by 1992-93 (total 11)
- Construction of 4 more platforms by 1992-2000 (total 15)

(2) From the viewpoint of minimizing the construction cost and the impacts of the construction works troubling the normal train operation, however, the investment timing had better be short-ranged. A work may have to be done in the same step concurrently with another, whether or not the transportation plan needs it at the timing.

(3) It is planned in this study that the work steps will be completed preemptively by March 1995, for all of the overbridge passage, the platforms and the arrival/departure/ washing/stabling lines that will be required by 2000.

611 Investment Cost and Implementation Schedule

(1) Investment Cost

The required reconstruction cost of New Delhi Station itself is Rs 1,431 million by 2000, and additional Rs 125 million after 2001, as shown in Tables 6.6.1 and 6.6.2.

(2) Implementation Schedule

The work schedule and the year-wise investment cost of the improvement are as shown in Table 6.6.3.

Table 6.6.1 Investment Cost for Modernizing New Delhi Station

Up to 2000 (Rs million)

Item	Classification	Total	Breakdown		
			Personal expenses in local Currency	Material expenses in local Currency	Foreign Currency
Track and Structure	Roadbed	2.7	0.5	2.2	-
	Platform	119.2	25.7	93.5	-
	Station Building	906.8	369.3	537.5	-
	Track	66.0	8.0	58.0	-
Machine and equipment	Car Washing Machine and Reparing equipment	25.4	0.7	2.7	22.0
	Escalator and Elevator	24.2	2.4	21.8	-
	Air Conditioner	26.2	5.5	20.7	-
	Electric Power equipment	50.0	15.5	34.5	
Signalling and telecommunication	Signalling	120.0	72.0	48.0	-
	telecommunication	73.4	8.3	13.6	51.5
Electrification	Electrification	17.5	7.8	9.7	-
Ground Facilities Total		1431.4	515.7	842.2	73.5

Note ; Construction cost includes contingency, supervision charges, and general charges.

Table 6.6.2 Investment Cost for Modernizing New Delhi Station

After 2001 (Rs million)

Item	Local Currency	Foreign Currency	Total
Track and Structure	105	-	105
Signalling and telecommunication	10	-	10
Electrification	10	-	10
Total	125	-	125

Table 6.6.3 Implementation Schedule for Modernizing New Delhi Station

(Schedule of investment up to 2000)

Rs million

	1989~1990	1990~91	1991~92	1992~93	1993~94	1994~95
Ongoing improvement						
Designing						
Track and structure						
Building						
Machine and equipment						
Signalling						
Telecommunication						
Electrification						
Local currency			115.5	231.1	458.2	553.1
Foreign currency			0	0	2.2	71.3
Total			115.5	231.1	460.4	624.4

612 New Delhi Improvement and Road Congestion

The countermeasures to be taken are:

1) Widening of Ajmeri Road, Thompson Road, connecting with East Gate of the Station and other roads connecting to Ring Road.

2) Construction of guided urban mass transit system such as LRT and underground, which should be linked with New Delhi Station.

3) Road traffic regulations for dividing the use of lanes for higher speed road vehicles and for lower speed vehicles after having widened the roads. Characterizing the traffic around the Station is its low speed. Buses, trucks, taxis account for only 10% of the traffic. Horse/ox drawn carriages and rickshaws 25~ 40%. The rest is two or three wheelers.

CHAPTER 7 - ECONOMIC ANALYSIS

701 Cases for Analysis

The case "With the Project" and the case "Without the Project" are compared in investment cost and operating cost, and the difference obtained is added with the benefits brought about by the Project.

The case "With the Project" is the case where the New Delhi Station is modernized and the related sections within 200 km radius circle connected with the Delhi Area are improved.

The case "Without the Project" is the case where no such railway improvement would be made, and buses and trucks would transport the increasing traffic.

702 Investment cost:

(1) Case "With the Project";
The investment cost corresponds, in items, with the cost given in 510 Column "Total" of Table 5.5.1 (P.37). But the amount is calculated in economic prices (detaxed).

Table 7.3.1 Estimated Economic Investment Cost of "With the Project"

(In Thousand Rs.)

