10 EAST-WEST PRIMARY BUSWAY PROJECT

10.1 Project Outline

10.1.1 Background and Objectives of the Project

Public transport in Chengdu depends mainly on bus at present. However, its modal share is low at 18% excluding walk trips as of 2000, though the share has been increasing (the modal shares of bicycle and car/taxi are 50% and 32%, respectively). The Master Plan aims to lift up this share to 28% by 2010 through improving bus services in terms of both quality and quantity and promoting the shift from private to public transport. The achievement of this policy goal is imperative to mitigate congestion, protect environment and improve traffic safety, as long as the road network development is difficult economically and socially in built-up areas.

Although railway network needs to be developed in the long run considering the city size and the demand magnitude, this requires a long time and huge investment. Hence, the Master Plan considers the next 10-20 years as the transition period from bus to rail, and proposes various projects for improvement of bus services. These include development of exclusive bus lanes or priority lanes, improvement of bus terminals and stops, channelization of traffic (particularly with bicycles), upgrading of intersections, rationalization of bus business through privatization and improvement of bus-related administrative system.

The project of exclusive bus lane development aims at high-speed bus operation and safety improvement, and is proposed in four routes in the Master Plan, i.e., two radial primary roads of East-West and North-South and two circumferential roads of 1st and 2nd Ring Road. The East-West Primary Busway Project discussed hereafter is the most highly evaluated project in the Master Plan (refer to Chapter 9).

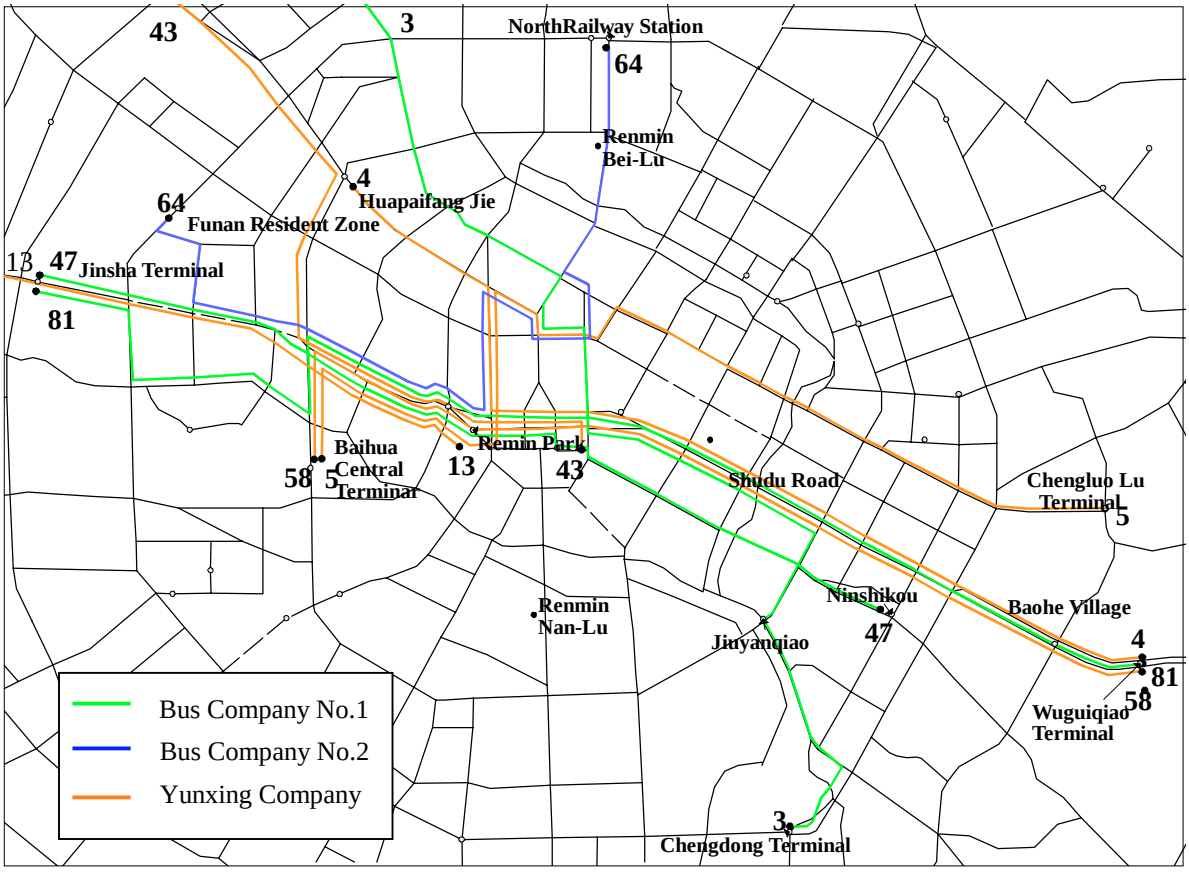
In this Project, bus exclusive lanes are proposed on Shudu Road for the section inside the 2nd Ring Road. For this purpose, the cross-section of the road is changed so that the exclusive bus lanes can be developed using the half space of existing bicycle lanes.

10.1.2 Bus Routes on Shudu Road

As of July 2000, 11 bus routes were operated on Shudu Road (section inside the 2nd Ring Road), as shown in Figure 10.1.1. Bus routes were shared as follows: three (3) routes are being operated by No.1 Bus Company, one (1) route for No. 4 Bus Company and seven (7) routes for Yunxing Company, a newly created private bus company which absorbed former No.2, No.3 and No.6 bus companies. No.3 Bus Company used to have the largest share on this road in the east-west direction.

As is obviously illustrated in the figure, there is no existing route running through the whole section of Shudu Road inside the 2nd Ring Road (route No.81 passes nearly the entire stretch of this section only avoiding Qingjiang Dong-Lu. However, this might be due to the construction work ongoing during the day of the survey). After the completion of the proposed busway, it is necessary to create a new route operating on the proposed exclusive bus lanes having origin and destination at Jinsha Terminal and Wuguiqiao Center Terminal, respectively.

Figure 10.1.1 Bus Routes on Shudu Road (2000)



10.1.3 Bus Traffic Volume on Shudu Road

Bus traffic volume on Shudu Road is presented in Table 10.1.1 and Figure 10.1.2 for 2000 and 2010 (demand forecast is discussed in the next section). Each of the above-mentioned 11 routes operates 65 to 192 buses per day per direction. Most heavily trafficked section shows about 2,000 buses per day for both directions. On Zongfu Lu and Dacisi Lu, it is about 1,400 and between the 1st and 2nd Ring Road, the eastern section has more traffic volume of about 1,100 than that of the western section of 400-700.

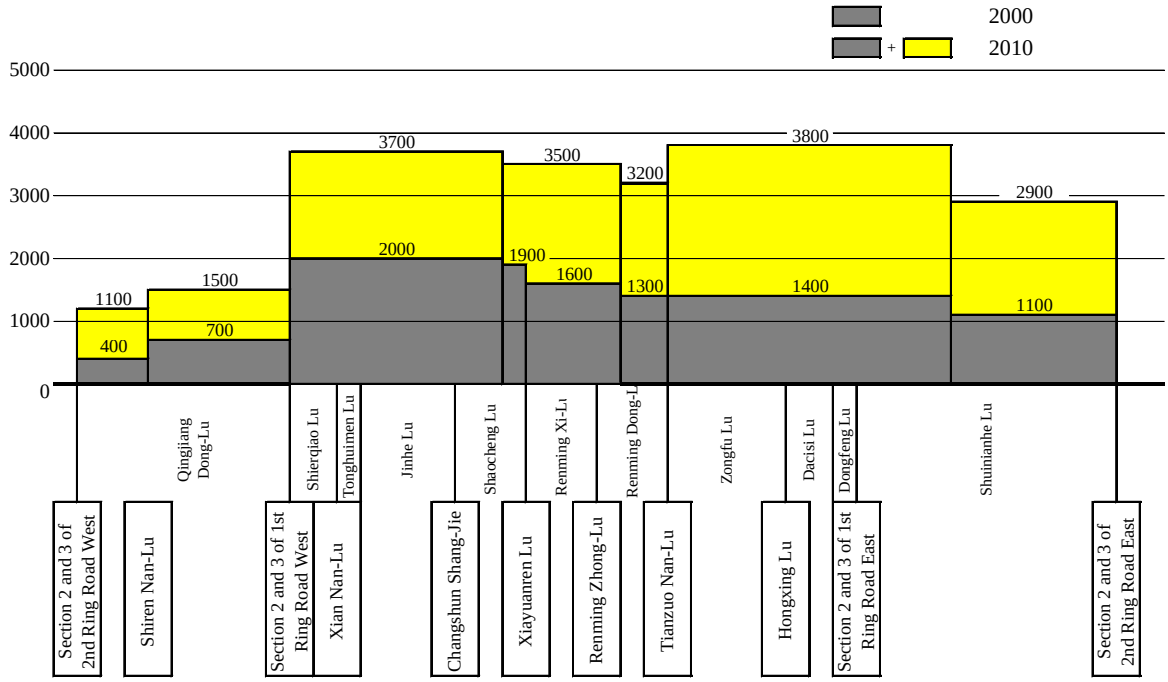
As urban development is being promoted in the future in the eastern suburbs, bus traffic volume will increase remarkably by nearly 3 times on Zongfu Lu and Dacisi Lu in the east of Tianfu Square. In the west of Tianfu Lu, the increase will be relatively moderate at 1.8-2.5 times. As a result, the bus traffic volume inside the 1st Ring Road becomes almost the same at 3,700-3,800 buses per day in the east and west of Tianfu Square.

