CHAPTER 5

THROUGH OPERATION POLICY

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5.1 Through Operation Plan

5.1.1 Advantages of Through Operation

(1) Advantages at the Side of Passengers

1) Alleviation of Congestion at the Terminal Stations

The north and south terminal stations are considerably congested.
Monumento station, the north terminal of LRT Line 1 handles 42,000 passengers daily. This number represents four times the mean number of boarding and alighting passengers in all stations, while Baclaran, the south terminal serves double the mean number.

As regards Line 3, which started partial operation in December 1999, the number of boarding and alighting passenger at the North Avenue station is 11,800 which is double the mean number for all the stations. Buendia station served as the south terminal during the partial operation until July 2000, and it handled three times the mean number of boarding and alighting passengers.

Line 3 share common trends with LRT Line 1 which has 15 years of operating history.

Japanese urban railways experiences over a long period of time with respect to means for alleviating congestion at terminal stations. The greatest measure that has been implemented is launching 'through operation'. By the implementation of through train service, the role and conditions of terminal stations have been attributed to the same as intermediate stations, alleviating congestion at the stations, providing a great convenience to passengers.

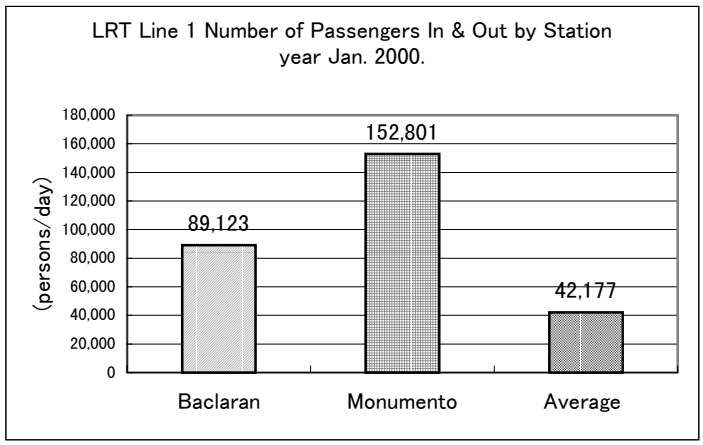


Fig.5.1.1　LRT Line 1 of Passengers In & Out by Station

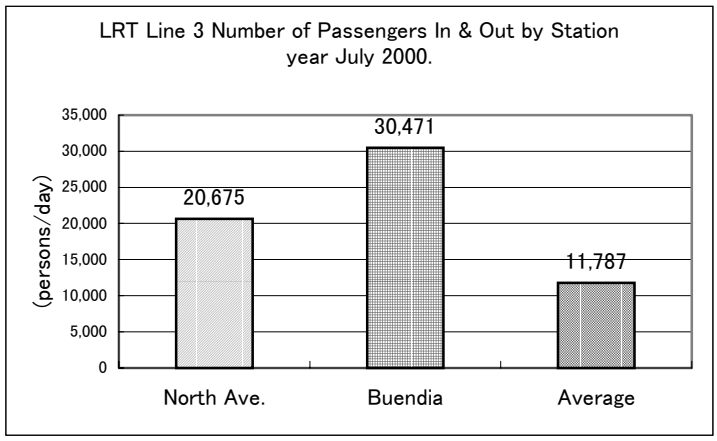


Fig.5.1.2　LRT Line 3 of Passengers In & Out by Station

2) Travel Time Saving

Approximately 60,000 passengers a day on an average utilized Line 3 immediately after it started operation, accounting for 16% of around 380,000 passengers a day utilizing Line 1 (refer to Appendix).

The low ridership on Line 3 is due to high level of fare compared to LRT Line 1, plus the inconvenient location of stations. The stations and end terminals are short of complementing other transport systems or services. Passengers completing their trip within the area of operation is limited. Stations also lack facilities for passenger comfort and convenience.

Often passengers cannot complete their trip only by existing urban railways, instead, they continue their trips changing route at plural railways, taking buses and jeepneys. Passengers want to reach destinations of their trips as soon as possible.

What passengers want is the availability of the network of urban railways, forcing them to take minimum changes. 'Through operation' makes the dream of passengers come true and substantiates the travel time saving. Line 3 can contribute to passengers through the formation of a urban railway network, rather than as an individual line. Furthermore, by implementing through train service jointly with other lines, Line 3 will be able to increase the number of passengers completing trips within the network.

The same holds true for Line 1. By conducting 'through operation', it will help increase changes for respective stations on this line to become destinations of passengers.

(2) Advantages for the Railway Companies

1) Reduction of Construction Cost

In the case of 'through operation', one station at the junction of railway suffices, contributing to reducing the construction cost of railways to half.

By 'through operation', passengers can utilize the train without making a transit at connecting stations. For 'non-through operation' railways, two stations are needed for one connecting point, forcing the passengers to move between the two stations.

When planning construction of a through train service line, railway companies should decide on through negotiation which party takes the charge of constructing stations at junctions respectively, while the other party bears the half of the construction cost.

2) Saving Initial Investment and Maintenance Costs of Polling Stock

By running a through train service, there is no need for turning back trains at connecting stations. Time saved would mean reduction in number of cars per train set or less train sets running on the loop line of LRT Line 1 and Line 3.

This makes it possible to reduce the number of cars of which a train is composed, while maintaining the same transportation capacity.

Saving in maintenance cost is expected due to the reduced number of operating cars.

3) Competitive Advantages

'Through operation' provides a great improvement in terms of service to passengers. It has been verified in Japan that people don't like to change trains at connecting stations. Passengers want to do away with going up and down long and congested stairs ways. With 'through operation' transfer is avoided and passenger time is saved.

Urban railways operating through trains connecting cities and towns possesses high competitive advantages over other means of land transportation. From the viewpoint of management, this service encourages people to use newly constructed railways with through train service. On the other hand, a stand alone railway line would be difficult to promote.

Moreover, since transfer is avoided, there will be less users of access roads to stations thereby minimizing congestion.

5.1.2 Draft of a Through Operations Plan

We will study the possibility of through operations, including the track sections for which construction is already being planned, for the transportation authority responsible for railways for the Manila metropolitan area. A route map of these track sections is shown in Figure 5.1.3.
Of the track sections illustrated, we will study the following tracks, including LRT Line 1 and LRT Line 3 that are already in operation, as well as planned tracks. No planning will be carried out for MRT Line 2 and LRT Line 4 because the through operations in the study results will be very complicated.

(1) Plan proposal

1) Through operations on LRT Line 1 and LRT Line 3
   ① Through operations at the Monumento Station in the north
   ② Through operations in the vicinity of the EDSA Station in the south
   Furthermore, LRT Line 6 now being planned is included in LRT Line 1.
2) Improvements and through operations for North Rail Line and MCX Line
   ① Through operations based on elevation of the track between Tayuman and Vitocruz (use existing track bed)
   ① Through operations based on placing the track between Tayuman and Vitocruz underground (shorten by using a separate line)

(2) Prerequisites for the comparative study

1) Date for start of through operations will be 2015.
2) The transportation demand estimates for the improvement plans for each track section are shown in Table 5.1.1 as Case 1 through Case 4.
3) A comparative study in conjunction with the through operations will be conducted for the following cases.
   ① LRT Line 1 and LRT Line 3 will be studied by comparing Case 1 and Case 3, including LRT Line 6.
   ② North Rail Line and MCX Line will be studied by comparing Case 3 and Case 4.

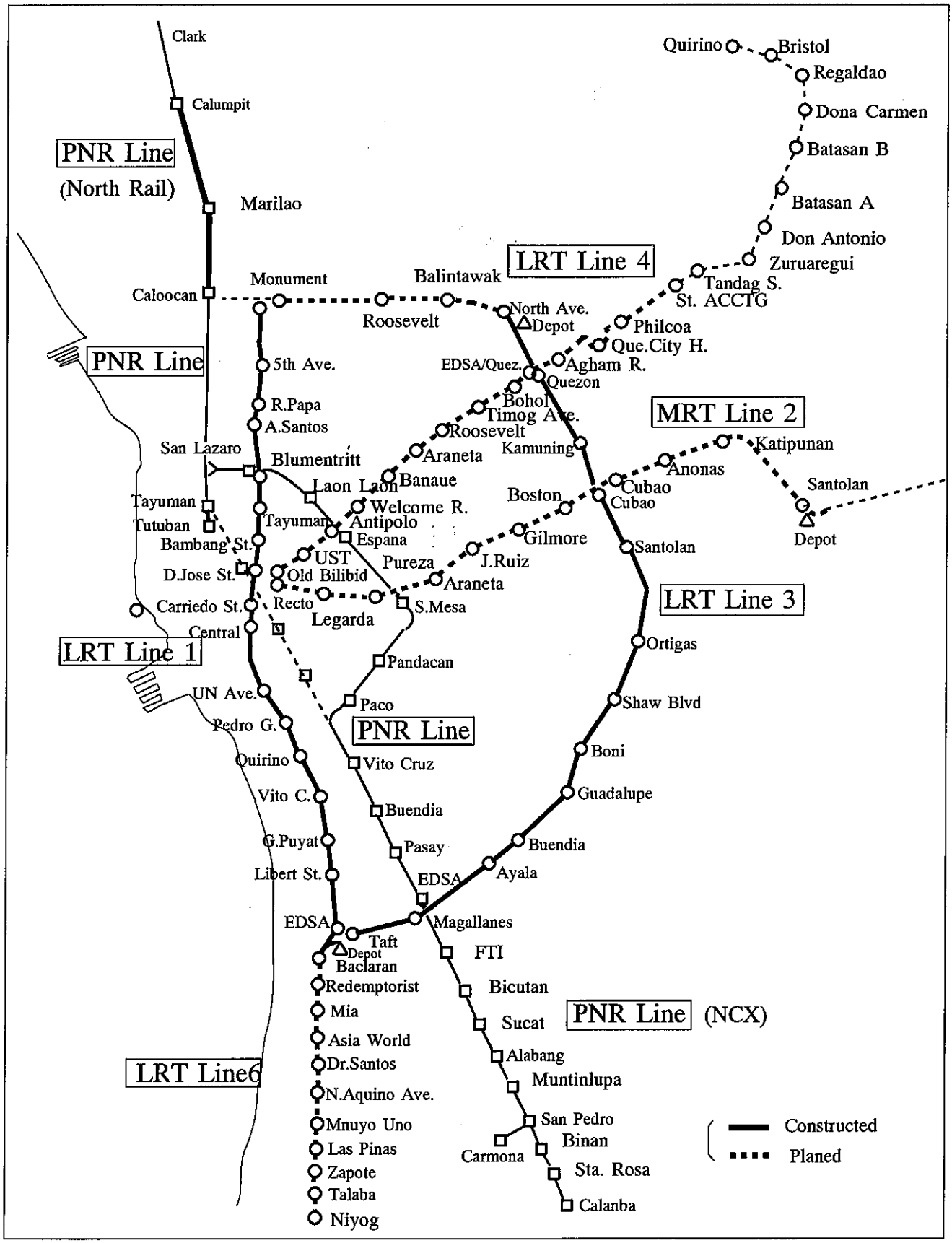
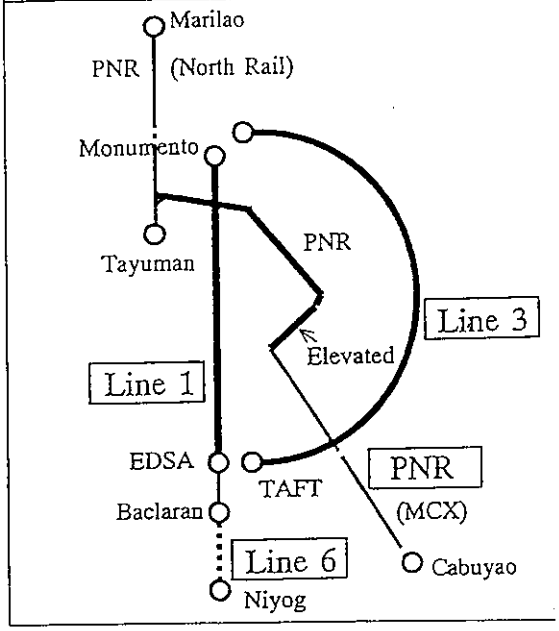
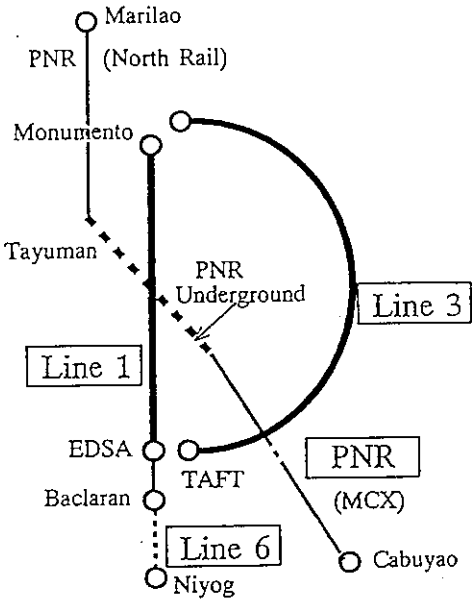
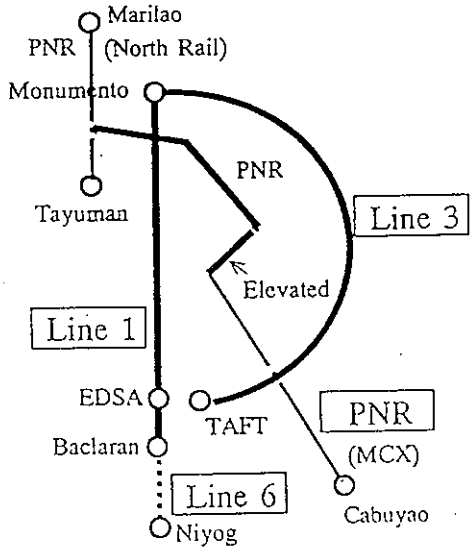
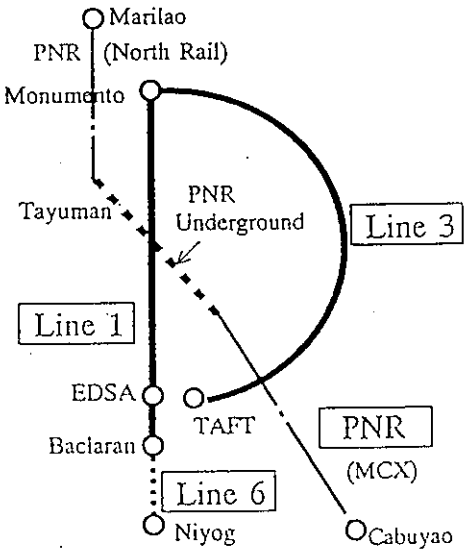


Figure5.1.3 Metoro Manila Railways

Table 5.1.1 Through Train Operation Plan

Separate operation on Line 1 and line 3	
Conventional track improvement on PNR North-South Line	Shortcut PNR underground route construction connecting with North- South Line
Case 1	Case 2
	

Through operation on Line 1 and line 3 via Monumento station	
Conventional track improvement on PNR North-South Line	Shortcut PNR underground route construction connecting with North- South Line
Case 3	Case 4
	

5.2 Plan for Through Operations on LRT Lines 1 and 3 and LRT Line 6

5.2.1 Plan for Through Operations at Monumento Station

The construction planning section for LRT Line 3 extends from North Avenue in a westward direction through Monumento to Caloocan on the PNR Line. Construction for this section has not begun at this time, and it is believed that changes to the construction plan will be comparatively simple.

We believe that implementing through operations of trains over this section will not only eliminate passenger transfers but will also make construction of a new Monumento Station on the LRT Line 3 unnecessary and will increase the effectiveness of LRT Lines 1 and 3.

When Lines 1 and 3 are linked it will be necessary to form the route in such a way as to circumvent "Monumento", an important memorial monument located at the road intersection.

Following the start of through operations as well, some trains will probably be operated between Monumento Station and Baclaran Station to the south, just as they are today, depending upon the difference in transported volume on LRT Line 1 and LRT Line 3.

