THE REPUBLIC OF INDONESIA

REPORT
ON
URBAN/SUBURBAN RAILWAY TRANSPORTATION
IN
"JABOTABEK" AREA

(FEASIBILITY STUDY ON
[illegible] IN CENTRAL JAVA)

MARCH, 1982

JAPAN INTERNATIONAL COOPERATION AGENCY
(JICA)

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PREFACE

In response to the request of the Government of the Republic of Indonesia, the Government of Japan decided to conduct a feasibility study on the Central Line Track Elevation Project in JABOTABEK Railway and entrusted it to the Japan International Cooperation Agency (JICA). The JICA sent to Indonesia a study team headed by Mr. Mikio Sudo, Executive Vice-President of the Japan Railway Technical Service in June, 1981, under the guidance of the Supervisory Committee chaired by Dr. Yoshiji Matsumoto, Professor of Tokyo University.

The team had discussions with the officials concerned of the Government of Indonesia over the Project and conducted a field survey in Indonesia. Subsequently, further studies were made in Japan and the present report has been prepared.

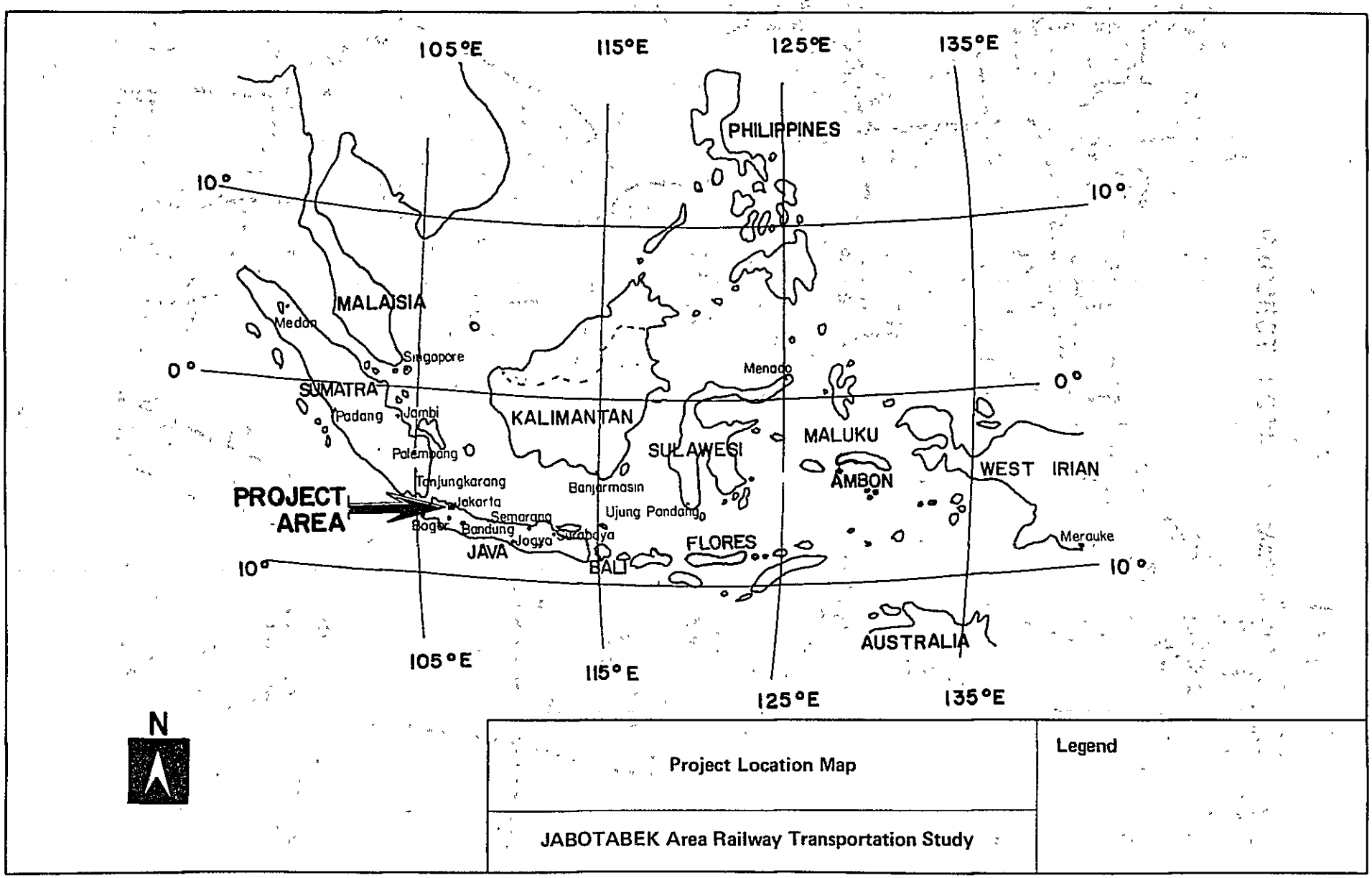
I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of Indonesia for their close cooperation extended to the team.

March, 1982

Keisuke Arita

Keisuke Arita
President
Japan International Cooperation Agency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Project Location Map
JABOTABEK Area Railway Transportation Study
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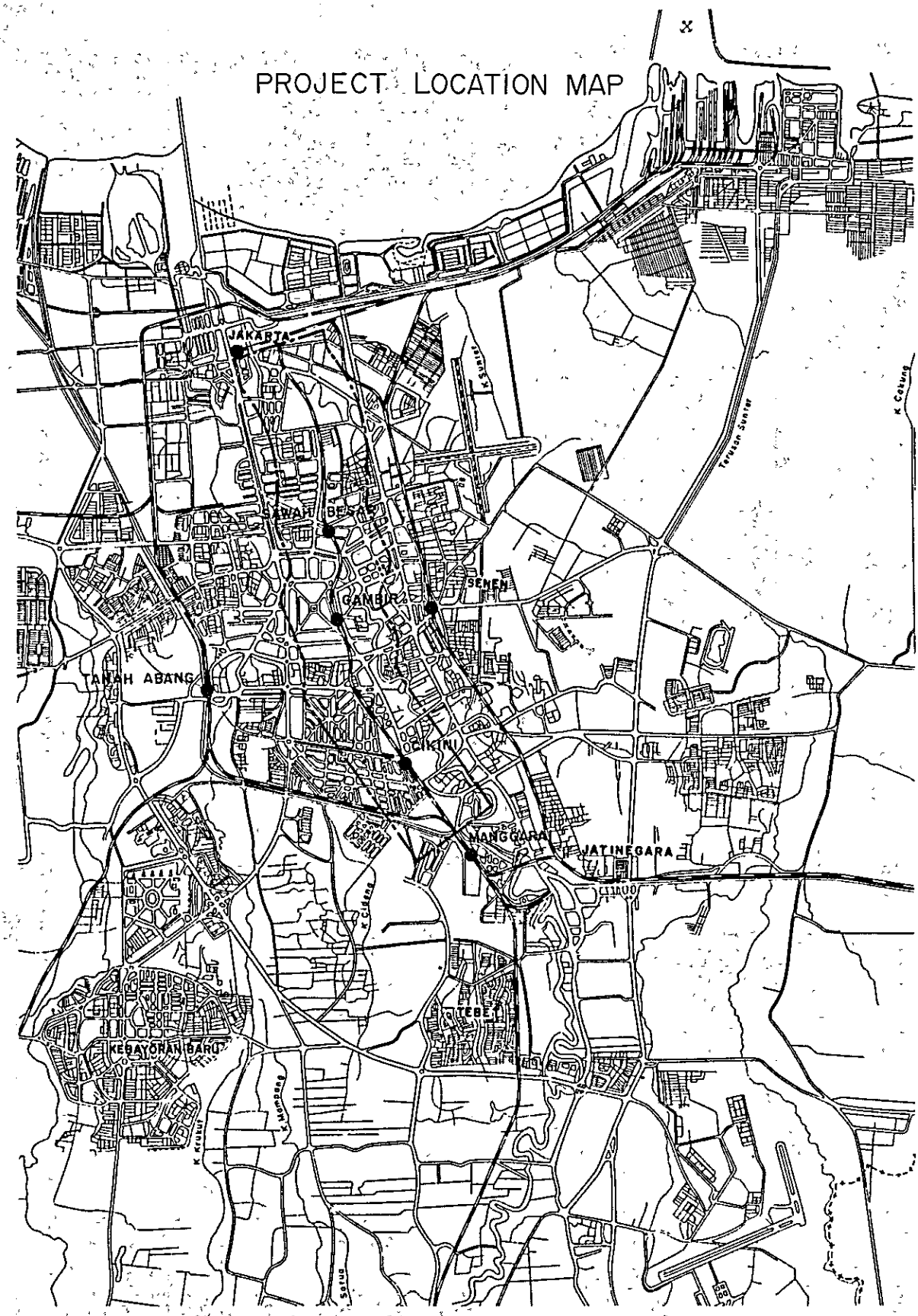
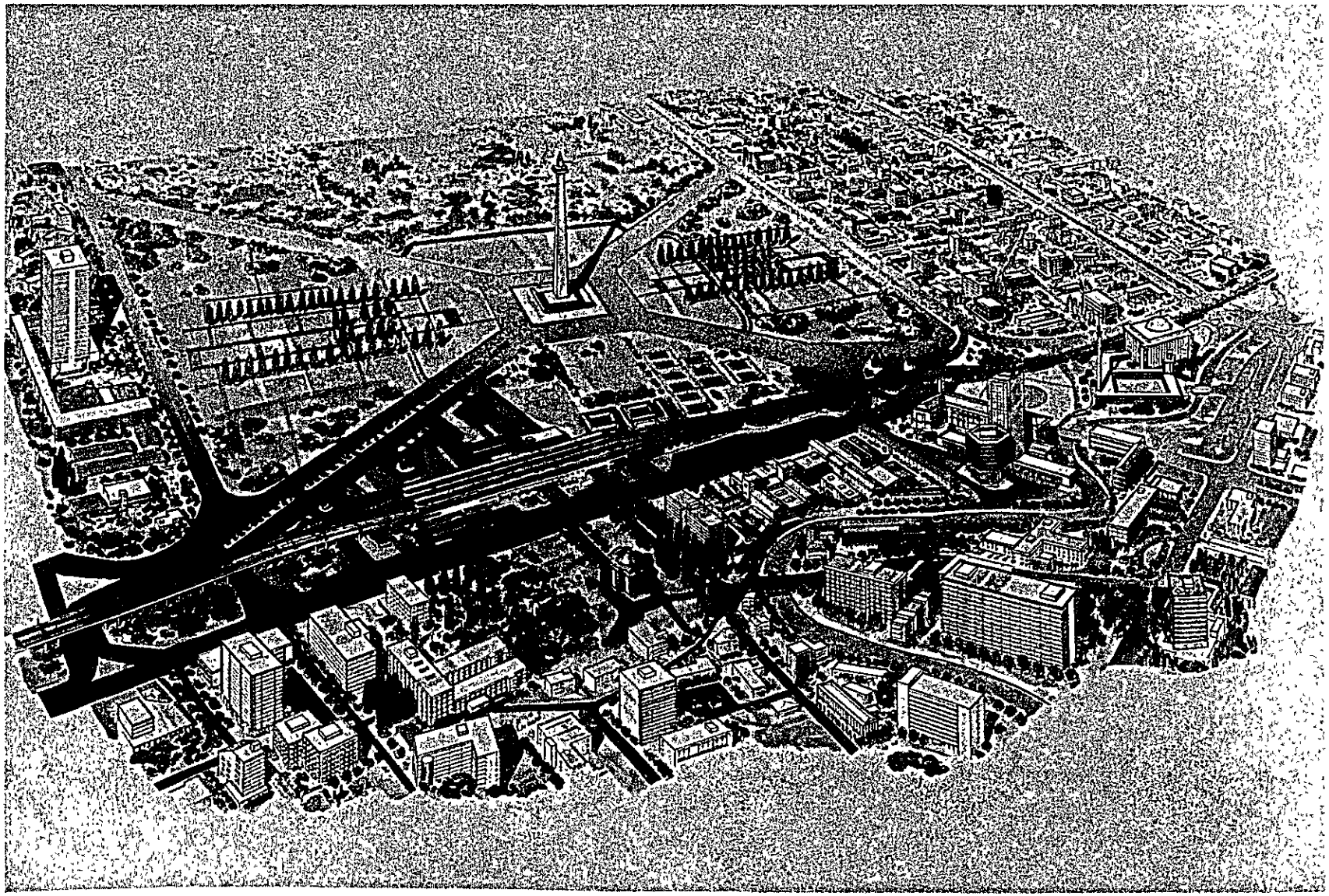
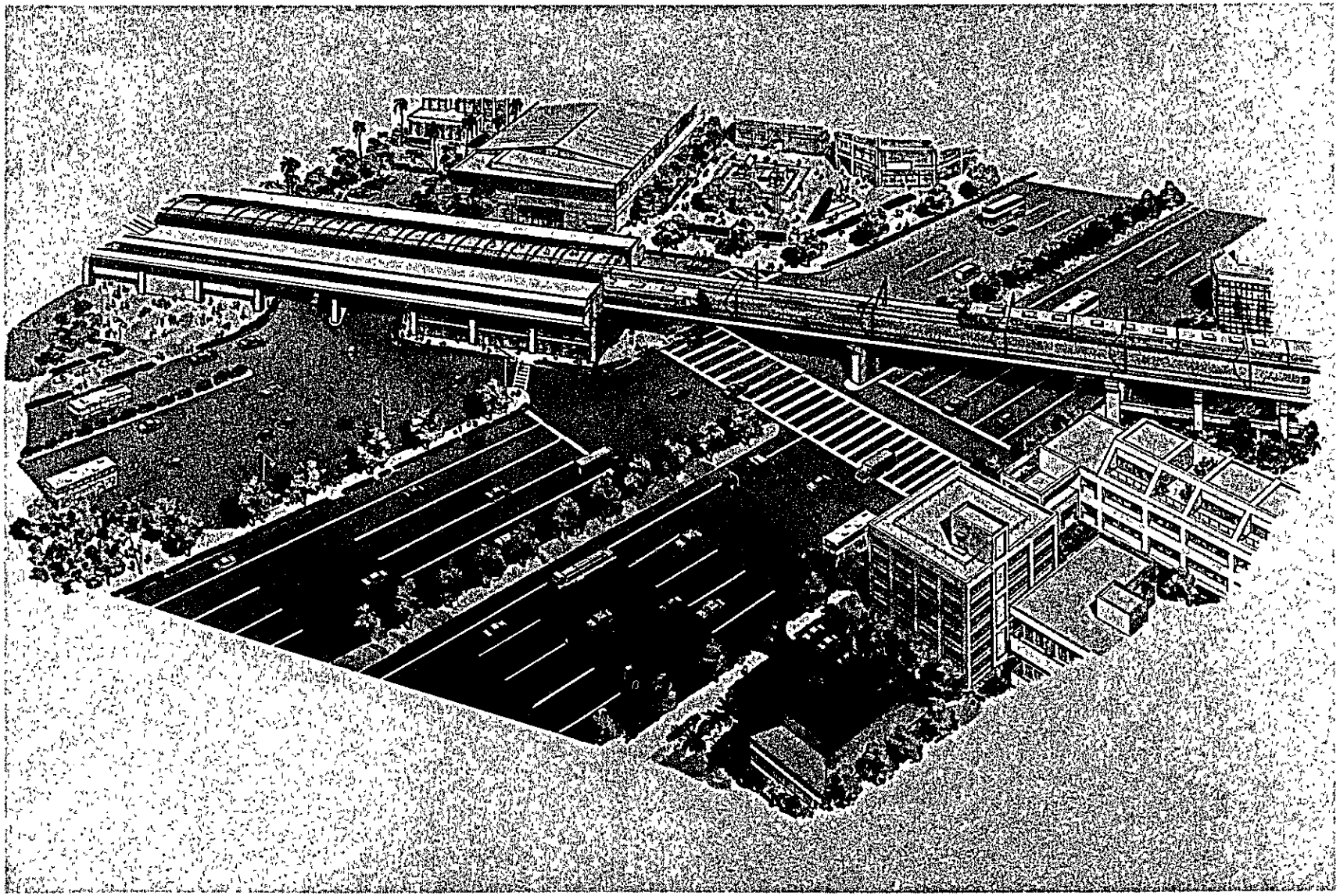
PROJECT LOCATION MAP