Table10.1.1 Bus Traffic Volume on Shudu Road

Bus Route		Company	No. of Passengers / Day			Service Frequency/Day/Direction	
No.	Origin-Destination		2000	2010	2010/2000	2000	2010
3	Chengdong Bus Terminal - Jiaodaluxi	No. 1	18,030	62,325	3.5	127	439
4	Wuguiqiao – Ximen Bus Terminal	No. 3	21,289	63,992	3.0	169	508
4 (part)	Wuguiqiao – Chadianzixikou	No. 3				65	234
5	Chengdu 97 Middle School (Chengluo Lu) – Baihua Bus Terminal	No. 3	21,673	77,431	3.6	110	393
5 (part)	Chengdu 97 Middle School (Chengluo Lu) – Dongfang Building Material Market	No. 3				85	120
13	Renmin Park – Huangtianba	No. 3	4,104	5,027	1.2	80	98
43	Tuqiao – Tianfu Square	No. 3	9,127	11,353	1.2	123	153
47	Niushikou – Jinsha Bus Terminal	No. 1	8,953	10,445	1.2	144	168
58	Baihua Bus Terminal – Wuguiqiao	No. 3	12,871	17,829	1.4	122	169
64	North Railway Terminal – Funanxinqu	No. 4	11,466	15,288	1.3	150	200
81	Wuguiqiao – Jinsha Bus Terminal	No. 1	N.A.			192	232
Proposed	Jinsha Bus Terminal - Wuguiqiao		-	29,925	-	-	308

Note: The date of the 2000 is given by Chengdu Public Transport Company, and the date of 2001 is forecasted by Study Team.

Figure 10.1.2 Bus Traffic Volume on Shudu Road



In order for exclusive bus lanes to effectively function, the balance of traffic volume between bus and other vehicles is essential. If bus traffic volume is very small compared to other vehicles, traffic congestion will worsen for the other vehicles while the small number of buses inefficiently occupies a wide space. On the other hand, if bus traffic volume is very large, the level of bus service will be lowered with too many buses packed in the designated lanes.

The bus traffic volume on Shudu Road is ideal for exclusive bus lanes. The capacity of an exclusive bus lane is, in general, 200 buses per hour per direction or 2,000 buses per day per direction (4,000 buses per day for both directions). As such, the volume/capacity ratio of bus is 30-50% at present and will be about 90% in 2010 on Shudu Road inside the 1st Ring Road. Volume/capacity ratio for other vehicles is 60-70% present and will be 70-80% in 2010 on the same road assuming a capacity of 50,000 PCUs for a 4-lane road for both directions.

If traffic demand increases after 2010 at the same rate as predicted for 2000-2010, however, the proposed bus exclusive lanes will become insufficient with a huge number of buses exceeding the lane capacity somewhere between 2010 and 2020. Therefore, the plan for constructing Subway Line No.2 should be promoted in the east-west direction towards 2015.

10.1.4 Construction and Operation

(1) Implementation Period and Project Life

This project should be started immediately. As proposed, project implementation schedule indicates project approval and design in 2001; funding arrangement, bidding and commencement of construction in 2002; completion of construction in 2003; and start of operation in 2004. The project life of exclusive bus lanes is assumed to be 10 years.

(2) Implementing Body

The proposed exclusive bus lanes will be used mainly by existing routes either partially or entirely for the whole stretch of the project. Considering the characteristic of the proposed project that do not entail construction of large-scale infrastructure, using the existing Right-of-Way, the private sector can not be involved by, for instance, introducing a toll system for the bus exclusive lanes.

This project should be implemented and maintained by the public sector (Construction Committee, Primary Road Administration Department, etc.). Operation and management of the exclusive bus lanes would be the responsibility of the Public Utilities Bureau. The proposed bus exclusive lanes shall be free of charge.

(3) Bus Operating Body

The existing bus companies shall operate the bus routes. For the proposed new route, Jinsha Bus Terminal-Wuguiqiao, however, the bidding process may be applied to determine the operator of the new route, depending on the progress of the proposed bus privatization as discussed in Chapter 11 of this report.

(4) Premium Bus

It is assumed that ordinary buses shall operate on the proposed exclusive bus lanes. The bus fare will be the same as other routes despite the improved levels of service, as the main objective of the project is to promote bus ridership. However, for the proposed route Jinsha Bus Terminal-Wuguiqiao, it is possible to adopt premium services such as air-conditioned buses and soft-seat buses which may be effective for the promotion of public over private transport mode.

10.2 Transport Demand Forecast

This section will explain as to what extent transport demand will change by providing exclusive bus lane on Shudu Road.

10.2.1 Methodology

(1) Traffic Assignment

Transport demand is basically forecast based on a way of traffic assignment as already explained in Chapter 5. Among others, it needs to provide bicycle network, public transport network and road network. The bicycle network is conceptually equal to road network but the assigned traffic volume of bicycle, if assigned on non-separated bicycle lane, affects travel speed of car and bus. The public transport network is made based on public transport routes on the road network. Similar to the bicycle network, the assigned traffic volume of public transport affects travel speed of car at the section where public transport and car are mixed. As for public transport (or transit) assignment, origin-destination trips of public transport are assigned on the public transport network and operation frequency by route is determined by taking the maximum traffic volume by route into account. The operation frequency becomes a key factor to forecast traffic volume of public transport on roads. After the calculation of traffic volume of bicycle and public transport, traffic assignment calculation for private cars is done. Therefore, the traffic assignment of private cars is done based on the decreased road capacity for the sections where bicycle and public transport are together mixed.

(2) Traveling Conditions on Network

Traveling conditions are summarized in Table 10.2.1. Maximum travel speed of bicycle was assumed at a fifth of maximum speed of road on mixed lane and 15.0 km/h on exclusive lane. For instance, if maximum speed of road is 60.0 km/h, maximum travel speed of bicycle becomes 12.0 km/h. This means that if travel speed of bicycle becomes less than 12.0 km/h on exclusive lane due to heavy traffic, bicycle users will choose the mixed lane, the same case with bus users.

Table 10.2.1 Traveling Conditions on Network

Network	Transport Mode			
	Bicycle		Bus	
	Mixed Lane	Exclusive Lane	Mixed Lane	Exclusive Lane
Bicycle Network	1) 1/5 of 2)	1,200 veh./m/hr 15.0km/h		
Public Transport Network			1) 1/3 of 2)	2,500 PCU/hr 30km/h

Note: 1) road capacity, 2) maximum speed of road, 3) Traveling Conditions on the Shudu Road

(3) Traveling Conditions on the Improved Road

It was assumed that travel conditions would change on the Shudu Road as follows:

- Exclusive bus lane introduces on all sections of the Shudu Road;
- Road capacity a little bit improves due to separation of car and bus;
- Maximum travel speed is the same;
- Exclusive bicycle lane introduces on all sections of the Shudu Road; and
- Section between the 1st Ring Road and the 2nd Ring Road in the west is impassible at present because it was under construction when person trip survey was conducted.

10.2.2 Estimated Traffic Volume

Table 10.2.2 shows the estimated traffic volume. Note that the present traffic volume was also estimated using present assignment network, OD table and the same assignment method for transport demand in the future.

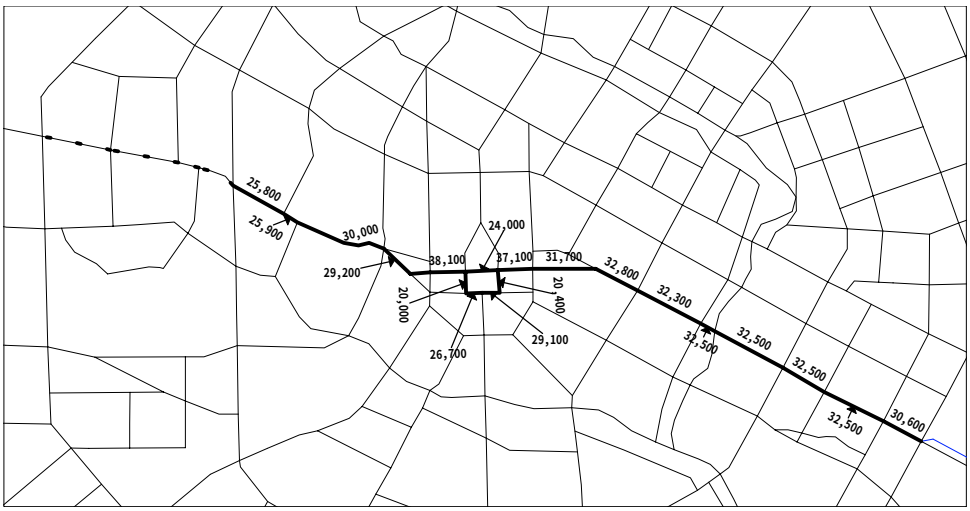
Since trips by bicycle in the study area will be totally reduced in the future, traffic volume of bicycle shall also be reduced to about 80%. On the other hand, traffic volume of bus shall also increase by 1.8 to 2.8 times. Heaviest traffic volume of car is found at the section between Tianzuo Nan-Jie and Dong'an Nan-Lu, amounting to 42,000 PCU per day equivalent to four lanes. In addition, it becomes 39,000 PCU per day at the section between Qintai Lu and Dongchenggen Nan-Jie. Heaviest traffic volume of bus is also found at the section between Tianzuo Nan-Jie and Dong'an Nan-Lu. Traffic volume in 2000 and 2010 on Shudu Road are shown in Figure 10.2.1 and Figure 10.2.2 respectively.