Department	New Delhi Station	Delhi Area	Relevant Sections	Study Area	Total
Civil Work	1,001,407 (163,324)	852,863 (131,293)	370,011 (369,114)		2,224,281 (663,731)
Signalling & Telecommunication	149,781 (32,475)	124,930 (26,444)	1,002,199 (120,345)		1,276,910 (179,264)
Electrification & Power Supply	56,508 (29,982)	123,203 (26,471)	111,571 (0)		291,282 (56,453)
Sub Total	1,207,696	1,100,996	1,483,781		3,792,473
Rolling Stock				9,090,820	9,090,820
Total	1,207,696 (225,781)	1,100,996 (184,208)	1,483,781 (489,459)	9,090,820 (-)	12,883,293 (899,448)
Grand Total	1,433,477	1,285,204	1,973,240	9,090,820	13,782,741

Note: The costs in brackets show the cost planned in the Action Plan (on-going).

(2) Case "Without the Project";

The investment cost is identified with the cost procuring such number of buses and trucks as may be required for transporting the traffic, which would have been diverted to the improved railway, had the Project been implemented.

Table 7.3.2 Estimated Economic Cost of "Without the Project"

(In Thousand Rs.)

Item	Within the Boundary of the Study
Bus	629,322
Truck	3,477,502
Total	4,106,824

Note: The cost of reinvestment is not included.

703 Operating Cost

(1) "With the Project"

The railway operating costs are calculated based on working expense and maintenance cost.

The economic working expense per train-km is estimated using the unit cost of the "Working Expense per Train-km" obtained from Railway Board and the Northern Railway. The maintenance cost of depreciable assets is calculated using the maintenance rate.

(2) Case "Without the Project"

The operating costs of buses and trucks are calculated based on the maintenance and fuel costs per kilometer and personnel cost per unit of bus/truck operation.

704 Benefits of Case "With the Project"

With the project, a remarkable increase in passenger traffic volume is expected. It will be diverted from buses, or it will be induced because the railway mode will attract passengers, qualitatively through the

improvements of station facilities and other passenger services, and quantitatively through the improvement of traffic capacity by track doubling, electrification, signalling modernization, etc.

Without the project, on the other hand, the passengers who would have been diverted to the railway must be transported by buses. The transport time of buses are longer than that of railway. Hence, the passengers time-saving-benefit can be expected. This is estimated from the difference of transport time.

(1) Estimation of Passenger Time Value

The following formula is applied in estimating the time-value:

Passenger time value = Monthly wage per passenger
÷ Average working time per month
× Non-working time adjustment factor

Passenger time value per hour in each year is calculated as shown in Table 7.4.2.

Table 7.4.2 Passenger Time Value in Each Year

Year	Passenger Time Value (Rs./hour)	Growth Rate of GDP per capita (%)
1988	4.42	-
1990	4.63	2.39
1995	5.25	2.56
2000	6.03	2.81
2005	6.97	2.94
2010	8.15	3.18
2020	10.51	2.58

(2) Result

Passenger time saving benefit is calculated by the following formula:

Passenger time saving benefit
= Passenger time value x Saving in passenger-hours (number of passengers x travel hours saved)

Saving in passenger-hours and passenger time saving benefit is shown in Table 7.4.3.

Table 7.4.3 Passenger Time Saving Benefit

(Per Year)

Year	Saving in Passenger-hous (In 1,000 passenger-hours)	Passenger Time Saving Benefit (In 1,000 Rs.)
1995	36,000	189,000
2000	88,000	530,640
2005	107,000	745,790
2010	109,000	888,350

(See Appendix Table 2.7)

706 Other Benefits of Case "With the Project"

Besides above mentioned passenger time saving benefit, some indirect benefits can be expected from this project. Their quantitative evaluation was not made in this analysis, but they will become important factors in decision making for the implementation of the project. They are:

(1) Improvement of Road Traffic Conditions
(2) Promotion of Related Industries
(3) Promotion of Employment of Opportunity
(4) Promotion of Inland Trips
(5) Development of Local Areas
(6) Technology Transfer

707 EIRR

Comparing the cases "With the Project" and "Without the Project", the EIRR is calculated as 19.5%.

708 Sensitivity Analysis

The above-mentioned EIRR was verified of its sensitivity to the factors: reduction in diverted traffic volume, in time value and cost overrun. The result is shown in Table 7.6.1.

