3 PROJECT PLANNING

3.1 Project Objective

1) Basic Concept

The objective of the Ho Chi Minh (HCMC) Urban Mass Rapid Transit (UMRT) System is to provide a high-capacity mass transit service on the major heavily congested transport corridors connecting the HCMC central district with the surrounding suburban areas.

The Urban Mass Rapid Transit system for HCMC would be designed using a combination of both rail and busway technologies, which would significantly reduce the project initial capital cost and match the UMRT capacity with growing passenger demand along the existing transport corridors in HCMC. The patronage profile along a transit line is usually variable along the route and tends to taper off at the outer suburban fringes. Thus, to provide a rail based transit system at those sections of the transport corridor may not in the short to medium term be an economical option.

Conversely, initial results of the patronage forecasts of passenger demand on the inner sections of the transit line closer to HCMC central business area would appear to be greater than can reasonably be carried by a road based bus transit system on the existing road corridors. Hence, the study team concluded that demand forecast will be crucial in determining the transition interface from a bus to a rail based urban mass rapid transit system and the corresponding route lengths for each of the public transit modes.

In addition to determining the most cost effective transit system the study team have recommended that in order to ensure that the UMRT system has the capacity for future development, the bus-rail transit combination will be designed in such a manner that future capacity expansion of the transit system would be possible by upgrading the bus to a rail transit system.

The report also recommends that the government authorities also reserve in advance the necessary right-of-way for a potential future rail transit extension along the transport corridor. Therefore, the study team has strongly suggested that during this feasibility stage of the project that the vertical and horizontal alignment of the busway system should be designed to the more rigorous standards of a rail based transit system.

In addition, as the vision of the government authorities is that UMRT Line 1(East) would be the first mass transit system to be introduced in HCMC and the recommendations made in this report for the preferred transit system would set fundamental technical precedents for other potential urban rail and bus based transit lines in HCMC, in particular with respect of design standards for rolling stock, trackwork, traction power, signaling, communications, fare collection, depot facilities, station layouts including interchange and intermodal facilities and the like, Including operations, maintenance and integration of common systemwide design standards.

2) Proposed UMRT Network

From the results of the HOUTRANS Master Plan study the team has identified the potential for a proposed the UMRT network initially comprising of four (4) lines along major transport corridors within the study area. These routes are as shown in Figure 3.1.1.

UMRT Line 1 is the major east-west route traversing the inner central area of HCMC and connecting with the satellite towns of Bien Hoa, provincial capital of Dong Nai Province in the east and Tan An, provincial capital of Long Province in the west. Both towns are located along National Highway 1 (NH1). The total route length of UMRT Line 1 is about sixty six (66) kilometers.

From the results of the various transport studies it is proposed that UMRT Line 1 is composed of a rail based transit within HCMC central zone and a busway transit system on a dedicated and segregated right of way in the suburban areas. The rail transit section is envisaged connecting the rapidly developing suburban centers of Thu Duc (Cho Nho) in the east and An Lac in the west with an approximate route length of twenty seven (27) kilometres passing through HCMC central city areas of Ben Thanh market and Cho Lon Area.

The transit rail section alignment would generally follow the existing major transport corridors of Hanoi Highway, Nguyen Huu Chanh, Le Thanh Ton, Le Loi, Tran Hung Dao, An Duong, Vuong, Hung Vuong. The two busway sections of UMRT would be an extension from the rail transit to the satellite towns of Bien Hoa (15km) in the east and Tan An (25km) in the west.

The east section of UMRT Line 1 between Ben Thanh Market HCMC and Bien Hoa town was selected for further study, because from the initial output from the patronage forecast studies carried out as part of the HOUTRANS study the team identified that the future potential ridership and public transport demand on this corridor was extremely high, due to the fact that the route followed a very important existing road corridor connecting HCMC urban area with Bien Hoa, the biggest satellite town in the HOUTRANS Study Area.

In addition the team observed that there was high interest from the local authorities that the potential for developing this eastern section of UMRT Line 1 corridor should be studied to a similar level of detail as other recent studies into the development of UMRT Line 2 and the western part of Line 1 to determine the economic and technical issues could be fully defined and developed to ensure an integrated urban mass transit system was a practical and affordable option for HCMC.

3) Objective of UMRT Line 1 (East) Project

In order to define the concept and outline design of the proposed UMRT Line 1 (East) transit development this study will consider the following key issues:

Route Alignment and Operations Structure Plan: The proposed route alignment and the operating structure for UMRT Line 1 (East) was reviewed during this study.

Initial Investigation by the study team indicates that land acquisition and right of way for the route and station locations will be of particular constraint on the development of the project in particular for the section located within 7km from HCMC city center. An elevated viaduct or underground track alignment would therefore be the preferred option within this zone. In addition in order to preserve the historical city center section of HCMC would suggest an underground route for the transit system in this section would be the preferred alignment option.

Beyond the 7-km zone of HCMC central area an at-grade route alignment would appear to

be feasible with the exception of some grade separation at major road crossings along the route such as the major river crossings.

For the transition section from an underground to an elevated viaduct would require a tunnel portal and associated earth retaining structures will be necessary. For reasons of construction, project program, railway safety, environmental and engineering issues including any flood mitigation measures the tunnel portal would require land space that can be easily made available by the authorities. A potential site has been identified by the study team located within government-owned property where this key element of the project can be located.

Existing Vietnam Railway (VR) Line and UMRT Line1: Vietnam Railway caters primarily for regional and inter-city transport routes, and the present rail facility is not designed to serve suburban trips within HCMC.

The current VR infrastructure comprises an un-electrified single-track and grade line with many level crossings with a basic communications and signaling system with diesel locomotives.

Potentially, it may be possible to upgrade the existing service and introduce a commuter service by double tracking and upgrading the signaling system and the introduction of electrical traction power for the commuter service. The commuter train service could be interleaved with the existing diesel-powered long distance trains, through the introduction of a new signaling system, operational scheduling and the construction of new passing facilities possibly at commuter station locations.

It is recognized that Vietnam Railways are considering extending its existing line inside the HCMC central area westward from the existing Saigon Station. The study team for UMRT Line1 (East) will endeavor to harmonize the development plans of Vietnam Railways with the overall requirements in the transport corridor identified by the team during the master plan stage of the study.

Engineering: Based on the most recent topographical survey information available to the study team the basic transit horizontal and vertical route alignment will be determined and the major civil and structural works identified. Taking in to account all major urban development issues along the transport corridor, including patronage demand forecasts and the like, the engineering and operations elements for both the rail transit and busway systems are reviewed and include the following:

- Design and performance standards
- Outline basic design including civil and structures, railway systems and facilities plan, interchange, terminal and intermediate station planning, depot workshop and stabling, construction methods and project implementation schedule etc.
- Project Budget Cost estimation

Operation Plan: Operation plan includes the level of service, rolling stock type and size, required operations and maintenance organizational set up and an indicative budget estimate for operation and maintenance costs.

Land Acquisition, Right of Way and Resettlement: Based on the proposed preferred alignment and topographic survey, a condition survey has been conducted to identify the

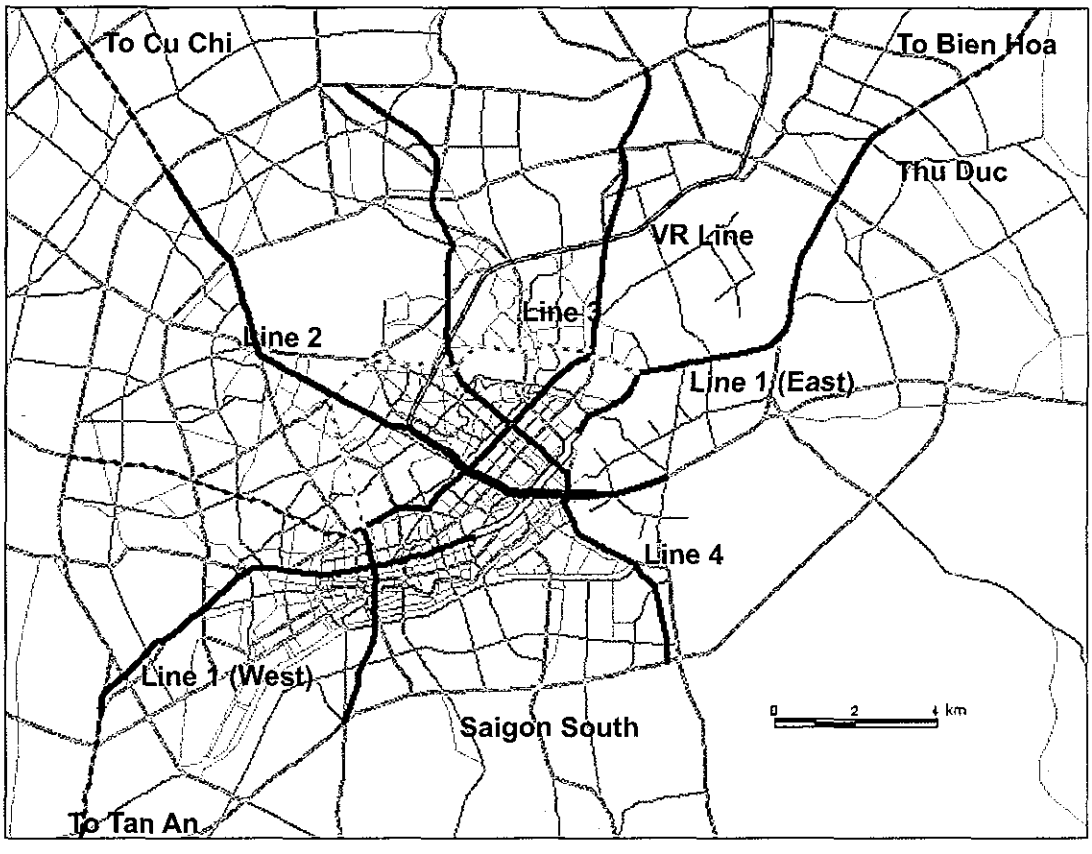
order of magnitude scale of this important issue to determine the approximate affected volume of land, property, people and relocation costs including the following surveys:

- Inventory survey for identification of affected land and structures
- Socio-economic survey for sampled affected stakeholders
- Property appraisal survey

Implementation Method: *This includes the establishment of alternative development* scheme, management and institutional arrangement to construct, operate and maintain the proposed transit system.

Evaluation of the Project: *a comprehensive evaluation and analysis of the UMRT Line* 1(East) project has been conducted by the study team from the perspective of the impact to local economy and financing, social and environmental issues and benefits which the construction of a modern, clean, secure efficient urban mass rapid transit system will bring to HCMC and in particular to the communities along this important transport corridor served by UMRT Line 1 (East).

Figure 3.1.1 Proposed UMRT Network



Source: Study Team

Table 3.1.1 Proposed UMRT Lines

Code	Section	System[1]	Length (km)	Route [2]	Length by Type [3] (km)			Capital Cost [4] (USD mil.)		
					UG	EL	AG	Total	ROW	Const.
UR1	**Line 1** (Thu Duc - Ben Thanh - Cho Lon- An Lac)	Rail / D	26.6	U	4.3	11.3	11.0	952	13	939
	(Thu Duc - Bien Hoa (East), An Lac - Tan An (West)	Busway	39.4	S	-	-	39.4	130	10	120
	Sub-total	-	66.0	-	4.3	11.3	50.4	1,082	23	1,059
UR2	**Line 2:** (Thu Tiem - Ben Thanh - Ba Queo - Hoc Mon)	Rail / D	16.3	U	4.2	4.1	8.0	627	33	594
	(Hoc Mon - Cu Chi)	Busway	17.2	S	-	-	17.2	57	4	52
	Sub-total	-	33.5	-	4.2	4.1	25.2	684	37	646
UR3	**Line 3:** (Binh Phuoc - Mien Dong - 3/2 - Cho Lon - Dist.8)	Rail / D	19.8	U	-	13.6	6.2	612	35	577
UR4	**Line 4:** (Dist.12 - Go Vap - Phu Nhuan - Dist.4 - Saigon South)	Rail / D	18.9	U	-	12.2	6.7	660	8	652
	Rail Total		81.6	-	8.5	41.2	31.9	2,850	88	2,762
	Busway Total		56.6	-	-	-	56.6	187	14	173
	UMRT Total		**138.2**	-	**8.5**	**41.2**	**88.5**	**3,037**	**102**	**2,935**

Source: Study Team
1) D: Double Track
2) U: urban, S: suburban
3) UG: underground, EL: elevated, AG: at-grade
4) Cost for rail Includes capital cost of infrastructure, E&M, depot and rolling stocks. Cost for busway does not include bus fleets.

3.2 Traffic Demand Forecast

The future potential passenger traffic volume on UMRT Line 1 (East) transport corridor is estimated as part of the HOUTRANS master planning study in order to define the future public transport demand volume on this corridor and the impact on the existing and proposed road network along the corridor.

Figure 3.2.1 shows the estimated traffic volume on the UMRT Line 1 (East) Corridor without the construction of the UMRT Line1 transit system from Ben Thanh market, central HCMC to Bien Hoa town in the eastern suburbs of the metropolis. In this 'No Build" scenario, it is assumed that the half (50%) of passenger traffic demand is carried by a road based public transport system.

Preliminary study results suggest a high growth of traffic volume during the study period. To satisfy the public transport demand the capacity of a road based public transport system will require a head way of a bus system will be about every ten (10) seconds during peak hours. To achieve this capacity will require about 5,000 bus vehicles to operate on this transport corridor every day[1]. In this regard, In order to provide the necessary capacity to carry the public transport passenger only on the existing road network within the transport corridor in the design year of 2020 will require a road based bus volume of 6,000-10,000 vehicles per day by section if there is no UMRT Line 1 (East) project.

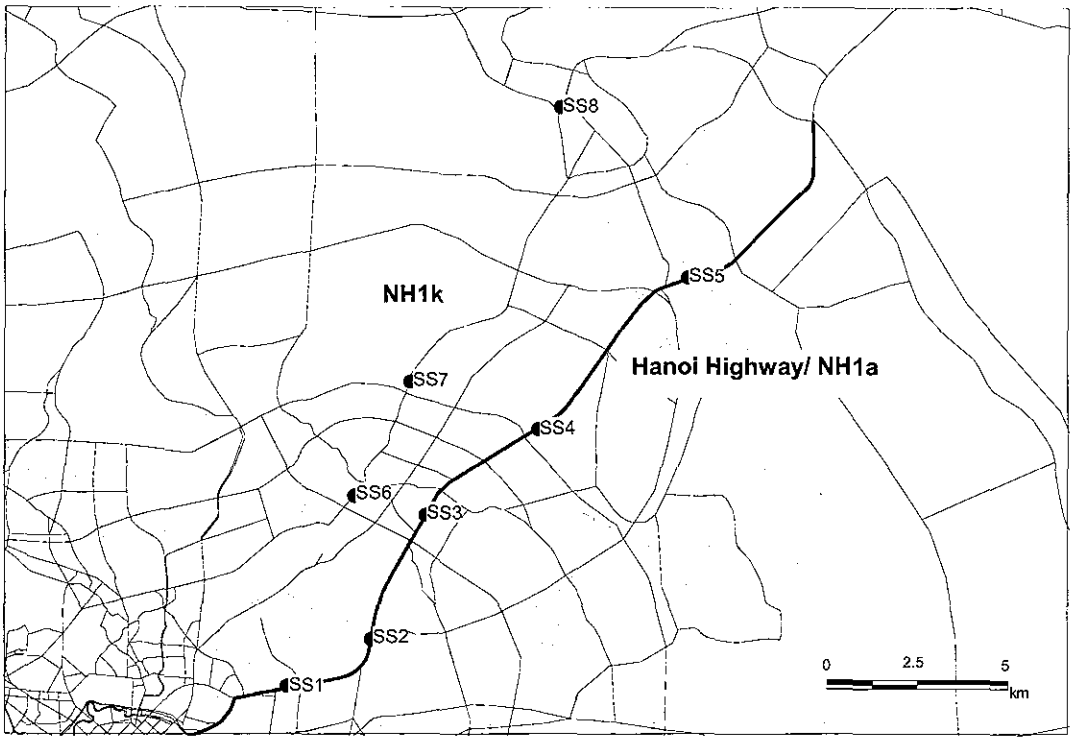
With public transport volumes of this magnitude there will be significant adverse impact on the corridor including poorer level of service to passenger, longer journey times, serious traffic congestion, higher vehicle maintenance costs, and hydrocarbon pollution along the

[1] Assuming the peak rate by direction is 15%

route.

Therefore, the study team have concluded that this transport corridor has sufficient potential to be developed as a public transport (mass transit) corridor which in time will accelerate the future growth and economic benefits to the communities along this important transport corridor.

Figure 3.2.1 Estimated Traffic Volume on UMRT Corridor (w/o F/S Project)



	2002				2010				2020			
	Traffic Volume (000/day)			PCU (000/ day)	Traffic Volume (000/day)			PCU (000/ day)	Traffic Volume (000/day)			PCU (000/ day)
	M/C	Car	Bus		M/C	Car	Bus		M/C	Car	Bus	
SS1	174	13	4	65	82	42	4	75	50	52	10	111
SS2	160	13	4	62	150	48	4	102	104	91	8	202
SS3	123	13	4	58	124	43	4	91	49	58	6	113
SS4	70	15	3	51	59	43	2	65	58	79	5	142
SS5	60	15	3	49	96	37	2	70	86	88	6	180
SS6	98	10	3	47	76	26	2	54	56	79	6	141
SS7	81	2	1	21	75	28	6	65	50	61	5	116
SS8	57	2	1	17	82	13	4	47	37	40	6	83

Source: Study Team and HCMC-PC TUPWS Traffic Count Data (2002)

Passenger flow on the UMRT Line1 from Ben Thanh Market HCMC to Bien Hoa town is estimated by the traffic assignment with other master component projects. It is conservatively assumed that the travel speed of railway part is 30km/h and the one of busway part is 25km/h while ordinary buses are running at the 70% of road traffic. For the railway, the fare is set to 5,000+500VND/km while bus fare is 5,000VND flat.