Table 10.2.2 Estimated Traffic Volume on the Shudu Road

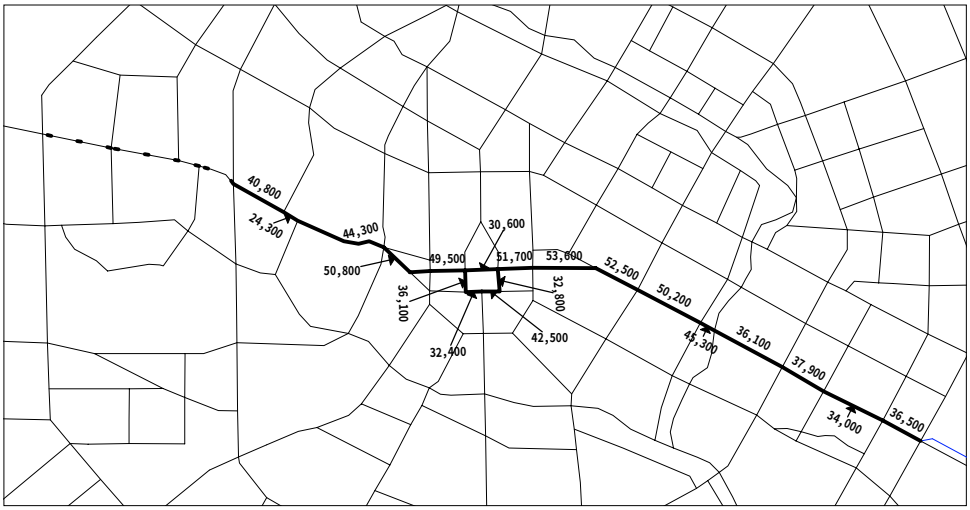
Section	Mode	Year 2000	Year 2010	Growth Rate
Section 2 of 2nd Ring Road West → Section 3 of 1st Ring Road West	Car		25,300 – 36,800	
	Bicycle		21,700 – 47,800	
	Bus		1,150 – 1,550	
Section 3 of 1st Ring Road West → Qintai Lu	Car	25,800 - 25,900	26,000 – 34,200	1.32
	Bicycle	24,300 - 40,800	31,200 – 31,500	0.77
	Bus	2,010	3,680	1.83
Qintai Lu → Dongchenggen Nan-Jie	Car	26,800 - 30,000	31,500 – 38,700	1.29
	Bicycle	39,500 - 50,800	34,800 – 42,500	0.84
	Bus	2,010	3,680	1.83
Dongchenggen Nan-Jie →Tianzuo Nan-Jie	Car	24,000 - 38,100	34,100 – 39,400	1.03
	Bicycle	49,500 - 51,700	27,200 – 45,200	0.87
	Bus	1,340 – 1,630	32,10 – 3,540	2.17
Tianzuo Nan-Jie → Dong'an Nan-Lu	Car	31,700 - 32,800	33,900 – 42,400	1.29
	Bicycle	50,200 - 53,600	36,100 – 43,100	0.80
	Bus	1,350	3,780	2.80
Dong'an Nan-Lu → Section 3 of 1st Ring Road East	Car	32,500 - 32,500	33,100 – 35,300	1.09
	Bicycle	36,100 - 45,300	32,200 – 32,200	0.71
	Bus	1,350	3,780	2.80
Section 3 of 1st Ring Road East → Section 3 of 2nd Ring Road East	Car	30,600 - 32,500	35,300 – 36,500	1.12
	Bicycle	34,000 - 37,900	30,600 – 31,300	0.83
	Bus	1,090	2,900	2.66

Note: Units are PCU/day for car and veh/day for bicycle and bus.

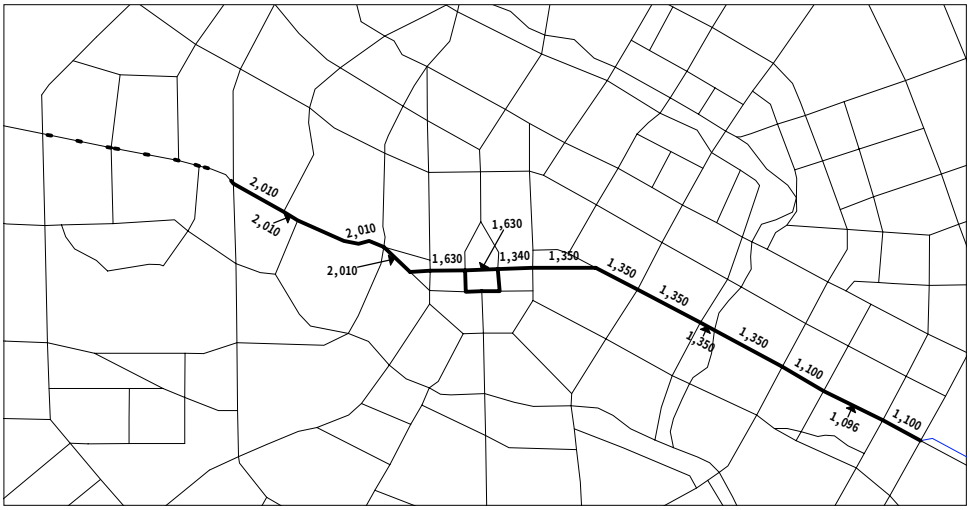
Figure 10.2.1 Traffic Volume on the Shudu Road (2000)



car (veh/day)

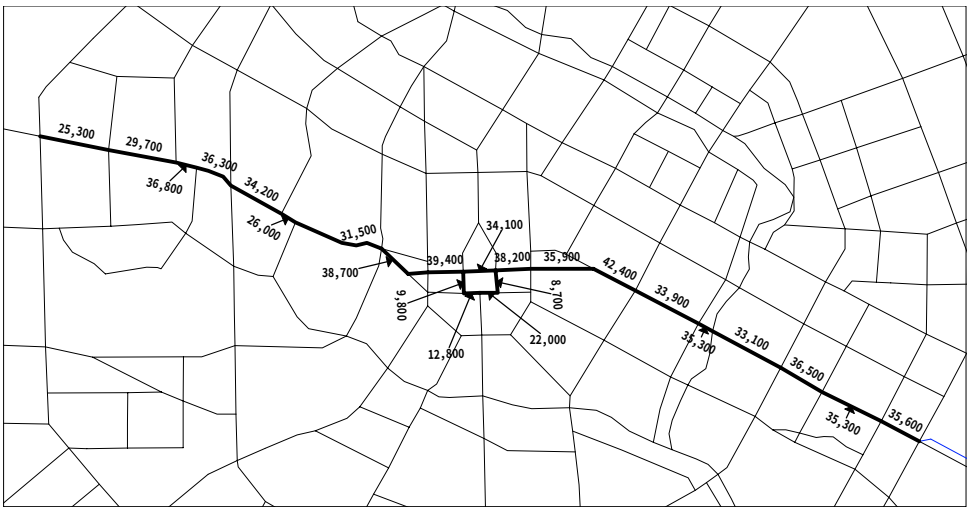


Bicycle (veh/day)

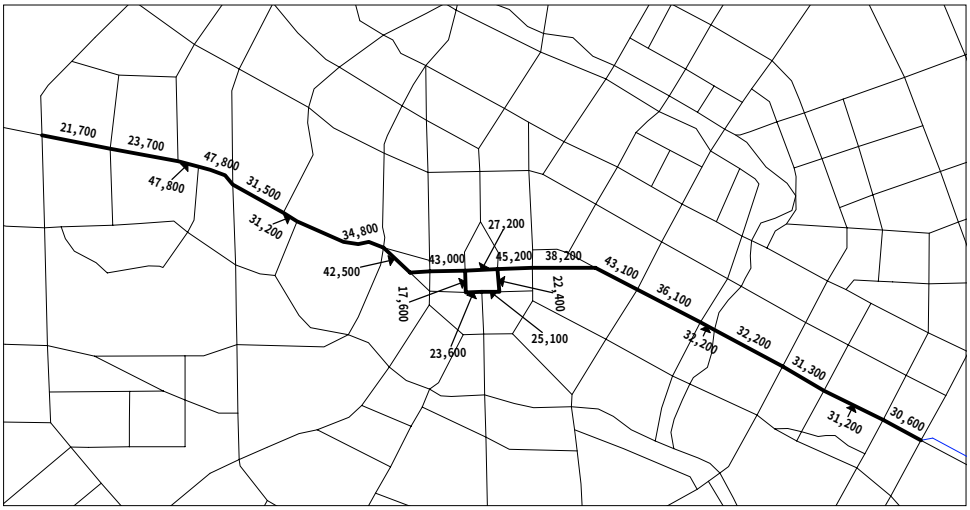


Bus (veh/day)

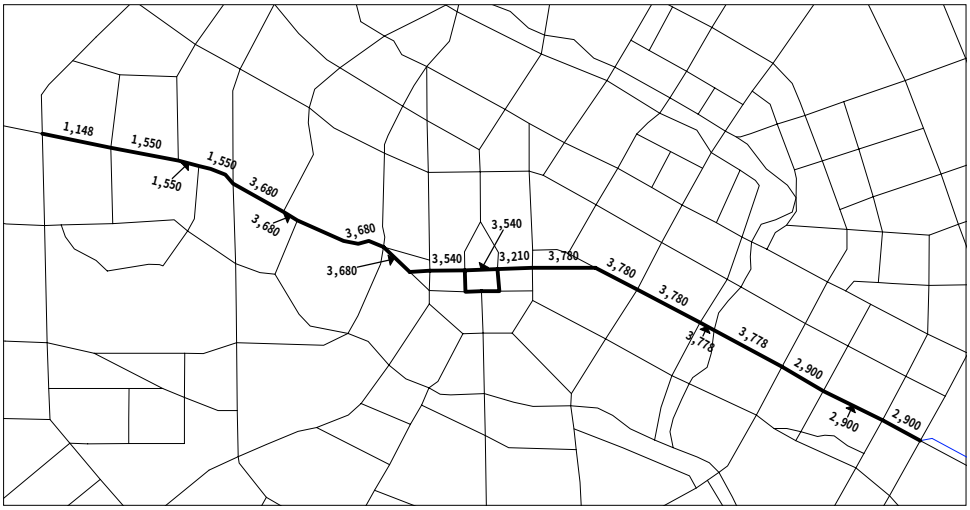
Figure 10.2.2 Traffic Volume on the Shudu Road (2010)



car (veh/day)



bicycle (veh/day)



bus (veh/day)

10.3 Preliminary Design of the Exclusive Bus Lane

From April to December 2000, the JICA Study Team prepared a Master Plan for the improvement of public transportation in Chengdu. The output, which is the Plan, is contained in Chapters 1 - 9 of this report. One of the high priority projects identified in the Plan for immediate implementation is the proposal for exclusive bus lanes/priority bus lanes to be introduced on Shudu Road. This chapter will now discuss the results of the Feasibility Study conducted for this proposed priority project including the general design for the proposed facilities of the dedicated bus lanes on Shudu Road based on the plan recommended in the Master Plan.

The basic map used in the preliminary design was prepared by Chengdu Research Department of Exploration, Measuring and Drawing. In contrast with the original detailed topographic maps with scale 1:500, the present scale is 1:1,000. Also, the topographic map used is relatively new with sections of the map modified either in 1995 or 1999. The Drawings Volume of this report contains the preliminary designs of this study.

Structure and facilities of roads, demand for buses, land utilization, etc. are just some of the factors which shall be considered in designing for the location of the dedicated bus lanes. The study area for preliminary design starts from the crossing of Shudu Road and the 2nd Ring Road of west to crossing of Shudu Road and the 2nd Ring Road of east, 8.9 kilometers longer than the area where bus lanes will be introduced, as illustrated in refer to Figure 10.3.1 and the preliminary design is discussed in the succeeding sections.