Table 7.6.1 Economic Sensitivity Analysis

Case		EIRR(%)
a	Base Case	19.5
b	10% reduction in diverted traffic	17.4
c	20% reduction in diverted traffic	15.1
d	10% cost overrun	17.6
e	20% cost overrun	15.9
f	50% cost overrun	11.7
g	b + d	15.5
h	50% reduction in passenger time value	18.0
i	b + d + h	14.1

708 Evaluation

The EIRR for the base case is 19.5%. The worst EIRR in case of 50% cost overrun is 11.7%. The EIRRs in all other cases are more than 12%.
Furthermore, the costs of constructing new national highway in the case "Without the Project" were excluded. Consequently, the effects this project will give are considered highly favorable.

CHAPTER 8 - FINANCIAL ANALYSIS

801 Project for Analysis

The Project consisting of 1) Modernization of New Delhi Station, 2) Improvement of Terminals in Delhi area and 3) Improvement of related sections within a 200 km radius of New Delhi.

802 Cash Flow Calculation

The financial analysis primarily aims to clarify its cash flow.

Note 1) Cash flow is the cash amount which remains in the hand of the entrepreneur after he has made investment without relying on borrowing.

Cash flow
= Operating profit + Depreciation - Investment
where Operating profit
= Operating revenue - Operating cost
where Operating cost
= Working expense + Maintenance cost
+ Depreciation

2) Net cash flow is the cash amount which remains in the hand of the entrepreneur after he has made investment relying on borrowing.

803 Investment Cost

(1) Investment cost of the project

The estimated investment cost of the project consists of (1) the investment made under Action Plan in the 200 km

radius circle and (2) the investment corresponding with the column "Total" of Table 5.5.1 (5) (which comprises of "Related sections", "Delhi Area" and "Terminals") and (3) the investment for the rolling stock required. They are as shown in Table 8.3.1.

Table 8.3.1 The estimated investment cost of the Project

(Unit: Rs in thousand)

Department	New Delhi Station	Delhi Area	Relevant Sections		Total
Civil Work	1,170,507 (197,400)	997,600 (155,300)	435,100 (434,200)		2,603,207 (786,900)
Signalling & Telecommunication	193,409 (35,000)	135,000 (28,500)	1,080,300 (129,700)		1,408,709 (193,200)
Electrification & Power Supply	67,492 (34,000)	143,320 (29,500)	125,002 (0)		335,814 (63,500)
Sub Total	1,431,408 (266,400)	1,275,920 (213,300)	1,640,402 (563,900)		4,347,730 (63,500)
Rolling stock				12,255,980	12,255,980
Total	1,431,408 (266,400)	1,275,920 (213,300)	1,640,402 (563,900)	12,255,980	16,603,710 (1,043,600)
Grand Total	1,697,808	1,489,220	2,204,302	12,255,980	17,647,310

(See Table 5.5.1 for details)

(2) No new investments after 2000

Excepting for the reinvestment for the assets whose useful life will have been expired, it is assumed in this financial analysis that no investment will be made after 1999-2000. Those works referred to in Table 5.5.1 (6) are, therefore, not included in the investment cost in this analysis.

(3) Interest and repayment

The amounts of interest payment and repayment are assumed to be subject to financing plans.

(4) Financing plans

The financing plans and their consitions are shown in Tables 8.3.2 and 8.3.3.

Table 8.3.2 Finanicng plan

Currency / Plan	Foreign Currency Portion	Local Currency Portion
1 (Base Case)	Government to Government Borrowing	Government Budget
2	Borrowing from international Financial Institution	Government Budget

Table 8.3.3 Terms and conditions of each financing source

Item / Sources	Interest rate (%)	Term (Years)	Grace (Years)	Repayment
Government Budget	6.5 (rate of divided)	-	-	-
Government to Government Borrowing	2.5	30	10	Semi-annual installment
Borrowing from International Financial Institution	7.74	20	5	Semi-annual installment

804 Incremental Operating Revenue/Cost

(1) The fare/tariff levels being assumed as in para 8-4, and the diverted traffic assumed as in para 8-4 the increase in operating revenue is calculated.

(2) From the working expense and the incremental train-kms, and from the maintenance rate/depreciation cost and the incremental assets, the incremental operating cost is calculated.