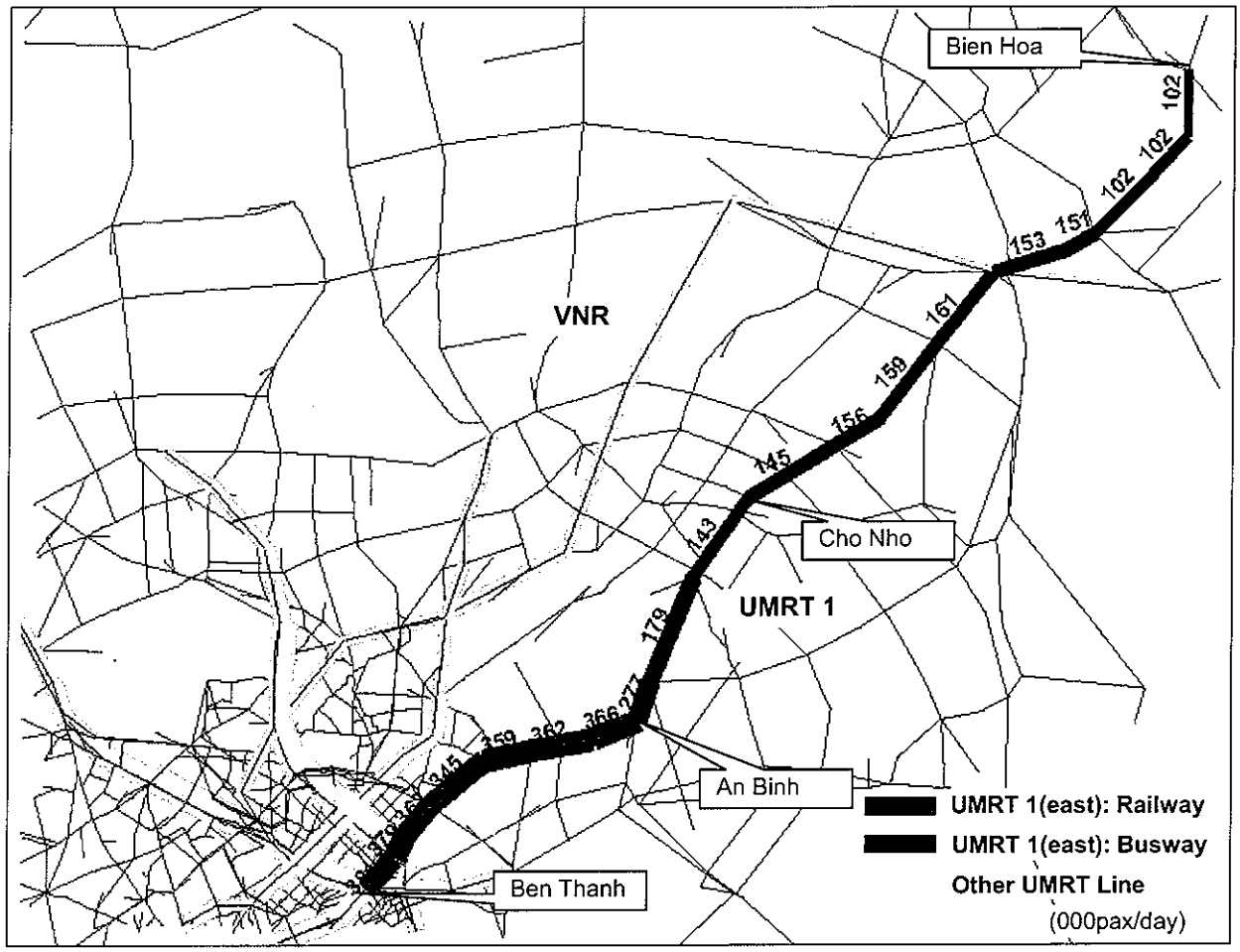
Table 3.2.1 show the estimated ridership of UMRT Line1 from Ben Thanh to Bien Hoa through the traffic assignment and Figure 3.2.2 illustrates the sectional data for ridership.

Table 3.2.1 Estimated Ridership of UMRT Line1

	Route Length (km)	No of Passenger (000 pax/day)	Average Trip Length (km)	Estimated Revenue (000 US$/day)
Railway (Ben Thanh – Thu Duc)	13.7	526	11.1[1)]	358
Busway (Thu Duc – Bien Hoa)	14.5	240	9.8	77
Total	28.2	766	10.8	435

Source: Study Team
[1)] Including west part of UMRT Line1

Figure 3.2.2 No. of Passengers on UMRT Line 1 by Section



Source: Study Team

From the output from the traffic study it is estimated that the patronage or ridership in the design year of 2020 will be in the region of 526 thousand (526,000) passengers per day in rail transit section and 240 thousand (240,000) passengers per day in Busway section. The sectional ridership patronage volumes will be in the region of 14-38 thousand passengers in rail transit section and 10-18 thousand passengers in busway section.

The volume of the patronage forecasts indicate that UMRT Line 1 (East) project will play a significant and essential role in matching capacity with the demand for public transport along the corridor for the design year of 2020 and beyond.

After the implementation of the UMRT Line 1 (East) project, the number of public buses on the Hanoi Highway (SS1-SS5) will drop to between 50-70% of the case 'No Build' (see Table 3.2.2). Overall the total traffic volume and VCR on Hanoi Highway will slightly decrease. The economical evaluation of this project is reviewed in more detail in the last part of this report.

Table 3.2.2 Comparison of Estimated Traffic Volume on UMRT Corridor

	Without project					With project				
	Traffic Volume (000/day)			PCU (000/ day)	VCR[1)]	Traffic Volume (000/day)			PCU (000/ day)	VCR[1)]
	M/C	Car	Bus			M/C	Car	Bus		
SS1	50	52	10	111	0.80	43	47	3	43	0.62
SS2	104	91	8	202	1.37	99	96	2	99	1.08
SS3	49	58	6	113	0.92	49	61	3	49	0.89
SS4	58	79	5	142	0.75	57	81	2	57	0.83
SS5	86	88	6	180	0.79	84	87	4	84	0.82
SS6	56	79	6	141	1.23	47	80	5	47	1.02
SS7	50	61	5	116	0.87	42	59	3	42	0.91
SS8	37	40	6	83	0.77	33	41	5	33	0.80

Source: Study Team
Note: Refer the location in Figure 3.3.1

The sensitivity analysis on the fare lave of UMRT Line 1 is conducted as shown in Table 3.2.3. As a result, the fare system which is 5,000VND for base fare and 500VND per km shows the largest revenue.

Table 3.2.3 Sensitivity Analysis on Fare Level

Fare System (for railway)	No of Passengers (000/day)			Revenue (000 US$/day)
	Railway	Busway	Total	
5,000+300VND/km	574	240	894	386
5,000+500VND/km	526	240	763	**435**
5,000+1,000VND/km	384	235	619	427
5,000+1,500VND/km	256	190	446	364

Source: Study Team

Table 3.2.4 2020 Ridership Forecast

	Passenger (person/day)	Passenger (person/h/direction: AM peak)			
		BT->BH		BH->BT	
		boarding	alighting	boarding	alighting
Ben Thanh* Stn 1	185,843	7,790	16,843	3,967	15,374
People's Com.*Stn 2	178,098	6,528	12,592	7,644	12,365
Saigon Zoo Stn 3	40,555	384	4,612	1,399	2,544
Thi Nghe Stn. 4	35,494	203	1,809	5,501	1,533
Saigon Bridge Stn 5	38,215	3,170	399	1,231	2,698
Thao Dien Stn 6	26,007	1,543	186	3,301	918
Huong Hiep Stn. 7	28,495	714	918	2,732	206
An Binh* Stn 8	205,909	6,428	8,260	24,584	1,851
Phuoc Long Stn. 9	123,400	2,988	8,149	8,652	773
Thu Duc Stn 10	48,556	2,742	4,297	5,843	358
Cho Nho* Stn 11	142,645	6,509	16,409	6,188	7,424
(BS01) Stn 12	52,428	1,051	6,200	2,307	4,470
(BS02) Stn 13	16,708	567	3,345	1,245	2,412
(BS03) Stn 14	14,692	1,536	1,317	1,612	2,545
(BS04) Stn 15	49,502	1,570	1,346	1,648	2,602
(BS05) Stn 16	15,608	113	196	424	751
(BS06) Stn 17	42,248	396	1,924	2,926	557
(BS07) Stn 18	25,349	237	1,154	1,755	334
(BS08) Stn 19	16,899	158	770	1,170	223
Bien Hoa* Stn 20	102,236	0	3,428	10,411	0

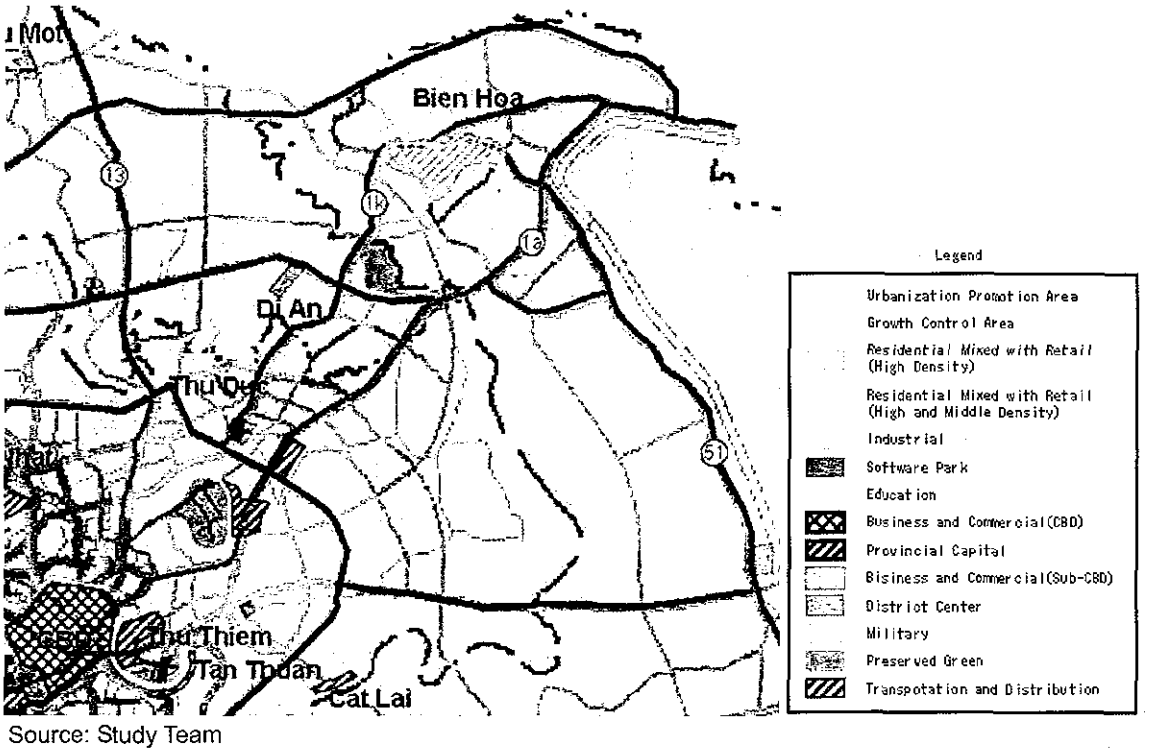
Source: Study Team
* Interchange Station

3.3 Integrated Development

1) Future Land Use

A conceptual land use is proposed in the HOUTRANS Master Plan. In the area along the HCMC-Ben Thanh section large scale of economic activities will be expected in this corridor, in particular the impact of high levels of urban development in Bien Hoa satellite town, sub-CBD in Thu Duc, high-medium density residential and commercial mixed, industrial, educational land uses are proposed as shown in Figure 3.3.1.

Figure 3.3.1 Conceptual Land Use for Recommended Scenario



Source: Study Team

2) Integrated Urban Development along the Corridor

The development of a public transport oriented urban development plan along the corridor will, the team believe minimize the likelihood of further rapid expansion private vehicle usage and improve the urban environment, by providing convenient, affordable and safe public transport alternatives for commuters, shoppers wishing to travel to the HCMC urban area. This is a basic concept objective of town planners of all major cities in the world which the team believe can be achieved in HCMC should the UMRT Line 1 (East) project is implemented.

The acceleration of use by the residents of HCMC and its suburbs of the future public transport system is the overall objective of this master plan study for the reasons noted below, and the study team believe is a necessity for the prosperity and sustainability of the economic growth of the HCMC Metropolitan Area.

"Ensure mobility and accessibility to needed urban services for its people and society that is characterized by safety, amenity and equity and sustained by an efficient public transport system."

Based on the above concept objective, the concept of an integrated urban development along urban mass rapid transit (UMRT) Line 1 (East) corridor is the key issue in the implementation of the local area transport planning along this major public transport route to HCMC. The following factors affecting future land use, urban structure, primary road network and trunk public transport system, the study team has identified several important and key issues in this study. They are:

(1) Provide the major urban functions such as institutional and business facilities around the intermodal transport interchange areas at the station sites including such as the development of a district centre within the station interchange areas which will in turn generate major activities for the local population and will accelerate the economic prosperity in the district.

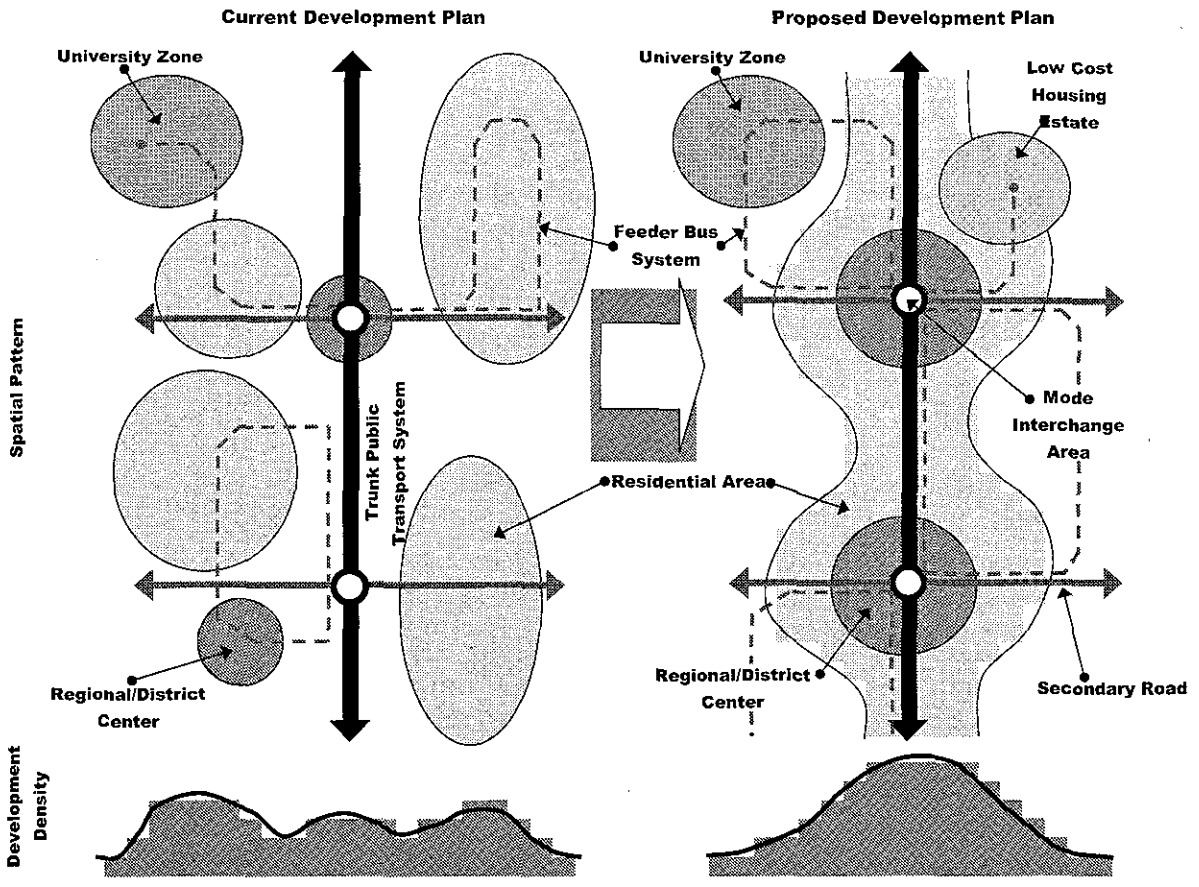
(2) Develop the residential area near the intermodal station interchange area. Residential areas located near transit stations give an incentive to people to relocate from the congested urban areas to live living in the suburban area along the UMRT route because the travel time to the city center is short and the living environment in the suburbs is of a higher standard and quality. In addition the people who have been displaced during the construction of the UMRT system can be relocated to areas close by within the catchment areas of the UMRT Line 1 (East) which would minimize the social impact on the local community along the corridor.

(3) As part of the project government should include the construction of convenient access roads and parking structures either integrated with or close to the intermodal interchange station development areas which will minimize the time taken for UMRT Line 1(East) commuters to transfer between the various transport modes including feeder bus public transport system

(4) Not only will a convenient feeder bus system and public transport improvement measures such as park & bus ride parking but also development of smooth transfer at transit station but will encourage people to use public transport system more and reduce the use of private vehicles in the urban area with major savings to the local and countries economy by utilizing less oil based products and generally improve the local environment.

Figure 3.3.2 shows the concept of integrated urban development along transit corridor and the potential for development of major intermodal interchange stations along the transport corridor.

Figure 3.3.2 Concept of Integrated Urban Development along Transit Corridor



Source: Study Team

4 ENGINEERING

4.1 Introduction

This chapter reviews the major engineering options for the proposed Urban Mass Rapid Transit (UMRT) Line 1 (East) rail and busway transit system from Bien Thanh Market in HCMC central district to the new eastern suburban area of Dong Nai, a distance of approximately twenty nine (29) kilometres.

The engineering aspects of the study were prepared based on a review of existing transit studies, topographic & geotechnical survey information and various field trips made by the study team of the proposed transit corridor.

The study scope includes an initial review of all key elements of a modern transit system and includes the following:

- Alignment
- Design Standards
- Civil & Structural
- Facilities & Systems
- Construction
- Budget Costs

Each of these elements of the UMRT Line 1 (East) is reviewed in some detail in this section of the feasibility study with the study teams suggestions and recommendations on key issues necessary for the successful implementation of the project.

4.2 Alignment

1) Rail Transit Segment

(1) Underground Section:

Bien Thanh Market Interchange Station 1 to Saigon Zoo Station 3

The proposed UMRT line 1 (East) section starts at the underground interchange station with Line 2 and overrun tunnels located at the western side of the rotunda at Ben Thanh Market,

The twin running tunnels follow the center line of Le Loi street passing People's Committee street where they bifurcate to pass on either side of People's Theater and its 50-meter deep pile foundations to the station located either just before or to the north east of the existing theater where an underground interchange station with the proposed Line 4 planned alignment along Dinh Phung Hai.

The twin bored running tunnels continue in a north easterly direction under existing streets and low rise dwellings to a cut and cover station located under the existing road, or alternatively below the land presently occupied by Saigon shipyard, at the eastern side of Le Thanh Ton street near the Saigon Zoo Station 3. After the station the running lines will be in a cut and cover section leading to a tunnel portal and retaining structure before the twin track elevated viaduct along Nguyen Huu Chanh Street.

(2) Elevated Viaduct Section:

Saigon Zoo Station 3 to An Binh Station 8

The line then continues on a twin track elevated viaduct along the center of Nguyen Huu Chanh street from the southeast, thence along Thi Nghe Street at second/third level after crossing two minor rivers up to the left bank of the Saigon river near the existing highway bridge crossing.

There are two elevated stations on this section at Thi Nghe Station 4 and Saigon Bridge Station 5.

In order to maintain the river navigation channel a high level twin track bridge has to be constructed either downstream or upstream from the existing Saigon Bridge road crossing.

The elevated twin track viaduct alignment track continues for about a further three (3) kilometres from the eastern bank of the Saigon river along Thao Dien and Huong Hiep streets either parallel to and south of Ha Noi Highway, or alternatively along the center line of the Highway to end at An Binh street station.

There will be two elevated stations at Thao Dien Station 6 and Huong Hiep station 7 on this section of the line.

At An Binh Station 8 for operational reasons there will be a three platform arrangement with a spur line to the Rang Depot and stabling yard located parallel to the river Chiec.

(3) At Grade Section:

An Binh Station 8 to Cho Nho Interchange Station 11

From An Binh Street Station 8, the elevated viaduct alignment crosses over Hanoi Highway and continues at-grade on the highway median until reaching Cho Nho Terminal interchange station just past Thu Duc Street.

There will be two intermediate stations at grade in this section at Phong Long Station 9 and Thu Duc Station 10.

There will be a connection with the proposed Busway transit system will be at Cho Nho Station 11, which is the highest point of the rail transit at about 30 meters above sea level.