This through operations planning proposal can be executed and should be executed. Lines 1 and 3 form an important route grid for metropolitan area transportation as loop lines. In particular, as shown by the dotted lines in Figure 5.2.1, thought is also being given to extending these lines in a northward and westward direction, respectively, at Monumento Station. Making Monumento Station into a junction station will be extremely complicated and difficult as a railway route, however, and creates concerns that formation of trains needed as inner-city transportation will be impossible because of intersection obstacles. For this reason a transportation grid linking the suburbs and the downtown area should be planned, like the PNR, as a separate line of radiating tracks.

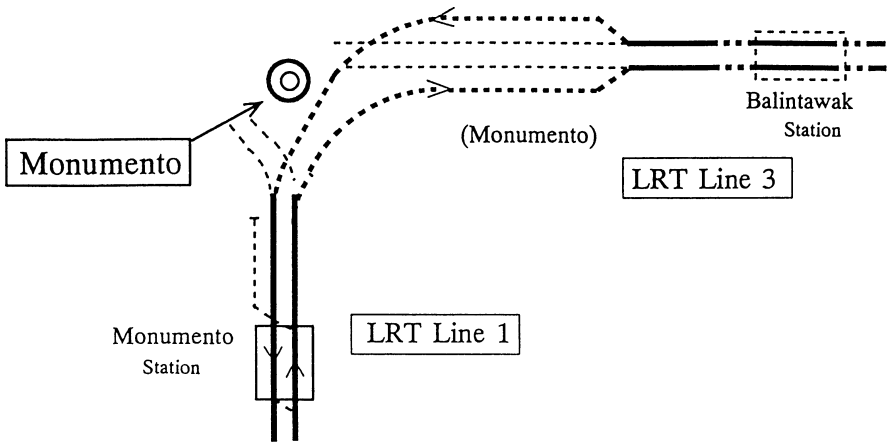


Fig. 5.2.1 Through operation plan for LRT Lines 1 and 3 near Monumento Station

(1) Study of facilities and other needs for through operations

The present status of transportation facilities on LRT Lines 1 and 3 and the plan for facilities that will accompany through operations is shown in Table 5.2.1.

Table 5.2.1 Existing transportation facilities on LRT Lines 1 and 3 and planned through operation facilities

		LRT Line 1	LRT Line 3	LRT Line 1 & Line 3 Through train service section	Remarks
Existing section		Baclaran ～ Monumento 13.95km	North Ave. ～ TAFT 16.4km		
Section to be constructed		— —	(Monumento) ～ North Ave.5.4km	Construction section based on conversion to through operations Approximately 0.2km	Operating km
Through operations section		Make Monumento Station a junction station to LRT Line 3		Baclaran ～ (Monumento) ～Taft 35.75km	
Track	Gauge	1,435mm	1,435mm	1,435mm	
	Center-to-center distance of adjacent rails	3,200mm	3,400mm	Minimum: 3,200mm	
	Distance between rolling stock and structures	Will require investigation	Will require investigation	Will require investigation	
	Axle load and resulting stress	Can handle trains from LRT Line 3 at present (Requires study)	LRT Line 1 rolling stock will require investigation	Must investigate loads, etc.	
	Platform length	105m	130m	130m	Study will be required for LRT Line 1 in the future.
	Platform height	690mm	920mm	(690mm) & 920mm	
	Maximum gradient	40‰	39.5‰	40‰	
	Curve radius	R170 (Depot: R25)	R370 (Depot: R25)	R170 (R100)	
Power	Power method	DC: 750V	DC: 750V	DC: 750V	
	Current collection method	Overhead line	Overhead line	Overhead line	
Rolling stock	Measurements	26.35L*2.59W*3.32H	31.72L*2.5W*3.65H	26.35L*2.59W*3.32H	Rolling stock measurements must be standardized
	Floor surface height	920mm	920mm	920mm	
	Axle load	10.7 ton	8.8 ton	8 ～ 10 ton	Development of light-weight new-type coaches required
	Control system	VVVF	Chopper(DC Motor)	VVVF	
	Rate of acceleration	1.0m/s^2	1.03m/s^2	1.0m/s^2	

	Rate of deceleration (Normal)	1.3m/s^2	1.01m/s^2	1.0m/s^2	
	Rate of deceleration (Emergency)	2.08m/s^2	1.58m/s^2	1.5m/s^2	
Rolling stock depots	Maximum railcar capacity	30 train sets (4 cars)	40 train sets (3 unit)	64 train sets required (in Case 3 all sets are 4-unit sets)	Construction of new depot
	Other equipment	Convert depots to relays	Convert depots to relays	Convert depots to relays	Transport stabilization
	Depot enhancement	Enhancement difficult	Enhancement difficult	Will be necessary whether or not related to through service	Enhance future transportation capacity
Trains	Formation	3 ～ 4 Cars	3 Unit	3 ～ 4 Cars	
	Maximum operating speed	60km/h	65km/h	60 ～ 65km/h	
	Minimum headway	2min.	2.5min.	1.5 ～ 2min.	
Passenger capacity	4 persons/m^2	912	702	912	Development of light-weight new-type coaches required
	7 persons/m^2	1,358	1,062	1,358	
Operating safety	Blocking	Automatic blocking-type	Automatic blocking-type	Speed control-type	Increase safety Enhance transportation capacity Reduce operating time intervals
	Signals	Wayside signal: G-R aspect	Wayside signal: G-R-R aspect	Cab signal: G-O-X aspect	
	Interlock	Multiple unit control electric relays	Multiple unit control electric relays	Multiple unit control electric relays	
	ATS, etc.	ATS (Point control)	ATP (Point control: speed check)	ATC (one step control)	
Traffic management	CTC, etc.	—	CTC	CTC, PRC	Transport stabilization
Communications equipment	Radio	400MHz	800MHz	400 ～ 800MHz	

Note: Various equipment for the through operations section will be indicators that should be studied in the future as standard items

1) Current condition of facilities and facilities study

Given the current condition of facilities, items that particularly should be examined include problems such as the setback distance of structures from the center of track and coach body shape (including corner cut and bogie-center distance), bridge bearing strength, platform length and platform height.

① The shape of rolling stock currently in use and the relationship to the center-to-center distance of adjacent rails and distance from structures assumes through operations of rolling stock on both LRT Line 1 and LRT Line 3. But detailed on-site inspections will be needed, particularly at the implementation stage.

② Effect rolling stock will have on bridges and other facilities

The results of investigation of the maximum bending moment of simple girders and shear force are shown in the Appendix. Under present conditions running LRT Line 3 rolling stock onto LRT Line 1 is believed to be the simplest.

Running LRT Line 1 rolling stock onto LRT Line 3 will depend upon an investigation of issues such as reinforcement of LRT Line 3, but under present conditions using LRT Line 1 rolling stock on LRT Line 3 will be difficult.

③ Platform length

Platform length on LRT Line 1 is 105m and 130m on LRT Line 3.

In contrast, the train length of the new-style coaches on LRT Line 1 is 105.7m, so the length of the platforms on LRT Line 1 is insufficient. Normally a platform length equal to train length+10m is used as a standard, but this will not make through operations impossible. (Take a length clearance of approximately 5m.) Moreover, the length of the rolling stock on LRT Line 3 is 95m, so there are no particular problems.

④ Platform height

Platform height on LRT Line 1 is 690mm, and platform height on LRT Line 3 is 920mm.

The floor surface height of the new-style coaches on LRT Line 1 and the rolling stock on LRT Line 3 is approximately 920mm, or a step difference of 230mm on LRT Line 1, so it is impossible to use the existing facilities immediately. Consideration probably needs to be given to modification at some pint in the future.

2) Power and transformer facilities

Electricity for power on both track sections is DC750V, with the power supplied by overhead lines. We believe there are no particular problems with power, as the results of surveys related to the electric train power lines shown in the table below indicate.

Table 5.2.2 Comparison of electric train power line conditions including voltage

		LRT Line 1	LRT Line 3	Difference
Electric train power line voltage (V)	Standard	750	750	0
	Maximum	1000	900	100
	Minimum	525	500	25
Electric train power line height (m)	Standard	4.6	4.5	0.1
	Maximum	6.0	4.9	1.1
	Minimum	4.3	4.3	0
Electric train power line deviation (mm)	Left to right	300	500	200

There will be no major equipment changes to transformer equipment, but small-scale improvements such as those described below will be needed.

① In order to provide parallel feeding between substations on LRT Line 1 and substations on LRT Line 3, including junction stations, equipment such as inter-linked breaking devices will be required to halt parallel feeding between the substations of both lines whenever there is an accident.

② In the same way, in order generate power on LRT Line 3 using LRT Line 1 voltage and vice versa, it will be necessary to equip section points with voltage measuring devices and install equipment to perform precise voltage measurements.

3) Rolling stock and rolling stock depots

For all rolling stock it will be necessary to investigate problems including measurements such as rolling stock width, axle load and deceleration in greater detail.

At rolling stock depots it will be necessary to strengthen the depots by increasing the yards' rolling stock equipment, regardless of whether or not through operations are implemented, because of the growth in transportation demand in 2015.

The depot for LRT Line 1 is at Baclaran and the depot for LRT Line 3 is at North Avenue. These will be enhanced but their capacity is restricted to 40 train sets. The North Avenue depot in particular will require 34 train sets of trains of 4-unit trains in 2015, but the yard is constrained and there is almost no room for expansion. If through operations are also conducted on LRT Line 3 along with LRT Line 1 and LRT Line 6 currently being planned, an increase in transportation capacity will be possible by building an integrated train depot along LRT Line 6, which will probably be essential in the future.

① Rolling stock measurements

The new-style coaches on LRT Line 1 measure 26.35L x 2.59W x 3.32H

The coaches on LRT Line 3 measure 31.72L x 2.5W x 3.65H

The width of old-style coaches is 2.45m and steps to address this when the new-style coach were introduced have already been implemented.

② Axle load

Axle load for coaches on LRT Line 1 is 10.7 tons, and axle load for coaches on LRT Line 3 is 8.8 tons.

The coaches on LRT Line 1 are 1.9 tons heavier than the coaches on LRT Line 3; detailed study of problems such as bridge bearing strength will thus be required. If a decision is made in the future to build new rolling stock for through operations, efforts should be implemented to lighten rolling stock weight rather than change passenger capacity from existing technology standards. In combination with the following items it will be necessary to plan the coaches for LRT Lines 1 and 3 as future standard coaches.

③ Rate of acceleration and deceleration

For the rolling stock rate of acceleration and deceleration a high value of 1m/s² (3.6km/h/s) or greater has been adopted.

The rate of deceleration for LRT Line 1 in particular is 1.3m/s² for normal stops and 2.08m/s² for emergency stops, much greater than the 1.01m/s² for normal stops and 1.58m/s² for emergency stops used on LRT Line 3.

In the future it will be necessary to ensure total system integration by taking these numbers into consideration and prepare to unify them to a standard value, when planning improvement of the train protection system for Phase 2 on LRT Line 1. For plans for automatic blocking devices and ATS or ATC devices in particular, these numbers are a problem directly related to the safety of train operations and the performance of rolling stock will have to be standardized.

④ Rolling stock depot curve radius

Curve radius on LRT Lines 1 and 3 is R25m.

A curve radius of R25m also has an effect on rolling stock make-up and train set length, and invites a decline in the overall transportation system and transportation capacity. In the future it will be critical to conduct a complete review of rolling stock depots including track layout, functions and equipment after the start of through operations, such as improving part of the track layout in the rolling stock depots. The rolling stock depot on LRT Line 3 in particular has a track layout formation where the train set orientation will inevitably be changed depending upon the coupled rolling stock entry—exit section. This is a problem that will require adequate future study from its relationship to high-

frequency track circuits such as ATC.

In addition there are no interlocking devices and many switches are changed by hand at the existing rolling stock depots on both LRT Line 1 and LRT Line 3. Thus there are concerns about major transportation difficulties from causes such as derailment accidents when rolling stock passes through a yard's ingress/egress section during peak operating hours. In particular it will be critically important that high-quality safety equipment like that at other stations is installed along high-density operation track sections in the rolling stock depots.

4) Train operations and train protection systems

Train set formations on LRT Line 1 and LRT Line 3 differ because of the coach plans. Although coordination of stop positions at each station may not be fatal, it may present a slight problem from the point of operations and handling passengers.

The train protection system for through operation hours should be standardized as an ATC system, including shortening of headway in conjunction with enhancing transportation capacity.

If by chance complete standardization is not possible, both ATS and ATC devices will be installed on the coaches and the train safety devices atop the coaches will be switched at the junction station (Monumento Station).

① Maximum operating speed

Maximum operating speed is 60km/h on LRT Line 1 and 65km/h on LRT Line 3. Although the maximum operating speeds differ, it will be possible to address this by switching between ATS and ATC and by exchanging crews.

Furthermore, a speed limit of 40km/h over the station platform sections has been imposed on LRT Line 3, but this is thought to be nearly meaningless. If possible trains should pull into stations at the maximum operating speed of 65km/h. By eliminating the 40km/h speed limit during train operating hours it will be possible to shorten operating time as a whole by 2~3 minutes.

② Blocking devices and ATS

The automatic blocking method on both LRT Line 1 and LRT Line 3 is a two-step aspect system (Proceed (G) and Stop ®), with point control-type ATS (Automatic Train Stop) used as auxiliary equipment.

The ATS system differs somewhat between LRT Lines 1 and 3, as shown in Figure 5.2.2 and Figure 5.2.3.

On LRT Line 1 a normal procedure that establishes an R – R signal buffer section (Over-lap section) is used. For LRT Line 1 system further improvements to the signal system such as shortening the headway are being planned as Phase

to the signal system such as shortening the headway are being planned as Phase 2 of the transportation capacity upgrade plans. It will probably become necessary to introduce an ATC (Automatic Train Control) system based on a cab signal in order to introduce this procedure to eliminate the overlap section and conduct 90-second high-density operations. Given current transportation conditions along this track section as well, it is thought that enhancing the transportation capacity on this track section should have priority over other track sections. LRT Line 3 does not have any over-lap sections, but uses a system to perform stop controls based on speed checks. As on Line 1 the automatic blocking method has been adopted, with ATP (Automatic Train Protection = A.T. Stop) installed as back-up devices as a train protection system. This ATP system transmits wayside information to an on-board device using transponders placed 400-500m in the opposite direction of the signal device that will display a stopping signal, and the target speed is displayed. Furthermore the distance to the stopping limit point is calculated, and the system set so the train's brakes operate automatically to stop the train by the time it reaches the signal displaying the stopping signal.

The operation systems for LRT Line 6 are a problem that will be studied in the future.

There systems are an issue that should be adequately investigated for the ATS improvement plan for Phase 2 of LRT Line 1 and are important as components of any future structure.

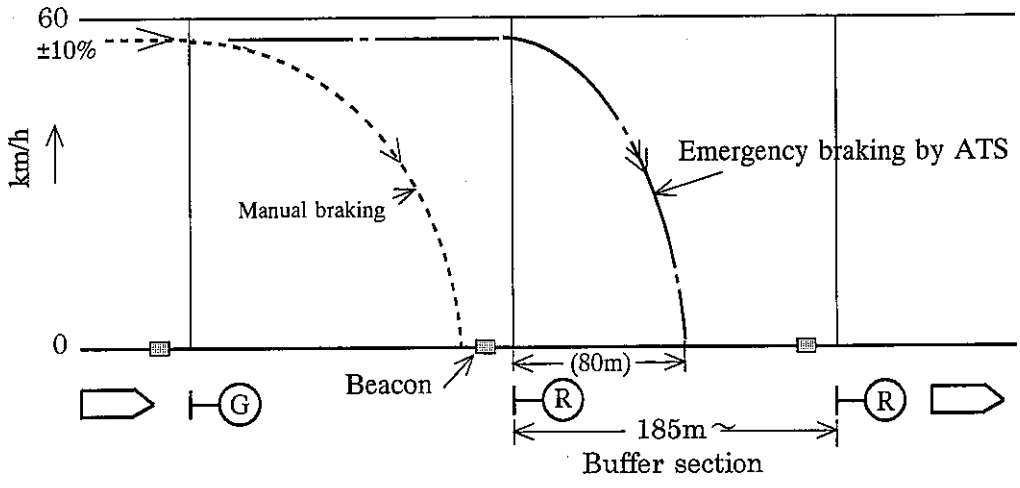


Figure 5.2.2 Automatic blocking and ATS system on LRT Line 1

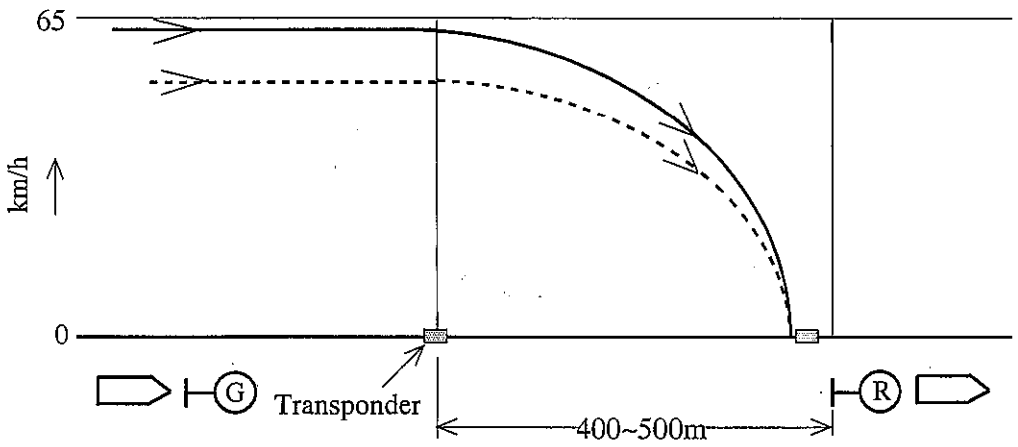


Figure 5.2.3 Automatic blocking and ATP system on LRT Line 3

③ Interlocking devices

The interlocking devices on LRT Line 1 are electric relay interlocking, but on LRT Line 3 the track sections are divided into three sections and computerized interlocking devices are installed in each section. With these devices train intervals are controlled and operations managed from the traffic control office (C.C.S.: Central Control System) at the North Avenue Station. Because the signal devices are currently undergoing testing, train operations are being carried out by communication between the traffic controller in the control office at each station and the traffic control office (a cluster control panel train position display is currently in use). We're told this track section was recently completely modernized and high-grade systems have been adopted.