Elevated Railway of Central Line



View of Elevated Railway Crossing

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SUMMARY AND CONCLUSION

1. Traffic Demand Forecast

(1) Existing Traffic Conditions

Person trips generated (= attracted) per day in the year 1980 was estimated at 5.1 million trips (excluding intra zonal trips) in DKI Jakarta. Number of person trips transported by mass transit amounted 2.7 million trips, out of which 43.7 thousand trips were transported by railway. Number of passengers transported by railway has been increasing rapidly since the year 1977 according to the improvement of "JABOTABEK" train.

In the year 1980, annual passengers on JABOTABEK train amounted to 15.5 million passengers, out of which 5.8 million passengers were generated on Central Line from Jakarta Kota Station to Manggarai Station.

There are nineteen level crossings on Central Line from Jakarta Kota Stn. to Manggarai Stn. Total traffic volume on all of these crossing accounted for 793 thousand vehicles in 12 hours and number of vehicles stopped at the crossings was 102 thousand vehicles.

(2) Population Trend

The population in DKI Jakarta was estimated at approximately 6.6 million in the year 1980, which was about 4.5 % of that in all Indonesia. The population density in DKI Jakarta was estimated to be 101 persons per hectare, while that in Indonesia was 0.8 person per hectare.

The annual growth rate of the population in DKI Jakarta was much higher than that in all Indonesia, which means DKI Jakarta has attracted a large number of immigrants from other regions. This immigration into DKI Jakarta will continue for a decade or more, but on account of the optimum population density of the city it will stop in a long term. Future population framework of DKI Jakarta and BOTABEK area was estimated as follows by taking the above into consideration.

POPULATION FRAMEWORK

Unit: Million Persons

	1980	1990	2000	2010
DKI Jakarta	6.6	8.4	9.9	11.3
BOTABEK	5.0	7.2	9.7	11.7
JABOTABEK	11.6	15.6	19.6	23.0

(3) Future Person Trips

The future person trips in DKI Jakarta and surrounding area was estimated based on the population framework. Total person trips will increase from 5.1 million trips per day in the year 1980 to 13.1 million trips per day in the year 2010.

FUTURE PERSON TRIPS

Unit: thousand trips/day

	1980	1990	2000	2010
Mass Transit:	2,710.3	4,302.4	6,280.3	8,647.3
Railway	43.7	523.3	1,478.6	2,195.3
Bus	2,666.6	3,779.1	4,801.7	6,452.0
Private Means:	2,435.5	3,330.4	3,978.7	4,446.8
Total:	5,145.8	7,632.8	10,259.0	13,094.1

Note: Excluding intra zonal trips

Person trips by railway were estimated to increase rapidly in accordance with railway improvement plans, but person trips by bus and private transportation means were estimated to increase steadily to be doubled by the year 2010. Considering the present traffic situations in DKI Jakarta and even the future improvement plans of road network, railway will be expected to play a more important role in relieving traffic congestions on road network in the future.

(4) Passengers on Central Line

Passengers on Central Line excluding medium and long distance passengers were estimated as follows:

PASSENGERS ON CENTRAL LINE

Unit: thousand passengers/day

	1980	1990	2000	2010
Jakarta Kota – Gambir	1.7	25.8	74.1	110.6
Gambir – Manggarai	3.1	38.9	110.9	164.7

Note: Maximum passengers on each section

In this study, new stations were planned at Jayakarta, Mangga Besar, Juanda and Gondangdia in addition to the existing stations at Sawah Besar, Gambir and Cikini. It is recommended that these new stations will be opened simultaneously with the completion of track elevation, because new stations will generate and attract more railway passengers through their impact on area development, and because they are required to be opened by the year 1995 at the latest according to the traffic demand forecast.

(5) Traffic Volume on Railway Crossings

Traffic volume on the existing level crossings from Jakarta Kota Stn. to Manggarai Stn. was estimated.

TOTAL TRAFFIC VOLUME ON RAILWAY CROSSINGS

Unit: thousand vehicles/12 hours

	1981	1990	2000	2010
Motorcycle	239.2	267.2	282.2	295.4
Bajaj	155.3	204.9	276.4	350.3
Automobiles	398.8	605.8	842.2	1,020.7
Total	793.3	1,077.9	1,400.8	1,666.4

Traffic volume on the railway crossings will be doubled around the year 2000. Track elevation will therefore be very effective in relieving traffic congestion on each crossing. Considering the increase of traffic volume on the crossings, an alternative case for without track elevation project was assumed to be the case with flyovers on several crossings. The assumed without project case is analysed in the study of economic evaluation for this track elevation project.

2. Land Use

(1) Existing Land Use along the Central Line

According to the survey, nearly one thousand households were located in the right-of-way from Jl. Mangga Dua to Manggarai Stn.

Section	Number of Houses
Jl. Mangga Dua ~ Jl. Mangga Besar	372
Jl. Mangga Besar ~ Sawah Besar Stn.	156
Sawah Besar Stn. ~ Gambir Stn.	272
Gambir Stn. ~ Cikini Stn.	31
Cikini Stn. ~ Manggarai Stn.	148
TOTAL	979

The inhabitants belong to lower income group, whose houses are made of crude materials. The right-of-way is used as their life space.

The wayside area around Gambir Stn. is utilized mainly for administrative and public use. For the other part of the wayside area, residential use is the most prevailing one.

(2) Future Station Allocation

Jakarta Kota Stn. and Gambir Stn. are terminals for long distance trains. Accordingly, a large number of long distance trains are operated on Central Line between Jakarta Kota Stn. and Manggarai Stn. In order to cope with a marked increase of passengers on Central Line in future, it will become necessary that terminals for long distance train should be relocated from Jakarta Kota Stn. and Gambir Stn. to Manggarai Stn. or that another double track should be constructed when commuter trains will reach the full capacity of Central Line. Relocation of the terminals to Manggarai area will serve to relieve excessive concentration to the Central Business District and form a subcenter of DKI Jakarta.

The adequate distance between railway stations in urban area is considered to be 1.0 to 1.5 km for passengers' easy access to stations. From this point of view, four new stations are proposed based on the land use survey of the wayside area; they are, Jakarta Stn., Manggarai Besar Stn., Juanda Stn. and Gondangdia Stn. These new stations are recommended to be open to the public simultaneously at the completion of track elevation from urban planning point of view, although the traffic demand forecast predicts that the new stations should be opened by 1995.

(3) Land Utilization under Elevated Track

New space of about 11.4 hectare will be created by track elevation of Central Line. In planning its utilization, the principles adopted were as follows;

- to create open space as much as possible
- to make use of the space only for public purposes in consideration of the surrounding area

	Area (m^2)	Composition (%)
Station Facilities	15,000	13.2
Station Plaza	8,200	7.2
Commercial Facilities	24,700	21.7
Distribution Facilities	3,700	3.3
Open Space	62,100	54.6
TOTAL	113,700	100.0

(4) Planning of Station Plaza

Railway station is a junction of railway with other means of transportation, where smooth and safe connection between station and each mean is of great importance. Three patterns by station type was presented as follows for the year 2000.

Type	Station	Planning Area (m^2)
Large Station	Gambir	10,000
Medium Station	Sawah Besar, Cikini	6,000
Small Station	Jayakarta, Mangga Besar, Juanda, Gondangdia	3,000

Special attention should be paid to the station plaza to enable smooth traffic flow to and from each station. Road network is required to be adjusted accordingly especially for station area.