(4) Alignment: Vertical & Horizontal parameters

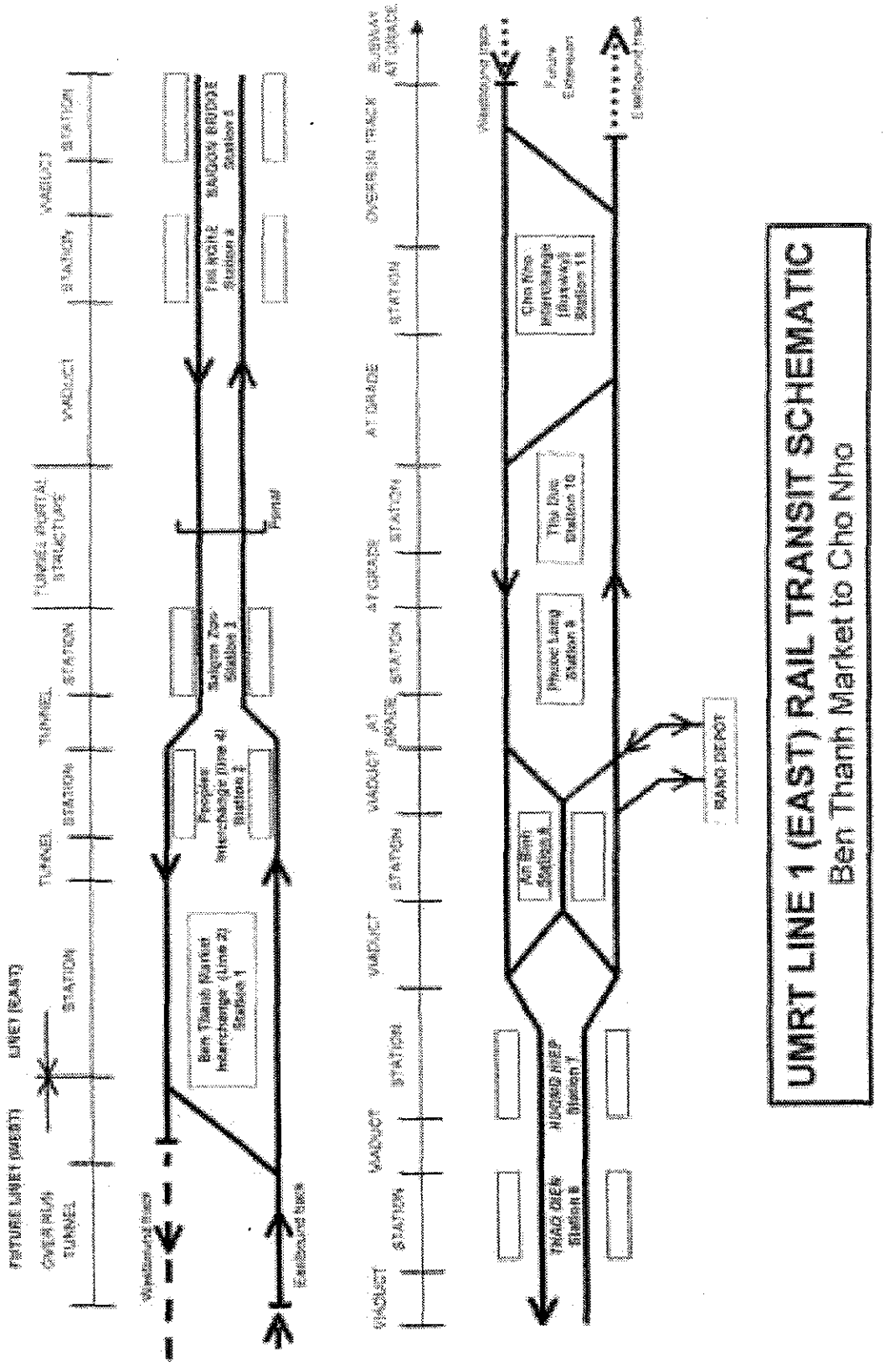
The maximum gradient for the rail transit alignment varies from 0.5% to 3% along the route with a minimum horizontal curvature of 350 metres. Table 4.2.1 and Figure 4.2.1 gives the principal structures and outline characteristics of the rail section of the transit system.

Table 4.2.1 Outline of the Rail Transit Segment

Section	Between Ben Thanh to An Binh	Between An Binh to Cho Nho	Total
Route Length (km)	8.2	5.7	13.9
No. of Stations	3 Underground (2 interchange) , 5 Elevated	3 At-grade (1 interchange)	11
Structures	Over-run tunnels, Twin running line tunnels (2.0 km.), tunnel portal structure, Elevated viaduct (6.2 km.), and Depot track, Workshop with stabling, ventilation shafts, traction substations and ancillary buildings	Elevated twin track viaduct (0.9 km.) + At-grade twin track (4.7 km.) Traction substations	

Source: Study Team

Figure 4.2.1 Track Layout of UMRT Line 1 (East) (Metro Rail Transit Section)



Source: Study Team

2) Busway Segment: Cho Nho Station 11 to Bien Hoa Multimodal Station 20

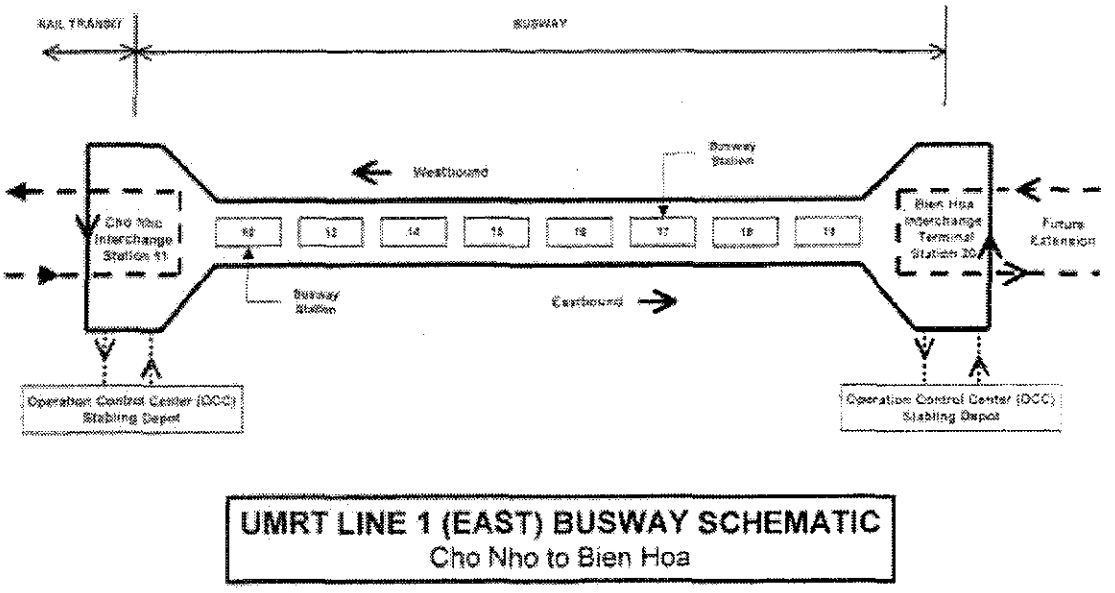
From Cho Nho Street multimodal Interchange station 11, the transit line extends as a Busway system, at-grade, on an exclusive twin lanes in the middle of Hanoi Highway to the proposed multimodal interchange terminal station at Bien Hoa, Dong Nai. To accommodate the exclusive busway lanes, it is proposed that the existing Hanoi Highway be widened to approximately 72.5m. The Busway will cross the Dong Nai River on the existing bridge with two new bridges constructed to accommodate other road users. In addition to the two (2) Busway interchanges

There are six (6) intermediate Busway stations along the route from Cho Nho to the multimodal interchange and turnaround facility at Bien Hoa terminal station, The total route distance of the busway transit system is approximately fifteen (15) kilometres.

Alignment: Vertical & Horizontal parameters

The horizontal and vertical alignment of the Busway will be designed to allow for future capacity expansion to a rail based transit system when the demand on this section of the transit system can justify the additional costs of a rail transit system.

Figure 4.2.2 Track Layout of UMRT Line 1 (East) (Busway Section)



UMRT LINE 1 (EAST) BUSWAY SCHEMATIC
Cho Nho to Bien Hoa

Source: Study Team

4.3 Design Standards

In preparing the outline mainline route vertical and horizontal alignment for the UMRT Line 1 (East) rail and busway system it was assumed that both systems would conform to the standards outlined in Table 4.3.1 below. Before, the next stage of project development and the preparation of the preliminary engineering and detailed design stage commences, the implementing agency will have to decide on the final design standards and criteria to be adopted taking into account the existing and proposed transit systems in HCMC.

Table 4.3.1 Key Features of Design Standards

Design Item	Railway	Busway (Hanoi Highway)
Minimum Curve Radius	600 m (350 m)	200 m (150m)
Maximum Gradient	3.0 % (4.0 %)	4.0 %
Minimum Vertical Radius	3,000 m (1,600 m)	1,400 m (Crest) 1,000 m (Sag)
Car Clearance	3,000 mm	
Structure Clearance	3,800 mm	
Track Gauge	Optional (1,000mm, 1,435mm)	
Minimum Distance between Tracks	3.6-4.8 m	
Overhead Clearance over Track	6m from the rail level. For flood protection the height of trackbed of is required to be a minimum 50cm above the road surface.	
Track Bed	Concrete fixed track railway bed for the underground and elevated viaduct section, and ballast track bed for the at-grade section.	
Width of Station at Platform level	Underground section: 10 m + construction space 2 m Elevated section: 9.5 m + construction space 1.5 m At-grade: 13 m	
Width of Station at concourse level	Underground section: 20 m + construction space 2 m Elevated section: 17.5 m + construction space 1.5 m At-grade section: 20 m	
Length of Platform	Underground section: 120 + 5 x 2 m Elevated and At-grade section: 120 + 10 x 2 m	65 m
Width of Platform	Island: 9 to 11 m Side: 3 to 5 m	6 to 10 m 3 to 5 m

Source: Study Team
Note: Figures in parenthesis indicate the exceptional standard for critical sections.

4.4 Civil and Structural

1) Metro Rail Transit Section

(1) Running line between Stations

a) Underground Section: Bien Thanh Market overrun tunnels to Saigon Zoo Station

For the section between Bien Thanh overrun tunnels and Saigon Zoo station depending on the results of the geotechnical site investigation either a twin cell cut and cover tunnel approximately 14 meters deep or two number single track bored tunnels using a tunnel boring machine (TBM) will the likely engineering options to be considered for the section (~670meters) between Ben Thanh Street and People's Committee Street.

For the mainline section up to Saigon Zoo Street (approx. 1-km long), in order to avoid the existing piled foundations of the People's Theater. it is likely that the construction method will utilize a tunnel shield for the two single track tunnels will be adopted The starting base for single track shield is at the Zoo Street, turns at People's Committee Street, and loops back to Zoo St. (Refer to Figure 4.4.1).

The final engineering tunneling method to be adopted will be dependent on environmental issues whether open cut tunneling will be permitted thru this sensitive high amenity cultural area and which option will be the most economical preferred method of working to be proposed by the design/build tunnel contractors.

As a tunnel boring machine has to be mobilized for the section between the Peoples Theater and Saigon Zoo Stations the additional tunneling of the mainline to Bien Thanh market may be a viable and cost effective method of construction.

Tunnel ventilation shafts will be required in this section of the mainline track and can be used as the access and turning points for the tunnel boring machine(s).

Floating track bed may be required adjacent to noise and vibration sensitive receivers such as the Peoples Theater. Further study into this specialist topic is recommended.

b) Le Thanh Ton Street Section (Tunnel Portal)

The underground portal section from Saigon Zoo Street Station to Saigon shipyard is to be constructed by cut and cover, earth retaining structures and viaduct abutment. The mainline tunnel portal structure will be located just north of Saigon Zoo Station structure where the track goes from an underground to the elevated viaduct section over Nguyen Huu Chanh Street. The Portal structure must be provided with a flood protection sump and pump system and waterproof doors, to preclude rainwater and floodwater (Refer to Figure 4.4.1) from seeping into the mainline tunnels.

c) Nguyen Huu Chanh Street Viaduct

To avoid the existing bridges along Nguyen Huu Chanh Street, and with due regard to the aesthetics, a viaduct with single pier and segmental single box girder with a span approximately 30-35 meters long at either second or third level, to avoid the existing elevated approaches to the Saigon Bridge, depending on the final location at Saigon bridge Station is proposed for this section.

In order to minimize dead loading on the viaduct a concrete slab track is proposed to achieve a slender bridge design. Due to the poor soil conditions in the vicinity the viaduct

would require a piled foundation, since the bearing layer for the bored or driven concrete piles at this location is I the order of 35 to 40 metres deep. (Refer to Figure 4.4.2)

d) Saigon River Viaduct

Depending on the final location of Saigon Bridge Station the rail viaduct bridge will be constructed either one hundred (100) meters upstream or downstream from the existing Road Bridge on Hanoi Highway. In order to maintain the required vessel navigation clearance (80 x 10 meters) on the Saigon River, a continuous 275-m bridge with three spans is envisaged (central span =105 meters, side span = 85 meters). The track height is approximately nineteen (19.2) meters above high water level.

The bridge can be constructed either in segmental precast concrete or like the existing road bridge as a steel box girder supported by a concrete column with a piled foundation suitably protected against marine craft impact.

e) Hanoi Highway, (Saigon River to An Binh Station Section)

This elevated twin track viaduct will be on piles, The alignment will either be on the center line of the existing highway or dependent on the planning constraints and land use along this section of the transport corridor about a hundred metres on the north or south side and parallel to the existing Hanoi Highway. A viaduct of either a single column or a rigid frame with spans in the order of 30 to 35 metres will be located to avoid the existing road crossings. At An Binh Station the entrance/exit track to the Rang Depot will be on viaduct and embankment to the at grade depot tracks. The mainline viaduct will terminate at an MSDR earth retaining abutment follow a downward gradient to form an at grade track in the centre of Hanoi Highway at An Binh Street. (Refer to Figure 4.4.2). Due to the location close to a waterway and in order to minimize differential settlement there is likely to be a settlement transition slab for both the mainline and depot tracks at this location.

f) Hanoi Highway (An Binh to Cho Nho interchange Station)

For the at grade section of mainline track the track support will most probably be on ballasted sleepers, with drainage sub base and side drains at the interface between the rail transit corridor and Hanoi highway. The track will be a minimum of 500mm above the existing road level and have concrete "Jersey" crash barriers and security fencing to separate the transit route from the highway.

A ten to twenty metre wide right of way will be required for the transit corridor depending on the section of track width is needed at this section, to accommodate the Station platforms and the road lane curves. (Refer to Figure 4.4.3). Where there are major feeder road junctions there shall be grade separated crossings of the track.

For rail safety and security consideration should also be given to pedestrian overbridge crossings of the track at strategic locations along the mainline route in this section.

2) Metro Rail Transit Stations

a) Underground (Interchange (2no.) & Intermediate (1no.) Stations)

There are two types of underground station required for this project. At Bien Thanh Market and Peoples Stations there will most likely be a future interchange connection between the proposed future UMRT lines 2 and 4 respectively.

At these stations in addition to UMRT Line 1 passengers there will be a need to make provision for interchange passengers for rail to rail connections and also rail to other modes of transport such as feeder buses, taxis etc.. This will result in a larger number of entrances and exit points as well as additional future ticket gates for passengers transferring between the other transport systems.

At these interchange stations there is also an opportunity to develop park and ride facilities and also commercial or retail developments within the station sites.

The basic concept will be for a two level type station (that has a concourse level connections to ground level and other transit systems with booking office and AFC ticket barrier and a different platform level for incoming and departing trains) is adopted for the underground stations. For rail safety and minimization of the underground ventilation and air conditioning it is suggested that consideration be given to the installation of platform screen doors.

At Ben Thanh Market Station 1, the platform will be island-type which may also include a pocket track to allow storage of trains during out of service hours or to allow trains to terminate at this station while still allowing thru trains on the future UMRT Line 1 west extension, while the a more simpler island platform layout is chosen at the People's Theater and Saigon Zoo Street stations. The minimum earth covering over the station is 3 meter deep.

If a tunnel shield is the preferred method of construction it would be possible to reduce costs of the Bien Thanh and Peoples theater stations by constructing part of the station length as a tunnel platform with a central section constructed using cut and cover diaphragm earth retaining walls for the platform and concourse areas.

For Saigon Zoo station it is likely to be shallower in depth being near the tunnel portal therefore a cut and cover station box would be the most economic solution.

Each of the stations will have to include tunnel ventilation shafts in the final design with Bien Thanh Market likely to include a traction power substation and possible an infeed substation in the final design.

All entrances and transfers from platform to concourse level will require stairs, escalators and for the handicapped provision for an elevator. The means of escape and fire compartmentation within the underground stations should be designed to comply with the most recent fire safety codes such as NFPA130 or other similar codes.

In order to encourage use of the transit system it is also recommended that the underground stations shall connect to the road via the sidewalk, and to nearby buildings via pedestrian underpasses.

Two stations in the city center would have entrance/exit in nearby buildings, to avoid visual intrusion of the entrance structures these should be designed to suitably blend architecturally with adjacent buildings such as the Market at Bien Thanh and the Peoples Theater historical building. (Refer to Figure 4.4.1).

At Saigon Zoo intermediate station the size of the concourse may be smaller than the main interchange stations however in addition to tunnel ventilation systems there will be a need for flood protection measures such as sumps and pumps together with floodgates and the like to be incorporated within the station box.

b) Elevated (Intermediate (4no.) Terminal (1no.)) Stations

The basic concept design for the elevated stations consists of a concourse paid and unpaid areas on the second level, and the side platforms on the third level either side of the twin track viaduct in the centre of the highway. The concourse level will then connect to sidewalks at ground level, or to nearby buildings via pedestrian overpasses at second level. Escalators should be provided for vertical transfer of passengers with at least one elevator per station for the use of the handicapped or elderly passengers.

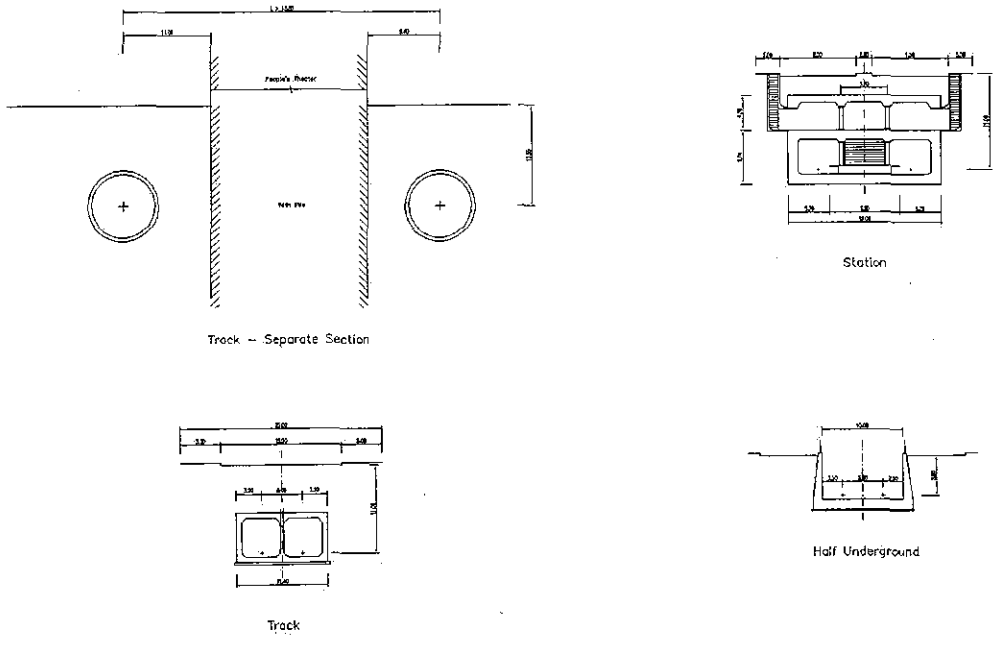
Where the track alignment is off the highway center line, the station would have the concourse floor on the at grade level, under the viaduct, and the side or island platform on the second or viaduct level. The station plaza would the be able to have direct access to feeder bus interchanges and access roads to/from the transit stations.