④ Traffic control systems

For traffic control on LRT Line 1, an operations and electric power control office has been set up in the LRTA headquarters building near the Baclaran Station depot, where operations are coordinated by dispatcher telephone. When future headway of 1 minute and 30 seconds is considered, we believe it will be necessary to introduce equipment such as CTC-based route control automation devices like the CTC devices on LRT Line 3 described above.

⑤ Operations management

The operations management at each station on LRT Line 1 should be abandoned following the introduction of CTC in the future. We believe it will be difficult to standardize and teach such management to driver and conductors on LRT Lines 1 and 3. Performing transit at the Monumento Station boundary station should be eliminated.

Operation procedures for LRT Line 6 will be planned in the future and will call

for procedures to be the same as the operations system on LRT Line 1.

⑥ Other

Train dwell time has been standardized at 30 seconds.

The limit speed at station turnout sections is 25~40km/h, and the draw-out track speed at terminal stations is 25km/h. Moreover, the limit speed when it is not possible to use ATP is 15km/h.

Based upon the above investigations, detailed studies will be conducted and the required improvements for the following items carried out during the implementation planning stage.

From the perspective of operations management and equipment, through operations on LRT Line 1 and LRT Line 3 are assumed to be possible at Monumento Station.

(2) Primary investigations and items for improvement during the implementation stage

1) Detailed investigation of train through operations

Decide upon either a procedure to repair on-board train protection devices (install two kinds of ATS), or a procedure to implement continually through replacement of rolling stock and the introduction of newly manufactured coaches for use in standardized through operations.

2) Improvement of train protection systems

Investigate the pros and cons of improving LRT Line 1 while making the LRT Line 3 system into an ATC system, installation of rolling stock devices, etc.

3) Investigate yard track layout at terminal stations

Study whether track layouts in the rolling stock depots at Taft Station, Monumento Station and Baclaran Station can handle future planned train operations.

Study storage track at Taft Station for train turn-back operations. In particular, study whether it can handle two-minute headway.

Increase facilities at Monumento Station to handle riders on LRT Line 1, as well as Line 3 riders who are detraining.

Furthermore, study whether yards can handle train turn-back operations for some trains on LRT Line 1 and LRT Line 3 and handle headway of 1 minute and 30 seconds.

Investigate yard track layout at Baclaran Station, taking into consideration train turn-backs and the through operations plan for LRT Line 6.

In particular, study handling of 1 minute and 30 seconds headway.

4) Agreements with businesses (companies) for through operations

It will be critical to create project teams between companies as “through operations promotion teams” and discuss and conclude various types of contracts and agreements between companies when through operations are implemented.

Topics that will be important to discuss and agree upon include the following items, in addition to the various types of transportation facilities outlined in the preceding paragraphs.

① Transportation plan

a) Through operation sections

Rolling stock under the jurisdiction of each company will operate mutually over the entire track section.

b) Common use agreement for Monumento Station

c) Train operation plan

Specify the number of trains each company will operate as through service for each period of time. In this case, consider making car kilometers as uniform as possible.

d) Train formation

Specify matters such as the number of coaches in train sets and the train set details for each company.

e) Rolling stock usage plan

Specify details such as how train set coaches will be used, parking locations, and inspection and repairs by each company.

f) Crew operations and transits, etc.

Specify the transfer tracks for through operation trains and use of the same tracks to complete crew shift changes and transits. Also stipulate the handling of cab equipment during shift changes, items to be completed during transits, etc.

g) Coordination of through train operations, use of train radios, etc.

Based on consultations between the traffic dispatch managers in both dispatch offices, create a manual for coordination of operations for times when there are train timetable difficulties, etc. In addition, specify switching, calling and other procedures for using train radios that are directly related to coordination of operations.

② Responsibility for operations-related expenses, etc.

a) Responsibility of construction expenses for work such as facilities improvements that accompany through operations

Conclude agreements on percentage allocations or amounts for construction expenses for items such as track elevation for expansion of the Monumento

Station and linkage of LRT Line 1 and LRT Line 3.

b) Fare adjustment procedures

Decide on the introduction of a common fare system and procedures for fare adjustments.

c) Rolling stock usage fees

Stipulate rolling stock running kilometers and unit costs (such as the unit cost per 1km based on items such as depreciation expense, maintenance expenses, management expenses, etc.), and settlement of the difference by offsetting the running kilometers. Normally this is accomplished by establishing train timetables in a way that equalizes the distance that both companies' coaches will run over the other company's tracks.

d) Liability for damages

Agree upon conditions such as the party that causes damage by its through service train operations will be responsible for the damages. Normally the time when crew transit at the junction station is completed is set to be the demarcation boundary for responsibility for a through operation train.

e) Operating accidents, etc.

Handling of matters such as reporting and division of responsibilities for accidents, responding to accidents, providing aid for passenger injuries, etc.

f) Other

Response procedures when there has been an accident, handling of rolling stock operation changes such as termination of through service trains, response procedures when natural disasters such as earthquakes occur, response when extending feeders, etc.

(3) Transport demand for each Case

Table 5.2.3 Transportation demand (2015)

(Unit: Persons/day)

	Separate (Line 1, Line 3)		Through (Line 1 and Line 3)	
	Case 1 Elevated	Case 2 Underground	Case 3 Elevated	Case 4 Underground
Line 1	594,933	559,368	645,397	637,037
Line 3	556,047	523,528	590,340	544,003
Total	1150,980	1,082,896	1,235,737	1,181,040
Line 2	557,607	574,287	571,797	588,305
Line 4	750,371	742,128	745,177	736,884
Line 6	404,095	403,291	404,909	404,012
NR/MC	1,233,684	1,404,842	1,225,888	1,400,206
Total	2,945,757	3,124,548	2,947,771	3,129,407
G. Total	4,096,737	4,207,444	4,183,508	4,310,447

Note: For demand projections refer to the Appendix.

1) Comparison of transported volume

By conducting the through service operations in Case 3 the total transported volume on LRT Lines 1 and 3 is approximately 1,236,000 passengers/day, an increase of approximately 8,500 passengers/day compared to Case 1, where operations are conducted over separate tracks. Almost no change is projected for LRT Line 6, with approximately 400,000 passengers/day. Transport volume of Line 1, 3, 6 and NR/MCX Line are as shown in Figure 5.2.4.

The transported passenger-kilometers/day are shown in the following table.

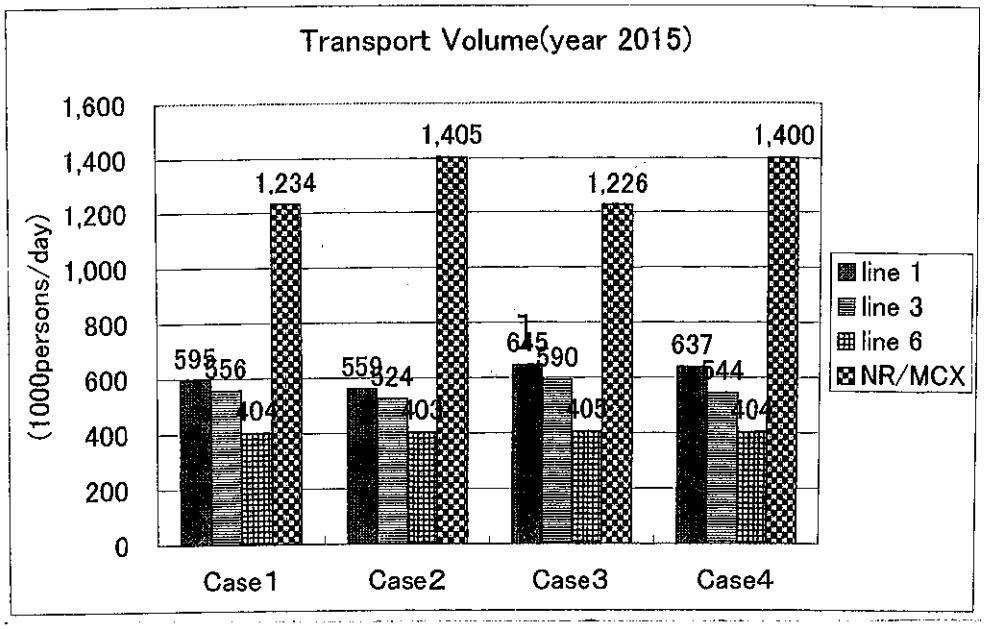


Figure5.2.4 Comparison of Transport Volume

Table 5.2.4 Comparison of transported passenger-kilometers

(1,000 person-km/day)

	Case 1	Case 2	Case 3	Case 4
Line 1, 3	Not Connect		Connected	
PNR	Elevated	Underground	Elevated	Underground
Line 1	4,929	4,325	5,874	5,206
Line 3	5,083	5,588	7,087	6,726
Total	10,011	9,913	12,961	11,932
Line 2	4,724	4,971	4,739	4,986
Line 4	7,507	7,391	7,501	7,375
Line 6	2,663	2,657	2,671	2,666
N.R/MCX	26,432	28,893	26,235	28,818
Total	41,326	43,911	41,146	43,845
G. Total	51,338	53,824	54,107	55,777

Notes: The average passenger-kilometers are 8.6km for Line 1 and 9.7km for Line 3. An increase of roughly 29% is achieved by the change to through operations.

2) Comparison of sectional transported volume

The sectional transported volume required for the train operating plan is shown in Figure 5.2.5 and Figure 5.2.6.

As a result of through operations there is a large increase in sectional transported volume on LRT Line 3 in particular, based on through passengers from LRT Line 1. Volume on LRT Line 1 also increases substantially, which can be understood as showing the effectiveness of greater passenger convenience.