(5) Recommendations from Urban Planning Aspect

Track Elevation of Central Line entails various aspects of urban planning;

- Clearance of the houses in the right-of-way and land acquisition of the wayside area
- Adjustment of road network with respect to railway stations
- Planning of land utilization under elevated track in harmony with the surrounding area
- Restriction of land use along the Central Line from environmental point of view
- Planning of better feeder transportation system, especially bus network.

In order to accomplish this project, a coordination board consisting of related agencies of government is recommended.

3. Train Operation

3.1 Train operation during construction period

(1) Preconditions

We examined train operation program during construction period under the following preconditions.

1) Operation of electric and diesel railcars required to satisfy traffic demand shall be secured. Actual operation network of long-distance trains shall be maintained as much as possible.
2) The related projects set up in the Master Plan shall be executed as scheduled.
   Electrification of the Western Line shall be completed in March 1984.
3) 8-railcar trains shall be operated.
   The required construction to this effect shall be carried out.
4) Track capacity on the Eastern Line and the Western Line shall be increased.

(2) Alternative A: Partial suspension of train operation

The track elevation work shall be divided into two periods; the sector between Jakarta and Gambir shall be constructed in the first period and the Gambir-Manggarai sector in the second period.

During construction, train operation shall be suspended on the concerned sector but shall be continued on the other sector.

1) Suspension of train operation between Jakarta and Gambir
The following measures should be taken, because the electric railcar trains and long-distance trains are shuttled at Gambir Station.
   i) At Gambir shall be constructed a temporary station which has enough capacity for shuttling operation and facilities for coach inspection and cleaning.
   ii) Deadhead trains between Jakarta and Manggarai shall be operated via the Eastern Line.
   iii) For passengers bound for Jakarta, countermeasures such as substitute transportation by buses from Gambir Station will be required.

2) Suspension of train operation between Gambir and Manggarai
Electric trains and long distance trains on the Central Line shall be operated via the Western Line and the Eastern Line respectively.
The following measures should be taken during peak time zone in 1989.
   i) Operation of electric trains via the Western Line
   As the track capacity on the Western Line is not sufficient, the total number of trains to be operated on the Western and the Central Lines shall be reduced from 15 to 11 and two Central Line electric trains coming from Depok shall be terminated at Manggarai Station. Resulting passenger load factor of electric train will become about 250 %. Substitute transportation by buses from Manggarai Station should be also arranged.
   ii) Operation of long distance trains etc. via the Eastern Line
   All Central Line long distance trains shall be operated via the Eastern Line. Deadhead trains shall be operated in other time zone than peak hours.
   iii) Operation of electric trains between Jakarta and Gambir
   Shuttling operation of electric trains shall be made by making use of completed elevated track section between Jakarta and Gambir.

(3) Alternative B: Single track operation

1) Required facilities
The following facilities are required for single track operation between Jakarta and Manggarai during track elevation work.
   i) Installation of Gambir temporary station
   ii) Train meeting facilities at Sawah Besar Station and Cikini Station.
   iii) Block device at Cikini Station
   iv) Home/departure signals and direction levers at each station.

2) Train operation

Difficult periods for train operation are the first half of 1987 just before completion of 8-railcar operating facilities and the year 1989 just before completion of track elevation work.

However, in both years, all the trains can be operated if the Central Line and the Eastern Line are utilized during peak time zone. But some of long distance trains on the Central Line will be operated via the Eastern Line and the passenger load factor of electric train will become about 250 %.

3) Prevention of train operation accidents

As single track operation involves a high risk of train operation accident, preventive measures should be promoted such as consolidation of operation-related regulations and education/training of operation-related employees.

(4) Alternative C: Double track operation

There is no problem at all for planning of train operation.

3.2 Future terminal stations for long distance trains

Two alternatives of future terminal stations for long distance trains can be considered as follows:

1) Alternative 1: Actual terminal stations shall remain unchanged; Jakarta, Gambir, Pasarsenen, Manggarai, Tanjungpriuk and Tanah Abang.
2) Alternative 2: Terminal stations shall be integrated into Manggarai, Jatinegara and Tanah Abang

Both alternatives have their respective merits and demerits from aspects of passengers' convenience, train operation, city planning and equipment investment, but, for the time being, the Alternative 1 shall be maintained for passengers' facilities. However, when it becomes difficult in future to operate long distance trains through city center during the peak time zone due to increased number of trains, operation shall be terminated at the Alternative 2 stations or shall avoid the peak time zone. Time is expected to come when further increase of trains is needed to make it difficult to operate long distance trains through city center. Switch to the Alternative 2 shall be considered in the light of changes in situation, such as city structure, road traffic and railway traffic improvements and long distance passenger demand, on the occasion of review of the Master Plan at several-year intervals.

3.3 Elevated track connecting gradient

An elevated track connecting gradient of 14 ‰ will pose no problem with train operation for the following reasons.

1) The hauling capacity of a CC201 type locomotive is 435 tons at 45 km/h on 14 ‰ gradient.
2) The largest train weight among long distance trains is 420 tons.
3) No freight train is operated nor will be operated between Jakarta and Manggarai.

3.4 Number of platforms at Gambir Station

(1) Number of platforms

The total number of platforms at Gambir Station shall be 2 with 4 tracks; each one platform with 2 tracks for electric trains and for long distance trains. This capacity is enough to accommodate trains.

(2) Handling in crowded season

In two crowded seasons of the year, one platform alone will be insufficient, if passengers are left waiting on the platform for a long while like the actual situation. However, one platform will do if the following measures are taken.

1) The originating station of long-distance trains, now concentrated on Gambir Station alone, shall be partially changed to Jakarta Station for break up of passengers.
2) Passengers' waiting place shall be changed from platform to concourse or temporary waiting rooms and station employees shall conduct passengers for orderly boarding.
3) Operation of long-distance trains, now concentrated on a specific time zone, shall be scattered into other time zones.

3.5 Train operation after completion of elevated tracks

Strengthened tracks without any level crossing upon completion of elevated tracks will enable much greater speed-up. Scheduled running time at maximum speed of 90 km/h is as shown below.

Operating Section	During Track Elevation Work	After Completion of Track Elevation Work	
	Train Stopping at Each Station	Train Stopping at Each Station	Fast Train
Jakarta ~Manggarai (down train)	29'30" (A)	25'00" (B)	14'30" (C)
Difference	—	(B – A) Δ 4'30"	(C – A) Δ 15'00"

Despite of addition of two stations due to track elevation, stopping train and fast train can cut short a running time by 4.5 minutes and 15 minutes respectively. In our calculation, we considered 2 minutes' stop at Gambir Station and one minute stop at other stations. However, as platforms will be upgraded upon completion of elevated tracks, such stopping times can be reduced to 30 seconds. In consequence, scheduled running time could be further shortened.

4. Geological Conditions

Jakarta is situated at the mouth of Ciliwung River. The area near the mouth of river is a delta, with a plateau of Diluvium extending in its hinterland.

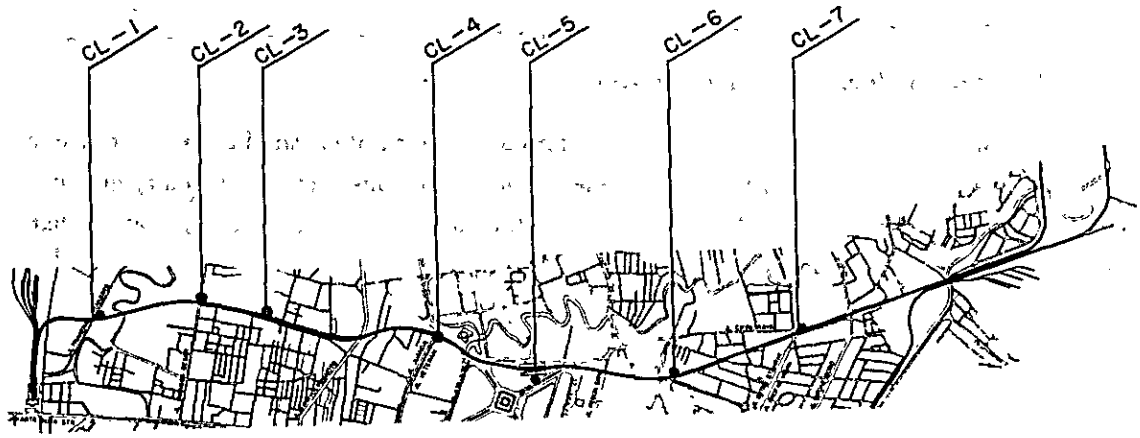
On both sides of the delta is a ridged beach plain.

The geological composition near Jakarta is as shown below:

Geological Period		Formation	Description
Quaternary	Holocene	Alluvium	Unsolid sediments composed principally from cohesive soil forming the delta
	Pleistocene	Diluvium	Volcanic ash forming the diluvial plateau in the south, which is lateritized to the substantial depth
Neogene	Pliocene	Centen-Formation	Basement rock, alternation of thin sandstone and mudstone layers. The upper portion of this alternate layers is weathered and becomes soft.

The outline of the survey of each borehole along Central Line is shown below:

Borehole No.	Location	Boring Length (m)	Number of S.P.T	Depth of N-Value ≧ 50 (m)
CL – 1	Jl. Jayakarta	43.60	17	16.70
CL – 2	Jl. Mangga Besar	23.45	9	16.70
CL – 3	Jl. Sawah Besar	22.30	10	14.00
CL – 4	Jl. Juanda	23.45	12	18.00
CL – 5	Jl. Monas Utara	23.60	12	18.00
CL – 6	Jl. Cut Mutiah	40.40	16	33.75
CL – 7	Jl. Cikini	23.60	11	18.00
TOTAL:		200.40	87	



5. Railway Facilities

Modernized and strengthened railway track elevation shall be newly constructed above abolition of existing ground railway facilities. Alternatives for method of elevated track construction shall be selected and their respective facilities plannings and investment programs shall be determined.

5.1 Present situation

The distance between Jakarta Kota Station and Manggarai Station, section to be elevated, is 9 km 754 m on which are installed Sawah Besar, Gambir and Cikini Stations with average station interval of 2.4 km. (Gondangdia Station was excluded from stations because of no passengers' handling.)

The Central Line is electrified and its section to be elevated is double-tracked.

As signalling facilities, mechanical signalling by tokenless type block system is adopted. Aerial wires are mainly used for telecommunication system.

At present, improvement program of railway facilities is being executed in the Jakarta Metropolitan Area. Main improvements to be made on the elevation-planned section are renewal of tracks, installation of automatic crossing barriers and upgrading of telecommunication facilities. However, small improvements, ongoing and planned, involve many problems to be solved for modern high speed and frequent electric railway service.

5.2 Facilities planning

(1) Selection of Grade Separation Type

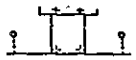
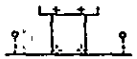
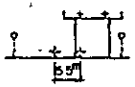
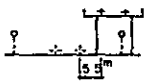
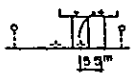
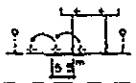
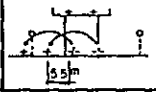
The grade separation can be classified into the elevation type and the underground type. The types of structures are as follows in general;

Elevation type : Bridge or embankment
Underground type : Tunnel or open ditch

Bridge structure type, the most economical one, was adopted in consideration of structural problems such as land and drainage from track and of effective use of land in the metropolis.

(2) Selection of Method of Track Elevation

It will be possible to propose eight cases for construction of elevated tracks as shown in following Table. After examination of investment amount on construction, difficulty in construction, construction period and passenger service for each case, the study team selected that three alternatives are feasible.