At the An Binh Street station, the island type platform with a third "pocket" track platform with access from both sides would be required to allow train movements to and from the spur link to the Depot and stabling area and also provide rail operations flexibility and allow storage of trains during off peak, degraded or emergency rail service scenarios. (Refer to Figure 4.4.2)

c) At-grade (intermediate (2no.) Interchange (1no.)) Stations

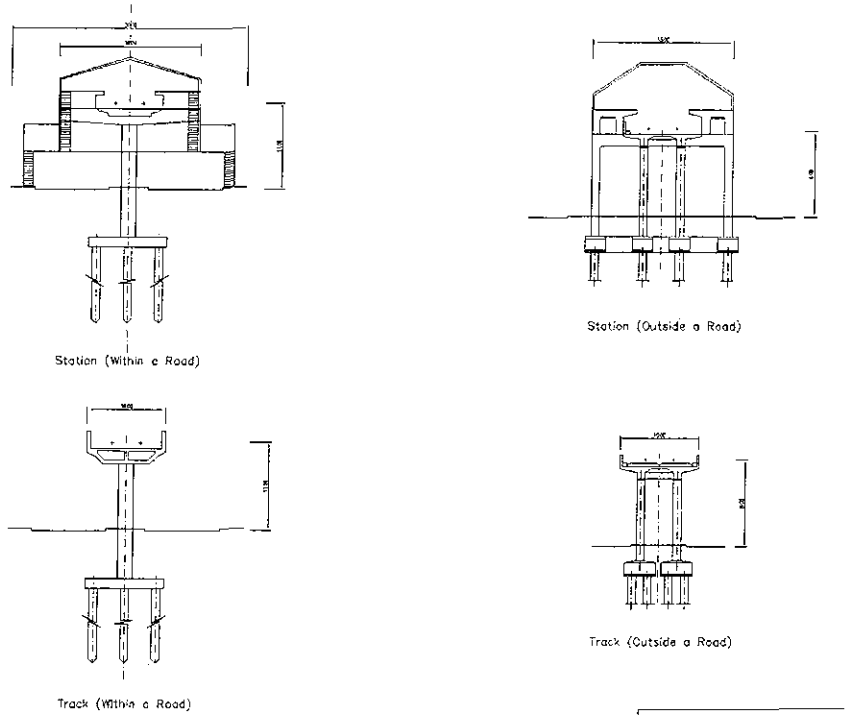
The platform would be at grade with the concourse at the second level. This would allow the station concourse to connect directly to the pedestrian bridges crossing the existing highway to connect the station concourse plaza for smooth transfer of passengers to the Busway transit system or feeder bus will adopt the more economical island platform configuration with elevators and emergency stairs access to the platform level and pedestrian footbridges to adjacent developments. (Refer to Figure 4.4.3)

Figure 4.4.1 Underground Station and Track



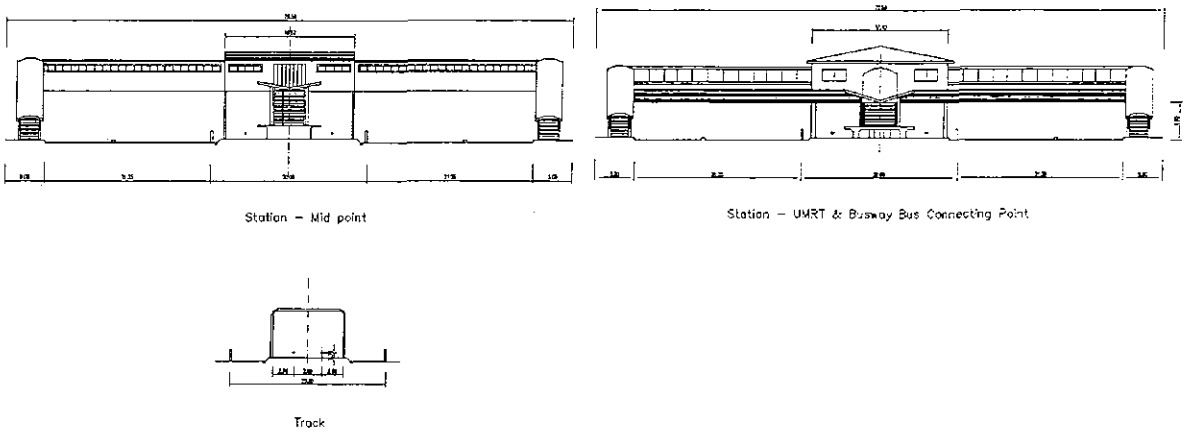
Source: Study Team

Figure 4.4.2 Elevated Station and Track



Source: Study Team

Figure 4.4.3 At-grade Station and Track



Source: Study Team

3) Depot and Stabling

a) Depot Facilities

All transit systems require special facilities for stabling and maintenance of the rolling stock and operations, maintenance and engineering staff facilities.

The facilities to be included in the layout of a Depot will consist of a stabling or storage tracks for the rolling stock, train cleaning facilities, an inspection and first and second line or light maintenance shed, a heavy maintenance shop for third line maintenance of the rolling stock.

In addition facilities such as civil works areas including track maintenance and other systemwide facilities such as infeed electrical substations operations control and maintenance, staff facilities will be included in the final depot design.

The layout of a typical depot and stabling facility is illustrated in figure 4.4.4.

This indicative reference depot layout model will vary depending on the type of rolling stock and operational requirements of the transit system. However the maintenance operation of the facilities may include but not be limited to the type of facility described below.

- ***Light maintenance*** - for daily inspection, cleaning and regular servicing of the rolling stock, and for other light maintenance activities every 3 months or so. In accordance with the rolling stock manufacturer's performance specifications for Inspection, testing and light maintenance of all the major components will be carried out including lubrication in accordance with the manufacturers operations and maintenance manual recommendations. Cleaning of the rolling stock will include a regular exterior water wash to the car body and interior cleaning of the carriages by cleaning crews. A more intense cleaning of the interiors will be carried out on an "as needed" basis depending on the condition and carriage usage. Exterior washing of the car body may include a drive through washing machine which will wash the exterior of the trains.
- ***Workshop*** – for heavy repairs including the car body, bogies, wheels, and other major mechanical and electrical assemblies, ac unit cleaning and replacement, pantograph removal, bogie repair, wheel re-profiling and the like. The depot facilities will include lifting cranage, inspection pits and high level walkways.
- ***Stabling Tracks*** – for storage of rail vehicles during non revenue service periods, when the trains are not in service, or when awaiting cleaning, maintenance and major overhaul. For efficient depot operations the track layout for the stabling area is critical. Ideally for flexible depot shunting operations, each track should have twin fan arrangement, so that, if one end is obstructed for any reason, train units can be maneuvered from the other end. There is no reason why two or more trains should not be stabled on each track if there is sufficient track length, again providing depot operational flexibility so that, if one train develops a fault and is not sent out on time, the other is not blocked in. Train stabling areas are traditionally outdoors however in order to protect the train units from inclement weather in particular radiant heat and UV rays affecting sensitive on board equipment sometimes a lightweight roof structure is included into the final depot design to provide a level of protection to the trains.

- ***Track Maintenance Area*** – to serve as the maintenance base for track work and other lineside activities including maintenance to traction power, signaling, and communications equipment. This area It will also be used to stable works locomotives and wagons used by works trains needed to transport equipment and engineering staff to work sites along the transit system.

b) Depot Location

The proposed location of the depot has been identified in vacant land adjacent to An Binh station near the river Chiec. The selection of the depot site is dictated by several physical and operational factors, including the availability of suitable land in close proximity to the main line of UMRT Line 1 (East). Preferably, the stabling tracks for the rolling stock should be where traffic demand falls sharply where the line capacity and the number of trains in service can be varied efficiently avoiding the need for long non revenue service trips by the rolling stock. Also for ease of operations, the light inspection and cleaning facilities and workshop should be contiguous with the stabling tracks. (Refer to Table 4.4.1)

Table 4.4.1 Location Choices for Each Facilities

	Stabling Sidings for Trains	Light Inspection Base	Workshop
Line1	Long line length from/to city center, plus AM/PM car requirements, suggest that the sidings be set near An Binh station (river Chiec).	It is set at An Binh, Bien Hoa direction.	It is set at An Binh, Bien Hoa direction.

Source: Study Team

At this early feasibility stage of the project development the required area for a stabling yard and light inspection base is calculated based on previous experience on similar depot and stabling facilities. The study team have therefore assumed the following space requirements for stabling areas of 300 sq.m per car, and for the workshop at 90 sq.m per car. To allow for future growth and capacity expansion of the system, as well as open space for other ancillary, administration, operations and maintenance facilities, the ultimate number of carriages to be accommodated at the depot is assumed to be twice the number of car required to provide sufficient capacity to meet the 2020 peak passenger demand. Whilst the rolling stock requirements for the line will be estimated based on the number of required cars to satisfy the 2020 passenger demand forecasts the design of the area of depot including the maintenance and administration facilities will be based on the ultimate line capacity. (Refer to Table 4.4.2)

Table 4.4.2 Area of Rang Depot (ha)

	Light Inspection Base with Stabling Tracks		Workshop	Total	
	2020	ultimate		2020	ultimate
UMRT Line 1 (An Binh)	4.4	8.9	2.0	6.4	10.9

Source: Study Team

c) Depot Access

An essential feature of a transit depot is good access for both road and rail vehicles. The depot tracks should be designed in such a manner to allow trains to get in and out of the depot without delaying train operations on the main line tracks or impacting the normal

operations within the depot area. Trains entering or leaving the depot area must be able to do so in a safe and efficient manner. It is not good railway practice if for example a train coming into the depot has to stop at the depot entrance while the driver gets authority to proceed from the shunter or depot control office and the rear of the train is still blocking the main line track. Situations like this can remove two or three paths from a timetable with potential disruption to revenue service. Therefore a long access track into the depot fan area is required.

If the railway is equipped with Automatic Train Protection (ATP) the changeover between ATP and restricted manual driver operation mode will have to take place on this track. This must be carefully incorporated into the depot track and signaling design during the next stage of project development

For Rang depot an elevated access track to An Binh station will be required together with the associated track turnouts. In order to allow westbound trains to access the depot an additional pocket track will be provided at An Binh station which will allow mainline services to terminate and be stabled at this station without affecting through trains on the mainline track. At the changeover from peak to off peak service trains can be introduced into revenue service very quickly which will allow the transit operator to match train frequency with passenger demand.

In addition, in the unlikely event of a train breakdown on the mainline track the disabled train can be quickly pushed into this siding before being taken to the depot for repair allowing normal mainline transit operations to resume revenue service as fast as possible.

Road access to the depot site is also important. Large items of equipment may be needed to be delivered to the depot such as electrical transformers, pre-assembled train units and the like therefore, space to allow heavy trucks to enter the depot site and turn, unload and exit will be provided in the final depot design. This will be of particular importance during commissioning of the transit system when it will be necessary to provide car delivery access by road from the docks. Temporary accommodation for systemwide suppliers and contractors including hard standing areas and unloading facilities like cranes or gantries will also be incorporated into the design when designing such a depot. The hard standing needs to be located over or near a suitable track so that cars being delivered can be craned off the road vehicle and mounted onto their bogies, which have been delivered in advance and are already on the track. The cranage can be hired, if permanent installation of such equipment is not considered justifiable.

d) Depot Facilities: Electric and Mechanical systems

The electrical power used in the depot operations and traction power for the rolling stock will be supplied directly from the Vietnamese Electric Company. This will require a step-down infeed substation. For the 1500V DC traction power on the line can be supplied from this power source with alternate power sources along the line, depending on the power grid layout, to ensure security of a power supply for the rolling stock traction power. The signaling and communications systems could be operated from the depot control center.

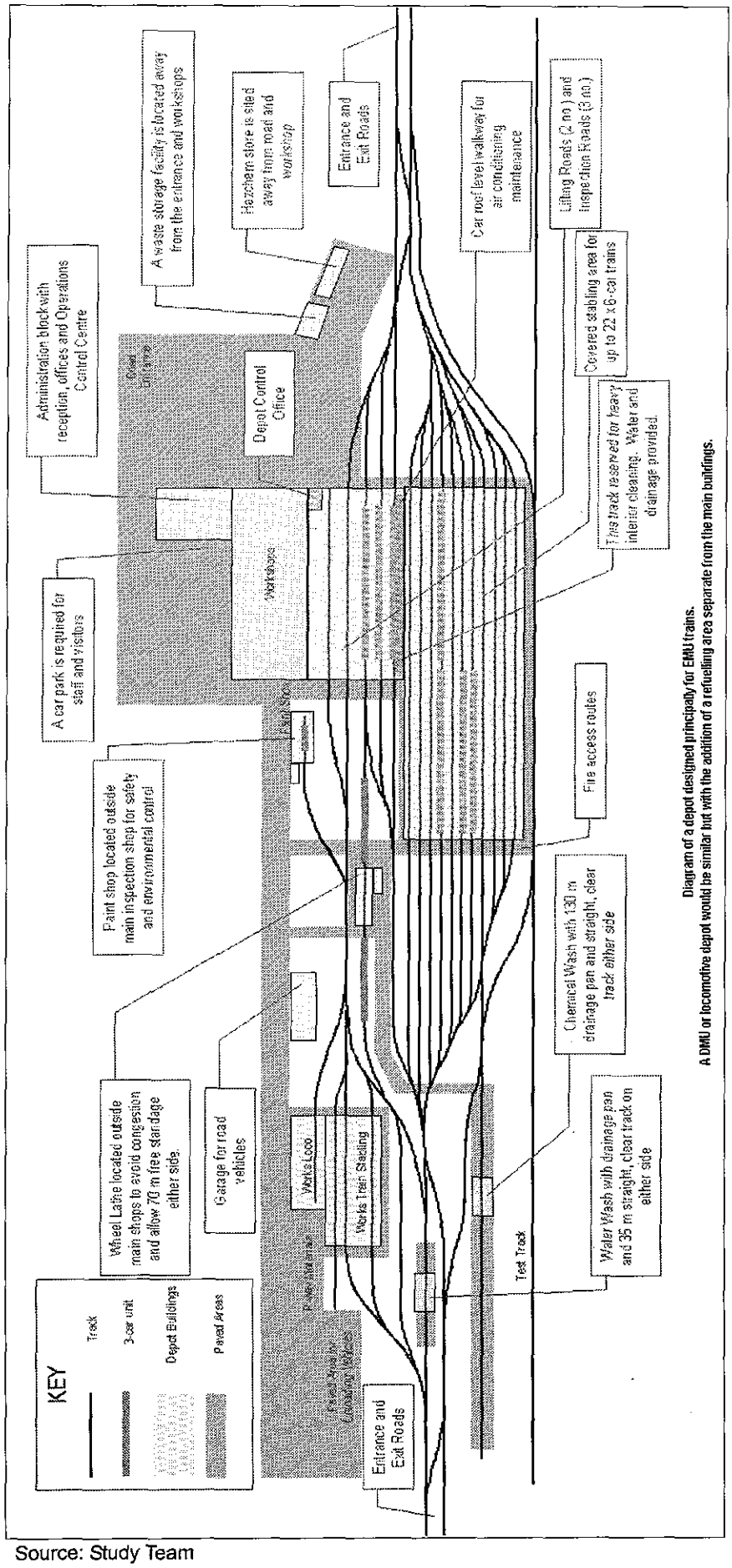
Other maintenance facilities to be provided at the Depot may include such equipment as wheel lathes, the lifting jacks for separating car body and bogies, testing equipment for

signal equipment and brake equipment and other small tools and equipment necessary to operate a modern maintenance depot facility.

Most transit depots are equipped with a wheel profiling facility or under floor wheel lathe. These lathes are normally designed so that the wheels can be re-profiled while still attached to the car body which saves valuable time by avoiding having to remove the wheels and bogies from the car body which results in shorter time a train unit is not available fro revenue service. Alternatively, if the initial project budget cannot justify the capital expense of an under floor wheel lathe the maintenance team can use the traditional method for accessing bogies by lifting the car body off the bogies by use of an overhead or mobile cranes. which lift both ends of the car body together and free both bogies at the same time. The body can then be removed to another part of the workshop for maintenance. Jacks are now the preferred method of lifting – where vehicles can be lifted individually or, if a fixed formation is used for normal service, lift the whole train set. This is done by synchronized jacks. The jacks are linked by control cables and controlled by one person from a control desk. The big advantage of this system is that the maintenance crew don't have to break up the train into individual cars to do the work on one vehicle. The time saved reduces the period the train is out of service.

After consultation with the proposed operator of the transit system rolling stock the preferred method of wheel profiling should be determined during the preliminary design stage of the project.

Figure 4.4.4 Schematic Layout of the Depot



Source: Study Team

4) Busway Transit System Cho Nho to Bien Hoa (Stations 11 to 20)

a) Busway Route Alignment

The width of the busway route alignment will require between ten and twenty metres on the median of Ha Noi Highway depending on the location with the widest being necessary at the busway stations with approximately ten metres required on straight sections of the transit route which will be slightly wider at curved sections of the route alignment. These exclusive busway lanes can be constructed at the same time when Hanoi Highway is upgraded and widened from the present 23.5m to a final right of way width of 72.5m. A low-height concrete "jersey" barrier and a pedestrian safety/security fence will be required to avoid interruption in the high speed bus flow, or the intrusion of other road vehicles on the busway transit corridor. For safety and operational reasons it is recommended that the busway have no at grade vehicular or pedestrian crossings along the route with either the Busway being elevated thru the existing junctions or alternatively new vehicular and/or pedestrian bridges being constructed over the Busway. The Busway should be slightly elevated above the existing or future road carriageway to minimise the likelihood of service interruption due to localised flooding of the busway.