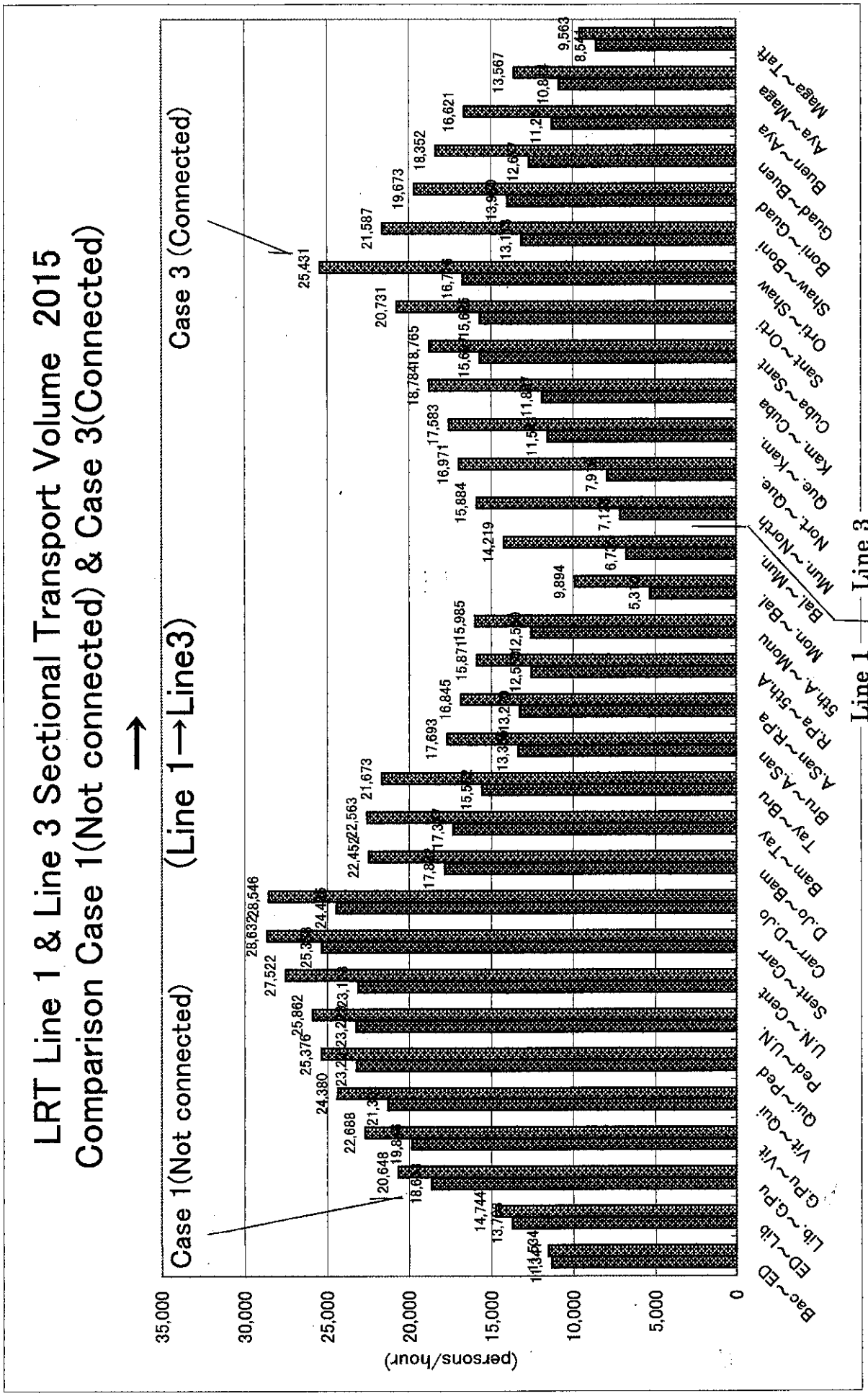


Figure5.2.5 Comparison of LRT Line 1 and Line 3 in Sectional Transport Volume

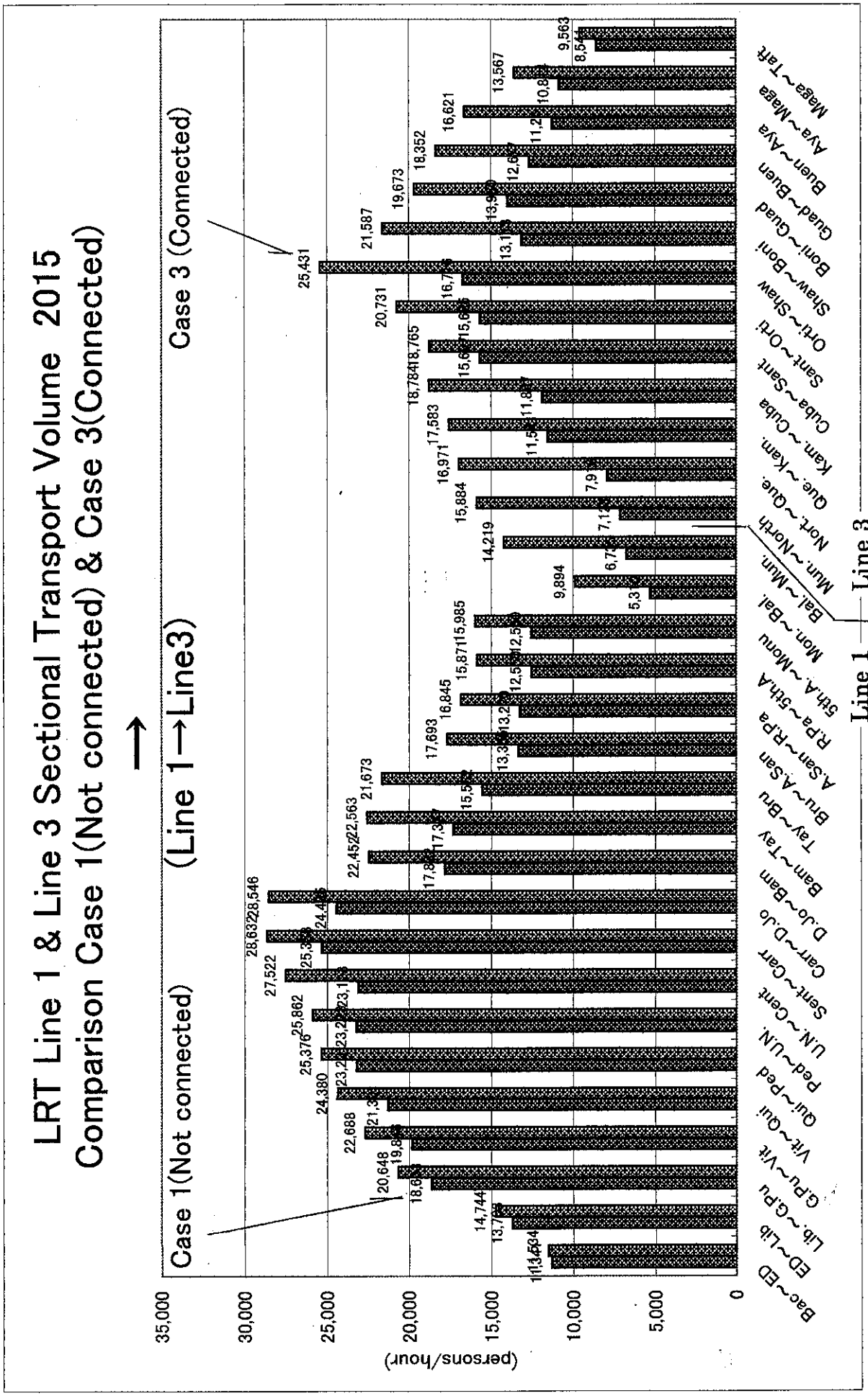


Figure5.2.5 Comparison of LRT Line 1 and Line 3 in Sectional Transport Volume

(3) Train operation plan

1) Basic operating plan conditions

The train operation plan establishes the following conditions using section transported volume (passengers/hour) as a base.

① Sectional transport volume

Based on sectional transported volume per peak hour.

Peak hour concentration is 10%.

② Train formation and nominal passenger capacity

Set using 120% or less (equal to 150% used in Japan) as a goal, based on 4 passengers/m^2 as shown in the following table.

Table 5.2.5 Train formation and nominal passenger capacity

Line / Section		LRT 1	LRT 3	#LRT 1 & 3
		Baclaran ～ Monumento	Taft Ave. ～ North Ave	Baclaran ～ Taft Ave.
(km)		13.95	16.40 + 5.40	35.75
Train Formation		4 cars	3 cars	4 cars
Nom.Pas.	4 pa./m^2	912	702	912
Capacity	7 pa./m^2	1,358	1,062	1,358
Train Head way (min: sec)		2:00	2:30	2:00
Ditto (Phase 2)		1:30	—	1:30
Max. No. of Trains (Train/h)		30	24	30
Ditto (Phase 2)		30 ～	—	30 ～
Transport Capacity (p/h)	4 pa./m^2	27,360	16,848	27,360
	7 pa./m^2	40,740	25,488	40,740
Ditto	4 pa./m^2	36,480	—	36,480
(Phase 2)	7 pa./m^2	54,320	—	54,320

Note: #LRT 1 & 3 is Through Train Service Plane

③ Train operation time

Operation time will be set by taking into consideration the modernization of the operation system (introduction of ATC, etc.), creating train performance curve and taking into consideration current operation conditions, and also by making dwell time a uniform 40 seconds in order to provide operating margin.

The calculated operation time between Baclaran~Monumento~Taft through

LRT Line 1 and LRT Line 3 is 1 hour 10 minutes.

LRT Line 1: Baclaran ~ Monumento : 32 minutes

LRT Line 3: Monumento ~ Taft : 38 minutes

④ Minimum headway

The required headway of 1 minute 30 seconds ~ 2 minutes will be set on the assumption it can be ensured based upon improvements such as train protection equipment and changes to part of the track layout at terminal stations.

2) Number of train operations

The number of trains operated during the peak 1 hour (8:00~, or 18:00~) are shown in the following table. Refer to the Appendix for the number of trains operated by section.

Table 5.2.6 Train operation plan (2015)

	Item	LRT Line 1	LRT Line 3	LRT Line 6
Case 1 (By track)	Passengers (4 passengers/m2)	912 passengers/train	702 passengers/train	912 passengers/train
	Maximum number of trains (trains/hour)	24	22	12
	Maximum passenger ratio (%)	120%	121%	123%
Case 3 (Through operation)	Passengers (4 passengers/m2)	912 passengers/train	912 passengers/train	912 passengers/train
	Maximum number of trains (trains/hour)	26	24	12
	Maximum passenger ratio (%)	121%	116%	121%

It will be necessary to operate trains at a rate of 24 trains/hour for the operation plan for 2015 for LRT Line 1 and LRT Line 3, with a premise of keeping the passenger ratio at a level of 120% based on passengers of 4 passengers/m^2. Moreover, on through operations the number of trains operated will come to 26 trains/hour because transported volume will increase. Accordingly it will be necessary to set headway for both tracks at two minutes or less, taking into consideration operations such as deadhead trains and the headway margin.

Particularly for yard track layout within terminal stations, one storage track for train sets will also be needed at Taft Station on the LRT Line 3 in addition to the arrival tracks.

Based on the premise of conducting through operations to Line 1, for LRT Line 6, approximately half of the trains on LRT Line 1 will be put into through service to LRT Line 6.

3) Comparison of the number of train formations required

Depending upon whether or not through operations are approved, the number of train formations required is shown in the following table for comparison purposes, if the number of through-trains operated is 30 trains/hour.

Table 5.2.7 Comparison of the number of train formations required on LRT Lines 1 and 3

		Operations by Line			Through operations		
		LRT 1	LRT 3	Total	Lines 1 & 3		Total
Operation time	(sec)	1,920	2,240		4,210		
Turn-back time	(min)	5	5		5		
Headway	(min)	2	2		2		
Formations required		37	42	80	75		75
Difference							-5

Notes: The calculation for formations required is as follows.
Formations required = (operation time + turn-back time) X 2/Headway
Refer to the Appendix for operation time
Formations required do not include standby formations.

With peak time two-minute headway, by conducting through operations it will be possible to eliminate approximately five train formations.

The number of train formations required for LRT Line 1 and LRT Line 3 in 2015 are shown in the following table.

Although the number of train formations is less in the case of Case 3 through operations, the same number of train sets will be necessary because the number of trains operated is higher.

Table 5.2.8 Number of train formations required (2015)

Case	Case 1	Case 3	Remark
LRT Line 1	28+2=30 (30*4=120 unit)	60+4=64 (64*4=256 unit)	4-unit formation
LRT Line 3	32+2=34 (34*3=102 unit)		LRT Line 3 trains in Case 3 are the same as LRT Line 1.
Total	60+4=64 (222 unit)	60+4=64 (256 unit)	

Note: "+2" shows the number of train sets in reserve

4) Construction to improve stations including Monumento Station for enhancement of transportation capacity (including change to through service)

Given the current minimum headway on LRT Line 1, two-minute headway will be difficult when margin time is added. For LRT Line 3 the planned headway is 2 minutes 30 seconds.

This means improvements such as changes to the station junction switches are needed in addition to safety equipment, in order to enhance transportation capacity as soon as possible and to ensure stable train operations. Therefore we believe that when the change to through operations is implemented, it will be necessary as well as wise to execute a total improvement plan in conjunction with the through operations, based on detailed studies of through operations.

For conversion to through service it will be necessary to link Monumento Station on LRT Line 1 with the LRT Line 3 tracks. Despite a plan to build a new Monumento Station on LRT Line 3 in the original plans, we believe this will be unnecessary because the station on LRT Line 3 will be accessed by the through operations, so the construction costs to build a new station can be cut. The distance to Malintawak Station, the next station on LRT Line 3, will increase to approximately 2km, however, and it will also be necessary to consider the construction of a new station.

The construction of an elevated railroad approximately 200m long and enhancement of facilities to handle the growth in passengers who use the existing Monumento Station will be needed in order to connect and join both track sections.

Furthermore, as described in the items that will need to be improved, temporary pooling tracks for train formations at Monumento Station and Taft Station will have to be added to enhance future transportation capacity, regardless of whether or not through service is implemented.

5.2.2 Through Operation Plan in the Vicinity of EDSA Station

Through operations by joining LRT Line 1 in the vicinity of EDSA Station and LRT Line 3 in the vicinity of Taft Station will be extremely difficult, due to the fact that one station is elevated and one station is at ground level and because of the stations' proximity. Nevertheless, the lines must be linked to form a loop line in order to utilize LRT Lines 1 and 3 to their fullest extent. Assuming they will be linked in the future, it will probably take the form of one EDSA station for both track sections, with Taft Station being bypassed.

From this point of view the results of an overview study of the possibility of through operations in the southern area of both track sections are shown in Figure 5.2.7. In this case a study is needed to determine whether the existing Taft Station should continue to be used during through operations. When Taft Station is bypassed yet remains in use as shown in the figure, it will be necessary to study whether to extend the track in the future to the west.

For immediate purposes we believe it is necessary to join the elevated EDSA Station and ground-level Taft Station with a single-level connecting passageway, in order to make passenger transfers more convenient.

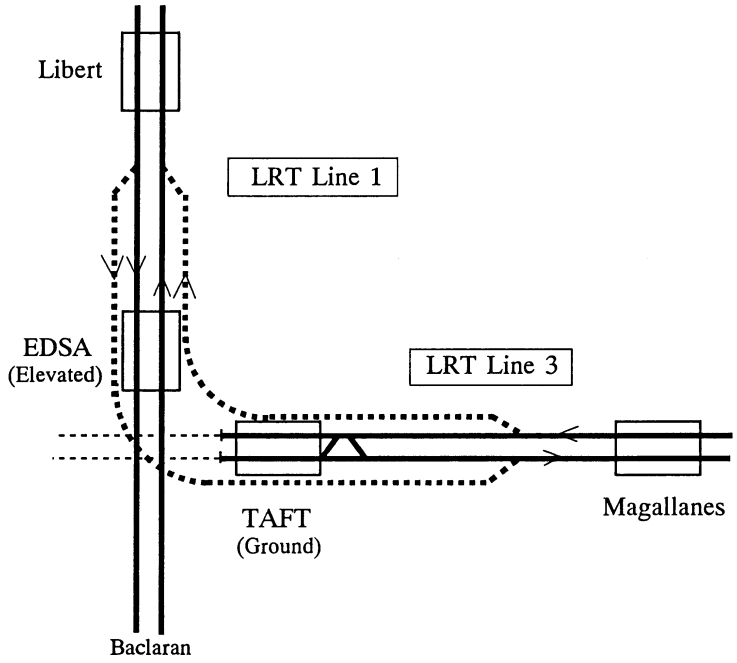


Fig. 5.2.7 Through operation plan in the vicinity of EDSA Station and Taft Station

5.2.3 Through Operation Plan for LRT Line 1 and LRT Line 6

A plan should be made to conduct through operations from the start in the form of an extension of LRT Line 1 by linking Line 6, which is currently in planning, and Baclaran Station on LRT Line 1. Therefore when drafting the implementation plan for LRT Line 6 in the future it will be necessary to implement the plan by giving consideration to the details of the implementation plan for the through operation plan on LRT Lines 1 and 3.

5.2.4 Results of the Investigation of the Through Operation Plan

(1) Investigation results

1) Problems such as bridge bearing strength

It is assumed that the coaches from both LRT Lines 1 and 3 can be used for through service but detailed studies are needed, particularly for the structures on both lines.

The preferable alternative is to put into service standard design trains built especially for through operation use, which can simultaneously eliminate all problems based on such detailed studies.

2) Problems of platform height and coach floor level height

Platform height on LRT Line 1 is 690mm, and currently there is a step difference of approximately 230mm with coach floor level. Elimination of this problem lies in future reforms (platforms).

3) Curve radius

The R25 curve radius at rolling stock depots is extremely small and presents an obstacle to all aspects of the plan as described in the body of this report. Investigations should therefore be carried out to study alternatives such as partially reforming existing rolling stock depots on LRT Lines 1 and 3 for use as electric train pooling tracks, and opening LRT Line 6 to service and through operations and constructing separate track on LRT Line 6 as a rolling stock depot.

4) Rolling stock standard design

It will be necessary to consider through operations on LRT Lines 1 and 3 and new track construction such as LRT Line 6 in the future, and establish a standard coach for the railway transportation authorities in the Manila metropolitan area.

5) Train safety equipment

The introduction of ATC is needed for the high-density operation track sections. Along with ensuring the safety of train operations this will make possible operating margins and stable transportation. For a discussion of a train protection system such as a proposal for the type of ATC that should be introduced, refer to

the implementation standard selection criteria in Chapter 3.

6) Traffic control facilities and radio devices

Along the high-density operation track sections, control of train groups will be required along with the introduction of ATC. For this purpose various equipment such as PRC (Programmed Route Control) will have to be added as basic facilities for CTC to respond to actual track section conditions.

7) Operations management

Matters such as crews and driver operations management normally differ depending upon the track section and the company operating the trains. Standardizing such factors by education and training is very difficult. Therefore this can be handled by exchanging crews at junction stations that will be the boundary stations.

8) Collection of fares and fare adjustment procedures (between companies)

This is basically handled by coordinating operations in both directions so rolling stock kilometers are equalized.

9) Construction expenses required for through operations

In order to conduct through operations expenses mainly for facilities and rolling stock improvements will have to be incurred.

10) Study of management and operating expenses

Operating expenses are classified into personnel expenses and expenses.

It should be possible to improve efficiency as a result of through operations and thereby slightly curtail these expenses.

(2) Results from through operations

Substantial benefits such as an increase in passenger convenience should be achieved as a result of implementing through operations as was described at the beginning of this paper. Considerable results can also be anticipated in various areas from the results of the investigations described above. Table 5.2.12 shows a summary of the results of the investigations, by comparing operations by track section and through operations.

1) Increase in passenger convenience (increase in delivery performance)

Passenger transfers at Monumento Station, a terminal station, will be eliminated by through operation on LRT Lines 1 and 3. It is assumed that a minimum of 20 minutes is required for transfers when both track sections are operated independently because the terminal stations on both lines are approximately 200mm apart. The start of through operation will eliminate this considerable loss of time, making an enormous contribution to passenger convenience.

Table 5.2.9 Change in number of entraining and detraining passengers at Monumento Station based upon through operations

(Unit: 1000 persons/day)

	(Case 1) (A) Separate track operations	(Case 3) (B) Through operations	Increase/decrease based on through operations (B – A)
Existing Monumento Station on LRT Line 1	225.3	308.6	83.3
Monumento Station planned for construction on LRT Line 3	101.5	—	—
Boarding and alighting passengers, total	326.8	308.6	−18.2

2) Increase in the role of transportation authorities (growth in transported volume)

As shown in Table 5.2.10 the transportation demand volume (2015) represented by the total number of passengers carried on LRT Line 1 and LRT Line 3 shows a difference of roughly 310,000 individuals per day between Case 1 and Case 3.