	CASE	GENERAL	CLEARANCE UNDER THE ELEVATION	DISTANCE FROM EXISTING LINE	INVESTMENT COST		CONSTRUCTION DIFFICULTY	CONSTRUCTION PERIOD	PASSENGER SERVICE	EVALUATION
					LAND ACQUISITION	CONSTRUCTION COST				
1. SUSPENSION OF TRAIN OPERATION										
ALL SECTION SUSPENSION (JAKARTA KOTA — MANGGARAI)	1		FOR ROAD	0 m	◎	◎	◎	◎	×	NO RECOMMEND
PARTIAL SUSPENSION (JAKARTA-KOTA — GAMBIR) GAMBIR – MANGGARAI	2		FOR ROAD	0 m	◎	◎	◎	△	△	RECOMMEND
2. CONTINUNITY OF TRAIN OPERATION										
SINGLE TRACK OPERATION	3		FOR ROAD	+ 5.5 m	○	○	○	○	○	RECOMMEND
TRACK ELEVATION ABOVE EXISTING LINE	4		FOR RAILWAY	0 m	◎	×	×	×	◎	NO RECOMMEND
PARALLEL WITH EXISTING LINE	5		FOR ROAD	+ 5.5 m	△	△	○	○	◎	RECOMMEND
PARALLEL WITH EXISTING LINE (ONE BY ONE)	6		FOR ROAD	+ 5.5 m	○	×	△	×	◎	NO RECOMMEND
ONE TRACK RE-ROUTING	7		FOR ROAD	+ 5.5 m	○	×	○	△	◎	NO RECOMMEND
TWO TRACKS RE-ROUTING	8		FOR ROAD	+ 5.5 m	△	×	○	△	◎	NO RECOMMEND

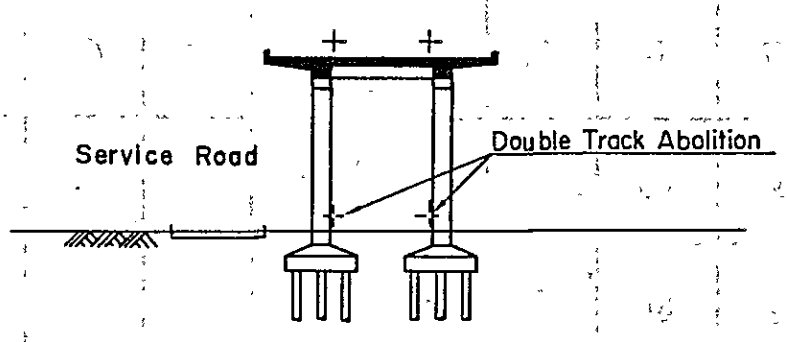
NOTE. ◎ EXCELLENT DEGREE ○ BETTER DEGREE △ NORMAL DEGREE × WORST DEGREE

Their respective features are as follows:

1) Alternative A (Case 2)

This alternative is to suspend train operation and to construct bridge structures. But total suspension on the whole section will pose a problem with passenger transport. So, the section to be elevated is divided into two block; the Jakarta Kota ~ Gambir block to be constructed in the first period and the other block in the second period.

The relationship between the existing tracks and the bridge structures for elevated tracks is shown in following Figure.

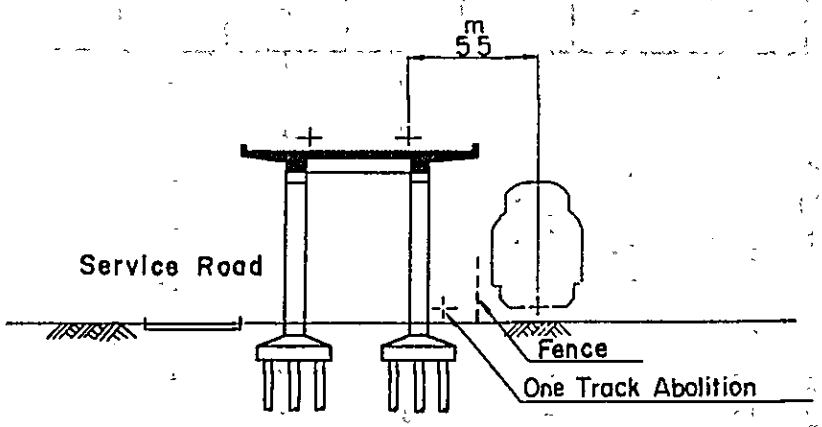


2) Alternative B (Case 3)

This alternative is to construct bridge structures while operating trains on single track of the existing line. It complements for the demerits of Alternative A in passenger transport.

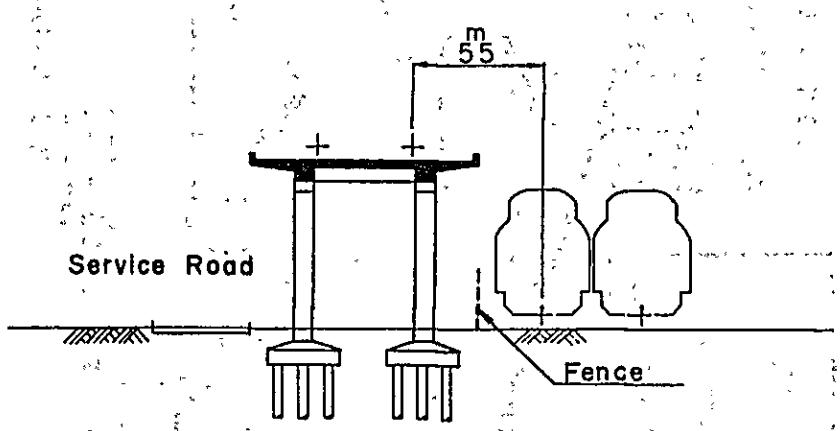
As track capacity becomes insufficient because of single track operation, train meeting facilities are needed at Sawah Besar Station and Cikini Station.

Due to construction in closeness to the existing line, adequate care should be taken for the security of safety, such as installation of guard fences. The relationship between the existing tracks and the elevated track structures is shown in following Figure.



3) Alternative C (Case 5)

This alternative, requiring much land space to be acquired than other alternatives, is to execute track elevation work while double track train operation is continued as ever. It is advantageous to passenger service and secures the space for future track addition in the land after removal of the existing tracks with reserve that the Central Line is to be converted into four-track line. The relationship between the existing tracks and the elevated track structure is shown in following Figure.



(3) Alignment Planning

As to alignment planning of the elevated tracks, the most suitable one was selected on the basis of total judgement on its influence on obstructive articles, difficulty in construction, construction cost and ease of maintenance for structures after completion.

1) Horizontal Alignment

With Alternative A, elevated track structure is to be constructed above the site of the existing track, and with Alternative B and C, it is on the east side of the existing line.

2) Longitudinal Alignment

Profile planning is the same for all alternatives.

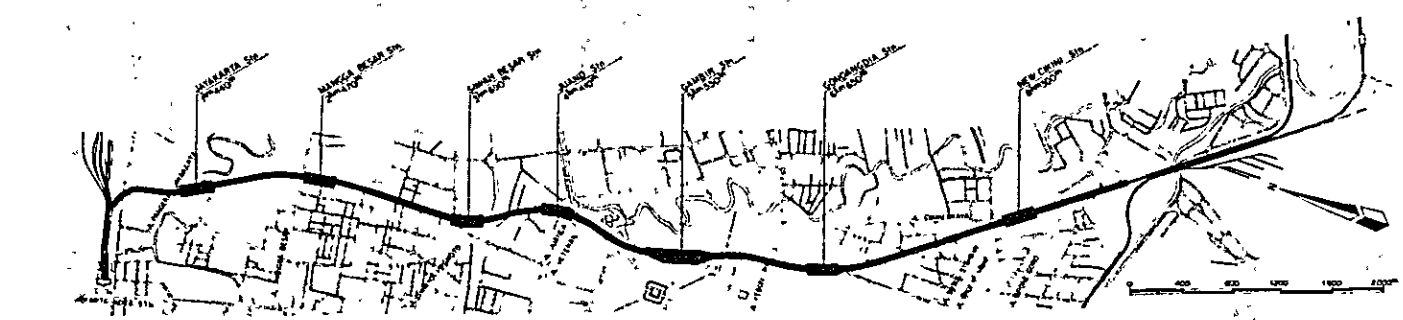
The section to be elevated includes now 19 level crossings, where overhead clearance of 5.1 m will be secured upon completion, except Jl. Mangga Dua with overhead clearance of 3.0 m.

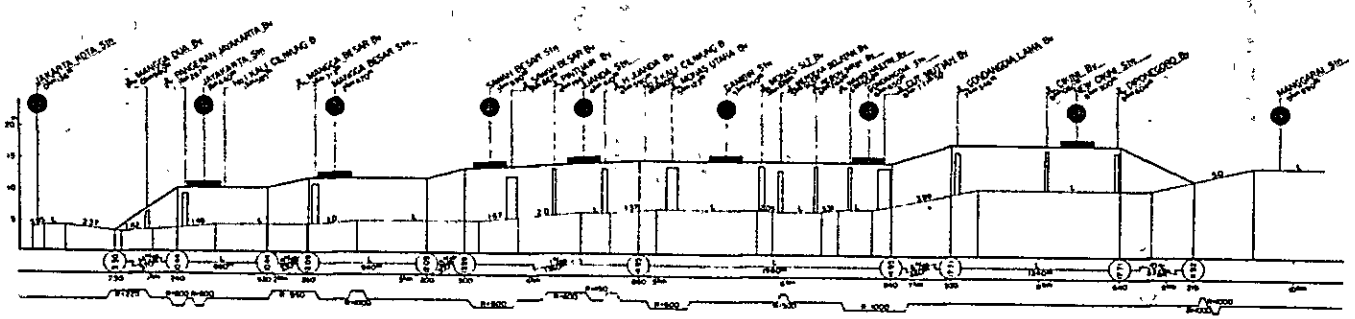
3) New Station Planning

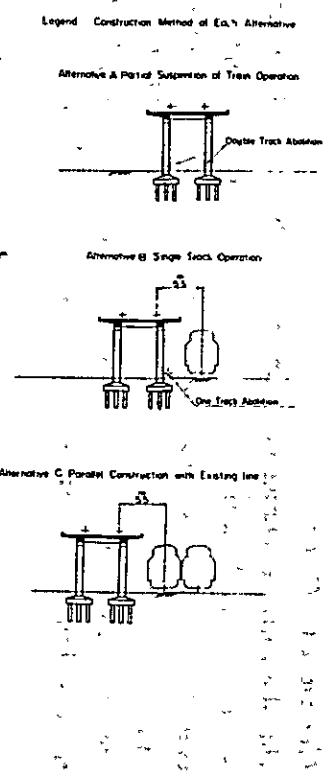
Location of new stations was decided by railway traffic demand forecast and of land use along the line. Accordingly, 7 stations with average spacing of 1.2 km will be opened between Jakarta Kota Station and Manggarai Station.