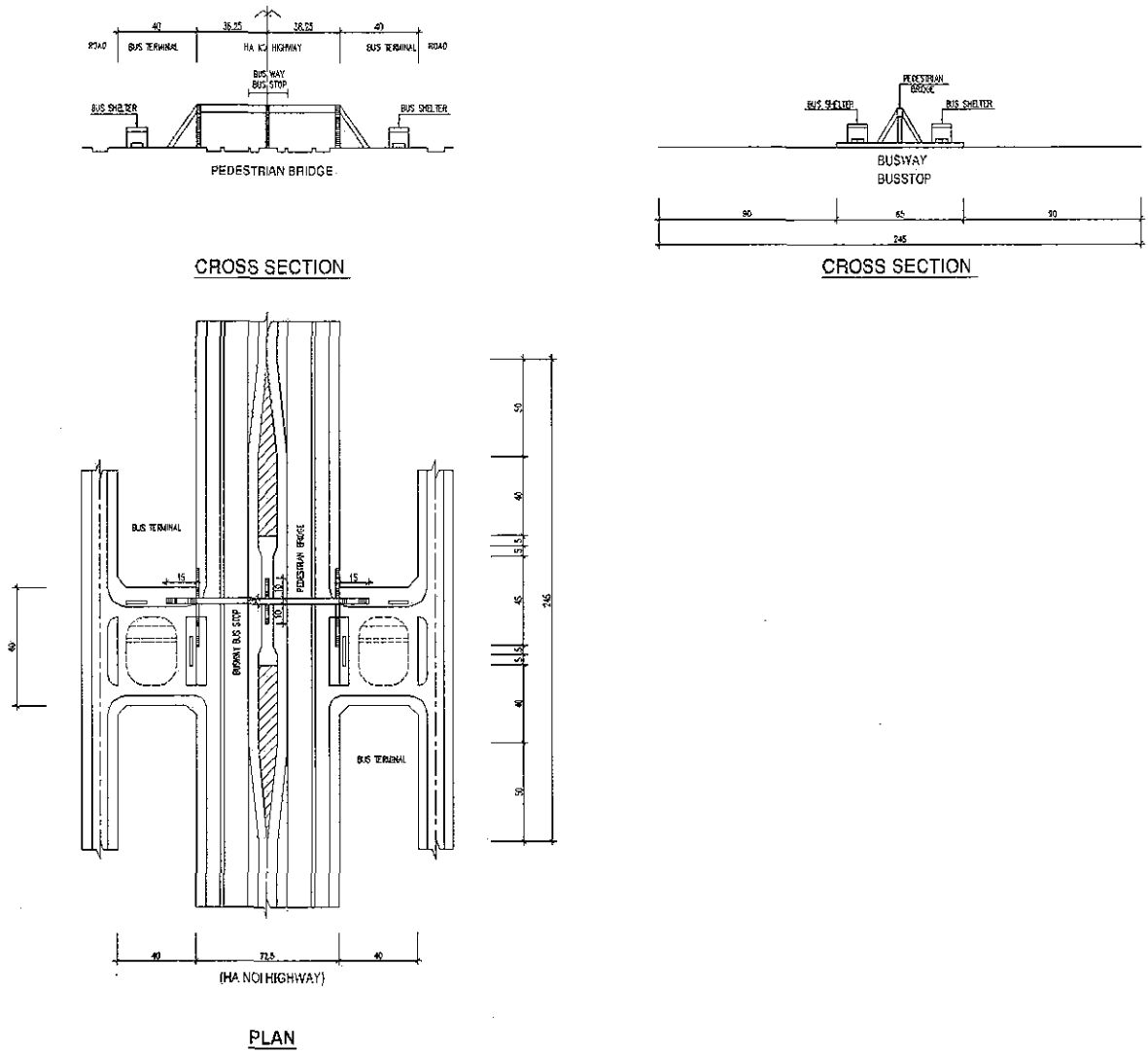
b) Busway Stations (Interchange (2) Intermediate (8))

In a similar manner to the rail transit station, the busway station will provide control and facilitate the fast and safe loading/unloading of passengers. For the busway station, a low island type platform (65m long and 6~10m wide) is envisaged (Refer to Figure 4.4.5). The number and proposed locations of the Busway stations have to take into account the following basic criteria:

- Easy walking distance from a ramp to/or a flyover crossing over the Hanoi Highway;
- Close to existing or planned public facilities such as retail, commercial or recreational establishments;
- Adjacent to suitable sites with development potential;
- Passenger demand and ease of access
- Close to existing and future planned feeder bus routes, car and motorcycle parking facilities.

For the Terminal or interchange stations at Cho Nho Station 11 and Bien Hoa a fully integrated multimodal facility should be provided. In addition to providing the basic transportation interchange, access roads and other operational facilities consideration should be given to developing a focal point for the local community incorporating, retail, leisure, commercial and possibly residential developments closely linked to the multimodal site. Further detailed planning of these multimodal sites is therefore recommended during the next stage of project development.

Figure 4.4.5 Bus Stop and Bus Terminal



Source: Study Team

For the first phase of the Busway system twenty (20) Busway stations are planned along UMRT line 1 (East) transport corridor from Bien Thanh market to Bien Hoa. For the section between Ben Thanh market and Thu Duc, these Busway stations should coincide with the proposed locations of the rail transit stations. Thus, the initial revenue service operations of the Busway transit service will commence at the interchange station located at Bien Thanh market with intermediate stations located near to the proposed future rail transit stations with a multimodal transfer station constructed at Cho Nho transport interchange, the future multimodal site and transfer station from the rail transit to the Busway system. Thereafter, intermediate Busway stations should be established at the permanent Busway station sites along Hanoi highway to the multimodal terminal site at Bien Hoa Station 20.

c) Multimodal Busway Interchange Terminals

Where a major passenger transfer point occurs, and the patronage forecasts indicate high passenger volumes, a multimodal interchange bus terminal is planned. This will include the construction of multimodals at the interchange station from road to rail transit at Cho

Nho and at the start of the Busway system in Bien Hoa. The size of a bus terminal will be a function of passenger volume forecast, the frequency of service to meet the demand, and land availability. Initial studies would indicates that these terminals will be grade separated from the feeder bus stations and park and ride areas and be linked directly with the concourse level of the transit station to ensure a smooth and direct transfer between the two high capacity transit systems.

It is proposed that the HCMC central terminal or transit plaza will be the intersection of UMRT Lines 1 and 2, at the Ben Thanh rotunda in District 1, The site is presently a major feeder bus terminal therefore land availability for the first phase Busway terminal is not foreseen as a major issue. A second intermediate bus terminal near the western approaches to the existing Saigon Bridge is planned. A suitable site for this terminal has been identified near the existing container port facing the Saigon River. A third bus terminal has been identified at Cho Nho Station 11 where the initial phase of the rail transit system will terminate.

Table 4.4.3 Proposed Locations of Bus Terminals (Initial Phase)

	Rail transit & Busway Station Number system		
Rail/Busway Station Type	Underground: Stations 1 to 3	Elevated: Stations 4to8	At grade: Stations 9 to 20
Location	Urban Stations 1~5	Suburban development 6~20	
Multimodal transport Terminals	Stations 1, 5, 20		
Interchange station for feeder bus	Stations 3, 4		

Source: Study Team

The size of a bus terminal will be determined based on the patronage forecasts for the number of passengers that are expected to use the transport interchange facility. From experience for the convenience and safety of vehicle and pedestrian movements, a minimum size of for a bus interchange terminal has been assumed as 2,400m2 (60m x 40m).this assumption should be verified during the next stage of design development.

Table 4.4.4 Size of Bus Terminal

Transit/ Busway station number	Area of Terminal planned		Remarks
	Westbound (sqm)	Eastbound (sqm)	
Bien Thanh Market Station 1	Redevelopment of existing bus terminal		Multimodal interchange UMRT Line 2
2	No terminal, no bus stop		Interchange UMRT Line 4
3	Bus stop		Built-up Area
4	Bus stop		Built-up Area
Saigon Bridge Station 5	-	11,050	Feeder bus interchange, m/cycle park & ride 130m x 85m
6、7	2,400	2,400	Feeder bus interchange, m/cycle park & ride 60m x 40m (min)
An Binh Station 8	5,400	5,400	Feeder bus interchange m/cycle park & ride, Depot 90m x 60m
9, 10	2,400	2,400	60m x 40m (min)
Cho Nho Station 11 (Multimodal Connection of rail transit and Busway system)	7,200	7,200	90m x 80m
	-	11,600	145m x 80m Rail transit/Busway transfer terminal, feeder bus interchange, car, m/cycle park & ride
12	5,400	5,400	90m x 60m
13 ~ 19	2,400	2,400	60m x 40m (min)
Bien Hoa Station 20	-	14,500	Multimodal interchange and terminal station of Busway Feeder bus terminal, car, m/cycle park & ride

Source: Study Team

d) Access Ramps and Turning Points

The Cho Nho (Station 11) and Bien Hoa (Station 20) bus terminals are considered the start/end point of the UMLRT line 1 (East) Busway system. When the rail transit phase of the UMRT Line 1 (East) project is put into commercial revenue service operations in 2010/11 the transfer from rail transit to the Busway system will relocate to Cho Nho (Station 11). This station will therefore have to be designed to allow for a phased development of the multimodal transport interchange facility and will require a special design for the feeder bus terminal on either side of the road so for safety and security reasons Busway passengers will not be permitted to make an at-grade crossings on the Hanoi highway. In addition to avoid vehicular traffic congestion/disruption on Hanoi highway an overhead access/exit ramp from the transport interchange to connect the Busway lanes in the median of Hanoi highway to the elevated passenger transfer station concourse will be necessary.

A ramp to a second level transport interchange concourse which will allow for grade segregated Busway turning movements will be provided at the Bien Hoa multimodal (Station 20) located off the eastbound carriageway of Hanoi Highway. This multimodal will be constructed above the intersection of Hanoi Highway and National Highway NH51with feeder buses entering from the rotunda at grade level to a feeder bus terminal and car,

motorcycle park and ride facility. The Busway concourse at second level will be reached from escalators, stairs and elevators which will allow the physically impaired to have easy access to the UMRT Line 1 (East) Busway system.

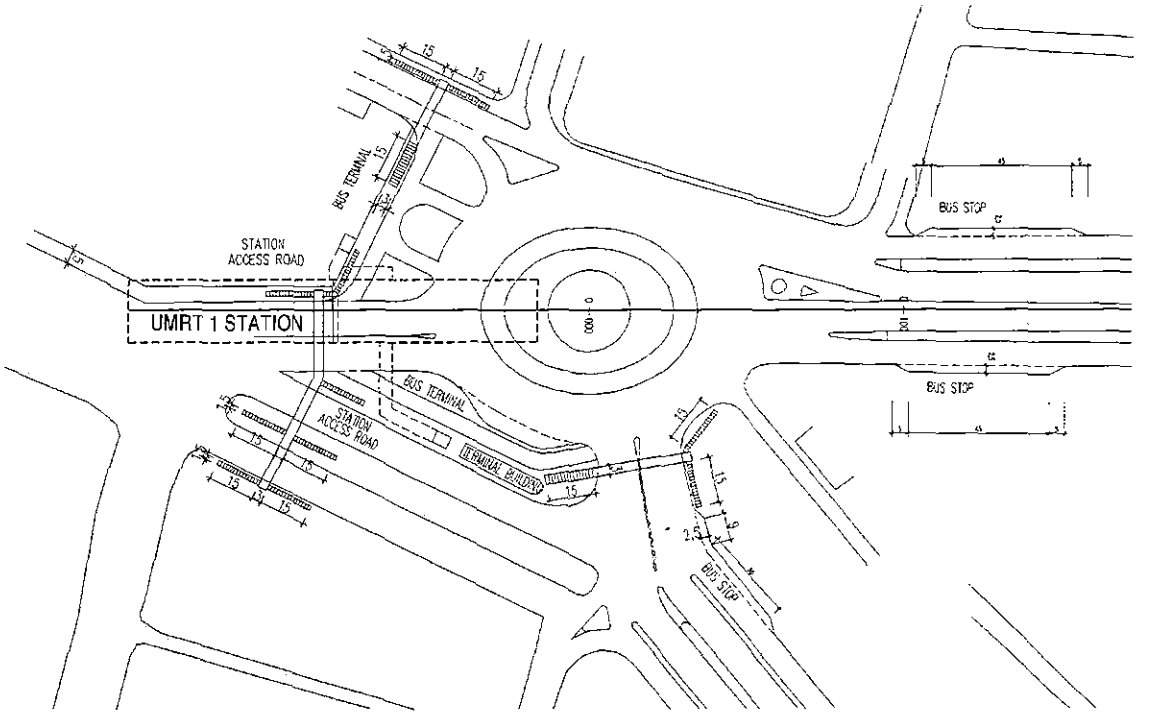
An access ramp to connect the adjoining bus terminal to Nguyen Huu Canh Street. For ordinary feeder buses and other vehicles including drop off/pick up, and park & ride facilities for cars and motorcycles is planned at the Saigon Bridge (Station 5),

Table 4.4.5 Design Criteria of Busway Access Ramps

Item	Design Criteria
Design Speed	40km/hr
Width of Lane	6.5 to 10.0m
Structure Type	Steel or Concrete
Maximum Grade	5.0%
Minimum Curve Radius	40m
Vertical Clearance	4.9m min.

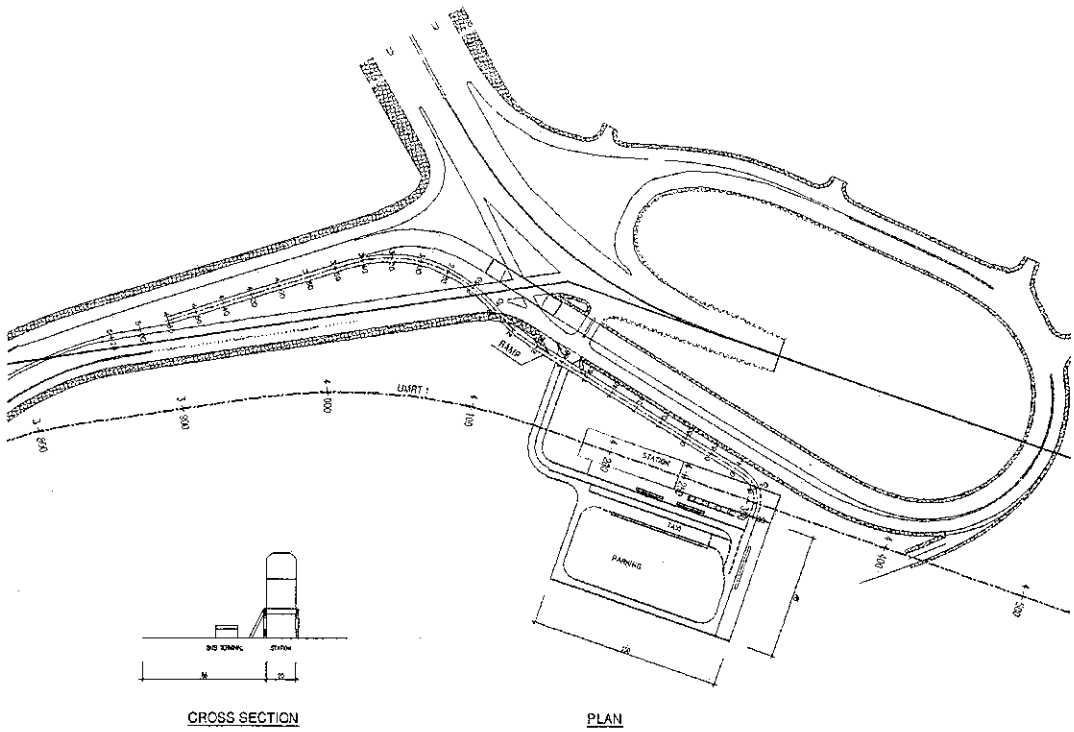
Source: Study Team

Figure 4.4.6 Multimodal Bus Terminal at Ben Thanh Market (Station 1)



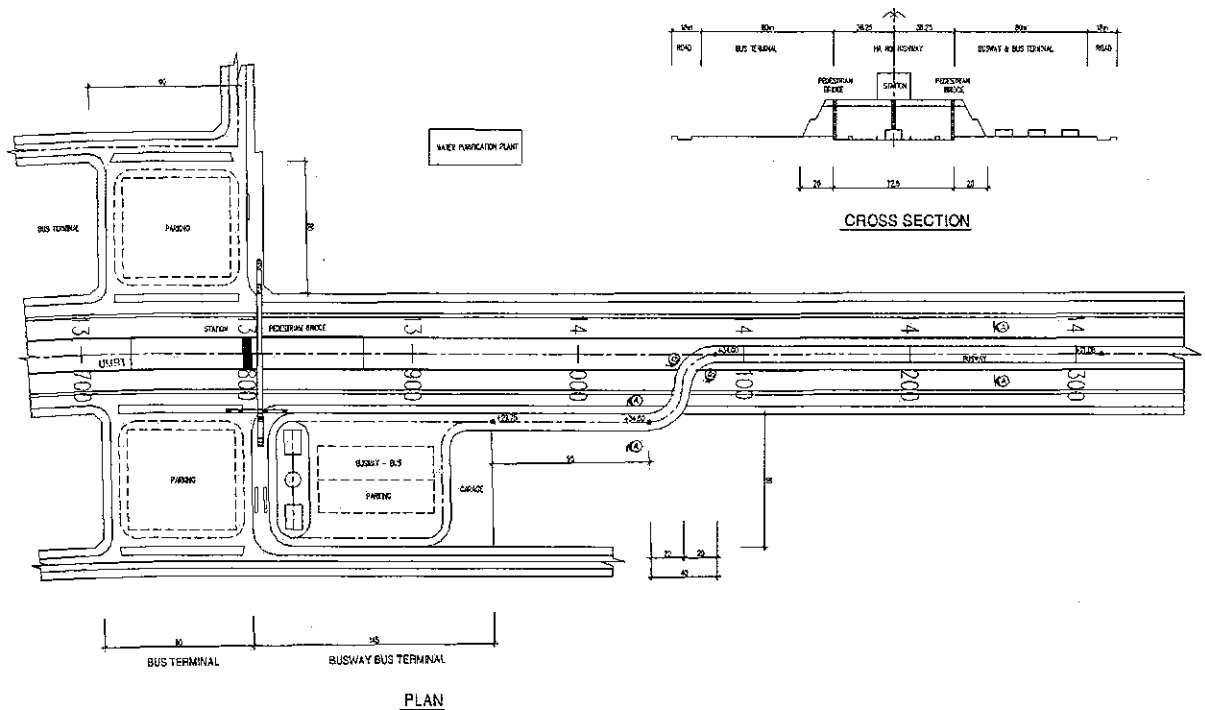
Source: Study Team

Figure 4.4.7 Feeder Bus Terminal at Saigon Bridge (Station 5)



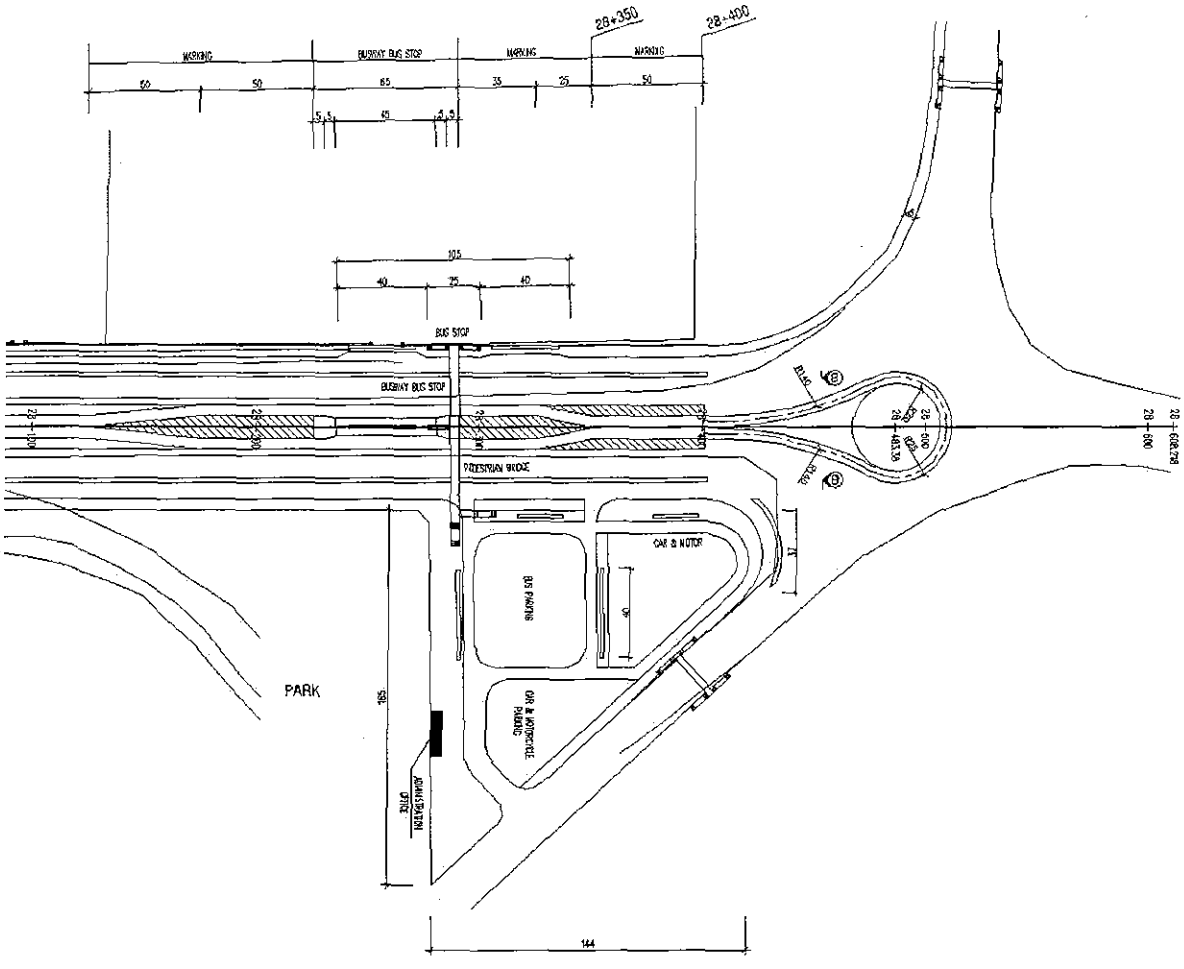
Source: Study Team

Figure 4.4.8 Multimodal Rail Transit/Bus Terminal at Cho Nho (Station 11)



Source: Study Team

Figure 4.4.9 Multimodal Terminal at Bien Hoa (Station 20)



Source: Study Team

4.5 Facilities Plan

1) Metro Rail Transit Facilities

a) Station Facilities

The rail transit stations shall be provided with sufficient space for operations staff and passenger facilities for each of the station types. In addition to plant and equipment rooms the facilities to be provided for operations will include rooms for the ticket sales and collection, staff rest area, the station operations control room, plant rooms for power, signal and communication, AFC and building control systems dependent on whether the station is underground, at grade or elevated. The public areas shall include the platform, concourse paid and unpaid areas, waiting & retail areas and passenger entrances and passageways.