10.3.1 Horizontal and Vertical Designs

(1) Horizontal Alignment Design

In order to introduce the exclusive bus lane on Shudu Road with the use of present road facilities, the horizontal alignment of bus lanes shall follow that of the existing roads as described in Table 10.3.1. There is a 100-meter minimum horizontal curvature at the crossing of Shudu Road and Citang Jie. According to geometric standards of inclined road, buses have no trouble running for the reason that they can operate at a speed of 50 km/hr on lines with a 100-meter curvature. Except for the above mentioned road segment, on other road segments of 240 meters and that of more than 80 km/hr of 400 meters curvature. Therefore, there is no need to change the horizontal alignment of present roads.

Figure 10.3.1 Project Outline

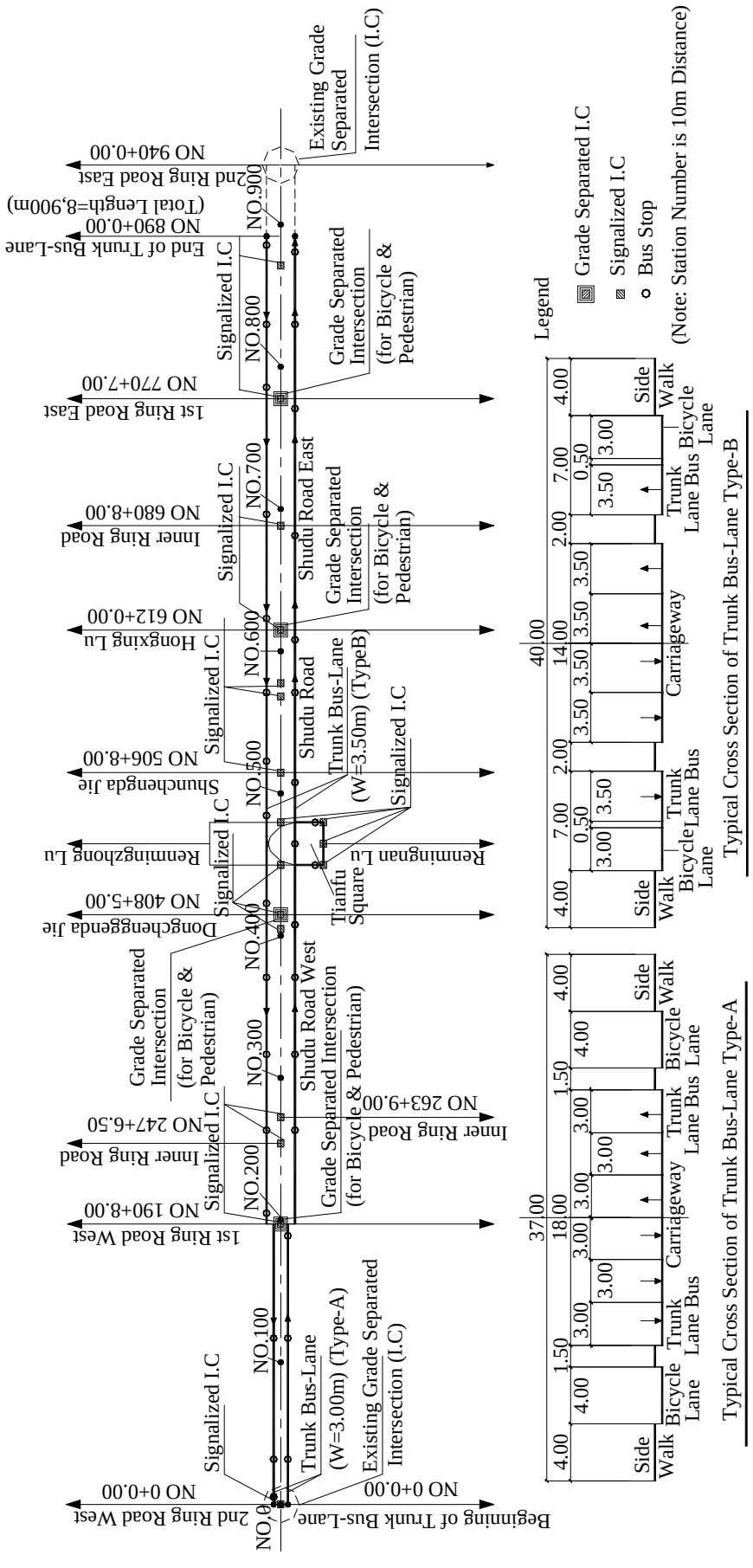


Table 10.3.1 Curve Semi Diameter of Shudu Road

Station No.	Length (m)	Horizontal Curvature (m)
No. 0+0		
No. 158+7	1,587	Straight Line
No. 166+9	82	R=+400
No. 180+0	131	Straight Line
No. 186+7	67	R=+400
No. 188+8	21	Straight Line
No. 192+8	40	R=+400
No. 286+0	932	Straight Line
No. 290+9	49	R=+400
No. 310	191	Straight Line
No. 325+6	156	R=-400
No. 335+8	102	Straight Line
No. 356+5	207	R=+240
No. 383+3	268	Straight Line
No. 393+8	105	R=-100
No. 563+5	1,697	Straight Line
No. 570+0	65	R=+140
No. 890+0	3,200	Straight Line

Note: R=+: clockwise curves
R= - : anticlockwise curves

(2) Vertical Alignment Design

As discussed in the horizontal alignment design, in order to introduce exclusive bus lanes on Shudu Road based on the use of present road facilities, the vertical alignment of bus lanes shall follow that of the road. As shown in Table 10.3.2, present longitudinal grade on Shudu Road is built on plain terrain. Thus, introduction of exclusive bus lanes will not be requiring improvement on the longitudinal grade of the present road. However, since the present minimum longitudinal grade is only 0.1%, attention should be given on the drainage system. Proper management therefore of road facilities especially of its drainage system, particularly where water flows in and out of the road, should be implemented.

Table 10.3.2 Longitudinal Grade of Shudu Road

Names of Roads Crossing Shudu Road	Station No.	Length (m)	Height of Present Road (m)	Grade (%)
The 2nd Road of west	No. 0+0	----------	504.17	----------
The 1st Road of west	No.190+7	1,907	505.30	0.059
Dongchenggen	No.408+6	2,179	502.39	0.135
Hongxing	No.611+3	2,027	500.28	0.105
The 1st Road of east	No.770+6	1,593	496.51	0.237
The 2nd Road of east	No.890+0	1,194	497.52	0.085
Average of all the intervals	----------	8,900	----------	0.074

(3) Grade-Separated Intersection Design

In the Master Plan for the improvement of the Public Transportation facilities in Chengdu, the proposal is for an exclusive bus lane to be built on the road network of West-to-East primary roads (Shudu Road), North-to-South primary roads (Renming Bei-Lu and Renming Nan-Lu), the 1st Ring Road, and the 2nd Ring Road. In addition, it is proposed that the primary road network be composed of two primary roads for east-west direction and three primary roads for north-south direction. The two primary roads for east-west directions are 1) Shuangli Lu and its extension and 2) the Shudu Road. The three primary roads for north-south directions are 1) Xinnan Lu and Hongxing Lu, 2) Renming Nan-Lu and Renmin Bei-Lu and 3) Chuan-zang Highway and Wuhouci Da-Jie and Dongchenggen Jie.

In view of the functional road and traffic characteristics, the location for the grade-separated intersections is identified. However, given Chengdu's road network physical characteristics, it is not advisable to build grade-separated intersections in the 2nd Ring Road area. Moreover, as discussed in the preceding sections, mixed traffic is a usual occurrence on present road intersections when pedestrians, bicycles and vehicles cross the road. Therefore, given the different speeds of pedestrians, bicycles and vehicles on the same space, traffic accidents often take place at the intersection.

For purposes of traffic safety, this plan proposed the building of grade-separated intersections at least on the above-mentioned roads to separate non-motorized and motorized vehicles. There are four grade-separated intersections with safe separation structure connecting Shudu Road with primary roads, as follows:

1) Intersection between Shudu Road and the 1st Ring Road west
2) Intersection between Shudu Road and Dongchenggen Jie
3) Intersection between Shudu Road and Hongxing Lu
4) Intersection between Shudu Road and the 1st Ring Road east

Since two intersections connected the 2nd Ring Road west, the 2nd Ring Road east with Shudu Road was constructed as grade-separated intersection, thus there is no necessity for a reconstruction on these intersections. The analysis of the structure of grade-separated intersection in detail and the preliminary design is contained in Drawings volume of this report. With regards to structure of traffic separation of motorized and non-motorized vehicles, results of the analysis of its general program and practical structural are as follows:

1) In general, it is best to build intersection for vehicles with consideration of function of roads. However, due to Chengdu's essential traffic policies,

specifically on the protection of landscape and environment in Chengdu, construction of the grade-separated intersection on the 2nd Ring Road is restricted. Thus, its long-term plan to build such intersection was already given up. However, the increase in traffic volume has resulted to traffic accidents. Thus, the plan for a grade-separated intersection separating motorized and non-motorized vehicles.

2) In accordance with the geometric design standard of roads in China, vertical clearance of pedestrian and bicycle lanes is limited to 3 meters and that of vehicle lanes is limited to 4.5 meters. It would have been more cost-effective however if these facilities will be built into overpasses. But given the restriction in Chengdu, underpasses for pedestrian and bicycles will be constructed to address this safety concern.

3) Taking into consideration the function and feature of the bicycle, the grade of approach road for pedestrians and bicycles are designed as slopes of 5-10%. As Modi River cross the west part of the intersection of Shudu Road and the 2nd Ring Road west, it will influence bridges if 5-10% grade are built there. It is therefore advisable to build with slopes of about 15%.

4) In view of economic and construction considerations, the use of concrete box tunnel for underpasses is planed. The underpass vertical clearance requirement should be 4.5 meters, thus sidewalk width for pedestrians can be kept at 1.5 meters and 3.0 meters for bicycles.

5) Since road widening is necessary for the planned grade-separated intersection, the existing sidewalks with trees will be converted into sidewalks. Given Chengdu's policy on greenbelt and landscape protection, trees that shall be displaced by the widening will be transplanted on intersections.

6) As the intersection of Shudu Road and Hongxing Lu is classified as primary road each other to build underpass plan for pedestrians and bicycles, which brings no influence on vehicle traffic. For this reason, the pedestrian bridges on each side of Shudu Road and Hongxing Lu should be removed.