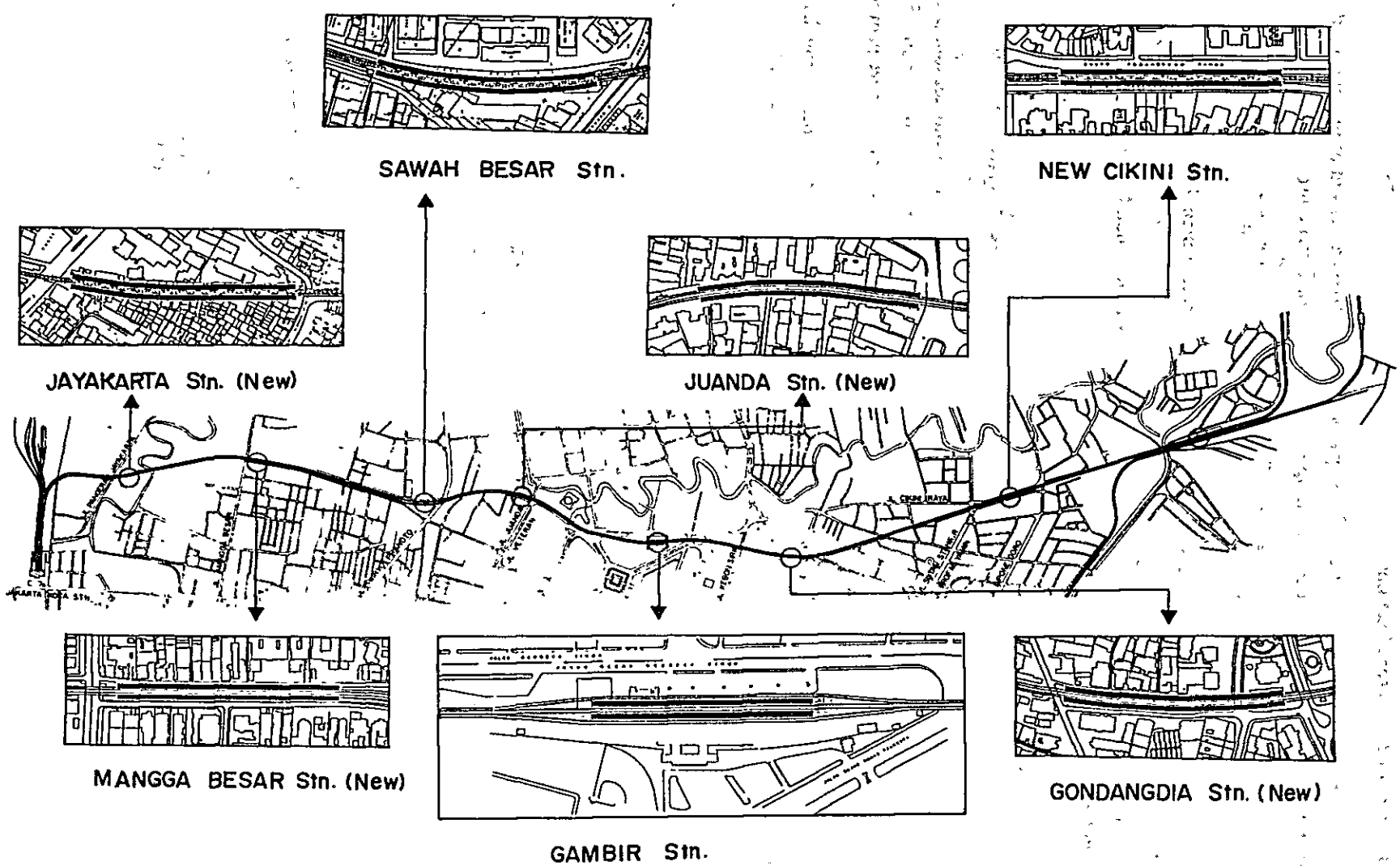
Demand forecast points out that new stations must be opened by 1995.

The rough drawings of plan and profile and locations of stations respectively are shown in following Figures.






Legend Construction Method of Each Alternative
Alternative A Partial Suspension of Train Operation
Double Track Abolition
Alternative B Single Track Operation
One Track Abolition
Alternative C Parallel Construction with Existing line


SAWAH BESAR Stn.
NEW CIKINI Stn.
JAYAKARTA Stn. (New)
JUANDA Stn. (New)
MANGGA BESAR Stn. (New)
GAMBIR Stn.
GONDANGDIA Stn. (New)

(4) Elevated Structure Planning

From viewpoint of utilization of the spaces under elevated tracks and of prevention of noise, reinforced concrete structure was adopted for elevated track structure.

(5) Station Facilities Planning

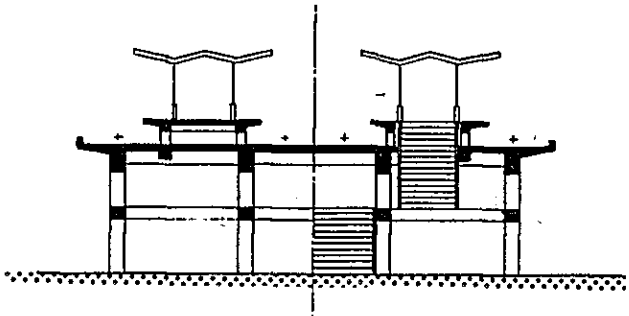
Station facilities comprise platforms, platform sheds, station main buildings and station front areas.

Their scale was classified as follows on the basis of estimated number of boarding and detraining passengers in the year 2000.

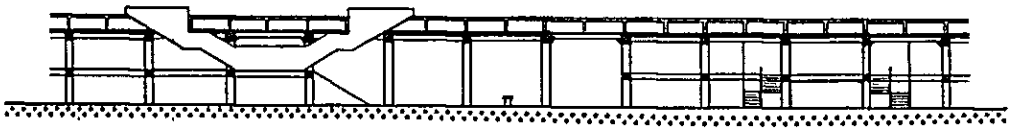
Large station	:	Gambir
Medium station	:	Sawah Besar, Cikini
Small station	:	Jayakarta, Mangga Besar, Juanda, Gondangdia

The scale of station main building depends on the number of boarding and detraining passengers, the number of station employees and the handling volume of parcels, but 3,600 m^2 for a large station, 1,800 m^2 for a medium station and 1,500 m^2 for a small station were planned at this time.

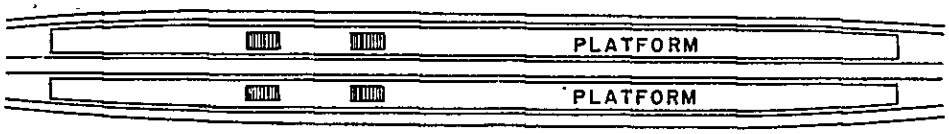
The concepts on station facilities under elevated tracks for large station and intermediate stations are shown in following Figures.



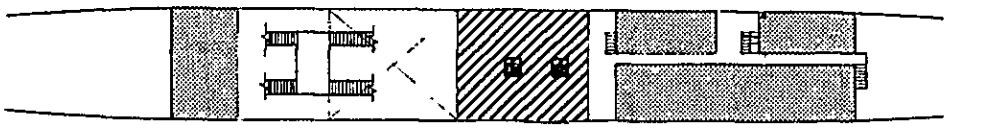
CROSS SECTION



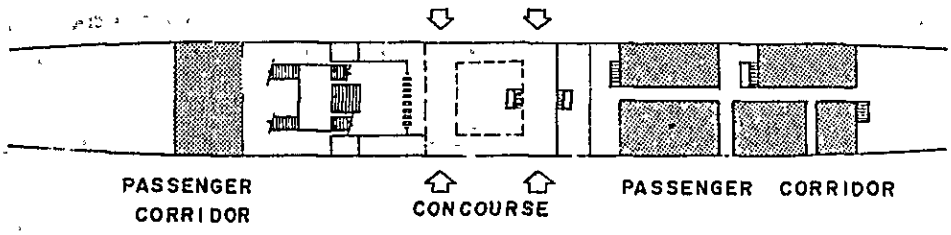
SIDE VIEW



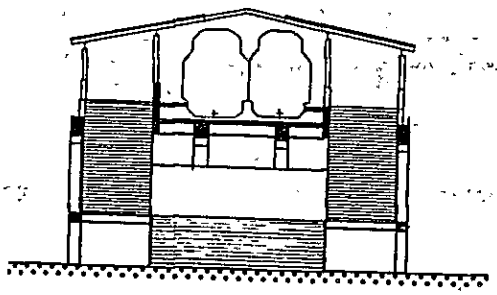
THIRD LEVEL PLAN



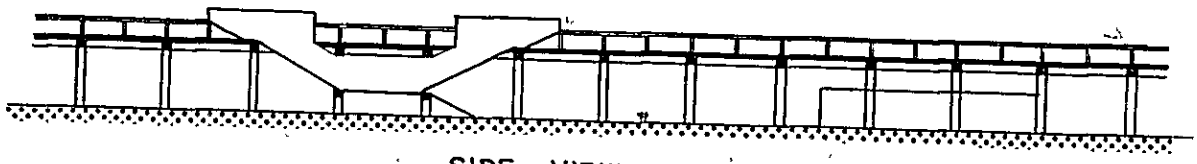
SCEOND LEVEL PLAN



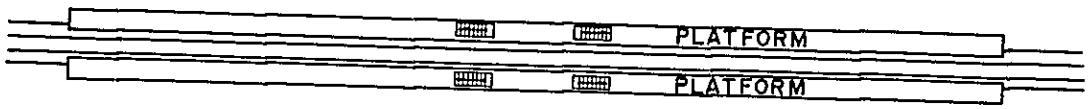
GROUND LEVEL PLAN



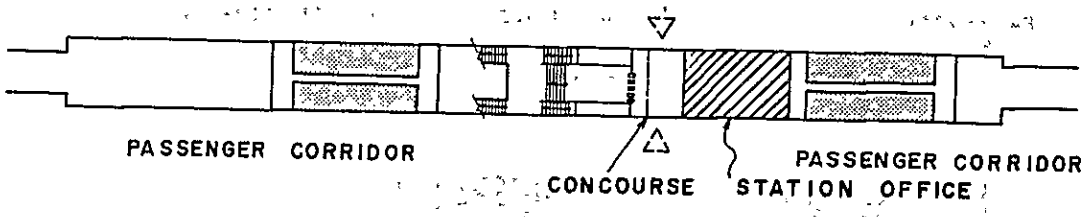
CROSS SECTION



SIDE VIEW



(2) SECOND LEVEL PLAN



(1) GROUND LEVEL PLAN

5.3 Electrification facilities planning

The electrification facilities on the Central Line have been rehabilitated these years but it is hard to say that enough function as mass rapid railway is provided. Transport capacity on the Central Line will sharply increase upon completion of track elevation work and conversion to automatic signalling system. The following facilities should be newly installed, added or improved as corresponding electrification facilities planning.

(1) Substation Facilities

Rectifiers and feeding facilities shall be added and high-tension circuit device shall be newly installed in Gambir Substation. Feeding facilities shall be added at Jakarta Kota and Manggarai. Interlinked circuit breaking devices shall be newly installed for securing protection of feeding circuit.

High-tension circuit devices shall be added in Jakarta Kota and Jatinegara Substations.

(2) Overhead Line and Lighting Power Facilities

Overhead line shall be newly installed on the elevated tracks. High-tension distribution line for automatic signalling system shall be newly installed between Jakarta Kota Substation and Jatinegara Substation. In Alternative A, a temporary station is to be constructed at Gambir Station. Accordingly, lighting power facilities becomes necessary at the temporary station and overhead line should be temporarily installed.

(3) Precautions for Work Execution

With Alternatives B and C, track elevation work in proximity to running electric trains calls for safety protection against contact with trains and falling objects. As existing DC 1500 V overhead line is situated near the elevated track structure, adequate care for workers should be taken against electric shock accident and grounding accident due to falling objects. If existing Gambir Substation gets out of elevated track structure work, this may give rise to a big technical problem with construction schedule. Therefore, attention should be paid to avoid such a situation.

(4) Problems due to Detour Train Operation

With Alternative A or B, transport capacity on the Central Line will show a remarkable decrease during construction. One of the countermeasures is detour operation of 8-railcar electric trains via the Eastern and Western Lines. However, both existing facilities and planned electrification on the Western Line only accommodate 4-railcar electric trains. Operation of 8-railcar trains will cause frequent accidents unless equipments are beforehand added in all substations to enhance protective capacity for feeding circuit. To relieve voltage drop of overhead line, feeders shall be added between Depok and Bojonggedeh Substations, and between Bogor Substation and Bogor Station. PLN power sources should be improved at the same time of the above facilities building-up.

5.4 Signalling and telecommunication systems

(1) Signalling System

As the signalling system which secures a safety train operation, it will be recommended to install an automatic signalling system which satisfies the improvement of degree of safety, the rationalization through ease of handling and maintenance of the facilities; and the adaptability to high speed and high density train operation.

a. Blocking System ..... Automatic Blocking System
b. Signalling Apparatus ..... Colour Light Signal (Home, Starting and Block Signal), Shunting Signal
c. Track Circuit ..... Commercial Frequency Track Circuit
d. Interlocking Device ..... First Class Relay Interlocking Device
e. Point Machine ..... Electric Point Machine
f. Train Control Device ..... Automatic Train Stop Device

The principal configuration of signalling system is shown on the figure on page 24.