Depending on whether the station is underground, at grade or elevated the type of equipment and systems facilities to be installed at each station will include but not be limited to the following:

- Tunnel and station sumps, pumps and associates pipework;
- Tunnel ventilation and smoke extract system
- Traction and station power supply switchgear and distribution
- Building services incl air-conditioning to certain rooms/areas
- Fire protection equipment, including firemains, smoke extraction for underground stations
- Signaling and communications systems
- UPS, earth bonding
- CCTV & SCADA system
- Fare collection equipment
- Escalators and elevators
- Platform screen doors
- Signage and advertising

The type of facilities to be included within the station complex will include equipment rooms to accommodate the above facilities. A station control room and operational control center (OCC) will be required and located at a suitable site within the rail system.

Underground stations shall be designed to an international safety standard such as NFPA130 for means of escape, fire compartmentation and type of materials to be used in the construction of the station, including architectural finishes. In recent years it has become accepted practice for modern underground Metro systems in Asia to include the installation of Platform Screen Doors (PSD) segregating passengers from the trainway. The principal reasons for installing screen doors in an underground station is one of safety to stop passengers falling into the path of oncoming trains and also to segregate the tunnel and platform ventilation systems. The advantages being better smoke control in the unlikely event of an underground fire and also to reduce the capital cost and energy consumption of the underground station air conditioning systems.

Station entrances shall include covered elevated or at grade walkways, drop off and pick up zones, parking facilities for cars and motorcycles, feeder bus interchanges, hard and soft landscape surrounding the station area.

b) Mainline Track Facilities

The mainline track including underground, at grade and viaduct sections shall include the following trackside services.

- Trackwork incl turnouts
- Traction power and overhead catenary
- Tunnel ventilation & ventilation shafts
- fire protection system incl. fire mains (underground)
- Signaling
- *Communications including fiber optic and leaky coaxial cables*
- Lighting (underground)
- Earthing and bonding system
- Trackside supports
- Tunnel drainage, (sumps pumps and pumping mains)
- Flood protection system including flood doors

Coordinated combined services drawings (CSD) and structural electrical & mechanical drawings (SEMs) defining major civil/structural and mechanical/electrical interfaces shall be defined during the next stage of design development.

c) Traction and Station Power Supply System

The ac power supply at 110 KV from the main distribution grid of the Vietnam Electric Company shall be stepped down from 110 KV to 20 KV, and rectified to dc current at either 1,500 KV to provide the motive power source for the rolling stock. The facilities required include the following:

- Passive Infeed Substation – to convert AC 110KV to AC 20 KV; This will be located at a convenient site close by existing VEC distribution system possibly either at Saigon Bridge station or alternatively at the Rang depot site.
- Traction Substations – to be installed within the transit stations at intervals of 2-4 km, to convert AC 20 KV to 1,500 V DC;
- Overhead Line – the traction distribution system will be either an overhead line to supply power to trains while at the underground section shall be of the rigid overhead type fixed on the tunnel lining, while the overhead line for elevated and at-grade sections shall be catenary flexible type supported by either central poles or steel portals across the track at a spacing of between 25 & 35 metres depending on the track geometry.
- Substation Central Remote Supervisory Control (SCADA) - is set up at the main operational control center for train operation monitoring and control. This shall be located at a convenient site along the route, possibly at An Binh station near rang depot;
- Power Distribution Room -, to supply LV power to various station equipment shall be

located at track level in each station.

- Single and three phase power shall be supplied to all heavy equipment in the stations and depot. Such as tunnel and underground station ventilation, lifting equipment, wash plant, wheel lathes and the like.

d) Signal System

This transit system shall be provided with a modern signaling system for the safe control and operation of trains while and shall consist of the following:

- Train Detection – AF (Audio Frequency) Track Circuit is used. Insulated track circuit is used at the station area and non-insulated track circuit is used between stations.
- Automatic Train Control (ATC) – controls speed of train operation based on restrictions and signal indication relative to other trains.
- Relay Interlocking Device - controls the train direction together with the signal device;
- Centralized Train Control (CTC) - is installed at the main control center to supervise the location of trains and train scheduling based on track condition and signal indications.
- Level Crossing Safety Device – it closes the gate automatically on at-grade crossings when a train is passing by, and detects any obstruction to stop the train automatically.

e) Communication System

To link the operation control center, depot, stations, and trains, the following communication facilities are to be provided:

- Communication facilities – A combination of radio, cable, optical fiber, and co-axial connections to provide voice and data exchanges within the system.
- Passenger Information System – include public broadcasting facilities, time table indicators, closed circuit television, synchronized clocks, and related facilities to guide and inform passengers.

f) Automatic Fare Collection (AFC) System

Automatic fare collection system (AFC) is now the international standard method for urban rail system. It usually refers to:

- Ticket Vending Machine (TVM) – for automatic issuance of single-pass (or season tickets) in exchange for money inserted into slots
- Ticket Collecting gates (TCG) – accepts and validates tickets upon entry and exit of passengers at station gates.
- Fare Adjustment Machine (FAM) - calculates the fare deficiency on a ticket that gets rejected at the exit gate on a particular station, and adjust the fare accordingly, upon payment.

Central Monitoring System (CMS) - manages the data from ticket vending and collecting machines and generates revenue and passenger statistics.

Depending on the passenger forecasts at each station the number of TVM's and TCG's will be determined. An FAM will be installed in each station control room located at the interface between the paid/unpaid concourse zones with a CMS included in the station

Operations Control Center (OCC).

g) Escalators and Elevators (Lifts)

Depending on the layout, interchange and intermediate stations may be fitted with escalators and lifts – to connect platform floor with the concourse, or from an underground/elevated station to the ground level entrances.

Lifts are normally provided to allow station access for the physically impaired or handicapped. Emergency stairs will also be provided. The number and location of elevators, lifts and stairs will be designed to suit station passenger forecasts and also to ensure compliance with safety standards such as NFPA130 for means of escape. Initial suggestions for the system would suggest consideration be given during the next stage of design for intermediate stations are provided as a minimum standard with up escalators and down stairs between platform/concourse and concourse/entrances.

During the next stage of design development a performance specification shall be prepared to allow for competitive bidding between the various elevator and escalator systems available on the international market.

h) Platform screen doors (PSD)

Platform screen doors are suggested for the platform level of the underground stations of the UMRT Line 1 (East) Metro Transit system. The station platforms which will have screen doors are Ben Thanh Interchange, Peoples Interchange and Saigon Zoo Stations.

The purpose of the platform screen doors is to form a continuous physical barrier between the Metro train and the passengers waiting to board the transit at the underground station the doors stop passengers from falling onto the tracks. The platform screens have sliding doors located adjacent to the train doors and when the train stops and it is safe to board or alight from the train both doors open simultaneously.

For safety reasons the doors are interlocked with the train signaling system so that the opening of the doors is synchronized with the train doors.

The operation of the platform screen doors is similar to elevators in a high rise building. As well as being a major safety feature the doors and glass screen for a barrier between the tunnel and station ventilations systems.

Generally underground stations are air conditioned and to stop leakage of chilled air into the un air-conditioned tunnels the platform screen doors retain the conditioned air within the station thus making significant savings in the size of ventilation chiller plant and the long term operating costs of the station.

The technology of platform screen doors has been operating successfully in Asia for over fifteen years now and has shown to be a cost effective and essential addition to the station facilities enabling the transit operator to better manage the operations and energy costs on the transit system. In fact they have become so widely accepted as the current standard there are several instances where platform screen doors are being fitted retroactively to stations on operating mass transit systems.

It is recommended that during the next stage of the project development the facility of platform screen doors be included in the project performance specification.

2) Busway Facilities

At the Busway terminal, interchange or intermediate stations basic facilities shall be provided by government. These should include a low level platform, a weather protective canopy, ticket machines, illuminated signboards, timetable for guidance of passengers. Adequate lighting and signage will be provided. In addition a signaling system, gps bus tracking and communication system will be provided as part of the Busway transit systems. Dependent on passenger forecasts elevators, stairs and/or lifts to elevated walkways across the highway at each Busway station will be provided.

The facilities for the bus terminal and interchange with the rail transit system will be more extensive. It will include loading/unloading, drop off pick up, kiss and ride facilities including bays for feeder buses, taxis, cars, and other road users, parking (for car, motor cycle and bicycle), elevated pedestrian walkways, ramp, public facilities within the public area (toilet, telephone, etc.), retail stalls, landscaping and the like.

The design parameters for the Busway stations are:

- Minimum lane width of 5m per direction for road way or ramp, based on size of an ordinary bus (10m x 2.5m)
- Minimum clear width of 5m for platform, stairs and access walkways
- 65m long platforms at Busway stations
- design standards similar to the rail transit system
- common ticketing with the rail transit system

Typical layouts at interchange, terminal and intermediate Busway stations are shown in the reference drawings. Other facilities including depot, workshop, stabling, refueling stations and maintenance workshops will be provided close to the Busway transit route near the interchange and terminal stations.

During the next stage of design development an operations and system performance specification shall be prepared to allow for competitive bidding between the various bus systems available on the international market including the possibility utilizing buses powered by environmentally friendly fuels such as LPG, CNG, biogas and the like will be investigated during the next stage of the study.

4.6 Design and Construction

1) Metro Rail Transit

(1) Underground tunnels and stations Section

a) Station structure

The three stations box structures in the underground section will most likely be constructed cut & cover "top down" method under the existing roadway most likely using concrete diaphragm walls or secant piling. For the sections of the stations constructed under the public road it may be necessary for traffic management reasons to install a temporary steel deck roadway. For the mainline and overrun tunnels, due to the alignment passing thru this environmentally sensitive area and the close proximity to the surrounding historical and cultural buildings, it is likely that the two mainline tunnels will be constructed using a tunnel boring machine (TBM).

The station platforms will be approximately 130 metres long, If a tunnel boring machine is used it is assumed that it would be possible to reduced the size of the station box by constructing part of the platforms for Stations 1 and 2 in a ten metre wide platform tunnel section typical details of which is illustrated in the FS drawings which suggest a 50m long central station box approximately 20 to 25m wide on two levels (platform and concourse) which will accommodate all station facilities including public areas, plant rooms and operations facilities and equipment.

b) Tunnels

The total tunnel drive length of 5.5 to 6m diameter mainline and overrun tunnels is approximately five kilometers.

Whilst preliminary soil information would indicate that, in general, the upper soil stratum between Ben Thanh Market and Saigon Zoo is suitable for tunneling albeit with a high water table level the type of tunnel shield can only be determined when further site investigation and soil tests are carried out along the proposed alignment.

During the next stage of design development it will be necessary to determine whether ground treatment or grouting will be required to protect the existing piles and stabilize the ground supporting the People's Theater during tunnel shield drilling operations.

The type of tunnel lining is likely to be precast concrete segments with between six and eight segments per ring which will be determined in the next stage of the design. It should be noted however that in future it is likely that there will be two major transit crossings of the tunnel route at Ben Thanh and Peoples interchange stations. Further study of the interface will be required to identify whether additional strengthening of the tunnel lining, possibly using SGI (spheroidal graphite iron) linings. A segment casting yard will have to be set up to manufacture the tunnel linings. This could possibly be near the Rang depot site, the linings could be cast there and transported to the worksite in HCMC central district at night and stored within the Saigon shipyard complex until installed in the permanent tunnel works.

As this area of HCMC, close to the river Saigon, is on the alluvial ground, the depth of bearing layer is 45 meters deep the team has been advised that most of the 5 to 7-story high buildings along the route are support on piles.

For the most part the tunnel alignment is along existing roads however for part of the section between Peoples Interchange Station 2 and Saigon Zoo Station 3 the mainline tunnel alignment passes under existing residential and commercial properties Where the building piles may obstruct the tunnel shield drive, therefore this section of the route must be surveyed in some detail to determine the likely constraints in determining the final mainline track alignment.

c) Ventilation Shafts, Station entrances, Tunnel Portal

Tunnel ventilation structures or shafts will be required along the underground section of the mainline route alignment. These shafts will be located away from environmentally sensitive structures and possibly incorporated into the station sites. The vertical ventilation shafts may be constructed using diaphragm walls or secant piles and will be used as temporary access points during the tunnel and systemwide construction works.

Existing monuments and statues in the route may require to be moved temporally, or alternatively protected during construction possibly by underpinning or ground treatment, Special clauses in the particular specification should be included to ensure the contractor after completion of construction these will be fully restored at there original location.

Several underground pedestrian walkways may be constructed particularly linking the existing bus interchanges to the interchange station at Ben Thanh Market station.

The portal for the east and westbound tunnels will be located after Saigon Zoo Station 3 either within the shipyard complex or along the east side of the existing adjacent roadway. the structure will be partly cut and cover tunnel, propped earth retaining structure and incorporate the abutment for the elevated viaduct section. The portal will also include tunnel ventilation equipment, flood doors and sumps, pumps and associated pipework.

As the tunnel portal is the interface between the underground and elevated viaducts sections it is likely to be a major work site during the construction phase where the tunnel boring machine will be installed and as a marshaling yard for precast concrete tunnel linings and viaduct beams. It is therefore extremely important that that this work site be made available to the civil works contractor from the start of the project in 2006. Therefore the handover of the work site from the shipyard authorities before the yard is closed in 2010 must be a matter of first priority if the rail transit is to be completed by 2010/11.

(2) Elevated Section viaduct and stations

a) Viaducts and Bridges

From Saigon Zoo Station 3 to An Binh Station 8 there is approximately six kilometres of elevated twin track viaduct including a major crossing of the Saigon River near the existing Hanoi Highway Bridge.

From preliminary soils information it is likely that the viaduct structure will have to be piled. In particular the area around Saigon River where a founding depth for large diameter bored piles will be in the region of 35 to 40 metres.

The width of the viaduct will be approximately ten metres which is sufficient to accommodate twin tracks, an emergency walkway and other trackside systems facilities including overhead power supply posts for the train traction power.

The viaduct will generally be between level 2 and 3 above the existing ground level with the exception of the Saigon Bridge section where for river navigation the height above high water will be about 22 metres to track level.

Viaduct spans in the order of 30 to 40 metres can be expected as the transit is not in a major earthquake zone. Precast concrete, possibly segmental box construction with external prestress may be possible. At the Rang depot site there may be sufficient space to establish a manufacturing yard for the PC box girder The system is adopted that after PC box girders are divided into a segments of 3 to 4 meters manufactured at the precast manufacture yard under strict quality control conditions then, the pieces or segments will be carried to the field and assembled above the road. The girders are then placed above the highway at night to avoid disruption to traffic during the construction period.

If there are special sections say at track crossovers and at station sites the viaduct may be constructed as an insitu rigid frame type which will need a longer construction period. Therefore, the construction of the viaduct section will be divided into several parts and each part is constructed simultaneously.

For the major bridge crossings such as the Saigon River with large clear spans a lightweight structural steel box or truss structure may be the most cost effective method of constructing the viaduct bridge particularly in view of the poor foundation materials likely to be encountered at this location.

b) Stations

For the five elevated stations a rigid insitu frame construction are proposed which would include the 130m long covered platforms approximately 13 to 15 m above the existing Hanoi highway with the station concourse and covered access walkways across the road to the station entrances located close to the proposed transport interchanges and possibly future residential, retail or commercial developments.

At An Binh Station 8 there will be a pocket track to store trains during off peak while awaiting access to the depot site. An elevated track part on viaduct and earth slope will need to be constructed at this location to access the depot area.

(3) At-grade stations and mainline Section

a) At grade Track

Approximately five kilometres of twin track will be at grade. In order to minimize the potential for flooding it will be necessary to construct the tracks approximately 500mm above the existing highway level using free draining material below the ballasted track. Minor civil works will be involved including crash and security barriers overhead line support post foundations and the like.

b) Stations

There will be three stations located in this section including the terminal interchange station at Cho Nho. With the platform at grade level the concourse will be located at Level two with covered walkways to either side of Hanoi Highway. At Cho Nho Station 11 there will be a need to construct an elevated podium on which the Busway terminal and drop off and pick up transfer facilities to the transit station. In addition access ramps and parking structures, feeder bus facilities will be constructed on both the west and eastbound

directions. As it is proposed that Busway operations will continue during the construction of the rail transit system the operation of the Busway can be continued by moving temporally the existing Busway to the outside road.

c) Construction Access

As delivery of construction materials is difficult during the day without causing traffic congestion it is proposed these are carried to the viaduct and station sites by road in the late evening and early morning, thus minimizing traffic disruption. The delivery of heavy equipment including precast segments, concrete and the like will be executed in the time band with a little road traffic at night. The contractor will also have to provide protection from falling objects so as not to affect the vehicles running below the construction section of viaducts and stations. Protective security and safety fences will be located so as not to affect public and private vehicles running along the Hanoi highway route and the cross traffic.

(4) Depot and Stabling section

Rang Depot will be constructed generally at grade. The level of the depot tracks will be determined taking into account any potential ground settlement and the likelihood of flooding from the adjacent river Chiec. The depot workshop and ancillary buildings to house the railway systems including intake & traction substations, train wash workshops, stores shall be located in either concrete or steel framed buildings. A large span lightweight roof structure will be required over a large part of the site to provide weatherproofing to major work and stabling/cleaning areas.

A typical depot layout is included in the FS drawing package. Temporary works trains, equipment loading and unloading facilities including assembly of rolling stock will be carried out at the depot site.

(5) Other Construction Works

Other construction works to be carried out as part of the civil works contract will include but not be limited to the following:

- Site investigation & condition surveys
- Ground treatment
- Work sites and casting yard construction
- Site clearance and demolition works including fencing
- Relocation or provision of utilities and drainage works
- Traffic management during construction
- Access roadworks and parking, bus interchanges
- Pedestrian and highway cross bridge construction
- Hard and soft landscaping at stations and viaducts
- Systemwide contract coordination & attendance
- Street lighting & signages

During the next stage of design development a performance specification and outline design of the major works shall be prepared to allow for competitive bidding using accepted international standards such as FIDIC for the Engineering Procurement Contract (EPC) for the main civil design and build contracts for the project.