(4) At-Grade Intersection Design

Similarly, there are six major intersections connecting to Shudu Road and other primary road. Four of these intersections should be reconstructed. The intersection connected with Shudu Road and the auxiliary roads all are used for signals. Give this the following are some suggestions on the at-grade-intersection as follows:

1) New signals only for bus traffic should be set up so that bus traffic can go straight or turn easily.

2) To improve traffic situation, a left-turning lane should be set up.

3) Road markings should be clear, such as stopping lines, zebra lines and separation signals, etc.

4) Make the area of crossings as small as possible and keep every traffic flow in order.

5) Protect the trees on sidewalks.

(5) Bus Stop Facilities Design

The length from the intersection of Shudu Road and the 2nd Ring Road west to that of Shudu Road and the 2nd Ring Road is 8.9 kilometers. It has 32 bus stops and most of these bus stops have a 2.0-meter divider. Cross section of bus stops and their location shall be illustrated later in detail. Two types of bus stop facilities are proposed: Type A and Type B. Type A is set up on the outer lane outside 6 lanes connected on the 2nd Ring Road west with the 1st Ring Road west. Type B is set up half of the bicycle lines, the original width of which is 7.0 meters. Considering the road facilities, 7.0 meters put forward. In view of road facilities, following the proposals on bus stops are identified. Besides, the details of bus stop facilities are shown in the Drawings Volume of this report.

1) Bus stops are basically set up before the intersection.

2) For pedestrian safety, bus stop facilities will be constructed on the box tunnels with signal.

3) The present divider shall be widened from 1.5 meter to 2.0 meters then Type A bus stop will be constructed on it.

4) The present outer separation of 2.0 meters will be moved to the right of the bus lanes, then Type-B bus stops will be set-up on it. However, bus lines around these stops must be moved 2.0 meters to the right.

5) A total of 32 bus stops facilities are recommended. When new bus stops will be constructed, there is no need for extra land acquisitions.

(6) Environmental Concerns to be Considered in the Designs

The Chengdu Government is carrying out a plan to promote and preserve its greenbelt areas. The plan highly emphasizes the preservation of greens on roads and sidewalks. Thus, a parallel program in support of that plan is considered. The following discussion outlines this program, as follows:

1) Environment facilities

As proposed, for the safety of pedestrians and bicycle users along Shudu Road, four (4) grade-separated intersections were identified. Though new lanes are built on the present roads, traffic will more or less be affected when vehicles or

people come in or go out of hotels, departments of affairs, shops, etc. It is therefore necessary to build access roads for both vehicle and bicycle users. Also, widening of the present road and the transplanting of affected roadside trees will be partially needed. In order not to reduce greens in the area, planting of trees at intersections will be conducted.

2) Re-pavement of Sidewalks

The present sidewalk is composed of two sections: a section for plant boxes and another for pedestrian purposes. Diameter of most trees is 10-20 centimeters and the height is 10-15 centimeters. Sidewalk is paved with concrete blocks. However, blocks of concrete are broken on many roads due to weak maintenance and substandard quality. Moreover, there are distribution pipes on the roads. Tress lining up the sidewalks lack water supply because rain dropping on the pavement would flow into distribution pipes. Thus, very little rain necessitates the reinforcement of their water supply. To ensure pedestrians' safety and to create the green effect, road pavement with the use of permeable asphalt is proposed. The estimated cost for road paving is 4.4% of the total costs of the whole project which is about RMB 4,850,000.

3) Ensure Traffic Safety and Improve the Social Environment

At present, vehicular and pedestrian traffic of different speeds such as vehicles, bicycles and pedestrians are moving on the same plane. This frequently results to traffic accidents in the crossings, the usual cause of traffic jam in the city. To distribute this mixed traffic and to keep traffic moving, four (4) grade-separated intersections are being proposed on road shoulders. To maintain the present city landscape and to minimize land acquisition, flyovers would be used to separate pedestrians and bicycles from vehicular traffic. The estimated cost for grade-separate intersection is 51 percent of the total costs of the whole project, about RMB 5,527,740,000.

4) Development of Bicycle Parks while Improving City Landscape

A great area of sidewalks around Zongfu Road is converted to bicycle parks thus space for walking gets smaller making pedestrians feel very uncomfortable. In this case, not only is city landscape affected but also the people who could not enjoy shopping due to the very limited space for pedestrians. In this plan, particularly on Zongfu Lu, the bicycle parks will be transferred to six identified appropriate locations. The estimated cost in building 6 bicycle parks is 2.6 percent of the total costs of the whole project which is about RMB 28,530,000.

10.3.2 Cross Section Design

(1) Number of Exclusive Bus Lanes Required

The number of required exclusive bus lanes should depend on existing bus traffic and the capability of the bus lane in the future.

The traffic forecast on each road section of Shudu Road in 2010 is shown in Table 10.3.3. The one-direction traffic on each road per hour of different traffic mode is shown in Table 10.3.4. The assumption is that traffic demand forecast is about 15,000 (pcu/d) outside of the 1st Ring Road area and about 25,000-30,000 (pcu/d) within the 1st Ring Road. Bus traffic demand forecast in the same section (average passenger is 45) is 5,000 (pcu/d) and 10,000 (pcu/d) respectively. One-direction bus traffic per hour is assumed to be 250-375 (pcu/h) in conversion of car. If this data is transformed to number of bus (bus' pcu = 2.5), it is 60 to 150 in one direction per hour. Thus, having 60 buses results to about one bus fleet per minute while bus fleet of 150 would result to about two or three buses per minute. At present, there are about two or three buses passing on he bus lane in Shudu Road per minute.

Table 10.3.3 Traffic Forecast on Shudu Road in 2010

Road Section on Shudu Road	Unit	Traffic Volume (2010)			Bicycle
		Vehicle (pcu)	Bus (vehicle)	Total (pcu)	
The 1st Ring Road (west)– The 2nd Ring Road (west)	Day traffic (2)	29,700	1,500	33,450	23,700
	Hour traffic (2)	2,900	115	-	2,900
	Day traffic (1)	17,200	750	-	13,500
	Hour traffic (1)	1,700	60	-	1,600
The 1st Ring Road (west)– The Inner Ring Road (west)	Day traffic (2)	39,400	3,600	48,400	42,500
	Hour traffic (2)	3,900	280	-	5,200
	Day traffic (1)	22,800	1,800	-	24,200
	Hour traffic (1)	2,300	140	-	2,900
The 1st Ring Road (east)– The Inner Ring Road (east)	Day traffic (2)	35,900	3,800	45,400	43,100
	Hour traffic (2)	3,600	300	-	5,200
	Day traffic (1)	20,800	1,900	-	24,600
	Hour traffic (1)	2,100	150	-	3,000
The 1st Ring Road (east)– The 2nd Ring Road (east)	Day traffic (2)	35,600	3,800	45,100	32,200
	Hour traffic (2)	3,600	300	-	3,900
	Day traffic (1)	20,600	1,900	-	18,400
	Hour traffic (1)	2,100	150	-	2,300

Note: * (2) is traffic of come-and-go directions, (1) is traffic of one direction.
* Traffic per hour is in rush hour. (The rates of vehicle, bus and bicycle in rush hour are 10.0%, 7.7% and 12.1%.)
* The different direction rates of vehicle, bus and bicycle are 58%, 50% and 57%.
* The unit of bicycle is vehicle.

Table 10.3.4 Traffic Capability and Traffic Demand, 2010

Road Section on Shudu Road	Traffic Capability		Forecasted Traffic Volume			Number of Lane Required (one direction)		
	Vehicle (pcu/h)	Bicycle (v/h)	Vehicle (pcu/h)	Bus (pcu/h)	Bicycle (v/h)	Vehicle	Bus	Bicycle
The 1st Ring Road – The 2nd Ring Road (west)	600 1,200	1,000	1,700	150	1,600	2	1	2
The 1st Ring Road-The Inner Ring Road (west)	600 1,200	1,000	2,300	350	2,900	2	1	3
The 1st Ring Road-The Inner Ring Road (east)	600 1,200	1,000	2,100	375	3,000	2	1	3
The 1st Ring Road – The 2nd Ring Road (east)	600 1,200	1,000	2,100	375	2,300	2	1	3

Note: 1. The up 600 of vehicle traffic is traffic per lane of traffic of come-and-go carriageway, and the down 1200 is traffic per lane of mart; road.
2. The bicycle traffic is computed by structure of 1.0m width and divider from vehicle.
3. The bus's pcu conversion is number of bus multiplying 2.5. (pcu of bus = 2.5)

The numbers of exclusive bus lane, vehicle and bicycle lanes required in Shudu Road in 2010 are as follows:

1) The max one direction bus traffic in rush hour is 375 pcu/h because one direction traffic capability of one lane is 600 pcu/h. The forecasting requirement of the number of bus lane is about 63% of traffic capability per lane (375/600 = 0.63). Thus, one bus lane is required.
2) The one direction traffic volume of vehicle in rush hour in 2010 (excluding bus) is 1,700 - 2,300 pcu/h. Two road lanes on one direction will be required because the max forecasting traffic is 2,300pcu/h and traffic capability (600pcu/h) per lane.
3) It is assumed that the maximum one direction bicycle traffic during rush hour is 2,200 in 2010. Given bicycle lane capability of 1,000 bicycles per 1.0 meer, bicycle lane of 3.0 meters (3,000/1,000 = 3.0) width is able to meet the requirement.

(2) Positioning of Exclusive Bus Lane within Existing Road Facility

The typical cross sections of Shudu Road between west crossing of Erhuan Road and east sections the 2nd Ring Road are listed in Table 10.3.5. There are two types of cross section: 6-lane segment and 4-lane road segment.

Table 10.3.5 Typical Cross Section Elements in Shudu Road

Item	Unit	The 2nd Ring Road West The 1st Ring Road West	The 1st Ring Road West The 2nd Ring Road East
Type of Trunk Bus Lane	-	A	B
Section Length	M	1,910	6,990
No. of Lanes	Roadway	6	4
Width of Lanes	M	3.0	3.5
Width of Carriageway	M	18.0	14.0
Width of Divider	M	1.5	2.0
Width of Bicycle Lane	M	4.0	7.0
Width of Sidewalk	M	4.0	4.0 (9.0)
Width of Right-of-Way	M	37.0	40.0 (50.0)

In the Master Plan, the exclusive bus lane was introduced on the Shudu Road by widening 4-lane to 6-lane, with exclusive buses operated on the outer lanes of 6-lane carriageway. However, in the Feasibility Study stage, the exclusive bus lane road segment between the 1st Ring Road East and the 2nd Ring Road East (it is 4-lane) is built using the strip on the side of existing bicycle lane (width = 7.0m). So it is recommended that the exclusive bus lane traffic occupy half of he existing bicycle lane (width = 3.5m) and the existing bicycle traffic shall occupy the remaining part of the pavement (width = 3.0m).