(2) Telecommunication System

The following telecommunication facilities to be constructed under the Intermediate Program will be planned to reallocate or improve not to obstruct the existing situation of telecommunication services.

a. Telecommunication Cable ..... CCP-LAP Cable
b. Carrier Equipment ..... PCM Cable Carrier Equipment (Terminal Equipment and Repeater)
c. Dispatch Telephone System ..... Train Operation, Electric Power and Signal/Telecommunication Dispatch
d. Facsimile Equipment ..... Combined Equipment with transmitter and receiver
e. Train Radio Equipment ..... Train Radio Base Station Equipment

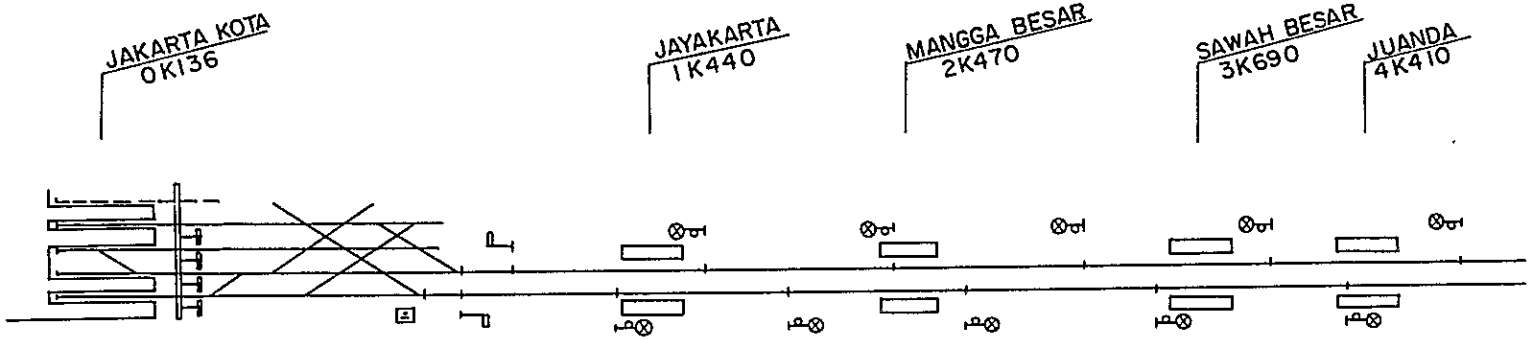
In addition to the reuse of above equipment, the talk-back equipment for communication and public announcing and the electric clock equipment will be installed at Gambir Station.

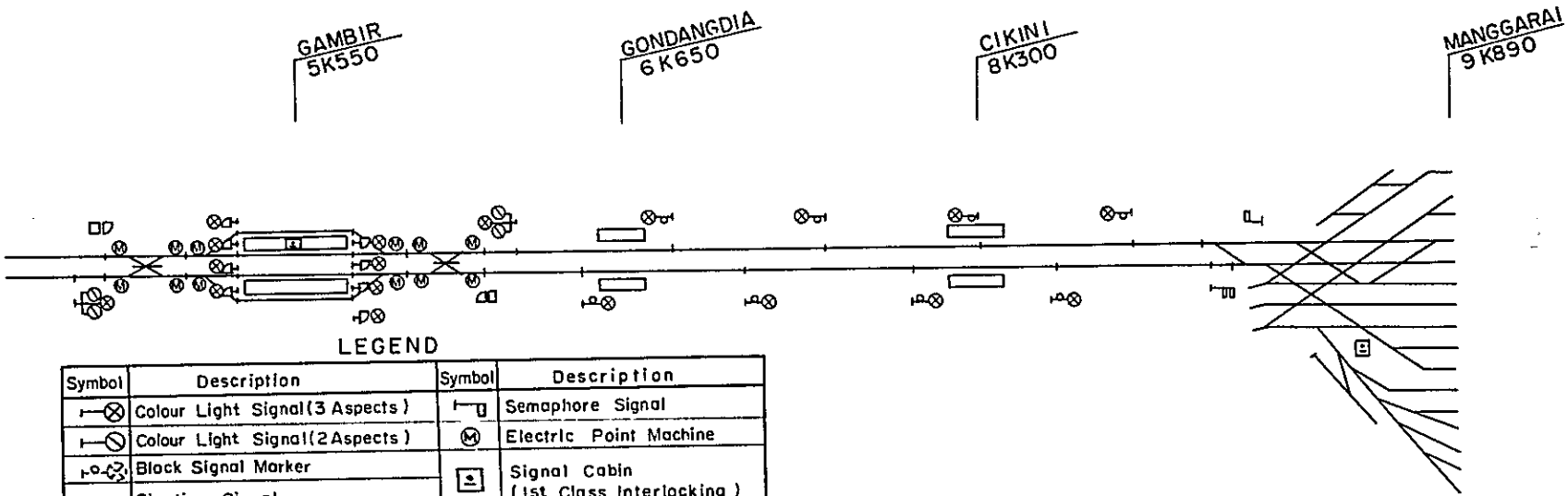
The principal configuration of telecommunication system is illustrated on the figure on page 25.

(3) Considerations on Construction of Signalling and Telecommunication Systems

The signalling and telecommunication installation works are planned to be executed on condition that building structures, cable ducts and insulated rail joint assemblies will be constructed by the facilities department in advance of the commencement of the work. Three alternatives require the same constructions regarding the installation of new facilities and the withdrawal of existing facilities. They, however, have differences, by alternatives, such as shown on the following table, regarding temporary constructions. These temporary works should be executed after the conference with other relative sections.

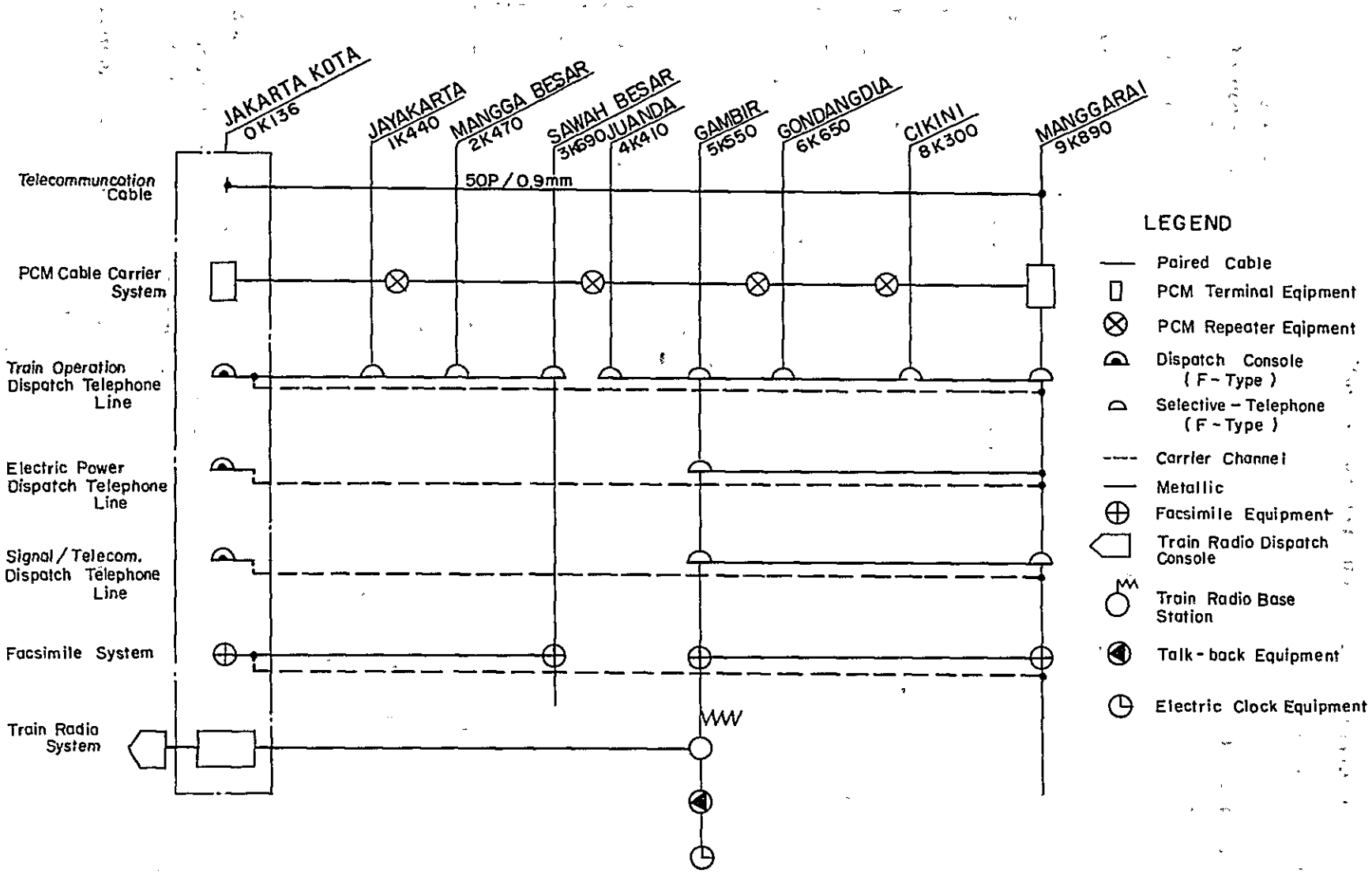
Relevant Works	Alternative A	Alternative B	Alternative C
Temporary Facility at Gambir Station	Shuttling Train Operation	Single-Track Train Operation	Double-Track Train Operation
Blocking Instrument	Rajawali Dukuh	Sawah Besar Cikini Rajawali Dukuh	
Interlocking Device		Sawah Besar Cikini	
Level Crossing Protection Facilities		Improvement for Single-Track Removal of Obstruction	Removal of Obstruction
Existing Facilities		Removal of Obstruction	Removal of Obstruction





LEGEND

Symbol	Description	Symbol	Description
	Colour Light Signal(3 Aspects)		Semaphore Signal
	Colour Light Signal(2Aspects)	M	Electric Point Machine
	Block Signal Marker		Signal Cabin (1st Class Interlocking)
D	Shunting Signal		
	Route Indicator		Rail Joint Insulation


JAKARTA KOTA
0K136
JAYAKARTA
1K440
MANGGA BESAR
2K470
SAWAH BESAR
3K690JUANDA
4K410
GAMBIR
5K550
GONDANGDIA
6K650
CIKINI
8K300
MANGGARAI
9K890
50P / 0.9mm
Telecommuncation Cable
PCM Cable Carrier System
Train Operation Dispatch Telephone Line
Electric Power Dispatch Telephone Line
Signal / Telecom. Dispatch Telephone Line
Facsimile System
Train Radio System
LEGEND
Paired Cable
PCM Terminal Eqipment
PCM Repeater Eqipment
Dispatch Console (F - Type)
Selective - Telephone (F - Type)
Carrier Channel
Metallic
Facsimile Equipment
Train Radio Dispatch Console
Train Radio Base Station
Talk - back Equipment
Electric Clock Equipment

5.5 Investment scale and construction time schedule

(1) Investment Scale

As to the investment scale on 8 km 500 m long elevated tracks, Alternative A is the lowest with 82.7 billion Rp, followed by Alternative B with 97.2 billion Rp and Alternative C with 103.4 billion Rp.

Item-wise investment scale is as shown in following Table. The difference among the alternatives originates from land purchase and house compensation expenses. Required land space is 41,400 m^2 for Alternative A, 67,200 m^2 for Alternative B and 96,300 m^2 for Alternative C.