2) Busway Transit Construction

The Busway transit system will be located along the centre of the Hanoi Highway when it is expanded from the present width of 23.5m to its final width of 72.5m to provide additional lane capacity to match future increased traffic volume forecasts. The dedicated Busway either in the middle of the expanded Hanoi Highway or alternatively on one side of the transport corridor. Therefore, the timing for the construction of the Busway should be with the major works associated with the Hanoi Highway expansion project.

The construction works will include a fully segregated two lane Busway with space provision for the eight (8) at grade intermediate Busway stations. These stations will comprise a low concrete boarding/alighting platform approximately 65 metres long together with access stairs, overhead covered walkways and at the more busy station provision for an escalator and/or elevator. There will be associated site formation works for feeder bus interchanges, park and ride and parking for private vehicles including cars and motor cycles.

At the two terminal stations at Cho Nho and Bien Hoa there will be a concrete podium structure for bus stabling and drop off/pick up together with operations control buildings and waiting areas for transit passengers. Busway access ramps will be provided to and from the Interchange terminal stations which will have covered platform areas. Areas shall be provided at the terminal stations for minor servicing, refueling and cleaning with major maintenance and servicing carried out possibly at Rang depot.

There may be some services and systems required to operate the Busway transit system. These will include:

- New high capacity articulated air conditioned buses (possibly with environmentally friendly fuel systems)
- Signaling, traffic control
- Communications including fiber optic cables, cctv GPS systems
- Escalators & elevators
- AFC equipment including ticket vending machines
- Advertising & signage
- Lighting
- Fire protection systems
- Hard and soft landscaping and
- Associated access roads and ramps
- Potential future connections to retail, commercial and residential areas
- Security and operational control facilities.
- Refueling stations
- Depot storage maintenance and cleaning facilities
- Utilities and drainage
- Associated building services incl fire protection at stations

During the next stage of design development a performance specification shall be prepared to allow for competitive bidding between the bus suppliers available on the international market as well as EPC contractors for the infrastructure works

4.7 Project Budget Costs

1) Metro Rail Transit Component

The project costs were derived using typical unit cost of similar urban rail projects in Japan and Southeast Asia, separately for civil works, bridge works, track works, electrical and signaling system, depot, and rolling stock.

Engineering design and construction supervision cost have been included into the project budget estimate.

Table 4.7.1 Breakdown of Metro Rail Transit Cost (in US$ million)

Work Items	UMRT Line 1 (Metro Rail)		Total Cost
	Foreign	Local	
Civil Works (Tunnels, viaducts & at grade)	130	40	170
Stations incl building services (11no.)	20	15	35
Trackwork	11	7	18
Rail Systems (Traction,signal,coms)	90	10	100
Depot, workshop equipment, including access & stabling tracks	20	15	35
Rolling Stock	135	33	168
Subtotal (a)	406	120	526
General items (a) x 5% =(b)	20	6	26
Subtotal (a)+(b) = (c)	426	126	552
Eng consultants Fee (c) x 5% = (d)	20	6	26
Grand Total (c)+(d)	446	132	578

Source: Study Team
Note:1 USD = 110 Yen = 15,500 VND

2) Busway Transit Component

The major cost items for the Busway component of UMRT Line 1 (East) will be the cost of the rolling stock and constructing the two interchange terminals and the eight intermediate Busway stations. As the route will utilize existing roads, hence, the cost of incremental works needed to modify the roads have been assumed to be provided by others as part of the highway upgrading works and have been excluded in the financial analysis for the Busway transit system. However, for the final Busway transit from Cho Nho to Bien Hoa multimodal stations the cost of constructing the dedicated Busway lanes have been included in the project cost estimate which also includes the cost of the associated operations and maintenance facilities including the depot, stabling and maintenance yard and operations control centre.

Also it has been assumed that there are two development stages for the Busway transit project – prior to 2010 when the basic operation will be from Ben Thanh to Thu Duc, and after 2010 when the basic operation will be from Cho Nho to Bien Hoa when the UMRT Line 1 (East) Metro rail transit component will be fully operational.

Table 4.7.2 Breakdown of Busway Costs (in US$ million)

Work Items	UMRT Line 1 (Busway)		Total Cost
	Foreign	Local	
Busway lanes(14.6km)	4	8	12
Stations incl building services (8no.)	4	3	7
Multimodal Interchanges (2no.)	2	2	4
Systems (coms, signals cctv, gps,afc)	6	1	7
Depot, workshop maintenance, stabling	4	2	6
Articulated buses	13	2	16
Subtotal (a)	34	18	52
General items (a) x 5% =(b)	2	1	3
Subtotal (a)+(b) = (c)	36	19	55
Eng consultants Fee (c) x 5% = (d)	2	1	3
Grand Total (c)+(d)	38	20	58

Source: Study Team
Note:1 USD = 110 Yen = 15,500 VND

5 TRANSIT SYSTEM OPERATION

5.1 Operating Concept

The operating concept for UMRT Line 1 (East) from Ben Thanh market in HCMC central district to Bien Hoa in the eastern suburbs is described in this section. The operating route length of UMRT Line 1 (East) is approximately twenty nine (29) kilometres consisting of two discrete operational sections: The first operational section is approximately fourteen (14) kilometres from Ben Thanh Market (Station 1) to Thu Duc (Station 10) and the second section is fifteen (15) kilometres from Thu Duc Station to Bien Hoa terminal interchange (Station 20).

From 2005 to 2010/11, or until commissioning of the rail transit segment from Ben Thanh Market Station 1 to Cho Nho (Station 11), the operation on the two sections will be by a Busway transit system. Thereafter, a rail transit service will operate on the first section, and a Busway transit service on the second section.

This chapter discusses the individual and combined operation of the two transit sections.

5.2 Rail Transit Operation

1) Operating Time

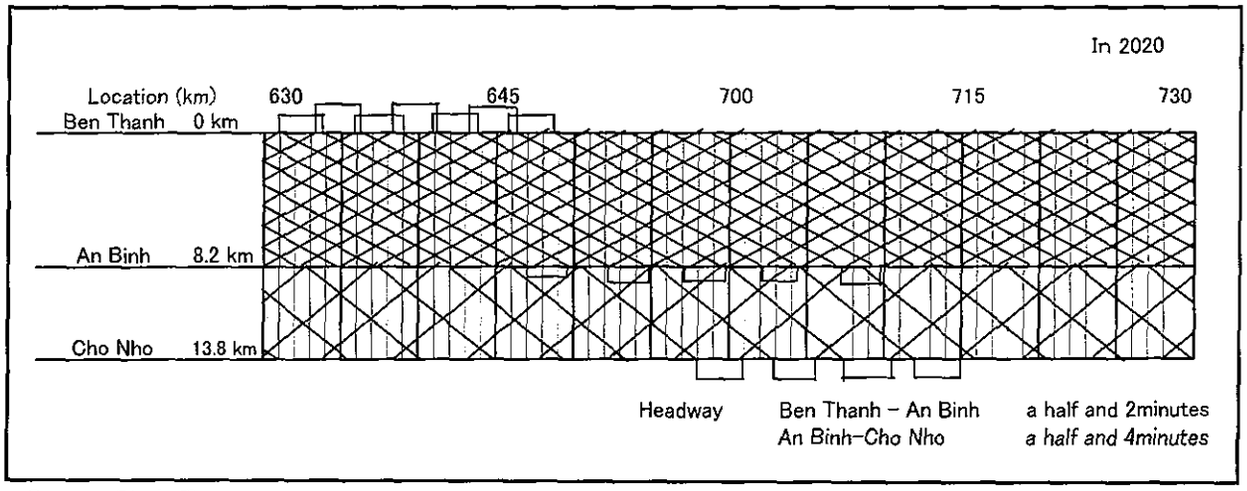
The operating time of trains is a function of traveling time, dwell time at stations, and turnaround time at the terminal stations. The running speed has been conservatively assumed to be 31km/h and the average distance between stations is 1.17 km in the inner city area. On the outer part of the city, the running speed is assumed at 46 km/h with inter-station distance of 1.87 km. The shuttling or reversing time is taken as 2.5 minutes at the Ben Thanh terminal and 3 minutes at the Cho Nho terminal (refer to Table 5.2.1 and Figure 5.2.1).

Table 5.2.1 Operation Plan

Rail Section	Distance (km/# of Stations)	Commercial Speed (km/h)	Operating Time, 1-way (minutes)	Shuttling Time (minutes)
Ben Thanh to An Binh	8.21/8	31	15.9	2.5
An Binh to Cho Nho	5.61/3 (excluding An Binh)	46	7.3	3

Source: Study Team

Figure 5.2.1 Train Diagram



Source: Study Team

2) Minimum Headway

A basic train consist of a 3-car train set which by coupling two units can form a 6-car train consist with an overall length of approximately 120 metres. The configuration of the train will be dependent on the final type of rolling stock to be selected for the line. For purposes of defining the basic operating characteristics for feasibility study, a typical train of the E231-model of Japan Rail (JR) is used. This train has been designed with a crush capacity 1.8 times the normal passenger loading, which would give a 6 car train consist with a capacity of about 1,717 passengers per train.

The peak ratio of railway passenger has been assumed at 20%, this is based on traffic surveys on the distribution of road user traffic volume by time band on the corridor. The total passenger volume on the line at peak hour is derived from the demand patronage forecast for 2020. The required frequency of service to satisfy this demand is estimated by dividing the forecasted traffic volume at peak hour between stations by 1,717 persons per train. The lowest headway possible on the route has been assumed to be 120 seconds.

The optimum headway at peak hour has been estimated at about 150 seconds on the section between Ben Thanh Market and An Binh intermediate station, and 4.6 minutes between An Binh and Cho Nho. Based on a 180% efficiency ratio. Accordingly, the design headway of 2.5 minutes and 4.5 minutes for the respective sections was adopted.

3) Number of Rail Car units

The number of rail car units to provide the necessary capacity has been estimated based on two (2) number 3-car train consist to meet ultimate peak-hour demand. An additional ten percent (10%) has added for stand-by or trains out of service for regular and special maintenance. Due to the passenger traffic forecast profile along the line, initially a shuttle service is envisaged from Ben Thanh Market Station 1 to An Binh Station 8 which will reduce the required number of trains in service (see Table 5.2.2). A pocket or turnaround platform track has been provided at An Binh Station to allow for this mode of operation.

Table 5.2.2 Number of Rolling Stock (Ben Thanh to Cho Nho)

	Ben Thanh to An Binh	Ben Thanh to Cho Nho	Total
Operation Time (round trip)	36.8	51.9	
Headway in Peak Hour (minutes)	2.5 x 2	4.5	
Number of Trains	7.4	11.5	18.9
Number of Stand-by Trains	2		2
Number of rolling stock units (6 cars)	126		126

Source: Study Team

4) Train Kilometres per Day

The operating and maintenance cost of train service is a function of train-kilometers. This can be calculated from the required frequency of trains by revenue service operations time band which has been assumed to be from 0500 to 2200 daily.

The distribution of number of train operation by time band is calculated assuming the value

at peak hour to be one. Thus, the total number of trips per day is derived by multiplying the number at peak hour by the peak factor, which is 10.1 (see Table 5.2.3).

Table 5.2.3 Distribution of Number of Operation by Time Band

Time Band	5	6	7	8	9	10	11	12	13	
Num of Train Operation	0.4	1	1	0.5	0.5	0.5	0.5	0.5	0.5	
Time Band	14	15	16	17	18	19	20	21		Total
Num of Train Operation	0.5	0.5	0.8	0.8	0.6	0.6	0.6	0.3		10.1

Source: Study Team
Note: Peak hour is assumed at 6 to 7 o'clock.

The maximum headway adopted for the two sections are 8.6 minutes and 15 minutes, respectively. This will apply at 2010 (see Table 5.2.4).

Table 5.2.4 Number of Train Trips between Ben Thanh and Cho Nho

Time Band	5	6	7	8	9	10	11	12	13	
Ben Thanh to An Binh	10	24	24	12	12	12	12	12	12	
An Binh to Cho Nho	6	14	14	7	7	7	7	7	7	
Time Band	14	15	16	17	18	19	20	21		Total
Ben Thanh to An Binh	12	12	19	19	14	14	14	7		241
An Binh to Cho Nho	7	7	11	11	8	8	8	4		140

Source: Study Team

The results show a total of 16,584 car-km per day, equivalent to 263 km/car and a fleet of 126 cars (see Table 5.2.5).

Table 5.2.5 Kilometers Run Per Day, by Section

Section →	Ben Thanh to An Binh	An Binh to Cho Nho	Total
Route Length (km)	8.21	5.61	13.82
Train trips/ Day (One Way)	241	140	
Total Mileage :(car-km) (x 6 cars) , One Way	11,872	4,712	16,584

Source: Study Team
Note: Number of trips includes the shuttle operations.

5) Rail Car Specification

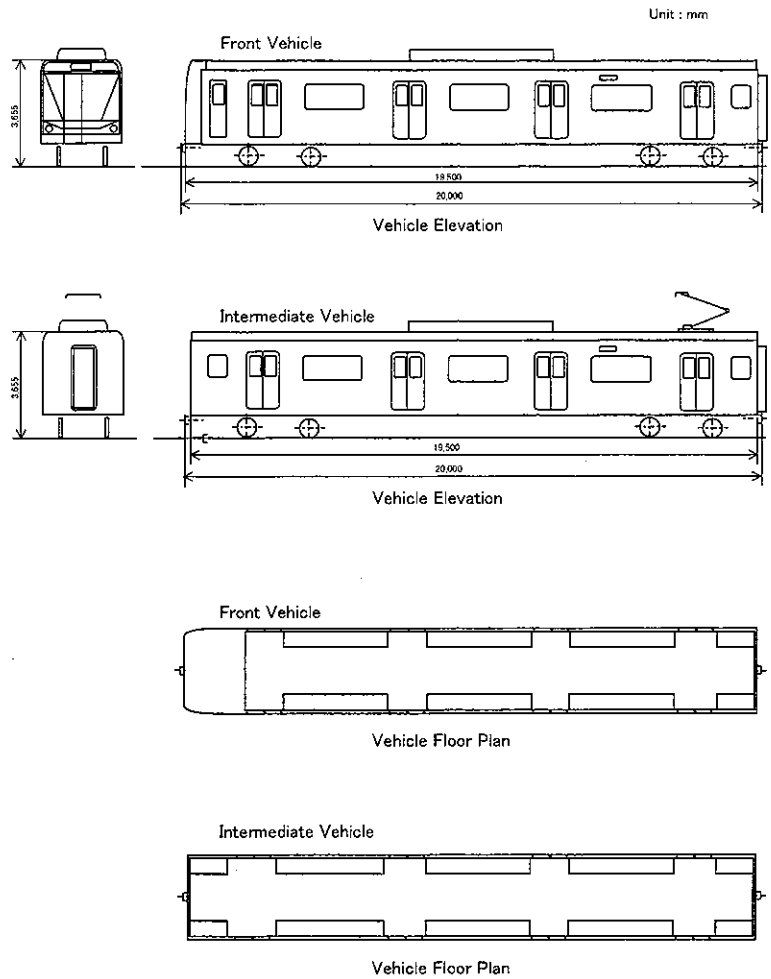
The performance specification to be adopted in determining the rolling stock type selection will be chosen to meet the basic system characteristics and will include the acceleration and deceleration requirements of short-distance trips between stations, minimize power consumption, achieve low maintenance cost, light weight of car body. (Schematic of rail vehicle is shown on Figure 5.2.2). The main rolling stock characteristics are as follows:

- Number of Car per Train: 2 * 3 car units
- Body Size: 19.5 m long X 3 m wide

- Capacity/Car: 158 persons
- Propulsion System & Motor: VVVF, three-phase induction motor
- Braking System: regenerative brake equipment
- Cooling Equipment: concentrated type on the roof

A typical car unit configuration is illustrated below.

Figure 5.2.2 Conceptual Drawing of Rail Car



Source: Study Team

5.3 Busway Operation

1) Multi-stage Development Program

The Busway system for the UMRT Line 1 (East) section will to be developed in three (3) stages, viz.:

Stage 1: (2005) Development Stage – For the initial Busway transit system operations several actions must be taken to increase and improve existing public transport system in the corridor including bus priority schemes should be introduced on major streets in the inner city area. In order to minimize the initial implementation cost, stage 1 should maximize the use of the existing bus service, shown in Table 5.3.1.

Table 5.3.1 Present Bus Operations in the North East Corridor

Section	Routes operating	No of Routes	Service level dep/day	dep/h	Freq. min	Bus cap	tot cap pass/h
Beyond Thu Duc	150	1	50	3,3	18	40	133
From Thu Duc	6,8,150	3	216	14,4	4	40	576
From Van Thanh	6,8,16,19,26,44,150	8	430	28,7	2	40	1 147

Source: Study Team

Stage 2 (2008) A Busway Rapid Transit (BRT) system will become the principal provider of public transport service in the corridor, This service will be supplemented by feeder and local bus lines. It is envisaged that dedicated bus lanes on the existing highway are implemented from Cho Nho Station 11 to Bien Hoa Terminal station 20, while a bus-priority scheme will be provided from Ben Thanh market to Thu Duc.

Stage 3 (2010/11) With the rail transit system in service from Ben Thanh Market to Cho Nho, the BRT will be discontinued on this section of the corridor and re-deployed to the Cho Nho-Bien Hoa section of the UMRT Line 1 (East) section.

2) Proposed bus operation principles (Stage 2)

There are two possible operation principles which can be implemented along the new busway; these are either a "rail-type" operation or a "maximized bus" operation.

The "rail-type" operation principle means that the bus operation will adopt as much as possible, rail operating practice. This scheme has the following advantages:

- Commuters become accustomed to the kind of service of the future rail line;
- Ridership will be built up in time for the rail system;
- Experiences from bus operation can be used for re-evaluating decision to invest on the rail system, and to design feeder service
- Common ticketing between the rail and busway transit systems

In the "maximized bus" operation, the operation is designed as if the Busway were the "ultimate" solution. The corridor will be provided with express and feeder express routes leading into the inner area. From there, the routes shall continue to the two major bus terminals at Ben Thanh and Cho Nho, or extend to peripheral terminals. This operating regime would have the following advantages:

- Higher busway capacity, since buses do not load at intermediate bus stops;
- More direct trips since feeder buses collect passengers before the busway;
- Better accessibility to the inner area since buses continue to other sections of the bus network;
- Smaller bus vehicle is required, since more buses can use the busway per hour

For purposes of this initial feasibility study, the first option of a rail type operation has been adopted.

3) Busway Capacity

The capacity of the busway is determined by the number and journey time of the Busway units.

For a closed section with a dedicated right of way corridor, the critical speed would be 50 km/h. This would suggest an ultimate Busway capacity of 1800 vehicles per hour or one vehicle every two seconds. Under ideal conditions (no intermediate bus stops and no intersections), a practical minimum headway is 5 seconds between buses, this would be the case in the "maximized bus" operation principle. However for a "rail-type" operation. the maximum bus headway adopted is two (2) buses per minute or 120 buses per hour.

The speed on the dedicated section is conservatively set to 30km/h. On bus-priority sections of the route where the Busway has to share road space with other transport modes, a speed of 20 km/h is assumed. giving an average route speed of 25.6 km/h. making due allowance for turnaround and intermediate station stops the commercial speed will reduce to 23.3 km/h or thereabouts.

The capacity of the Busway transit section also depends on the dimensions of the bus vehicles. For maximum performance, buses need to have bigger dimensions and wide doors to minimise passenger boarding and alighting times. The study team has suggested that articulated buses with a maximum capacity of 90 passengers could meet this criteria.