The major reasons for changing the exclusive bus lane position from the Master Plan Stage and Feasibility Study Stage are as follows:

1) The widening of Shudu Road is a large scale project. Also, during the construction period, there will be confusion in the traffic flow because the bus lane should be integrated on the existing traffic flows.
2) The result of analysis on previous shop drawing of Shudu Road shows that a lot of underground utilities (including waste pipe, flow pipe and cable) will not be laid in the sections to be constructed for the exclusive bus lane. Thus, small construction project will be enough.
3) The exclusive bus lane project can be constructed on the condition that it shall not affect traffic along Shudu Road.
4) Traffic forecast on one direction bicycle traffic per hour in Shudu Road is estimated at 2,200. Comparing it with bicycle traffic capability, the 3.0m width bicycle lane will be enough. Thus, reducing the width of the existing bicycle lane from 7.0m to 3.0m will provide for one exclusive bus lane.

There are two options in deciding for the position of the exclusive bus lane: 1) bus lane is built outside the carriageway to use the other lane of 6 lanes sections (between the 2nd Ring Road West and the 1st Ring Road west) and 2) new bus lanes are built

to use the existing bicycle lane in a 4-lane road. Bus lane in 6-lane road sections is hereinafter referred to as bus lane Type A while bus lane in 4-lane road sections is referred to as bus lane Type B. The typical cross section of existing road in bus lane Type A is shown in Figure 10.3.2. The typical cross section in bus lane Type B is shown in Figure 10.3.3.

(3) Safety Measure Between Bus and Bicycle Traffic Flow

Because bus lane Type B is running on the bicycle lane, then bus and bicycle traffic shall be running on the same road simultaneously. Although it is hoped that these different speed traffic mode can run on their respective road space, the plan to have the bus and the bicycle run on the same road is being effectively considered using existing road establishment, putting capable early project on record, improving economy and efficiency. Since this project emphasizes on the safety of bus and bicycle, a 50cm width shoulder is set between bus lane and bicycle lane and chatter bars (protruding and concave establishment on road) are set on the side strip.

Overtaking of buses shall not be allowed on the exclusive bus lane since this is a single lane with width of 3.5m. But if a bus breaks down, the following bus can get across the chatter bars, running in bicycle lane temporarily until it was able to pass over the broken-down bus.

(4) The Major Construction Work Items

To build an exclusive bus lane, the following work items modification on the existing facilities and structure of the road are as follows:

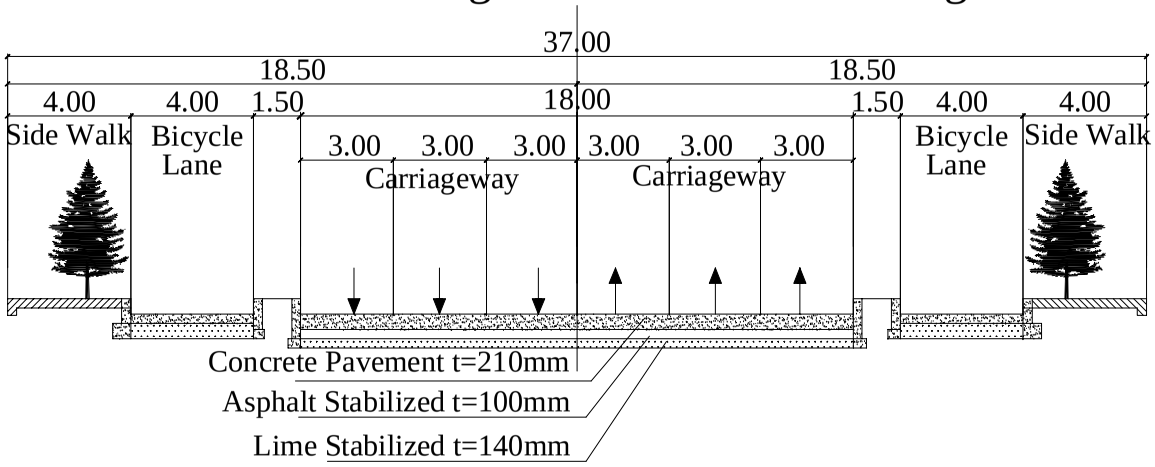
1) Bus Lane Type A

a) Because bus lane Type A is introduced at the outer side of carriageway of the existing 6-lanes, bicycle lane and sidewalks are not changed. But to define the range of bus lane, road surface (width = 3.0m) should be painted with color pavement.

b) Bus stops are built using outside divider (width = 1.5m). But because the projected width of bus stop is 2.0m, the width of outside divider of bus stop should be widened to 1.5m to 2.0m.

Typical Cross Section of Existing Road (6-Lane Dual Carriageway)

(Road Section between 2nd Ring Road West and 1st Ring Road West)



Typical Cross Section of Trunk Bus-Lane Introduced (Type-A)

(Road Section between 2nd Ring Road West and 1st Ring Road West)

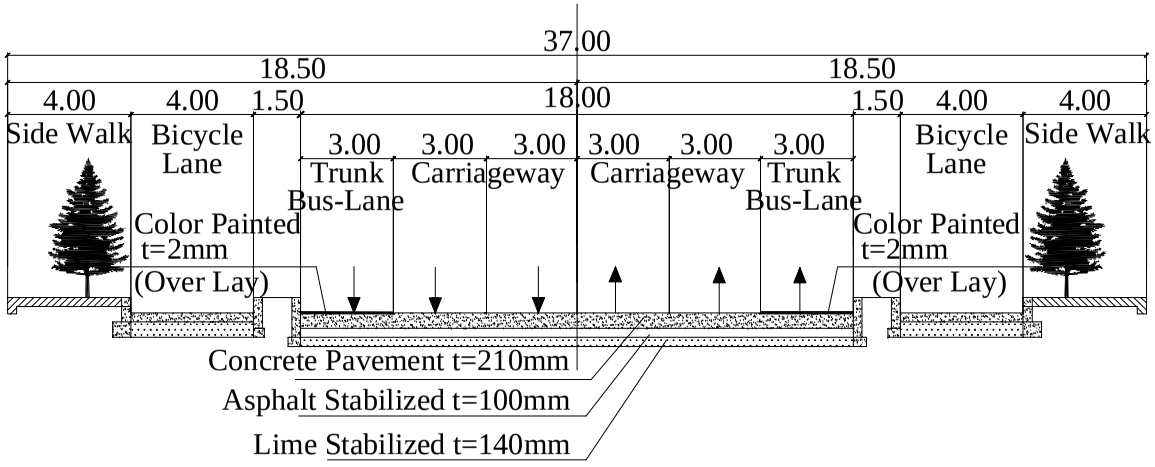
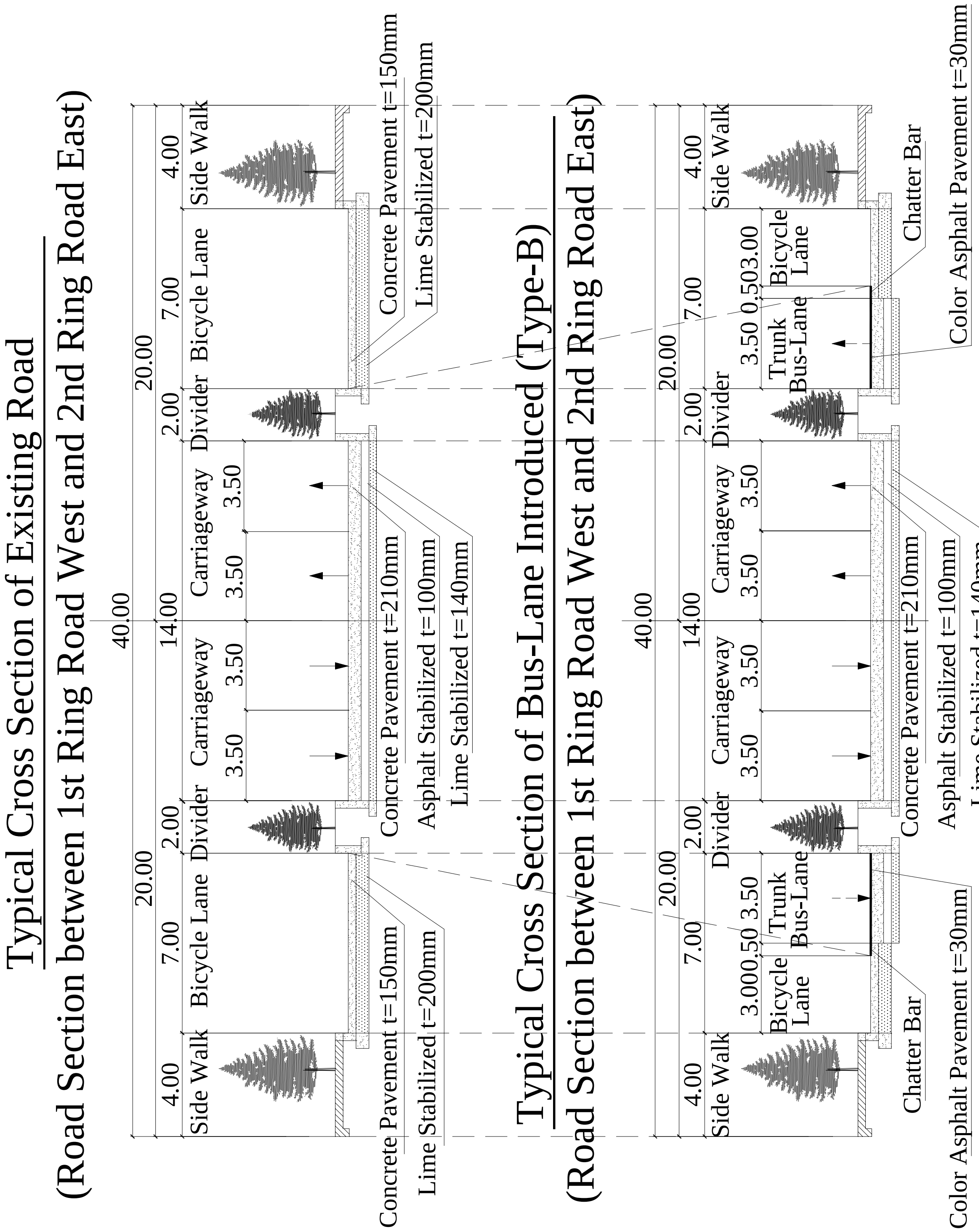