Unit: 10^9 Rp

Investment / Work	Alternative A			Alternative B			Alternative C		
	Foreign currency	Domestic currency	Total	Foreign currency	Domestic currency	Total	Foreign currency	Domestic currency	Total
1. Civil and building works	27.4	22.6	50.0	29.7	25.6	55.3	30.4	26.0	56.4
2. Electrification work	6.0	3.2	9.2	6.8	3.8	10.6	6.4	3.5	9.9
3. Signalling and telecommunication works	1.4	0.6	2.0	1.7	1.2	3.0	1.5	1.0	2.5
4. Land purchase and house compensation	0	7.2	7.2	0	12.5	12.5	0	18.2	18.2
5. Total	34.8	33.6	68.4	38.2	43.1	81.3	38.3	48.7	87.0
6. New station construction	6.4	7.9	14.3	7.2	8.7	15.9	7.5	8.9	16.4
7. Grand Total	41.2	41.5	82.7	45.4	51.8	97.2	45.8	57.6	103.4

Note 1. New stations to be constructed are Jayakarta, Mangga Besar, Juanda and Gondangdia.

Note 2. The construction unit price is as of July, 1981.

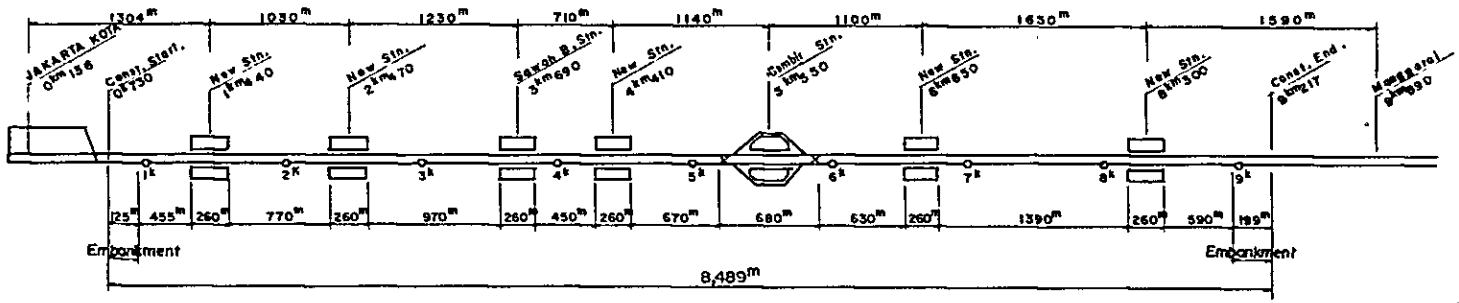
Note 3. Foreign currency exchange rate are as follows:

Rp.630 = US$1.00 = ¥230

(2) Construction Time Schedule

Construction time schedule by alternative is as shown in following Table. Alternative A, which aims at separate construction in the divided two sectors, requires a long period of time, 6 years 1 month (3 years 9 months for the Jakarta Kota–Gambir sector and 2 years 4 months for the Gambir–Manggarai sector).

Alternative B and C, extending for 4 years 4 months, need a period for safety education and training because of work execution in proximity to the existing line.



Alternatives for Construction Planning	1st	2nd	3rd	4th	5th	6th	Note
Alternative — A Partial Suspension of Train Operation	Land Purchase Track laying for shuttling (6) Dismantle (2) Electric	Elevated Track Structure (24) (Jakarta Kota ~ Gambir) 8-Coaches Operating Equipment※		Track Building Electric Dismantle (2)	Elevated Track Structure (20) (Gambir ~ Manggarai)	Track Building Electric Operation (6Y1M)	
Alternative — B Single Track Operation	Land Purchase Single Track Facilities (6) Dismantle (2) Electric	Elevated Track Structure (31) 8-Coaches Operating Equipment※		Track Building Electric	Operation (4Y4M)		
Alternative — C Double Track Operation	Land Purchase Temporary Track Works (6) Dismantle (2) Electric	Elevated Track Structure (31) 8-Coaches Operating Equipment※		Track Building Electric	Operation (4Y4M)		* Mark shows the investment apart from the section for the Track Elevation.

6. Environmental Survey for Track Elevation

6.1 Environmental preservation

Planning of development project in an urban area must take beforehand into consideration its effects on the surrounding environment.

Track elevation project not only eliminates crossing roads to recover road traffic function but also is useful as means of urban redevelopment.

As faulty planning of the project could exert a bad influence on the dwelling environment in the areas along the line, adequate care should be taken for environmental preservation.

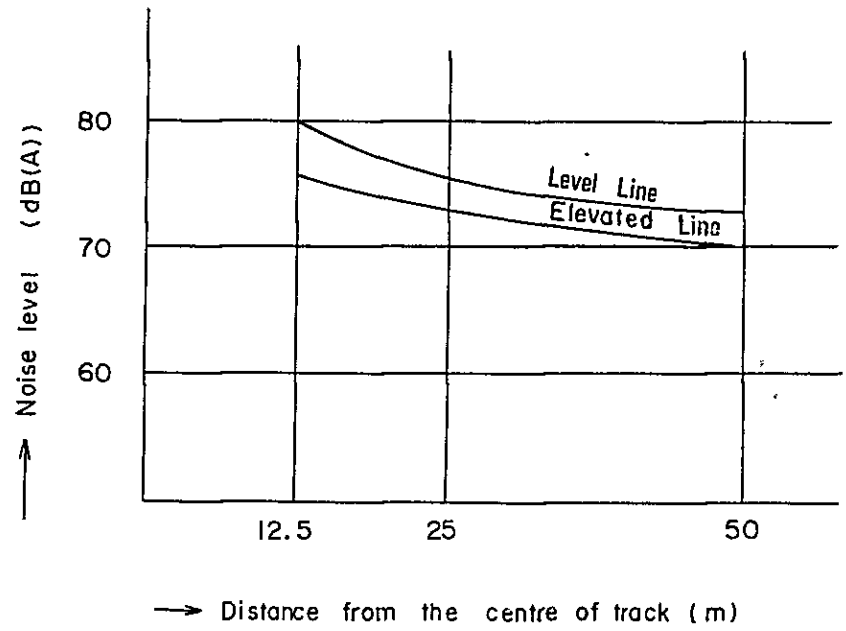
Looking into the Track Elevation of Central Line Project, it would be useful to make comments on the noise caused by trains.

6.2 Present conditions of noise and countermeasures

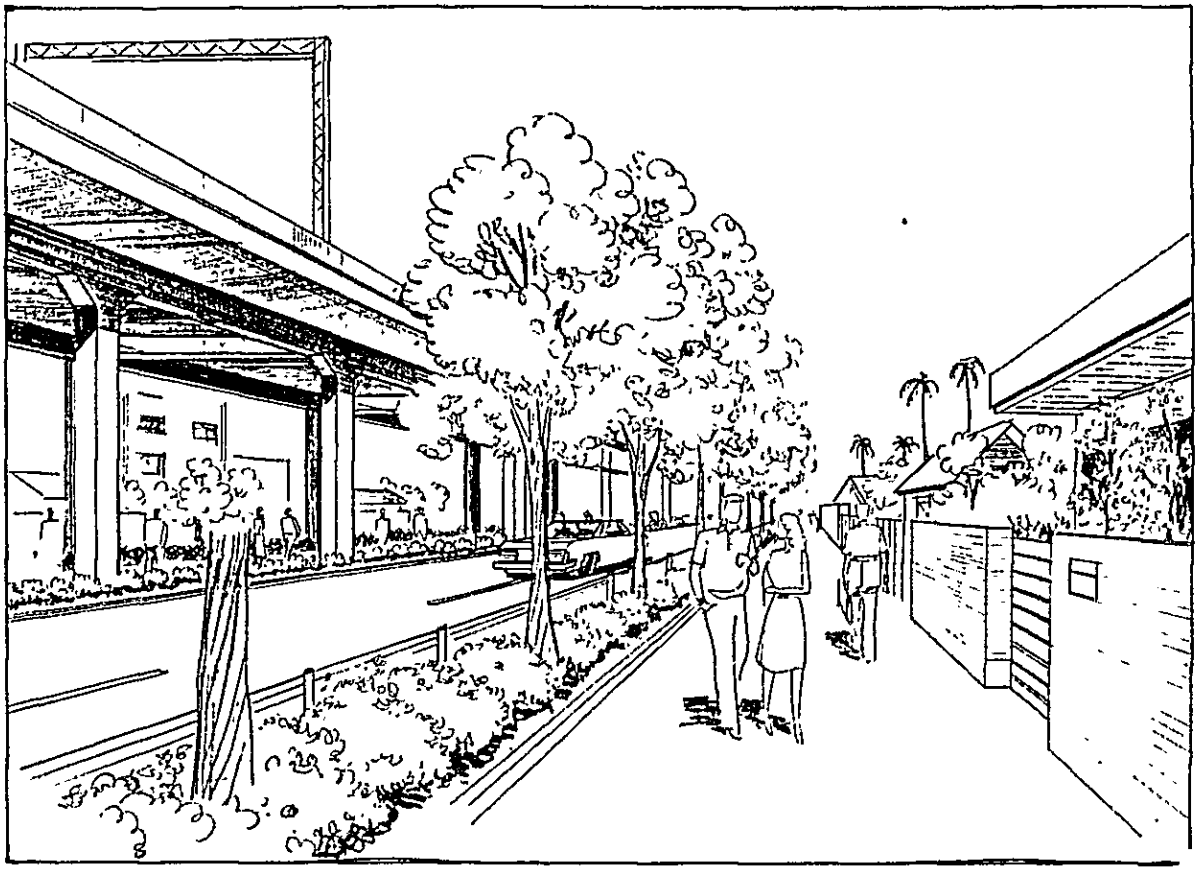
The study team surveyed actual conditions of noise along the Central Line and the results show that the noise level is 84 dB (A) ~ 100 dB (A) due to insufficient maintenance of tracks and rolling stock despite of a train speed of about 35 km/h.

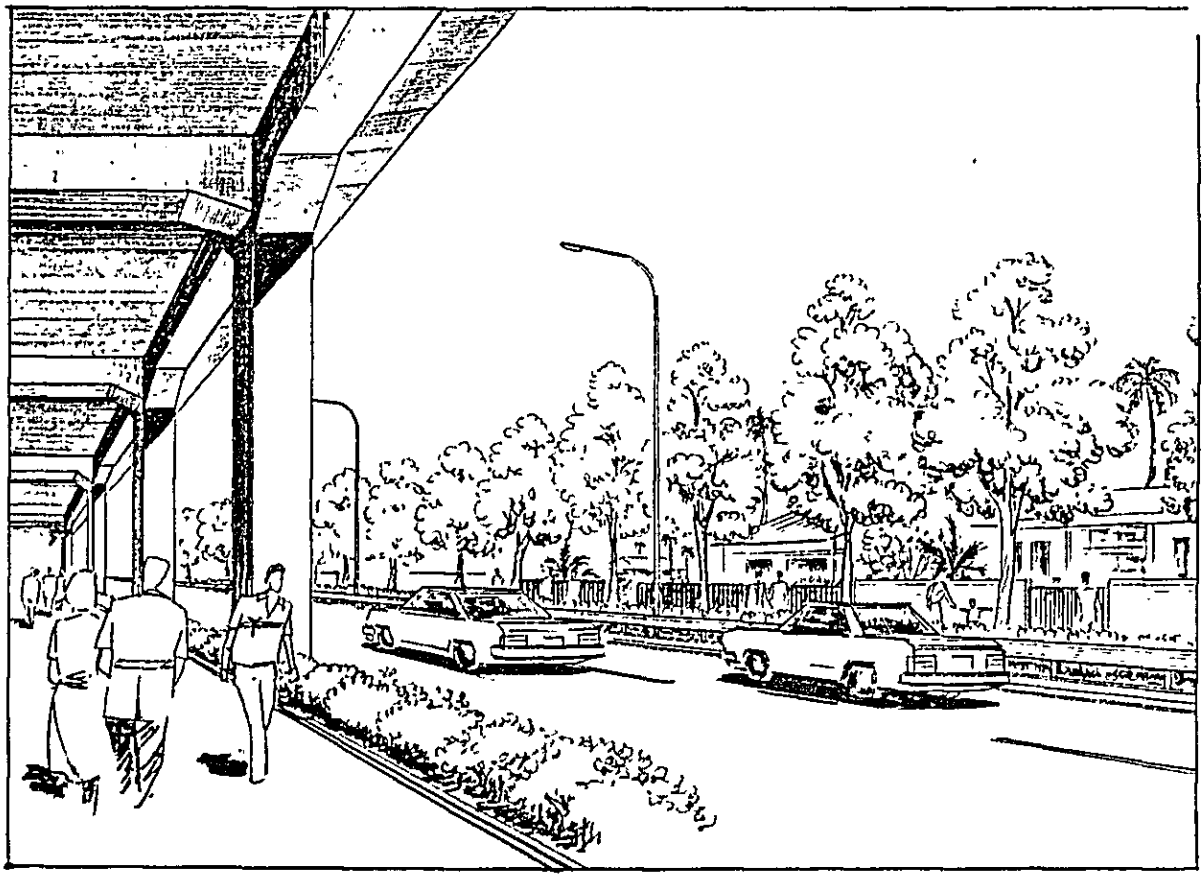
The noise caused by trains is closely related with the structure and maintenance of track, the structures and the train speed. In general, the noise becomes less intense on the elevated track provided with preventive measures than on the level track.