The number of buses on the corridor can be calculated from the passenger demand forecasts (see Table 5.3.2). The demand has been forecast to be about 7,000 passengers per hour in year 2010 for the Ben Thanh Market to Thu Duc section.

Table 5.3.2 Selected Sectional Demand on Busway, in Pax/Hour

Section	Year 2010	Year 2020
5	3,370	11,232
6	8	26
7	3,758	12,527
8	49	164

Source: Study Team

In Table 5.3.3, passenger demand and capacity has been assessed for varying frequencies of Busway service. With a frequency of 30 seconds (or 2 buses per minute), the maximum peak hour capacity will be 10,800 passengers per hour per direction. For this level of service capacity would require about 218 buses to be in daily operation.

Table 5.3.3 Number of Buses and Production (Stage 2)

Freq. min.	Dep /hour	Serv. /day	Trip time min	Bus cap	Buses	Sect. cap pass/h	Prod. placekm/h	Tot bus cap
0,5	120	1800	55	90	218	10 800	503 405	19 636
0,75	80	1200	55	90	145	7 200	335 603	13 091
1	60	900	55	90	109	5 400	251 702	9 818
2	30	450	55	90	55	2 700	125 851	4 909
3	20	300	55	90	36	1 800	83 901	3 273
4	15	225	55	90	27	1 350	62 926	2 455
5	12	180	55	90	22	1 080	50 340	1 964

Source: Study Team

In Table 5.3.3 the highlighted area represents the capacity requirement based on the projected demand. It suggests a bus headway of 45 seconds. At this level, the corresponding number of articulated buses needed to provide the service levels is 145. Assuming a bus availability factor of 90%, the total bus fleet required would be about 160 buses.

Similarly, the fleet requirements during Stage 3 operation can be derived from the projected demand. By 2020, this is forecasted to be 14,295 passengers per hour per direction, equivalent to 190,600 passengers per day

For 2013, the demand is estimated to be 45% of that figure, or approximately 6,400 passengers per hour, assuming a rail transit has commenced revenue operations from Ben Thanh Market Station 1 to Cho Nho Station 11.

Table 5.3.4 shows the number of buses during the stage 3 scenario. The required headway would be 71 buses/hour, or about 50 seconds between buses. (For 2015, when demand would be some 9 200 pass/h, the frequency would approach 30 seconds). The number of buses to support such a headway would be 78 buses (86 buses with 90% availability).

Table 5.3.4 Number of Buses and Production (Stage 3)

Freq. min.	Dep /hour	Serv. /day	Trip time min	Bus cap	Buses	Sect. cap pass/h	Prod. placekm/h	Tot bus cap
0,5	120	1 800	33	90	132	10 800	324 000	11 868
0,85	71	1 059	33	90	78	6 353	190 588	6 981
1,0	60	900	33	90	66	5 400	162 000	5 934
2,0	30	450	33	90	33	2 700	81 000	2 967
3,0	20	300	33	90	22	1 800	54 000	1 978
4,0	15	225	33	90	16	1 350	40 500	1 484
5,0	12	180	33	90	13	1 080	32 400	1 187

Source: Study Team

Considering the transition from Stage 2 to Stage 3, it would be advisable to plan for a transit fleet size of 80 high-capacity articulated buses.

4) Busway Transit System Project Budget

The investment in a fleet of 80 modern articulated buses with the above assumptions would be around 240 Billion VND (or US$ 16 million). With the supporting investments for depot, maintenance equipment, and initial spare parts, the project budget cost will be in the order of US$20 M, not including the cost of Busway infrastructure such as dedicated bus lanes, stations and pedestrian walkways which would be provided as part of the Hanoi Highway upgrading project. This capital outlay could be minimized, if one of the existing fleet operators would be leased or franchised for the Busway transit system operations.

6 LAND ACQUISITION AND RESETTLEMENT

6.1 General Concept

1) Institutional Framework

(1) Legal Frame for Land Tenure

The rights to acquire and own properties are embodied in the 1992 Constitution which provides that citizens have the right to own a house and protect their properties. A more significant law which specifies land rights and management is contained in the Land Law, dated 15 October 1993 and amended on 2 December 1998. The Land Law is a comprehensive law on land administration which declares that the land belongs to the people, with the State as administrator, who has the authority to allocate and determine land usage. Article 27 of the Land Law provides the right of the State to recover the land for national or public benefit and provides compensation to affected families.

Based on these laws, access to land can be achieved through the following modes:

a) Land allocation: This can be achieved through proper registration procedures and application for land rights use.

b) Lease or rent of land: This allows individuals or organizations to rent land.

c) Inheritance: Transfer of land rights use of parents to family or siblings.

d) Land mortgage: Transfer of land rights to another person through mortgage.

(2) Land Valuation

Land valuation is contained in Decree No. 87/CP issued on 17 August 1994 by the Government. This law governs the compensation value of cost of land based on urban categories or zonal locations. Compensation on land is further supplemented by a decision from the Peoples' Committee, Communiqué 145/1998/TT-BTC, affirming the execution of Decree 22/1998/ND-CP, a policy that sets the regulation on calculating the coefficient K value for compensation of property. The People's Committee determines the coefficient K value as guided by the Ministry of Finance, in consultation with other government agencies such as the Ministry of Construction, the Ministry of Agriculture and Rural Development, the General Land Administration, and the Government Price Committee.

Laws on land and resettlement are further supplemented by decrees to strengthen or amend the existing laws. Decree 87 states: "The prices for urban land herein have been calculated based on average free market price. The free market price of land varies from city to city, from area to area in one city, and street front to street backside. It sets the minimum and maximum prices for, among others, payment of land use rights and compensation for categories of urban land recovered by the State."

Decision No. 302/TTg issued on 13 May 1996 by the Prime Minister provides for the adjustment of the value of K in Decree 87/CP dated 17 August 1994 and gives it a wider range, from coefficient K 1.2 to 3.6.

(3) Compensation System and Subsidies

Regulations on compensation are specifically contained in the most recent law, Decree

22/1998 (July 24) which provides more beneficial coverage on compensation compared to the former law (Decree 90). The scope of compensation covers the following areas:

- Compensation for loss of land and housing structure
- Compensation for loss of property associated with land development
- Subsidy for livelihood and production activities of relocatees
- Subsidy for loss or change of jobs and other removal costs

Table 6.1.1 Relevant Legal Documents on Land and Resettlement

Application	Policy	Remarks
Land allocation, Land use rights and Comprehensive regulations on relocation and resettlement	Constitution 1992	Sets the rights to own a house and property,
	Land Law Oct. 1993	State is the Administrator of the land
	Residence Law of the State Council, (1991)	Protects property & defines the categories of property
	Decree No.04/2000 ND-CP (Feb 11,2000)	Regulates land adjustment, procedures for lease of land
	Decree No. 87/CP (Aug 17 1994)	
	Decree No. 38/2000/ND/CP (Aug. 23, 2000)	Sets price of land at free market value
	Decree 203 HDBT(Jan. 21, 1982)	
	Circular No. 145/1998 TT-BTC ((Nov. 4, 1998)	
	Decree 88/CP (Aug. 17 1994)	Procedure for certification of LUR Management & use of urban land
Land Valuation and Compensation	Decree 22/1998/ND-CP/ July 24, 1998 Decree 38/2000/ND-CP, Aug. 23 2001 Communiqué 115/2000/TT-BTC Nov. 4 1998 Decree 17/1999ND-CP Decision 71/2001/QD-UB,Aug. 29, 2001 Decree 87-CP Aug. 17 1994 Decision 05-UBQLDT Oct. 4 1995 Decision 302/TTG/Jan 5 1996	Signed at the central level
House Valuation	Decision 692 QD-UBTM May 4 19931996 Decision 38/2000/QD-UB-DT, Aug.26,1995 Decision No. 5184-QCUT/KT, Sept 11, Decision 5675/QD-UB-KT, Nov. 9, 1996 Decision No 05/QD-UB-QLDT	Determines the coefficient "K" factor of land and house Raised the coefficient from 1.2 to 3.6
Subsidies and other allowances	Decision 40/2001/QD-UB May 15,2001	Specifically for EWH Project

Source: Study Team

Note: Laws – signed at central level, Party Chairman; Decrees - signed at ministry level, Prime Minister; Decision - signed at district level by the People's Committee.

2) HOUTRANS Policy on Land Acquisition and Resettlement

The above institutional framework by the Government of Viet Nam is considered as a prerequisite to implement the project. Basically, the HOUTRANS Master Plan is prepared to minimize any resettlement through various measures. However, certain resettlement will be unavoidable in both urban and rural areas. Regardless of the project's financial sources, a project requires to observe GOV guidelines on resettlement. In addition, foreign-assisted projects should comply with each donor's guideline although the GOV is primarily responsible for resettlement.

The process of land acquisition, especially in the urban area, will take a long time and the HOUTRANS proposes a policy of resettlement as the following guidelines.

(1) Valuation and Compensation

Valuation and financial compensation should be based on the GOV's resettlement policy

even for a foreign-assisted project. Along the process, the GOV requires, however, much paperwork from the people, who, sometimes, do not have the readiness for it. Even the residents without appropriate legal certificates should be compensated in the same level as those with certificates.

Financial valuation on fixed assets should be fair by introducing an independent evaluator. Compensation on other assets and intangible effects cannot be underestimated.

At the same time, financial compensation is not always the best option: compensation in kind should also be prioritized for housing and production facilities. Production facilities include paddy fields, shops-cum-houses and backstreet workshops.

(2) Restoration of Social Environment

a) Neighborhood: It is an undesirable concept to "shuffle" the neighbors in the resettlement area. In order to keep good neighborhood, a project should prepare its resettlement site as close as possible to the original site. Preferably within the same *phuong* or *xe*. At worst within the same district. Because residents are mutually supported in a non-monetized manner, this will support the PAPs' life. The most difficult task is finding an available resettlement site that is close to the project site.

b) *On-site Business and Livelihood:* Because many households are working at home, sometimes as an informal sector, living and working places cannot be simply separated. Relocation of households may change their livelihood and lose their income opportunity in unforeseen ways. It is necessary to prepare a Resettlement Action Plan (RAP) to accommodate existing business activities on site with the people's participation.

c) Accessibility to Social Facilities: Resettlement will change the accessibility to various facilities. Among them, the accessibility to elementary schools by children is important. If a new relocation site is far from the original school district, the RAP should prepare a school bus to allow elementary schoolchildren to continue attending their schools until all have graduated.

In addition, accessibility to primary health care facilities is also important. Many residents have family doctors with whom they have had long-term relationships. For the health of resettled people, including mental aspects, it is necessary to guarantee their accessibility to primary health care facilities by various measures.

Religion is also a significant factor in resettlement. Because some religious groups in HCM City have built communities for their members, the resettlement scheme should consider restoring such environment.

Relocation of facilities for worship, such as temples, churches and mosques, is usually problematic because all aspects of site, such as location, orientation and landscape, should be carefully examined based on the each religion's requirement.

(3) Social Status

The registration status of residents at project sites may risk their social status. Although some residents have been living at their current locations for decades, their registration status remains as 'unregistered' or 'temporary'. In some cases, people without permanent registration status are not eligible for full financial compensation. Thus, upon relocation, those without permanent registration should be provided with a stable residential status.

6.2 Identification and Response of the PAP

1) Project-affected Persons

Project-affected persons (PAPs) of the UMRT Project are those who have their residence or business premises within the project's right of way (ROW), UMRT depot and terminal facility sites and will be resettled if the project is implemented. The preliminary number of PAPs is shown in the table below.

Table 6.2.1 Provisional Count of the PAP

Unit: Person

Section	Saigon Zoo St. -Thi Nghe St.	Thi Nghe St. -Rach Chiec River	Rach ChiecRiver - Bien Hoa Terminal	Total
Identified PAPs	44	96	1,176	1,316

Source: Study Team

6.3 Estimated Cost of Land Acquisition and Resettlement

1) Range of Land Acquisition

The range of land acquisition is defined as the area within the right of way (ROW), depot and terminal facility sites of the project. The area includes all ROW of the ring road, two secondary roads, one provincial road, and eleven flyovers.

2) Unit Price for Compensation

Based on the current government rule, the following unit prices were adopted for this study.

Table 6.3.1 Assumed Unit Price for Compensation

Compensation Items	Base	Category	Unit Price	
Land	-Market Price of Land -Tenure -Range of K Coefficient (Decree 17/1999ND-CP, Decree 87-CP Aug. 17 1994)	Residential/ Commercial	1,000,000-2,000,000	VND/sq.m
		Agricultural (Perennial, Field)	500,000-700,000	VND/sq.m
		Agricultural (Paddy Field)	150,000-200,000	VND/sq.m
House	-Life Expectancy and Structure -Legal Status -Floor Area and Story	Grade1	By its scale	VND/structure
		Grade2	4,000,000	VND/structure
		Grade3	2,800,000	VND/structure
		Grade4, Temporary	2,000,000	VND/structure
Transition Allowance			5,000,000	VND/PAF
Inconvenient Allowance			1,000,000	VND/PAP
Utility Loss (water, electricity)			3,500,000	VND/PAF
On-time Resettlement Bonus			5,000,000	VND/PAF

Source: Study Team
PAP: Project Affected Person, PAF: Project Affected Family

3) Total Estimated Cost

Based on the above unit price, the total cost is estimated is estimated as Table 6.3.2.

Table 6.3.2 Estimated Cost for Land Acquisition and Resettlement

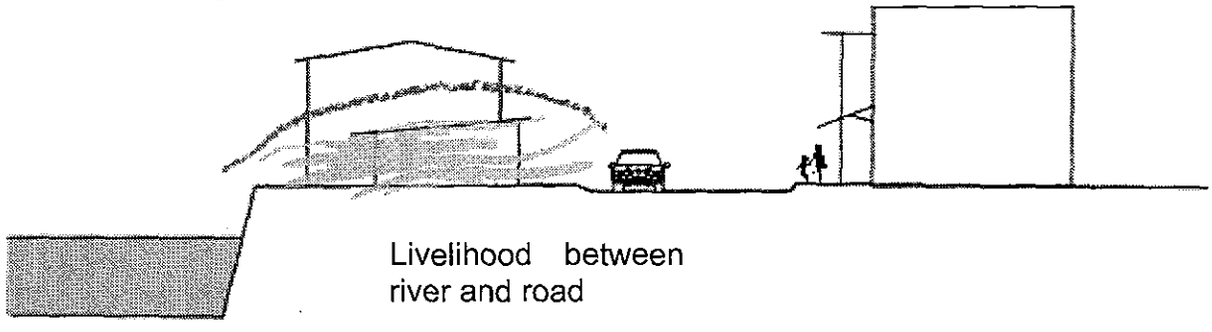
Project Component	Saigon Zoo St. (Thi Nghe St.)	Thi Nghe St. (Rach Chiec River)	Rach ChiecRiver (Bien Hoa Terminal)	Total
Land Acquisition and Development	31	212	719	962
Resettlement	1	2	14	17
Others	5	35	121	162
Total	37	249	855	1,141

Source: Study Team

6.4 Proposed Scheme

As shown in Figure 6.4.1, the East-West Highway Project had to resettle many residents living on the riverbank because there is no space for setback. Consequently, 80% of the PAPs in the East-West Highway Project received cash compensation instead of new residences. Many PAPs were likewise obliged to change their livelihood because their former livelihood required their access to both river and road.

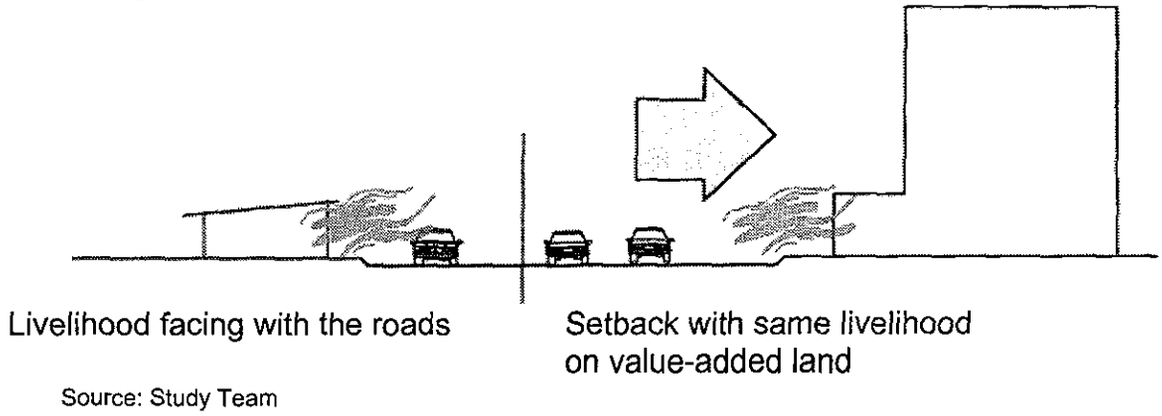
Figure 6.4.1 Livelihood and Location of East-West Highway Project



Source: Study Team

The livelihood of PAPs along Hanoi Highway depends only on accessibility to the roadside as shown in the left of Figure 6.4.2. This means that if they can move back, it is possible to keep their current livelihood, which is mostly selling through small shops and workshops as in the right of Figure 6.4.2.

Figure 6.4.2 Livelihood and New Development Scheme for Resettlement



Source: Study Team

Furthermore, the land along the new road has more value than before. This will enable the Government or road developer to develop the adjacent land to absorb the land acquisition cost. Thus, it will be possible to introduce a land adjustment system for this project especially for the new road development area.

This study proposes a new development scheme for resettlement by integrating urban development with the UMRT Project in a more detailed study.

6.5 Conclusion Summary

The alignment of UMRT Line 1(East) shall as much as possible follow existing roads and government land sites.

From Ben Thanh market Station 1 to Peoples interchange Station 2 the route is underground following existing roads. Stations are located on existing government owned sites. For the section from Peoples Interchange Station 2 to Saigon Zoo Station 3 the route will pass under existing mixed use properties. Further alignment study is required to identify which properties will be affected by the construction of the tunnel section.

For the construction of Saigon Zoo Station 3 and the portal section will either be located under or along the eastbound lanes of the existing highway. An alternative location of the station and portal would be within the existing shipyard area.

In addition a works site for the construction of the tunnel section will be required at this location. Several existing buildings within the shipyard will require to be demolished to allow for the construction of the tunnel portal. As the transit system should be complete by 2010 this land will be required perhaps as early as 2005/6 to allow the works contract to complete this critical section of the transit system.

From Saigon Zoo Station 3 to the Saigon Bridge Station 5 the elevated section will utilize the existing highway right of way except at the site of Saigon Bridge Station 5 where an area of the existing container port will be required to construct the station and the associated bus interchange. An alternative station location within an open park area to the north of the existing Saigon Bridge would eliminate the need to impact the container yard operations.

For the remainder of the route to Cho Nho interchange Station 11 and onwards to Bien Hoa Terminal Station 20 the train and Busway transit system will be located either in the center or to one side of the Hanoi highway. The plan to widen this transport corridor to 70m wide will result in the acquisition of the frontage areas to various properties along the route.

Rang depot will require approximately ten hectares of land space to accommodate all the necessary workshops, stabling, administration, ancillary buildings and facilities necessary for the operation and maintenance of the transit system. The land is apparently being temporarily occupied for recreational purposes which should be relocated at an early stage of the transit system implementation programme as the site will be required as a work site for the construction of the project.

Other sites including concrete precast yards, electrical substations and around station sites will also be acquired by GOV.

A coordinated land acquisition plan will be prepared during the next stage of project development including definition of temporary work sites.