Table 5.2.10 Increase in passengers transported based on through operations

(Unit: Persons/day)

	(A) Operations by separate track (Case 1)	(B) Through operations (Case 3)	(B) – (A)
Line 1	594,933	645,397	50,464
Line 3	556,047	590,340	34,293
Total	1,150,980	1,235,737	84,757
Line 6	404,095	404,909	814

3) Increase in revenue from the growth in number of transported passengers

The increase in revenue from the growth in the number of transported passengers as described above will be the new LRT fare of 12.72 pesos for the average travel distance of about 9km. Therefore the passenger revenue for LRT Lines 1 and 3 will be roughly 15.7 million pesos per day (1,236,000 passengers X 12.72 pesos). This is an increase of 1.1 million pesos compared to the 14.6 million pesos in Case 1 (1,151,000 passengers X 12.72 pesos). (393 million pesos annually)

4) Reduction in the number of train formations (reduction in construction expense)

As shown in Table 5.2.7 it will be possible to eliminate 5 train sets as a result of through operations. In fact, however, the number of train sets required will come to 64 train sets as shown in Table 5.2.8, because through operations will increase transported volume by 85,000 passengers per day. This means that in order to use the LRT Line 3 rolling stock to form 4-unit train sets identical to the train sets used on LRT Line 1, it will be necessary to add another 34 units. For Case 3 we've assumed that 34 more units will be required and that the expense to enhance rolling stock will be roughly 900 million pesos.

Furthermore, it would be advisable to standardize the ATC or ATS on LRT Lines 1 and 3 by 2015 along with the introduction of new rolling stock. In the event this is not possible, however, it will be necessary to install both ATC and ATS equipment on all rolling stock, at an additional cost of several hundred million pesos.

5) Reduction of station construction expenses

Changes to enhance strengthen Monumento Station on LRT Line 1 will be carried out to make Monumento Station on LRT Line 1 a junction station for LRT Lines 1 and 3. The Monumento Station planned for LRT Line 3 will not be necessary.

The elevated railway needed to link LRT Lines 1 and 3 is estimated to be approximately 200m long. If an extension in the direction of Caloocan is considered, however, a separate track section approximately 1km in length will have to be built.

Building an expressway-like junction location as a railroad track is particularly complicated on this type of urban loop line, and would probably have the opposite effect by becoming an obstacle to train operations.

The rough budget expense of construction expense for this through operation is estimated to be 2.6 billion pesos.

Moreover, although some additional investment will be needed for construction expenses to enhance Monumento Station, this will make it possible to eliminate the construction expense for a Monumento Station on Line 3.

6) Reduction of management and operating expenses

When through operations (Case 3, 4) are implemented, operating expenses overall will rise because transported volume will grow. In addition, activities such as accounting including fare collection and activities to coordinate through operations will expand. The number of coaches required will remain the same, however, regardless of the growth in transported volume. With cuts in expenses for rolling stock maintenance, this will be linked to relative reductions of management and operating expenses.

A summary of the results for operating expenses is shown below.

Table 5.2.11 Summary of management and operating expenses

(Unit: million pesos/year)

	Case 1 (Operations by separate track sections)		Case 3 (Through operations	
	LRT 1	LRT 3	LRT 1	LRT 3
Personnel expenses	238.3	236.2	242.6	264.6
Operating expenses	1,119.2	1,148.3	1,213.9	1,368.2
Total	1,357.5	1,384.5	1,456.5	1,632.8

Passenger revenue and operating expenses caluculated in 3) will be as shown in Figure 5.2.8.

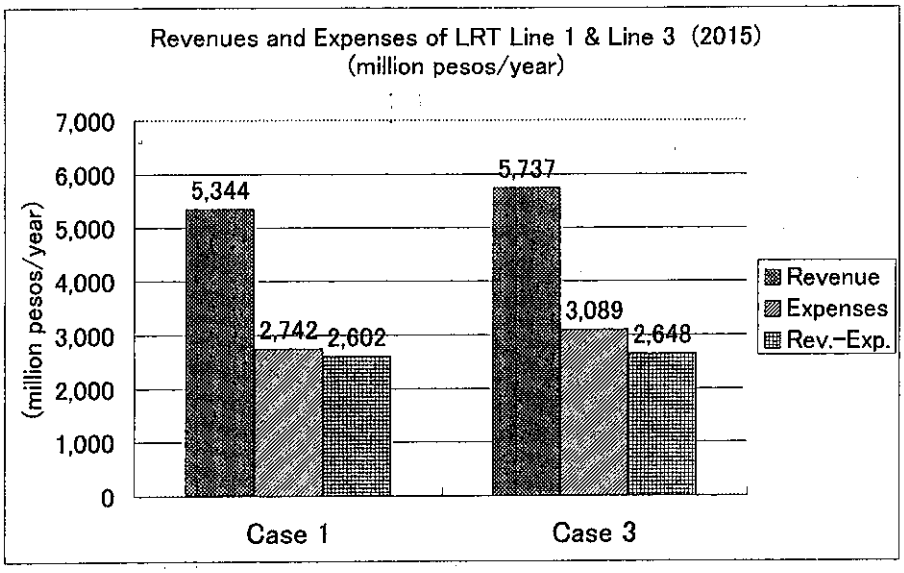


Figure 5.2.8 Revenues and Expenses of LRT Line 1 & Line 3

7) Consolidation and closure of rolling stock depots

Construction expenses will be incurred if a decision is made to implement through operations between LRT Line 6 and LRT Lines 1 and 3 and the rolling stock depots for LRT Lines 1 and 3 are consolidated and built within LRT Line 6.

If current conditions in which enhancement of existing rolling stock depots is difficult and the R25 curve radius or track layouts in confined areas are considered, consolidation and closing of rolling stock depots for through operations on LRT Lines 1, 3 and 6 is a critically important issue.

We believe that activities such as rolling stock inspections, centralization of repairs and improvements, and parts procurement can be made more efficient and effective for overall management through consolidation and closure of rolling stock depots. This matter should be more thoroughly investigated in the future.

Table 5.2.12 Comparison of operations by separate track section with through operations – Summary of investigation results

		Separate operations on Line 1 and Line 3		Through operation on Line 1 and Line 3	Remark
		LRT Line 1	LRT Line 3	LRT Line 1 & Line 3	
Section		Monumento～ Baclaran 13.95km	Monumento～TAFT 21.4km	Baclaran～Taft 35.75km	
Through operation conversion plan	Shunting track construction	—	—	Link in vicinity of Monumento Station Approx. 0.2km	Junction lines to the west and north not built.
				Enhance Monumento Station passenger facilities	
Enhancement of transportation capacity (To handle volume in 2015)	Operate more trains	Convert to ATC etc. (Phase 2)	Improve signal facilities	Study conversion of LRT Line 3 to ATC (1,600 million pesos)	Enhance transportation capacity by shortening train headway
	(Shorten headway)	Study changes to terminal station track layout	Study changes to terminal station track layout	Study changes to track layout at Monumento Station	
		Enhance electric power facilities	Enhance electric power facilities	Enhance electric power facilities	
Rolling stock	Rolling stock	Increase equipment for 4-unit train formations 30 train sets	Increase equipment for 3-unit train formations 34 train sets	Increase equipment for 4-unit train formations 64 train sets	Push standardization of lighter weight, large-size coaches; convert existing depot to pooling tracks
Depot	Depot	Enhance Baclaran depot	Enhance North Ave. depot	Same as at left, and new construction of LRT Line 6	
Operations management	Crews	Crew: A	Crew: B	Crew: A and B transit at Monumento	Unification of operating management difficult
Various types of cooperation	Various types of cooperation	—	—	Sign various agreements in order to implement through operations	
		—	—	Operations-related: coach operations, driver transit, procedures for coordinating operations, etc.	
		—	—	Management-related: Fare settlement procedures, allocations of losses, response to accidents, etc.	
Transported volume	Transported passengers (per year)	217 mil. Persons	203 mil. Persons	451 mil. Persons	Increased volume: 31 mil. Persons
	Transported person-kilometers (per year)	1,800 mil. persons. km	1,855 mil. persons. km	4,731 mil. persons. km	Increased volume: 1,076 mil. Persons. km
Revenues	Passenger revenue (annual)	2,762 mil. pesos	2,582 mil. pesos	5,737 mil. pesos	Increased revenue: 393 mil. pesos

Equipment investment related to link lines	Track-related	—	Construction expense between North Ave.~Monumento will be separately required	Single track extension: 3.7km 1,729 mil. peso	When through operations are implemented
	Electricity-related	—		Electricity, signals, communications equipment 654 mil. peso	
	Other	—	—	Building guarantees 201mil. peso	Guarantees in conjunction with building obstacles
	Total	—	—	Total 2,585 mil. peso	
Rolling stock investment	Improvement expenses	Increase in number of coaches to respond to transportation demand in 2015		Installation of ATC, ATS equipment on rolling stock 600 mil. peso	When through operations are implemented
Operating expenses	Personnel expenses	238 mil. peso	236 mil. peso	507mil. peso	Increase of 33 mil. pesos for Case 3
	Management expenses	1,119 mil. peso	1,148 mil. peso	2,582 mil. peso	Increase of 315 mil. pesos for Case 3
	Total	1,357 mil. peso	1,384 mil. peso	3,089 mil. peso	Increase of 348 mil. pesos for Case 3

Pros & con, and results	① Passenger service	△ Complexity of transfer stations	△ Complexity of transfer stations	○Reduces complexity	Reduced from increase in through passengers
	② Increase in revenue from delivery and induced ridership	△Transfers (lost time: 20 minutes) or through-rides to railroads, buses, etc.	△ Transfers (lost time: 20 minutes) or through-rides to railroads, buses, etc.	○ Eliminates lost time for transfers (shortens arrival time to destination), increases from induced passenger increase	Reduces transfer time by about 20 minutes
	③ Increase in transported volume	□Transported volume of 1,800 million passenger-kilometers	□ Transported volume of 1,900 million passenger-kilometers	○Increase in transported volume of 1,000 million passenger-kilometers per year	Annual increase of 29%
	④ Increase in revenue	□Passenger revenue of 2,600 million pesos annually	□ Passenger revenue of 2,400 million pesos annually	○Total annual passenger revenue of 5,400 million pesos	Annual increase in revenue of approximately 400 million pesos
	⑤ Rolling stock use	△ Operation over separate track sections	△ Operation over separate track sections	○ Increase operating efficiency: reduce number of cars	Possible to reduce number of train sets
	⑥ Expansion of rolling stock depots	△Expansion in future difficult	× Expansion of rolling stock depot extremely difficult	○Consolidate and expand depots on Lines 1 and 3 and Line 6	Move ahead with new construction of a depot on LRT Line 6
	⑦ Inspections and repairs	△ Individual inspections and repairs at depots	△ Individual inspections and repairs at depots	○Comprehensive inspection and repairs of rolling stock on Lines 1 and 3 and on Line 6 (greater efficiency)	Push ahead with standardization of coaches
	⑧ Effective investment	—	□ Requires construction of a new Monumento Station	○ Handle by enhancement of Monumento Station on LRT Line 1	Possible to utilize station construction expenses
	⑨ Facilities enhancement	—	—	△ Construction of tracks for through operations as well as facilities enhancement necessary	Investment of roughly 2,600 million pesos required
	⑩ Rolling stock improvements	○ Operations using ATC	□ Operate as equipment to supplement ATS	△ Will be necessary to standardize procedures for through operations or improve rolling stock	Need to install ATC, ATS equipment
	⑪ Reduction of operating expenses	□Operating expenses of 1,360 million pesos/year	□ Operating expenses of 1,380 million pesos/year	○ Total operating expenses of 3,100 million pesos/year	Increase by approx. 3,500 mil. pesos (13%) in Case 3

5.3 Plan for North Rail Line and MCX Line Improvements and Through Operations

The current track sections for train operations on the PNR Line are the north track between Tayuman~Caloocan, which is approximately 4.6km in length (double track), and the southern track between Tayuman~Legaspi (479.0km). Of these the section being used as a commuter track section is a 27.5km stretch between the north and south lines connecting Tayuman and Alabang.

The track gauge is 1,067mm; double track sections are the north track and the south track between Tayuman and Sucat (23.8km), approximately 28km in total.

The block system is a procedure that can be described as a "communications method", in which station masters between the neighboring stations in both directions mutually confirm that tracks are open for operation between stations. The station master on the side from which trains depart issues the notification ticket.

There are no signal devices, and trains depart after the station master receives the notification tickets from the driver and conductor.

Stations having sidings also do not have interlocking devices, and therefore turnouts are changed by marker point levers with handles and switch stands (almost no switch stands). Train operation safety thus may be said to rely solely on the care of the individual in charge of the point lever.

For level crossing protection equipment, manually operated gates (full-gates or half-gates) are installed in some sections, which are operated by officials. At level crossings without gates, trains are occasionally halted because automobiles violate building restrictions because of traffic congestion stop on the tracks, and trains are unavoidably halted.

As the railroad-related transportation authorities in the downtown area plan and build, the thorough overhaul of the PNR railway in its present conditions must be carried out in order to create the kind of railway framework the PNR should have had from the start.

We believe this means that the improvement of the PNR north track and south track to create a core public transportation institution is an urgent issue.

We believe that in order to complement LRT Line 1 (including LRT Line 6) where transport will be strained, and to fulfill its critical mission in the future as the principal trunk line for the Philippines, improvement and connection of the north track and south track is the topic of greatest urgency.

As already described above, in its present condition the existing PNR Line is nearly incapable of fulfilling that role. With only patchwork upgrades and maintenance it will be impossible to expect the line to fulfill such a role, and it is a question of should the line continue to be maintained in its current condition as in the past or should it be left to wither away. This is obvious from also looking at past operations. For these reasons an effective, full-fledged policy is required. The line cannot avoid or work around the

squatter problem, and any plan must be implemented in conjunction with a response plan to this problem as well.
In addition, improvement and strengthening of the PNR Line is expected to also have an effect as a measure to assist the LRT Line 1, where enhancement of nearly parallel transportation capacity is viewed as an urgent issue.

5.3.1 Plan Proposal

First, as the main trunk public transportation facility in the Philippines the PNR Line should implement serious, full-fledged reforms including measures to address the north line and south line squatters as well as changing operations to through service.
Two proposals have been developed as a countermeasure, as shown in Figures 5.3.1 through 5.3.5.

Ⅰ Proposal 1

Elevate the line currently in operation over a distance of roughly 10km from Tayuman to Vitocruz on the south line.

Ⅱ Proposal 2

Using Tayuman as the starting point, link to the south line in the vicinity of Vitocruz as an underground rail line and implement through service (construction of about 7km of underground rail line).

(1) Proposal 1 Track elevation proposal

Proposal 1 views elevation of the track as a necessary measure because the route will continue to pass through a high-density residential area, with numerous crossings 20m or wider handling heavy automobile traffic, and conversion to overhead crossing is needed.
Crossing the numerous expressways and the MRT Line 2, LRT Line 4 and LRT Line 1 that have already been elevated or are being built or planned for elevation in this area, however, would be a problem. Measures to address both construction of an elevated railway that passes above these track sections and overpasses as well as the squatter problem would have to be found. There are almost no precedents for elevated railways built to heights even greater than ordinary elevated railways, and this would engender the problems of how to locate the stations and provide access. In addition it would also be necessary to address problems such as how to remove the squatters below the elevated tracks. Furthermore, Tayuman Station is a terminal station where the operating direction of trains is changed, making engine changes necessary. Finally, the plan excludes trains that do not pass through Tayuman.

(2) Proposal 2 Short-cut proposal using an underground railway

Proposal 2 is a problem of investment amount. The proposal calls for building an underground track from the vicinity of Tayuman Station in the north and connecting it to existing track, making a short-cut that emerges between Paco Station and Vitocruz station. From the vicinity of Vitocruz Station on the existing line to FTJ Station there are numerous expressway overpasses that would make elevation difficult, and where improvements are needed it will probably be necessary to go underground. This is the same as in Proposal 1.

This underground rail line from Tayuman Station to the vicinity of Vitocruz station would mean building a central underground station in the vicinity of D. Jose Station on LRT Line 1, passing under the Pasig River and connecting to the Vitocruz Station.

The underground station to be built near D. Jose Station would be a connection point to LRT Line 1 as well as to the terminal station being planned for MRT Line 2 and LRT Line 4.

The length of the underground railway to be built would be approximately 7km.

As a commuter track section all trains including those in Proposal 1 would be electric operations. The existing commuter operations section between Tayuman~Alabang (approximately 27.5km) would be shortened by about 3km to a length of 24.5km by the placement of track underground.

With construction of an underground railway the existing track from Tayuman Station to the vicinity of Vitocruz Station could be provided for use as another publc transportation facility.