The following figure shows the comparison of noise between level line and elevated line, based on the measured values in Japan.



Construction of elevated track structures through the center of the urban area may spoil scenic harmony with the areas along the line. In such a case, it is possible to moderate or eliminate a discordance by planting of trees or by arrangement of sidewalks. An example of scenic preservation are shown in following figures.





7. Economic Analysis

7.1 Framework

This economic study is based on a comparison between the case if the Project is implimented ("With the Project") and the case if it is not ("Without the Project").

(1) "With the Project"

The following 3 alternatives are considered as conditions of "With the Project."

① Proposal for successive construction with partial suspension of operation (Alternative A)

② Proposal for construction while maintaing single track operation (Alternative B)

③ Proposal for construction while maintaining double track operation (Alternative C)

(2) "Without the Project"

Even "Without the Project," a certain amount of Investment is required for harmonious development of the facilities on Central Line.

Such Investment as Replacement and Modernization of obsolete railway facilities (Automatic signals, ATS, Improvement of the existing railway stations, Construction of new stations, Improvement of the squares in front of the stations) and construction of flyovers to eliminate traffic congestion at the railway crossings are considered concretely.

7.2 Economic value of investment

The economic value of the investment amount differs from the financial value of investment set out in table 5.5.1 in the following points.

1) Taxes & subsidies adjustment
2) Reutilization of the written-off assets
3) Utilization of economic price of land in calculating land acquisition price.

The economic price of the investment is set out below.

(Unit: Mil.Rp)

		With the project			Without the project
		Alternative A	Alternative B	Alternative C	
Capital cost categolized by the period	The first phase (1985 – 1988)	62,470	91,967	98,779	35,194
	The second phase (1989 – 1990)	17,489			16,583
	The reinvestment (1991 –)	2,765	3,516	3,222	1,853
Capital cost categolized by the kind of work	Civil work	58,128	65,251	67,441	30,387 (14,431)
	Land acquisition	9,040	14,628	20,857	17,356 (11,261)
	Electric facilities	9,477	11,348	10,145	3,436
	Signals & telecommunication	2,635	4,255	3,555	2,452
The financial cost due to the acceleration of investment for attainment of 8-car operation facilities	Civil work	0	0	0	
	Electric facilities	0	724	0	
	Signals & telecommunication	0	4	0	
Total capital cost		82,724	95,483	102,001	53,630

7.3 *Indices for evaluation*

(1) EIRR (Economic Internal Rate of Return)

EIRR is utilized as the integrated index of the following individual indices. Aspects which are not involved in EIRR are set out as supplemental indices.

① Investment
- Scale and difficulty of the construction.
- Required space of land for the construction.
- Investment in alternative means of transportation.

② Operating cost and maintenance cost

③ Benefits
- Time saving benefit to road vehicles at railway crossings.
- Time saving benefit to railway passengers.
- Fuel saving benefit.
- Benefit of averting accidents at the railway crossings.
- Land use benefit.

(2) Supplemental indices

① Strategic effects of early completion of the construction.

② Degree of preparation of land required for four track line in the future.

③ Negative influence on recent tendency for the number of railway passengers to increase due to suspension or limitation of train operation.

(3) Other indices

The following indices are attached because of important policies in Indonesia.

① Creation of job opportunities

② Energy saving effects

7.4 Evaluation

All these indices are set out in the next table.

Indices \ Alternatives		Alternative A	Alternative B	Alternative C
EIRR		23.8 %	17.2 %	15.5 %
Supplimental Indices	Completion year of the construction (Construction period)	January 1991 (6 years 1 month)	April 1989 (4 years 4 months)	April 1989 (4 years 4 months)
	Degree of preparation of land required for four track line in the future	20 %	60 %	70 %
	Manner of passenger transportation during construction period	Buses and additional operation of Western & Eastern Line are needed	Several long-distance train operations must be cut off	No change is needed
Sub indices	Creation of job opportunities during construction period	11,020 Mil Rp (4.8 Mil person-day)	11,837 Mil Rp (5.2 Mil person-day)	12,268 Mil Rp (5.3 Mil person-day)
	Energy saving effect (yearly average)	477 Mil Rp (4,543 Kℓ)	458 Mil Rp (4,362 Kℓ)	458 Mil Rp (4,362 Kℓ)

Note Alternative A = Pertial suspension proposal

Alternative B = Single track operation proposal

Alternative C = Double track operation proposal

(1) EIRR

According to the hearing conducted in the Study on Monster Plan last year, social capital cost (the evaluation standard of EIRR) is around 13 % p.a. concerning the railway project in Indonesia.

High level EIRR is better but it is more important whether. EIRR exceeds this standard. In the light of this standard all alternatives pass this standard.

(2) Supplemental indices

Supplimental Indices	Alternative A	Alternative B	Alternative C
Strategic effects of early completion of the construction	X	O	O
Degree of preparation of land required for four track line in the future	X	Δ	O
Negative influence on the recent tendency for the number of railway passengers to increase due to suspension or limitation of train operation	X	Δ	O

O : good, Δ : medium, X : poor

We can consider that alternative B and C invest the surplus which exceeds the EIRR standard to accomplishing supplemental objectives.

(3) Sensitivity Analysis

		Construction cost	
Road traffic volume	Condition of construction of flyover	110 %	120 %
90 %	Unchanged	14.2 %	13.4 %
80 %	Cut off the construction of Jl. Sukarjo's flyover	13.8 %	13.0 %

We considered 4 cases in sensitivity analyses based on Alternative C.

We can conclude that even if the worst case happens, namely there is a 20 % cost over-run, 20 % reduction of road traffic volume from the Alternative C and a cut off of flyovers at Jl. Sukarjo, the project is still viable enough to exceed the EIRR standard.

8. Final Consideration

Three alternative proposals for construction planning of the elevated Central Line were set forth in Chapter 5 and economic evaluation study was made in Chapter 7 in accordance with the indexes of (1) method of construction, (2) construction period, (3) measures for handling passengers during construction period, (4) difficulty in land purchase and (5) economic cost estimation.

On the basis of economic internal rate of return (EIRR) thus obtained, final consideration on Alternatives A, B and C is attempted.

(1) Judging from investment scale and EIRR only, Alternative A (or Alternative No. 1) is to be adopted.
Nevertheless, suspension of train operation has to do with political affairs from aspects of urban transport policy.

(2) Although it is accompanied by difficulty in land purchase, Alternative C is to be selected if a policy is made on preceding investment prior to another future track addition.

(3) Alternative B is placed in the middle between Alternatives A and C.

In either case of the three alternatives, measures to be taken prior to execution of the project are summarized as follows.

(1) Removal and transfer of houses standing in the right of way, which may interfere with construction.

(2) Land purchase for required service roads for construction works.

(3) Road net-work planning in presupposition of the Central Line railway project.

(4) Prior measures related to regulation of land use, taking effect on avoidance of environmental trouble in future along the Central Line.

(5) Transfer of obstructive articles such as electrification and signalling/telecommunication facilities and other municipal facilities, prior to civil construction work.

(6) Enough supply of electric power by PLN, which is necessary to implementation of the project.

(7) Improvement of feeder transportation means which connect with stations on the elevated Central Line.

Each item is as important as track elevation construction work itself.

In case of earlier commencement of the construction than 1985, a result of economic evaluation would be almost as same as the result concluded in this study report. In other words, it would be as viable and feasible as the construction schedule proposed in this study report.

INTRODUCTION

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1. Background of study

The Japanese government decided to execute " The Urban/Suburban Railway Transportation in JABOTABEK Area Study Project " as a part of technical assistance, and dispatched a preliminary study team in February 1980.

The Japanese and Indonesian governments made an agreement for the scope of work on the basis of the preliminary study results. Japan International Cooperation Agency (JICA), charged with the execution of the Study, dispatched to Indonesia in May 1980 a study team headed by Mr. Mikio Sudo, Executive Vice-president, Japan Railway Technical Service (JARTS) and, at the same time, set up a JICA supervisory committee under the chairmanship of Dr. Y. Matsumoto, professor of engineering department in Tokyo University. The Study, carried out from May 1980 through March 1982, comprises three phases according to the nature.

The 1st phase is preparation of Master Plan and the 2nd phase is feasibility study of projects with higher priority based on the Master Plan.

The 3rd phase is feasibility study of the Central Line Track Elevation Project with similar priority to that of the projects in the 2nd phase.

The 1st and 2nd phase studies were completed in March 1981 and we already submitted the final report to the Indonesian government. Field study in the 3rd phase for " the Central Line Track Elevation Project " was executed from June 29 to August 27.

The study team returned back to Japan after submission of the Progress Report and carried out study works in Japan. Based on the study results, the study team submitted and explained the Interim Report to the related Indonesian organizations from November 6 to 20, and the Interim Report was agreed. The study team submitted and explained the Draft Final Report in February 17 to 26, 1982 and the study was completed in March 1982.

2. Purpose of study

The purpose of study is to execute field investigations of actual conditions in Indonesia and analysis of investigation results in Japan, both necessary to feasibility study of the Central Line Track Elevation Project, in consideration of economic development activities in the region covered by the Central Line (Jakarta Kota Station - Manggarai Station), and to prepare final recommendation.

3. Outline and step of study

The study is divided into 6 steps as follows:

(1) 1st step: Preparatory work in Japan

Examination of collected data and information, determination of outline study policy and preparation of the Inception Report.

(2) 2nd step: Field study

Field study was executed for about 2 months, from June 29 to August 27, 1981. Main works of the study were as follows:

1) Submission, explanation and discussion of the Inception Report and request for cooperation to the Indonesian authorities concerned.
2) Seeking the comments of the authorities concerned.
3) Making of mosaic aerial photos, geological survey and sound level survey.
4) On-the-spot survey on the actual situation of land use and traffic volume in railway crossings and stations.
5) Review of existing data relating to land use, traffic demand, train operation and railway facilities, making any necessary revision (including additional studies).
6) Determination of the basic conception
7) Basic research from socio-economic aspects.
8) Preparation and explanation of the Progress Report

At the end of field study, the progress report was submitted and explained to the Indonesia-Japan joint steering committee.

(3) 3rd step: Preparation of the Interim Report in Japan

Preparation of the Interim Report in Japan was carried out from September to the beginning of November 1981.

1) Reexamination of basic conception for feasibility study.
2) Reexamination and correction of data related to analysis and forecast of traffic volume and demand.
3) Reexamination of alternatives of track elevation work method based on continuous grade separation system, and planning of train operation program during construction.
4) Outline design and computation for determination of railway facilities planning and investment scale by alternatives.

(4) 4th step: Submission and explanation of the Interim Report

The Interim Report was submitted and explained in Indonesia from November 6 to 20, 1981.

1) Submission and explanation of the Interim Report

The Interim Report was submitted and explained on November