Figure 10.3.2 Typical Cross Section Type A

Figure 10.3.3 Typical Cross Section Type B



2) Bus Lane Type B

a) The existing pavement structure of bicycle lane was built as bicycle road design. It cannot support heavy load of bus traffic. So the re-pavement works on the road surface (width = 3.5m) of bus lane should be conducted (including substrate groundsill, upper groundsill and concrete board). Because the main existing sewage pipe and water supply pipes are located near the sidewalks, bus lane can be built without transferring these underground pipes.

b) To define the area of the exclusive bus lane, the new pavement of bus lanes should be paved (recovered on road surface) by color cement asphalt pavement (thickness=3cm). Since road at the major intersections has been built on vehicle load design, exclusive bus lane in these sections does not need re-pavement, however, the lane should color painted.

c) The existing outside dividers will be transferred to the right side of bus lane, and bus stop will be built in it (width = 2.0m). So the width of bicycle lanes (3.0m) should not be reduced even in the bus stop section.

d) Four grade-separated intersections will be built in four crossings of Shudu Road and major intersections. Because of the in and out traffic of grade-separated intersections, frontage roads (width=4.0m) should be built.

e) This item has no direct relation with bus lane construction in Shudu Road. Its main purpose is to protect the roadside trees along Shudu Road (providing water), improving city landscape beyond city center, ensuring safety of passenger, etc. The existing concrete block surface of pavement on sidewalks should be changed to water permeating pavement to allow rainwater to permeate on the road surface.

10.3.3 Design of Structures

Concurrently with the road construction for the exclusive bus lanes on Shudu Road, it is proposed that grade-separated intersections to separate pedestrians and bicycles from motorized vehicles be constructed at four (4) major intersections along the road: two intersections at which the Shudu Road intersects the trunk road (the 1st Ring Road) and two intersections at Hongxing Lu and Dongchenggen Jie where the road intersects the sub-trunk road. Furthermore, pedestrian bridges across Shudu Road near other relatively large intersections will be built. Furthermore, it is proposed to construct five pedestrian bridges across the Shudu Road near at other relatively large five intersections along the road.

This section gives the description of ways of constructing these structures, which have selected after examinations, and the settings of rough dimensions of the structures to be built by the way of construction. Based on these dimensions, rough quantity of the structure components is to be estimated for calculating costs of construction. Because these structures are standard, their cross-sectional dimensions are determined by referring to standard designs and the designs of equivalent structures.

(1) Design Conditions

Cross-Section of proposed structures

a) Grade-separated intersections

1. Bicycle lane: 3.0 meters
2. Pedestrian lane: 1.5 meters
3. Bicycle and pedestrian lane: 4.5 meters

b) Pedestrian bridge

The width, basically, shall be 3.0 m, which may be variable in anticipation of how many people use the bridge at a time.

Vertical clearance

Vertical clearance limits of the structures comply with the "Design Standards of City Roads and Bridges"; $h_c = 2.5$ for pedestrian way and bicycle lane combination and $h_c = 4.5$ m as the clearance under the deck of the pedestrian bridges. A margin of 20 cm is added to the above clearance for the pedestrian bridges.

Geological Conditions

According to the result of the geological survey (the result of the boring carried out in the vicinity of the Tianfu Square and the Chengdu North Railway Station; see Appendix), the geological structure of the ground in the area within the 1st Ring Road is as follows. The ground mainly consists of the outer stratum (its depth is assumed to be an average of 4 to 5 m) of reclaimed soil and the underlying Boulder Stone stratum. Because the Boulder Stone stratum is well-compact or medium compactness, there is no problem about the ground as the foundation of the pedestrian bridges.

Live Loads

For designed live loads, of which the cross sections of the road-crossing underpass and pedestrian bridge structures are calculated on the basis, refer to the loads given in the "Design Standards of City Roads and Bridges."

(2) Selection of Optimum Structures Type

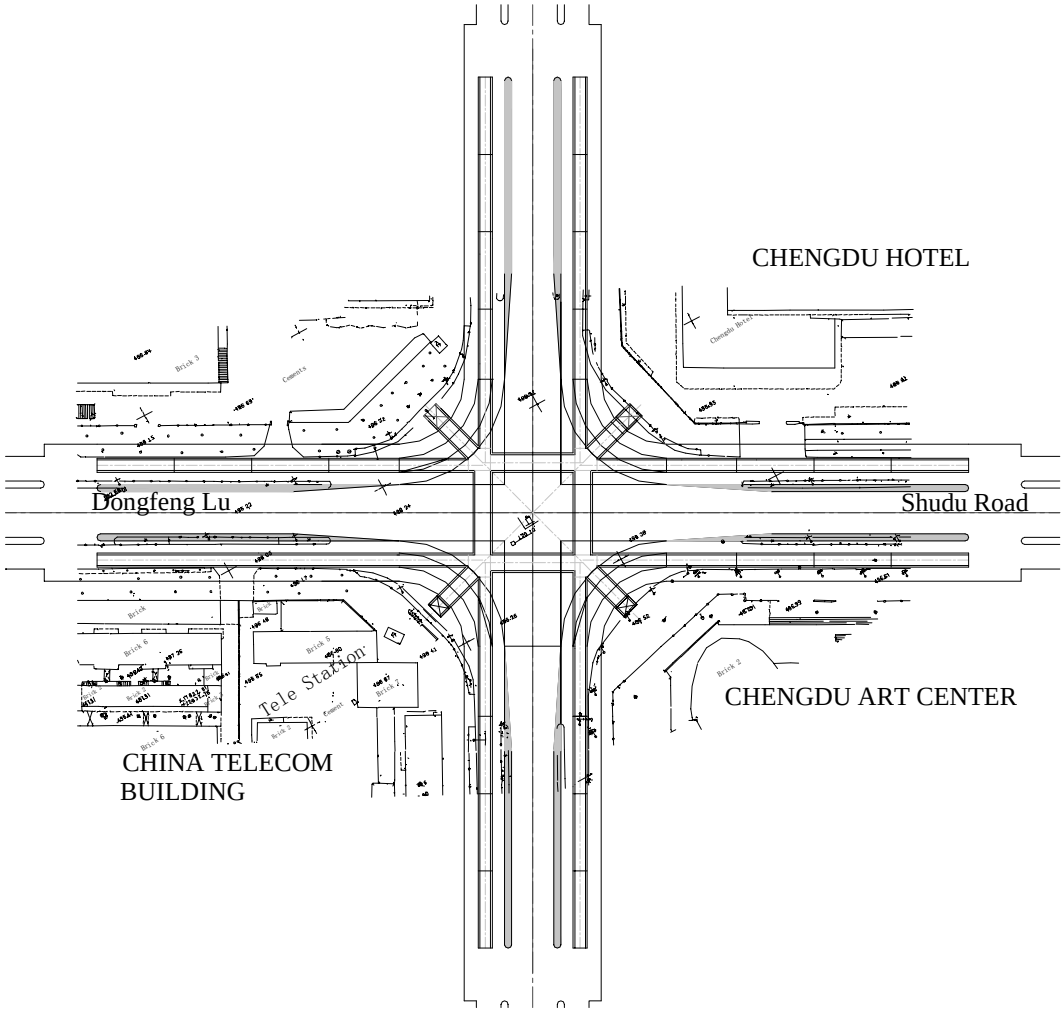
Grade separated intersections

There are three plans indicating the possible ways of constructing the grade-separated intersections:

a) Rising the current roads and semi-underpass provision (Plan A)
b) Providing an underpass comprising a bicycle lane and a pedestrian way (Plan B)
c) Converting the current road to an overhead road (Plan C)

Among them, Plans A and C require the operation of large-scale reconstruction of the current road and this greatly affects the daily road traffic of 30,000 or more cars a day. Therefore, Plan B is chosen as the way of constructing the grade separated intersections, because Plan B allows some of daily traffic to pass during the construction operation and is the smallest size of the structure to be built among the above three plans. As concerns the west intersection where Shudu Road and the 1st Ring Road cross, the bridge exists near, and consequently the Plans other than B are difficult to implement as the way of constructing the grade separated intersection. The selected type of structure that is Type B is shown in Figure 10.3.4.

Figure 10.3.4 Selected Structure (Road-Crossing Underpass; East Intersection where the Shudu Road and the 1st Ring Road Cross)



Pedestrian Bridges

a) Superstructure

Through consideration of the daily traffic of the Shudu Road, as the way of constructing the superstructure of the pedestrian bridges, plate girders for avoiding the use of the construction method is adopted, and staging or bents are used for erecting main girders. After being broken down into some blocks, the plate girders with hinges in the center span can be erected with a truck crane at night.

b) Substructure

For the substructure (piers) of the bridges, similarly, large block method by using the crane is recommended. Thereby, the schedule of construction can be prepared to complete in a shorter period at heavily trafficked places and single-column piers will be built using steel pipes.