Overall, the length of roughly 60km linking Marilao~Tayuman~Cabuyao would be converted to electric trains as a commuter electric train operation section. Long-distance trains would be changed from diesel locomotive (DL) to electric locomotive (EL) at Cabuyao Station. This is identical to Proposal 1.

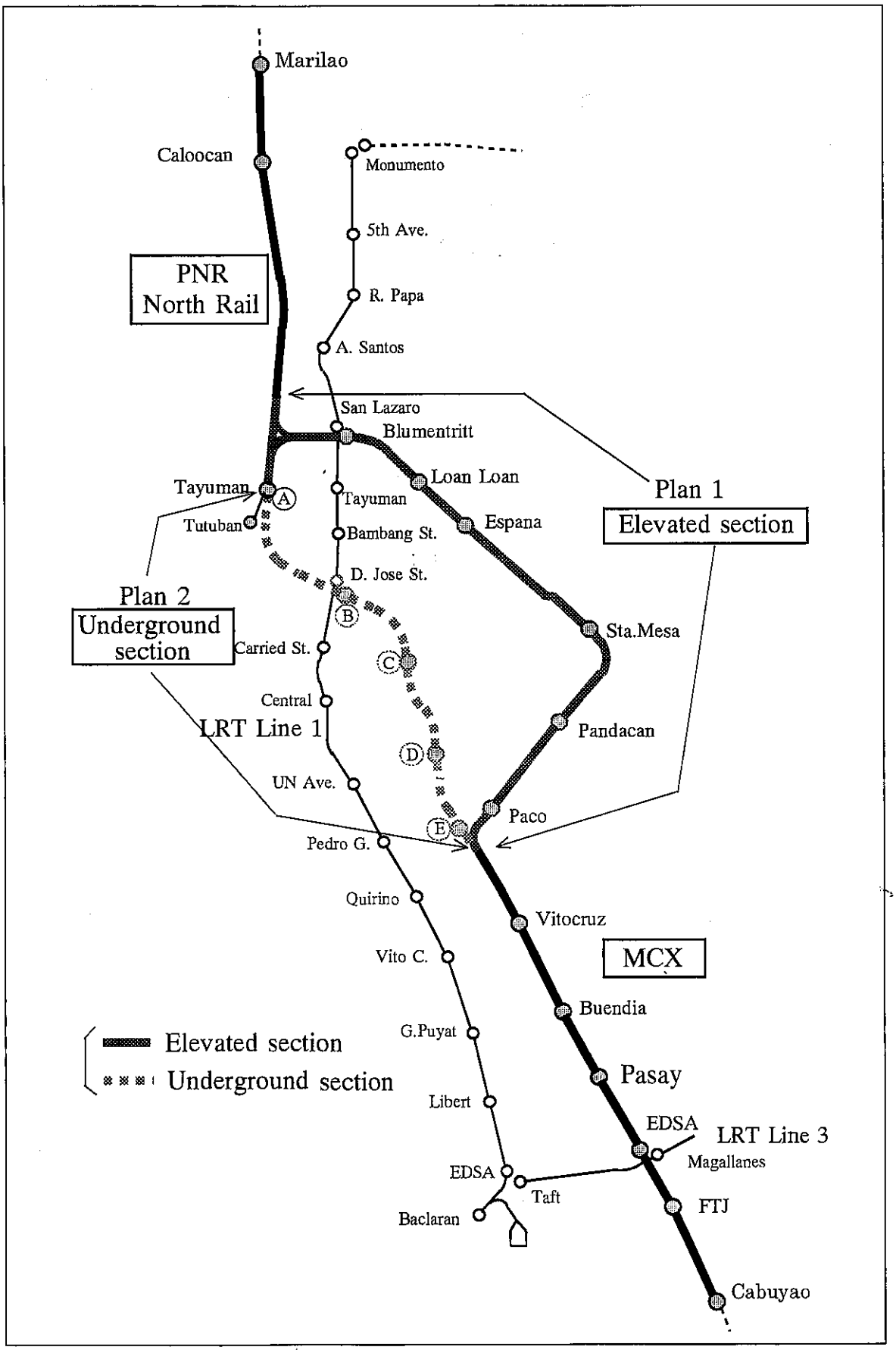


Figure5.3.1 Improvement Plan of North Rail and MCX Line

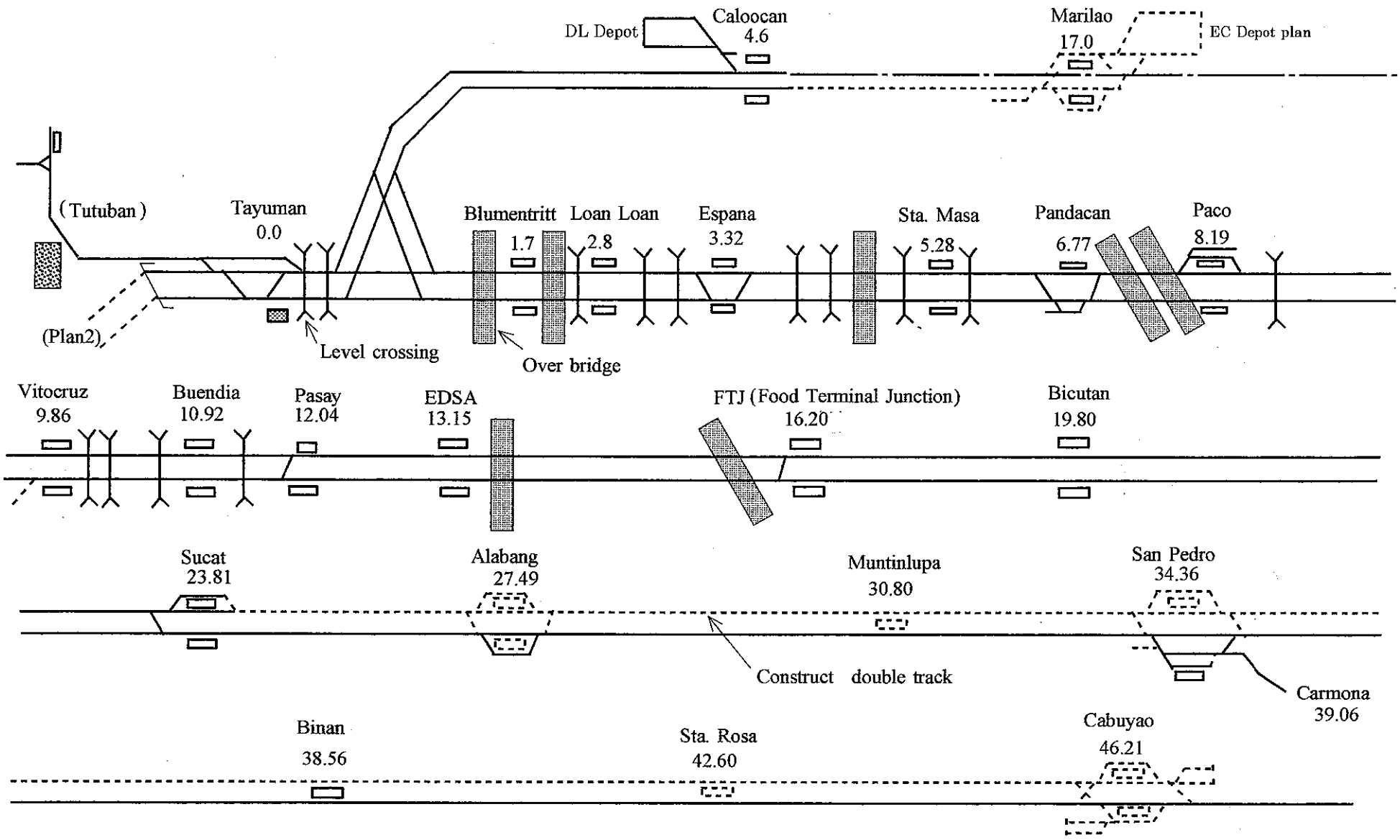


Figure5.3.2 North Rail and MCX Line Track Layout : Plan 1

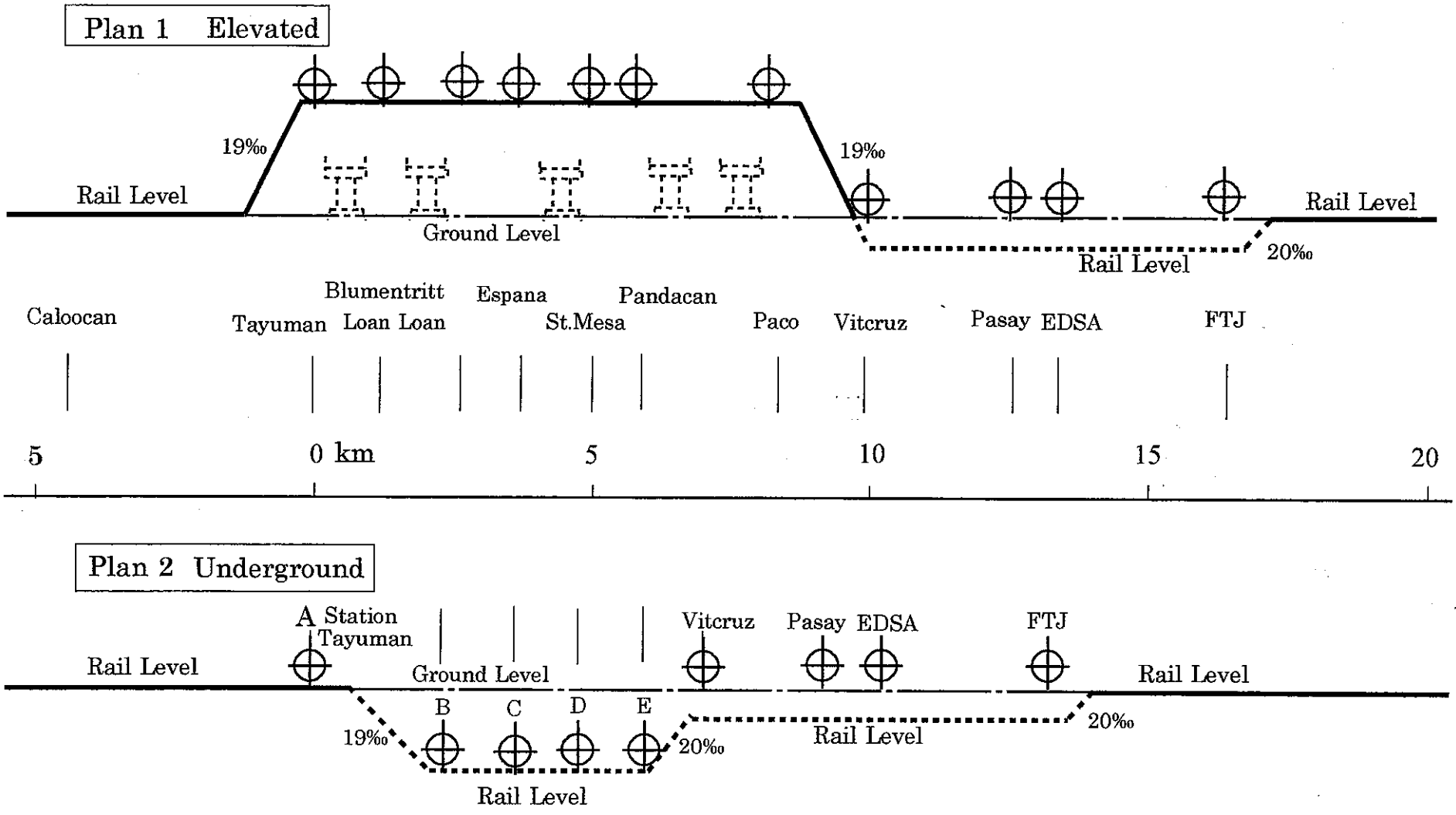


Figure5.3.3 Vertical alignment

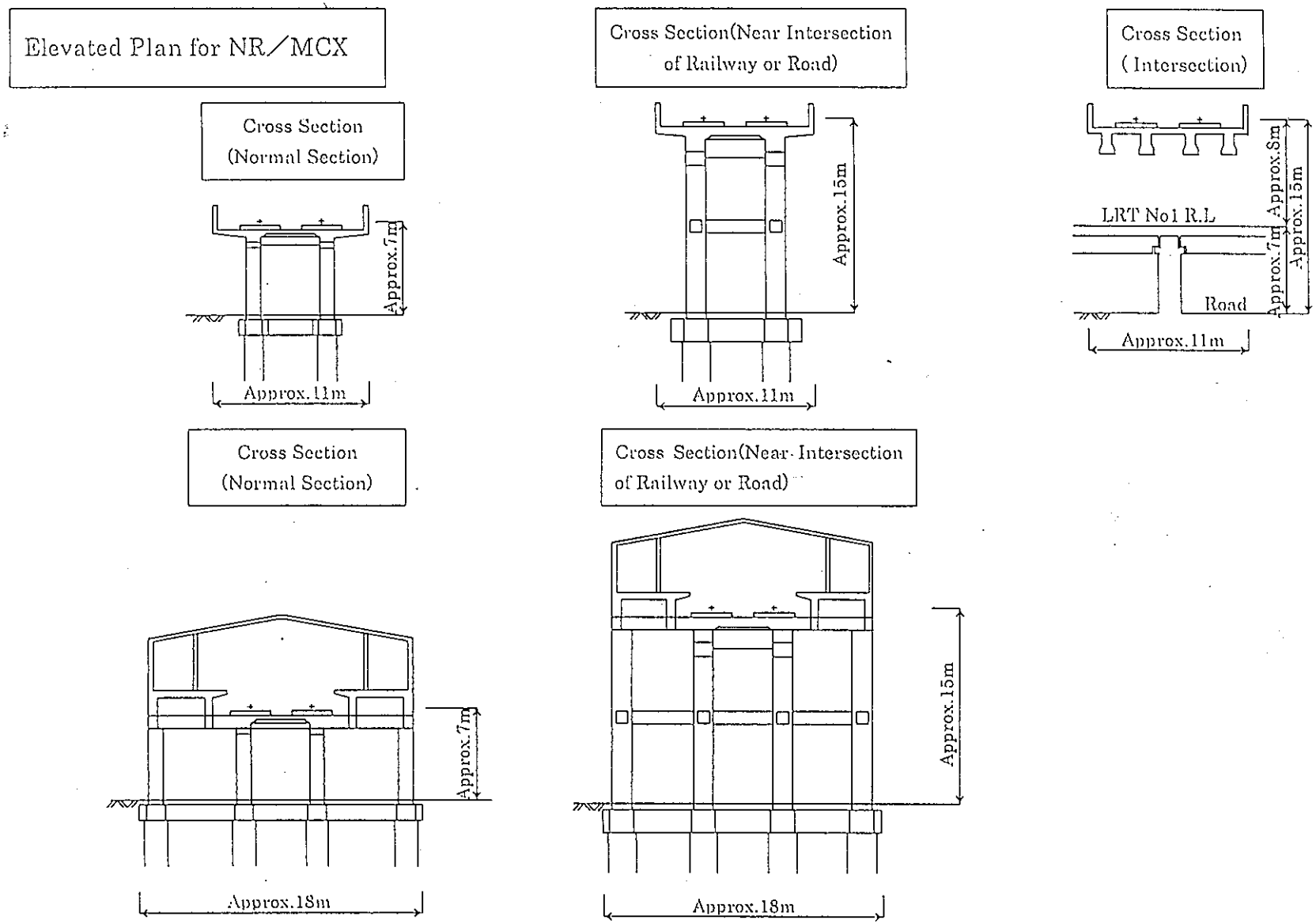


Figure5.3.4 Sectional plan of Elevated section

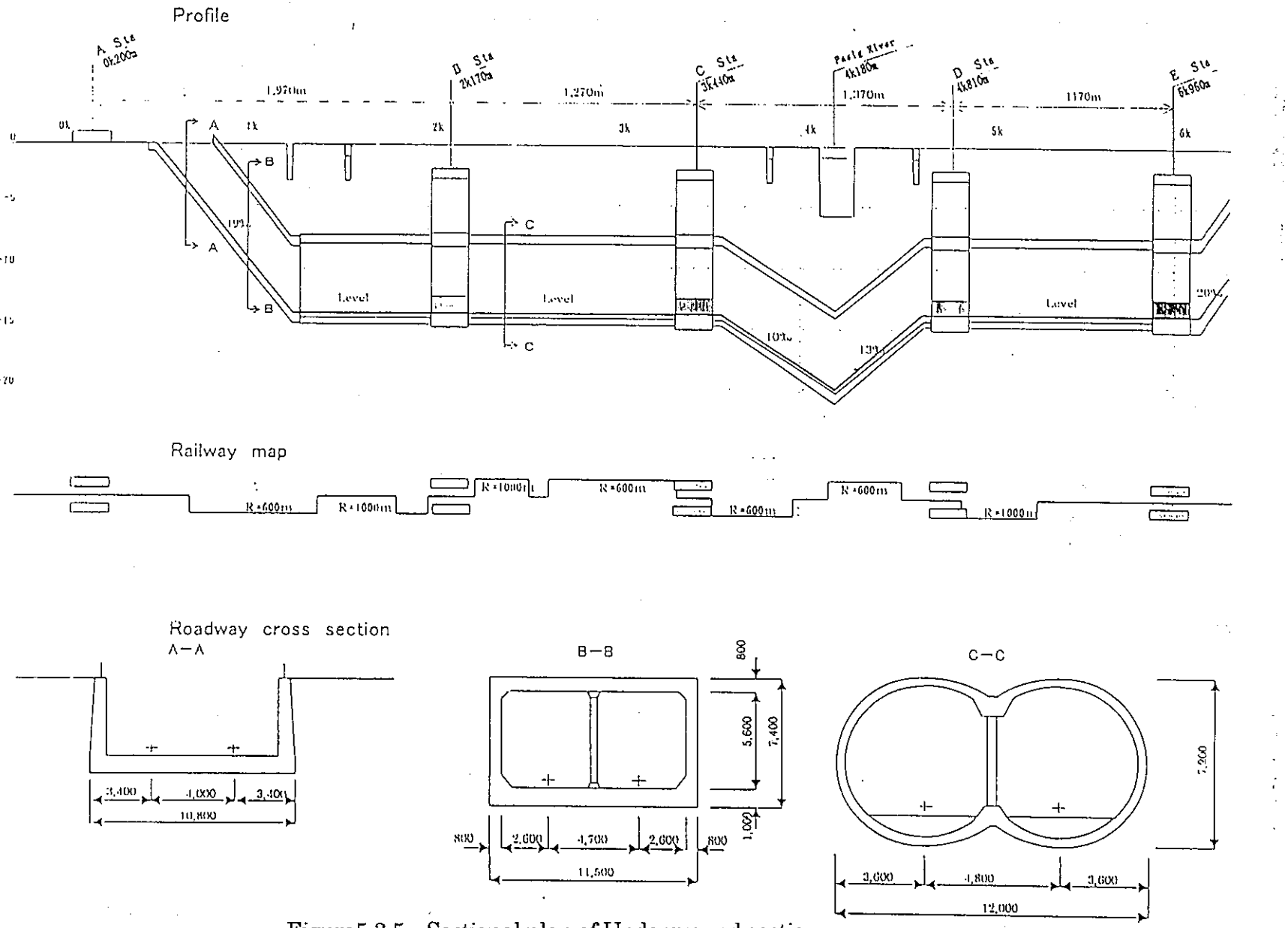


Figure5.3.5 Sectional plan of Underground section

5.3.2 Transportation Demand in 2015 and the Transportation Plan

(1) Transportation demand and Passenger revenue

Passenger transportation demand in 2015, taken from the demand projection results, is shown in the following table.

Of these, demand in Case 2 and Case 4 of the underground railway proposal show demand approximately 170,000 per day higher than for elevated railway.

Table 5.3.1 Projected transported volume, Estimated Passenger Revenue for North Rail/MCX (persons/day) 2015

	Case 1 (A) Elevated	Case 2 (B) Underground	Increase (B) – (A)	Case 3 © Elevated	Case 4 (D) underground	Increase (D) – ©
Transport Volume (Persons/day)	1,233,684	1,404,842	171,158	1,225,888	1,400,206	174,318
Passenger Revenue (1000pesos/day)	25,907	29,502	3,595	25,744	29,404	3,660

Sectional transported volume is shown as an example in Figure 5.3.6 for Case 4.

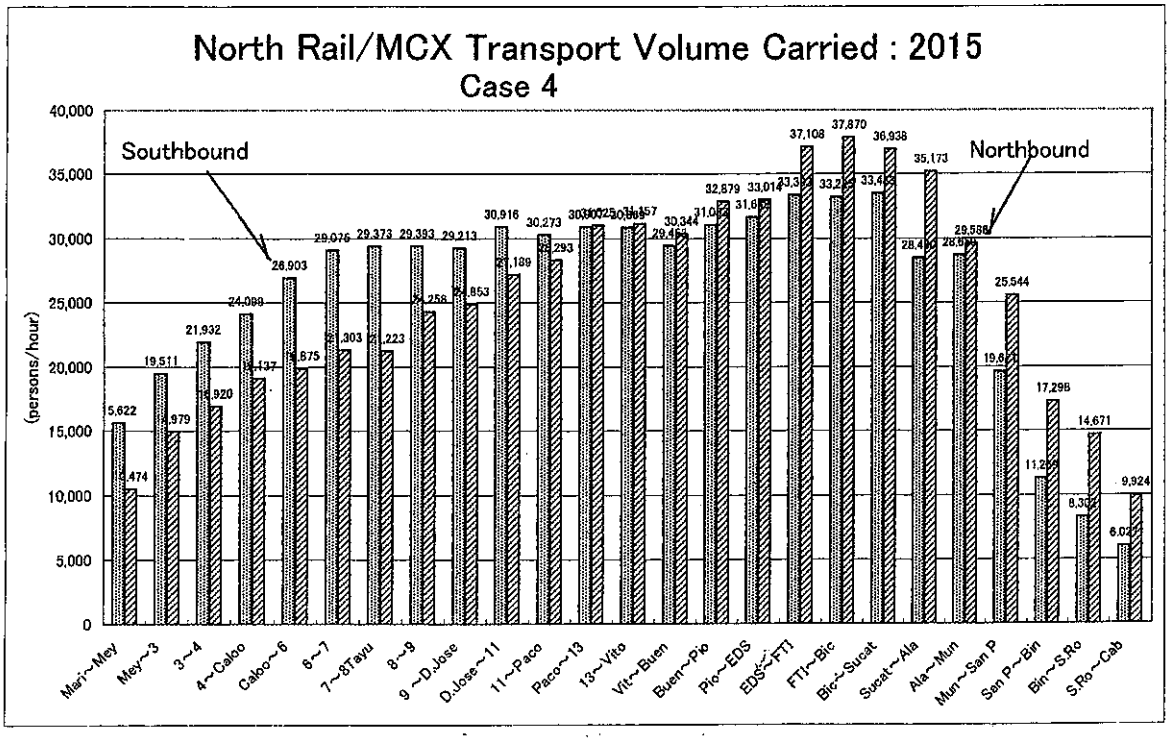


Figure 5.3.6 Sectional transported volume on the North Rail/MCX Line: Case 4 (2015)

Table 5.3.2 Comparison and Study of improvement alternatives on North rail Line and MCX Line

		Proposal 1 Elevated railway proposal	Proposal 2 Underground short-line proposal	Remarks
Plan summary	North rail	Tayuman~Marilao : (17.0km)	Tayuman~Marilao : (17.0km)	
	MCX	Tayuman~Cabuyao : (46.2km)	Tayuman~Cabuyao : (43.2km)	
	Study section	Tayuman~Vitocruz (Elevated: Approx. 10km)	Tayuman~Vitocruz (Underground railway: Approx. 7km)	Route shortened by approximately 3km by construction underground. (Refer to Fig. 5.3.3)
		Vitocruz~FTJ (Approx. 6km:)		
		Elevate the track to the vicinity of Tayuman~Paco; from this vicinity use a downward-sloping gradient as far as FTJ; operate through service to North Rail and MCX (South Rail) as an underground railway.	From the vicinity of Tayuman Station to the south, connect to the area around Vitocruz as an underground railway and shorten the route over this section. As far as FTJ convert to underground railway identical to Proposal 1.	Conversion of the track to an underground railway from the vicinity of Vitocruz south is the same in both proposals (refer to Fig. 5.3.3)
		Overpasses already exist as far as the vicinity of FTJ Station (16km)		(Refer to Fig. 5.3.2)
Improvement plan	Track	Elevate a section of approx. 10km, and move approx. 6km as far as FTJ underground (There are already elevated bridges for lines such as LRT Line 1, and elevation would require building above these.)	Build as an underground railway of approx. 6km from the vicinity of Tayuman Station to Vitocruz (approx. 6km) and as far as FTJ.	
	Power	Electric operations (Marilao~Tayuman~Cabuyao: 63.2km)	Electric operations (Marilao~Tayuman~Cabuyao: 60.2km)	Electric trains and trains pulled by locomotive
	Operation system	Add ATS as a multi-track automatic blocking procedure. (2 minutes, 30 seconds has been planned as the minimum headway)		Signal method will use above wayside multiple aspect system.
Operations plan	Maximum operation speed	Marilao~Tayuman~Cabuyao: 100km/h		Long-distance trains will be studied separately.
	Train formation	Commuter trains will be 10-coach formations, 43 train sets available	Same as Proposal 1	20m coach (JR East 209 Series)

Operating units	Organization	Public institutions will own and manage the infrastructure, and private companies will manage operations.		
	Structure	Individuals needed: Approx. 1,376	Individuals needed: Approx. 1,358	
Construction expense	Elevate, or move underground	Construction of elevated railway (Approx. 10km): 14.7 billion pesos Including 6km moved underground	Construction cost to move underground (Approx. 7km): 25.6 billion pesos Including 6km moved underground	Construction expense will be 7.9 billion pesos higher in Proposal 2
	Double track construction	Malilao~Caloocan, Sucat~Cabuyao (35km)	Same as at left	Same in both proposals