805 Summary of Cash Flow

Table 8.6.1 Summary of Cash Flow

(Unit: Rs in thousand)

Plan	Item	1995	2000	2005	2010
	Operating revenue	937,423	3,112,399	3,693,701	4,154,328
	Passenger Goods	223,449 713,974	513,900 2,598,499	636,495 3,057,206	666,448 3,487,880
	Operating expenses	650,129	1,535,249	1,745,721	1,922,331
	Working expense Maintenance cost Depreciation	405,238 76,525 168,366	1,058,102 109,876 367,271	1,233,244 109,271 403,206	1,374,344 107,781 440,206
	Operating profit	287,294	1,577,150	1,947,980	2,231,997
	Investment	1,696,995	253,629	303,841	95,109
	Cash flow	Δ 1,241,335	1,690,792	2,047,345	2,577,094
1	Borrowing	1,696,995	248,630	279,680	0
	Loan repayment	0	0	3,751	3,751
	Interest payment	666,309	1,071,558	1,154,381	1,226,629
	Net cash flow (Cumulative NCF)	Δ 210,649 (Δ 210,649)	867,864 (1,757,521)	1,168,893 (7,067,730)	1,346,714 (13,637,081)
	Net profit	Δ 379,015	505,592	793,599	1,005,368
2	Borrowing	1,696,995	248,630	279,680	0
	Loan repayment	0	5,219	5,219	5,219
	Interest payment	670,493	1,075,742	1,156,545	1,227,242
	Net cash flow (Cumulative NCF)	Δ 214,833 (Δ 214,833)	858,461 (1,727,198)	1,165,261 (7,000,203)	1,344,633 (15,578,484)
	Net profit	Δ 383,199	501,408	791,435	1,004,755

Note: Figures with Δ mean deficit value.

NCF means net cash flow.

806 Cash Flow Analysis

The investment, the incremental operating revenue and cost thus identified, the cash flow and net cash flow of the project is worked out as shown in the computer output. (See Appendix 8-1). It can be summarized in the Table 8.6.1.

807 Sensitivity Analysis

Under the assumed degrees of revenue reduction and cost overun, the same as in Economic Analysis, a sensitivity analysis was conducted. The result is as follows:

Table 8.6.2 Result of Sensitivity Analysis

Case		FIRR %
a	Base case	12.13
b	10% revenue reduction	10.24
c	20% revenue reduction	8.19
d	10% cost overrun	11.02
e	20% cost overrun	10.05
f	50% cost overrun	7.78
g	b + d	9.22

808 Evaluation

FIRR: 12.13% indicates a high potential of the project. As the rate of return is more than 10% (which is empirically considered as marking a safety line), the project is considered as financially viable.
The sensitivity analysis shows that, even if the revenue reduction by 20% or, the cost overrun by 50%, each representing rather pessimistic case, FIRR would be 8.19% and

7.78% respectively. They are still higher than 6.50%, the rate of dividend for the Government funds in India.
In cash flow analysis, the net cash flow becomes positive from 1997 and remains positive up to the end of the project life.
When it is assumed that the new investment from 1995 is not financed by new borrowing, the net cash flow turns into surplus in 2000 and the cumulative deficit turns into black in 2004.
It can be concluded that, through overall results of the analysis, the project is feasible and financiably viable.

CHAPTER 9 - EVALUATION OF THE PROJECT AND RECOMMENDATION

901 The result of the evaluation of the Project is as stated in 001 through 007. The project is considered technically, economically and financially feasible, the investment being suspended after 2000.

902 (1) As to the problem of congestion of the roads in the city centre the Project might be attributed to, it must be said that the problem would become more serious, if the MG goods and passenger handling work is not shifted out of the city centre as is proposed by this Project.

(2) It must be also said, on the other hand, that, as far as the railway passenger service, suburban or long distance, is requested to play the role of business-purposed passenger transport, the main passenger terminal should be located in the city centre where alone the purpose can be fulfilled. Removing it from the city center would not contribute to the final solution of the problem, but worsen it.

903 It is recommended that;

(1) The plan modernizing New Delhi Station itself should be preempted by the relevant plans to make it space-wise possible, and synchronized with the relevant plans to make it cost effective.

(2) High level consultations should be initiated between the Railway and City to implement the Project.

(3) Further studies should be conducted to verify the feasibility of the investments conceptually planned

for the years after 2000, their impacts on this Project being verified over the latter's project life.

END

JICA