	Other	Structural improvements at Tayuman Station, others	Same as at left, and tract improvements between Caloocan~Tayuman (4km)	
Operating expenses	Personnel expenses and management expenses Total	495 mil. Peso & 3,590 mil. Peso 4,085 mil. Peso/year	489 mil. Peso & 3,675 mil. Peso 4,164 mil. Peso/year	The difference between Proposal 1 and Proposal 2 is approximately 80 million pesos/year

(2) Train operation plan

In all of the cases, the operation plan for the same kind of trains as those on LRT Line 1 is as follows. Conditions used as premises were 4 passengers/m^2, a target passenger ratio of 120%, a peak hour concentration ratio of 10%, and operation of electric trains with 10-coach formations. Moreover, although no plans were made this time for long-distance trains, as trains we assumed passenger trains pulled by locomotives. Container trains from Tutuban to ICD are also of the same type.

The number of trains operated over nearly all sections is 16~18 trains per hour. Headway of three minutes must be maintained, which from the point of facilities means ensuring intervals of 2 minutes, 30 seconds. For these intervals obviously double tracking is required, and the equivalent investment will be necessary. The existing double tracked section is between Caloocan~Sucat (approximately 28km), and all other sections are single track.

The number of trains operated in the plans by case is shown in Figure 5.3.7.

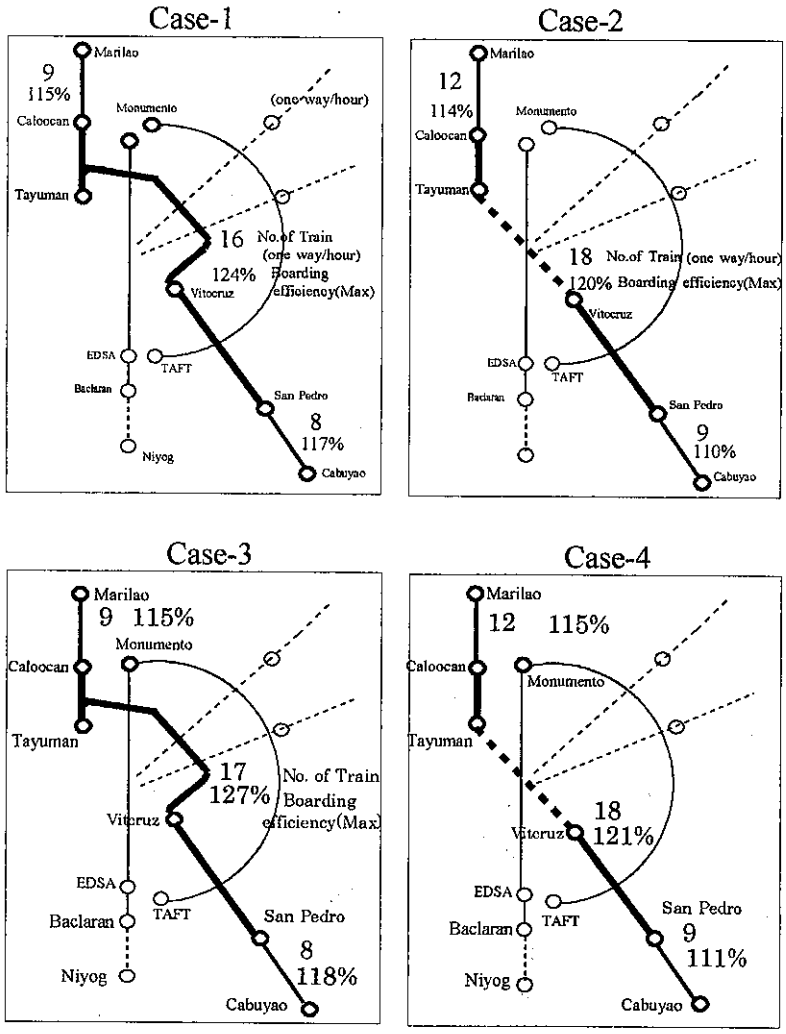


Fig. 5.3.7 Train Operation Plan (peak hour/one day)

(3) Operation equipment and rolling stock plan

Based on the prerequisites of the train operations plan outlined in the preceding section, the facilities including track equipment and operation safety procedures for both Proposal 1 and Proposal 2 are shown below.

1) Proposal 1
   ① Elevated section: between Tayuman~Vitocruz, approximately 10km
   ② Track enhancement, etc.: All sections between Marilao~Cabuyao except for section that will be elevated; 53km
2) Proposal 2
   ① Underground railway construction: Between Tayuman~vicinity of Vitocruz; approximately 7km
   ② Track reinforcement: Between Marilao~Tayuman; 17km
   Between Vitocruz~Cabuyao: 36km, total 53km
3) Both proposals
   ① Conversion to double tracks: Between Marilao~Caloocan; 12.4km
   Between Sucat~Cabuyao; 22.4km, total 34.8km
   ②Conversion to underground railway (aboveground stations):
   Between Vitocruz~FTJ; 6km
   ③ Station improvements: Each station between Marilao~Cabuyao (change track layout, interlocking devices, etc.)
   ④ Electric operation equipment: Between Marilao~Cabuyao; 63.2km (60.2km in Proposal 2)
   DC 1,500V
   ⑤ Train safety equipment: Installation of automatic blocking devices and ATS
   ⑥ Train formation, etc.: DC electric rolling stock
   10-coach formations, train length 200m, passenger capacity 1,740 persons/train (4 persons/m^2)

5.3.3 Comparison and Study of Proposal 1 and Proposal 2

The main items for comparison and study are shown in Table 5.3.2.

(1) Track equipment

In Proposal 1, elevation of the track will compete with overpass bridges, and in Proposal 2, the problem is the investment cost associated with the underground construction.

In both proposals, the repair of ground-level facilities to the south of Vitocruz Station is a separate issue.

In the interval from Vitocruz Station as far as FTJ Station there are expressway

overpasses, and crossing these will undoubtedly be a problem. The repair of this approximately 6km-long section will be important for either proposal. South of FTJ there are no overpass bridges, and improvement and double-tracking of the original track will be carried out.

(2) Necessity of through operations in the metropolitan core

In Proposal 1, North Rail and the MCX Line will be joined by utilizing the existing tracks in the urban core, and in Proposal 2 the lines will be joined by building an underground railway in the central downtown area.

Because the PNR tracks were planned from the start for the purpose of inter-city transportation, there is no through service between North rail and South Rail and the railways stop at terminal stations on the city perimeter (European-style).

In this arrangement movement from the terminal stations to the central downtown area is by inner-city railway, bus, etc.

Urban railways in the Manila metropolitan area cannot be said to be adequately developed. As a result, transportation between terminal stations will undoubtedly be difficult if Caloocan Station is used as the North Rail terminal station and EDSA Station is used as the South Rail terminal station. This is quite obvious if the flow of passenger transportation is analyzed, as shown in Figure 5.3.8.

As seen from the figure, transported volume between Caloocan Station and EDSA Station is very large. Moving these passengers on other railways is ineffective and will add further to transportation difficulties.

Moreover, directly linking North Rail and South Rail will form a basic, main trunk line for this track and will be critically important as a nucleus for an inner-city transportation grid developed with other railways.

In the Tokyo metropolitan area urban transportation grid as well, various medium and long-distance tracks such as the Tokaido, Tohoku, Yokosuka and Sobu lines are concentrated and linked with Tokyo Station as the core. This forms an effective railway transportation grid by linking to other urban railway-based public transportation facilities in various directions.

From this standpoint, linking North Rail and South Rail in the Manila metropolitan area the way railways are linked in the Tokyo metropolitan area will be very effective. We especially believe that joining the lines using the underground railway in Proposal 2 will be an extremely important issue for the future development of not only the Manila metropolitan area but the Philippines as well.

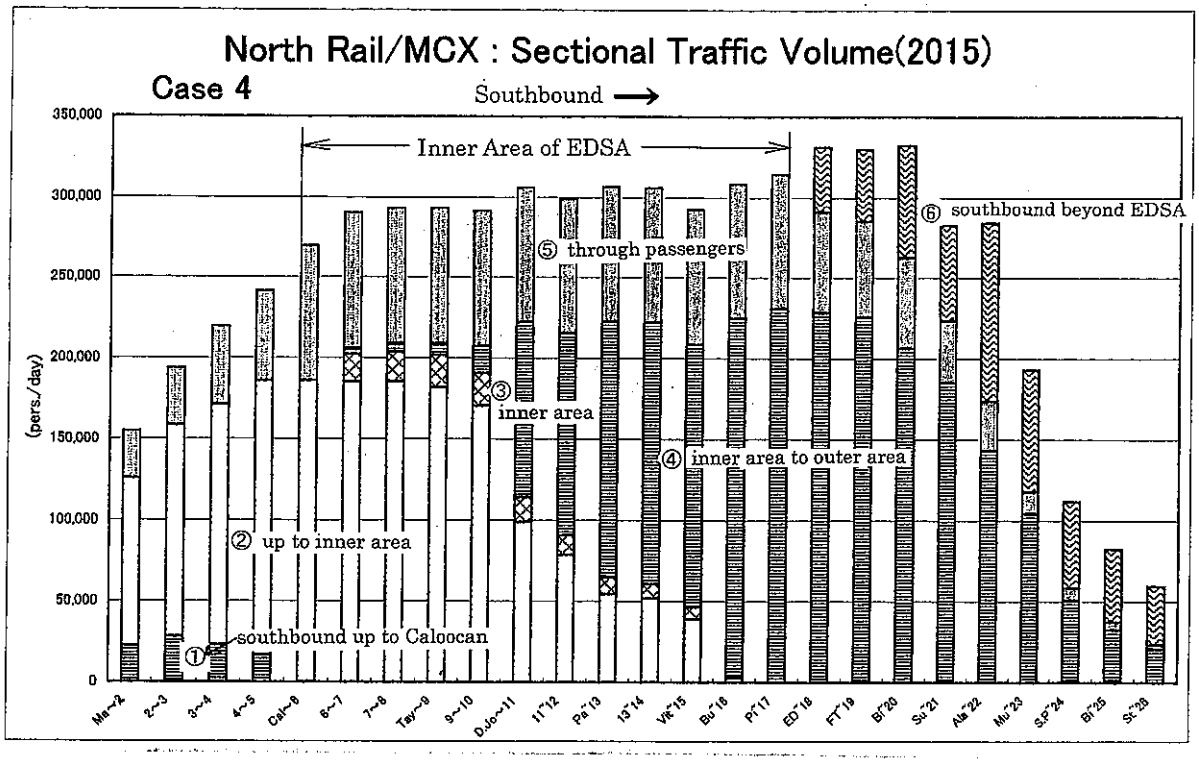


Fig. 5.3.8 Sectional transported volume analysis for North Rail and MCX Line: Case 4 (2015)

(3) Management nucleus and organization

If North Rail and South Rail are directly linked to form a modern railway grid, the question of how to manage that grid will become an important topic.

Some form of support such as central government assistance will be needed because track equipment-related investment for the railway will grow substantially larger. This is also clear from the actual management experience of PNR in the past. This means that following the improvements some arrangement, such as separation of upper and lower management, with the national government controlling above-ground track-related equipment and private companies being responsible for management of rolling stock and operations, should probably be studied. These management companies would be under the jurisdiction of the DOTC.

An example of this type of management structure is shown in Figure 5.3.9.

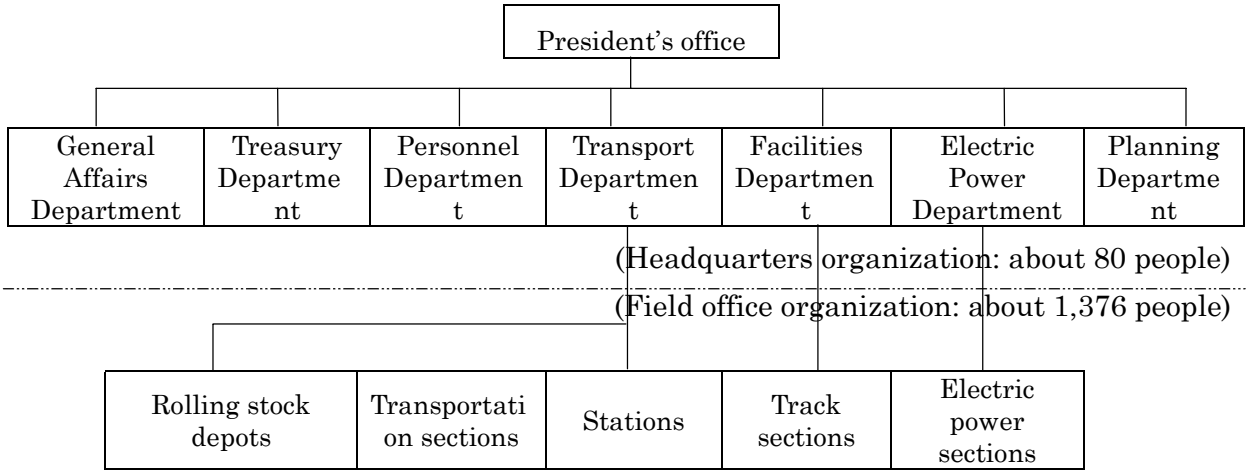


Figure 5.3.9 North Rail/MCX Line management company organization (Proposal)

(4) Operation time and number of train formations required

1) Operation time

The operation times in the train operation plan are summarized in the following table.

Train acceleration and deceleration performances are also described below.

① Type of coaches: JR East 209-Series DC electric trains

② Rate of acceleration (α): 0.6m/s² (2.3km/h/s: 0~40km/h)

③ Rate of deceleration (β): 0.8m/s² (3.0km/h/s)

④ Maximum operation speed: 100km/h

⑤ Dwell time: 1 to 2 minutes at major stations, 40 seconds at other stations

Table 5.3.3 Operation time between major stations

Station		Proposal 1		Proposal 2	
No.	Name	Km	Travel time	Km	Travel time
1	Marilao				
		12.4	15 min	12.4	15 min
5	Caloocan				
		39.0	60 min	36.0	53 min
8	San Pedro				
		11.8	13 min	11.8	13 min
27	Cabuyao				
Total		63.2	88 min	60.2	81 min

Note: Includes dwell time at intermediate stations.

2) Number of train formations required

Based on the drafting of the transportation plan and a summary study, the number of train sets required by the train operation plans in both Proposal 1 and Proposal 2 in 2015 is 40 train sets for operations and 3 train sets for standby, or a total of 43 train formations (430 coaches).

Specifically the train formations will be 4M6T.

(5) Investment

1) Construction investment

As shown in the following table, there is a considerable difference in the investment (improvement construction expense) between Case 3 (Track elevation proposal) and Case 4 (underground railway construction proposal). If consideration is given to future possibilities as described in the beginning, we believe that the construction of underground track as outlined in Case 4 should be pursued. A comparison based on these improvements is shown in Table 5.3.4.

Table 5.3.4 Construction investment for North/MCX improvements (Rough estimate)

(Unit: million pesos)

Item	Case 3 (Track elevation proposal)		Case 4 (Underground railway construction proposal)	
	Km	Construction expense	km	Construction expense
Construction of elevated section	10.9	5,238	6.9	13,828
Construction of quasi-underground section	6.3	6,371	6.3	6,371
E & M	17.2	3,042	13.2	2,338
Total		14,652		22,537

Note 1. Does not include expenses for purchase of land to be used or consulting expenses.

Note 2. Exchange rate assumption was US$1 = 40.197 pesos (99.12.28)

① Rolling stock expense

Because PNR currently owns DL and passenger coaches but does not have any electric trains, it will have to introduce approximately 430 electric coaches (EC). PNR will have to make this investment to respond to the demand for

transportation in 2015, regardless whether it assumes Case 1 or Case 2.
The total investment will come to approximately 9,245 million pesos.

(6) Operating expenses

Operating expenses are divided into personnel expenses and management expenses. These are assessed in original units and calculated approximately. Case 3 and Case 4 operating expenses are shown below as examples of the calculation results.

Table 5.3.5 Rough estimate of management and operating expenses

(Unit: mil. pesos)

	Case 3 (Elevation proposal) (A)	Case 4 (Underground proposal) (B)	Difference between Case 3 and Case 4 (B) – (A)
Personnel expenses	495.2	488.9	-6.3
Management expenses	3589.4	3675.5	86.1
Total	4084.6	4164.4	79.8

Case 4 operating expense are approximately 80 million pesos (2%) higher than for Case 3, but transported volume is 62 million passengers (12%) greater.
Further, estimated passenger traffic volume and fare revenue as shown in Table 5.3.1 and operating expenses will be as shown in Figure 5.3.10.

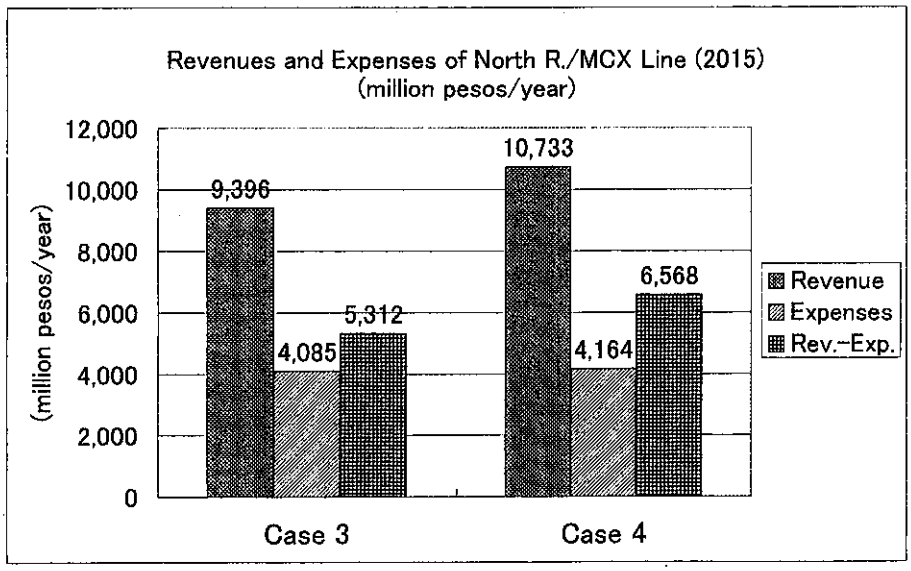


Figure 5.3.10 Revenues and Expenses of North Rail/MCX Line

5.3.4 Study Results

(1) Principal items for future study

We believe detailed countermeasures for items such as track elevation, underground construction and track improvements should be studied and implemented at an early stage, based on separate Feasibility Study (F/S) and other materials.

(2) Investigation results

We believe steps should be taken to move ahead with Proposal 2 from the standpoint of the following main points, as shown in the study results of Proposal 1 (elevation of existing track) and Proposal 2 (direct link based on construction of an underground railway) as shown in Table 5.3.2 and Table 5.3.5.

① Equipment aspects

The elevation of track as outlined in Proposal 1 is difficult from the point of the transportation grid such as route and track height. Passenger access would also be difficult.

② Transportation aspects

Under Proposal 1 train turn-back operations will be carried out at Tayuman, which will require engine substitutions (locomotive hook-up). This will increase operating time.

③ Proposal 2 can make effective use of the track already laid along main locations within the city.

④ Although the initial investment required for Proposal 2 is large compared to Proposal 1, the route has future possibilities as the city's main trunk line. In particular, the vicinity of D. Jose Station would become a common transportation point for the PNR underground station and LRT Line 1, LRT Line 4 and MRT Line 2, so further development can be anticipated. Therefore an underground station in the vicinity of D. Jose Station should be studied as a future transportation hub and as the point making a layout that also takes into consideration factors such as long-distance passenger train arrival and departure.

⑤ Although management and operation expenses are about 2% (80 million pesos) larger under Proposal 2, the transported volume is 62 million passengers larger. Revenue therefore increases by roughly 74 million pesos. Because the track length and train kilometers will oppositely decrease by 3km, we believe that Proposal 2 offers the greater benefit.

Table 5.3.6 Pros and cons, and results, from improvement of North Rail and MCX

	Proposal 1 Elevated track proposal	Proposal 2 Shortened underground railway proposal	Remarks
Planning section	Marilao~Tayuman~Cabuyao (63.2km)	Marilao~Tayuman~Cabuyao (60.2km)	Proposal 2 shortens route by about 3km
Train operation plan	Electric trains, 10-coach formation		Number of trains required is the same in both proposals
	Long-distance trains (passenger, freight) will use electric locomotives, and trains south of Cabuyao will use diesel locomotives (DL)		
Rolling stock depots	Electric train depot will be built in the vicinity of Marilao. The existing PNR depot will be utilized for the locomotive maintenance yard.		For both proposal it will be necessary to build new rolling stock depots
Management nucleus	Transportation activities will be organized into a new company. Infrastructure such as tracks will be owned by DOTC.		
Rough estimate of investment	14.7 billion pesos	25.6 billion pesos	Investment is 10.9 billion pesos higher for Proposal 2
Rough estimate of rolling stock expenses	9.2 billion pesos	9.2 billion pesos	Investment is the same for Proposal 1 and Proposal 2 (430 cars)
Rough estimate of operating expenses	4,085 mil. pesos/year	4,164 mil. pesos/year	Operating expenses are 80 mil. pesos/year higher in Proposal 2

Pros & cons and results	Squatters	○ Squatter countermeasures and elimination of crossing possible.	○ Squatter countermeasures and elimination of crossing possible.	
	Transported volume	△ Annual Approximately 447 million passengers. (9,580 million passenger-kilometers)	○ Annual: Approximately 510 million passengers (10,520 million passenger-kilometers), an increase of 64 million.	Transported volume increases 14% with Proposal 2.
	Revenue	△ Approximately 9,400 million pesos annually.	○ Approximately 10,700 million pesos annually, and increase of 1,300 million pesos.	Revenue is 12% higher under Proposal 2
	Equipment	△ Will be elevated at each station; access inconvenient.	○ Compared to Proposal 1, track length shortened by about 3km.	Shortens operating time (4~5 minutes)
	Operations	△ Train turn-back necessary at Tayuman Station (Engine change, increase in dwell time).	○ Link with urban core, also will link the various LRT lines	
	Land utilization	□ Possible to utilize the area approximately 10km long beneath elevated track.	○ Possible to utilize approximately 10km of land along the old track route.	Possible to utilize land along track bed under Proposal 2.
		○ Possible to utilize approximately 6km (ground surface above the underground railway) between Vitocruz~FTJ.	○ Possible to utilize approximately 6km (ground surface above the underground railway) between Vitocruz~FTJ.	Same in both proposals
	Investment	□ Smaller than construction of underground railway, but escalator very long.	△ Investment approximately 10,900 million pesos larger than Proposal 1.	
	Operating expenses	□ Operating expenses will be relatively higher than under Proposal 2.	○ Operating expenses will be relatively lower than under Proposal 1.	Transported volume is 2% higher in Proposal 2.
	Evaluation	Should move ahead with Proposal 2 – the shorter, underground railway proposal.		