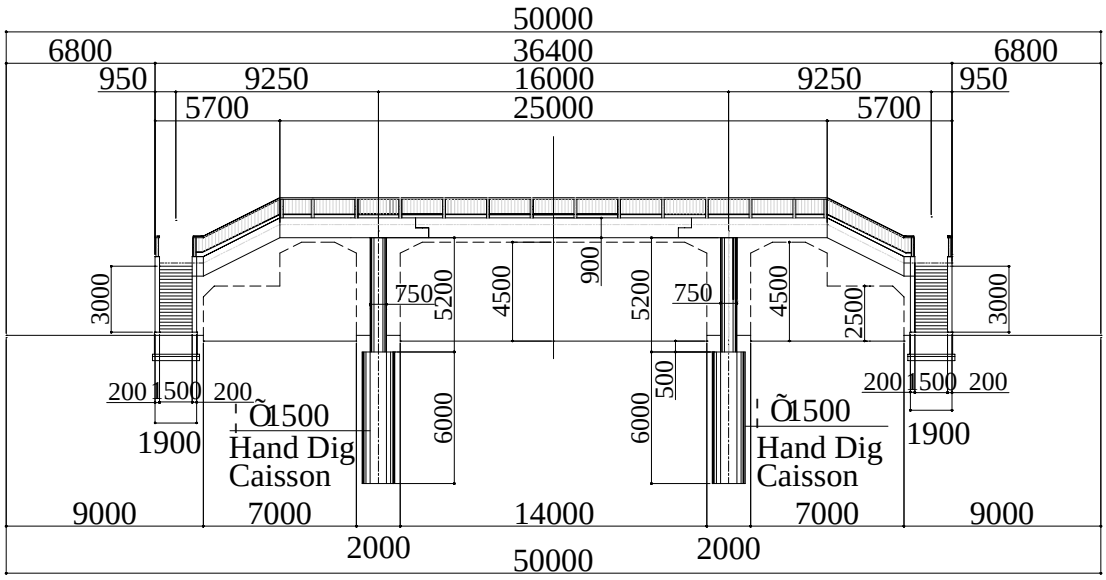
c) Foundation Structure

According to the boring survey, the estimate that the depth of the Boulder Stone stratum that bears the pedestrian bridges is about 3 to 6 m, though it is varied depending on the place where each bridge is provided. On the assumption that the position of the bearing stratum is the average depth obtained by the boring survey, Study Team opted to apply the Hang Dig Caisson method to the foundation work, that is, manual excavation using relatively large-diameter piles; a lot of engineering works were so far carried out by using the above method in the Chengdu City.

d) Bridge structure drawing

A typical drawing of the pedestrian bridges is shown in Figure 10.3.5.

Figure 10.3.5 Pedestrian Bridge Structure (Typical)



(3) Designs of Concrete Box Culvert

On the basis of standard designs and past similar designs and with the loads given in the "Design Standards of City Roads and Bridges" being taken into consideration, the dimensions of the main components are set.

1) Dimensions of Main Structures

(a) Overburden of Box Culvert

With the pavement thickness of the Shudu Road and the drainage pipes in the road being taken into consideration, the overburden of the structure is set at 1m.

(b) Inside Space Dimensions

For the box culverts to be provided at 1st Ring Road East, Hongxing Lu, and Dongchenggen Jie, the height of the inside space was set at 3.3 m, with the

following being taken into consideration: the minimum necessary height of 2.5 m for the pedestrian way and the bicycle lane; road surface level difference of 0.15 m; a height of 0.30 m for the overhead lighting space; and a height of 0.3 m allowing for a small-diameter electrical cable running buried under the road surface. The width of the underpass was set at 4.5 m: a width of 3.0 m required for the bicycle lane and a width of 1.5 m required for the pedestrian way. As for the 1st Ring Road West intersection with the Shudu Road, because the bridge and related structures located on the west of the intersection place restrictions on the structure, the height of the box culvert must be set as low as possible. Thus, with the same height being maintained for the space for the bicycle lane and the pedestrian way, the inside space height was limited to 3.1 m and the entire culvert height to 4.1 m.

(c) Other Box Culverts

For the box culverts furnished with the bicycle lane and pedestrian way only, only the culvert width was set to the passage width.

(d) Concrete Member Thickness

Member thickness is determined in the light of the live loads produced by vehicles moving on the road and the side pressure (earth pressure and hydraulic pressure) which are applied to the box culvert. Figures 10.3.6-10.3.8 give graph representations of the relation between the thickness of a box culvert with inside space dimensions of 4.5 x 4.5 m and the depth of its overlaying layer with regard to the Asian countries (for China, the inside space dimensions of 4.5 (B) x 2.8 (H) m apply). From the above reference, for China, it is seen that the member thickness is relatively thin, while design load setting is relatively large. Probably, this is due to the applied design method and the smaller inside space dimensions. Because of the smaller inside space dimensions, and with the addition of some allowance at this primary design point, the thickness of all members is set at 50 cm.

Figure 10.3.6 Thickness of Top Slab

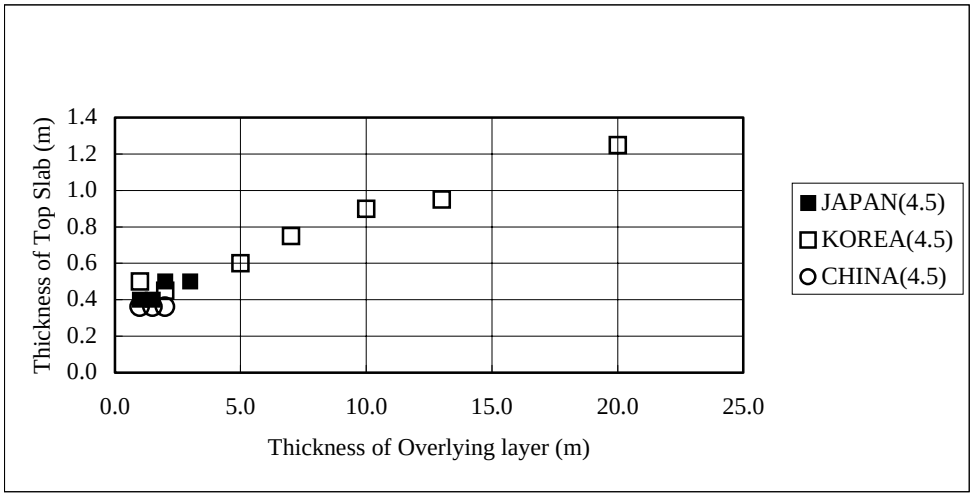


Figure 10.3.7 Thickness of Bottom Slab

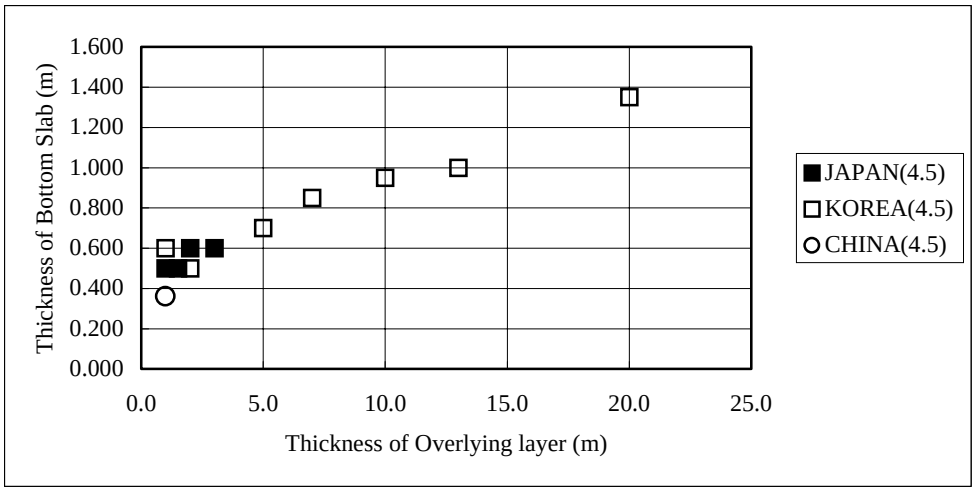
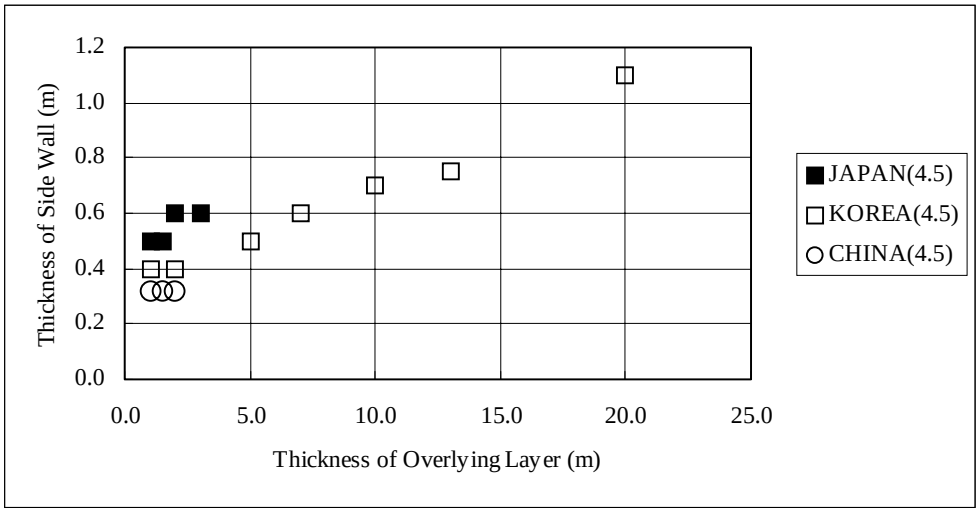


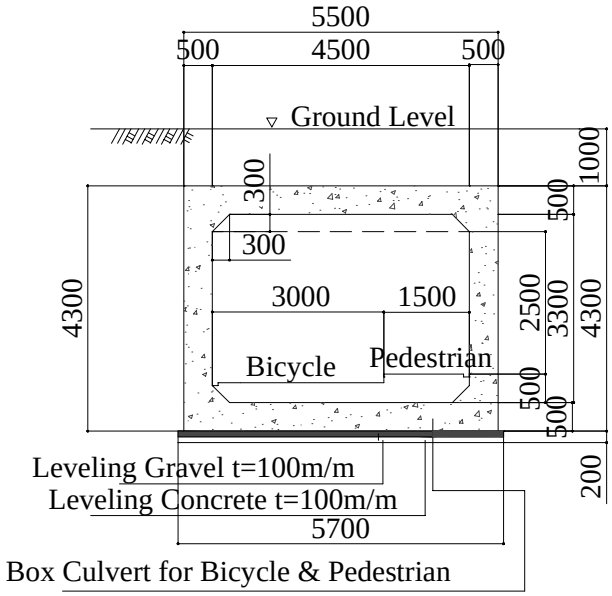
Figure 10.3.8 Thickness of Side Wall



(e) Setting of structure dimensions

In the aggregate of the above, the dimensions of the box culvert structure are shown in Fig. 10.3.9.

Figure 10.3.9 Cross section of Box Culvert



2) Others

(a) Drainage facilities

Every box culvert will be furnished with a cross drainage gutter at every entrance of the underpasses to prevent rainwater incursion from the Shudu Road and perform drainage in the same manner as for road drainage. For the inflow water from the openings of the U-type retaining walls and the infiltrating water, it is planned to make a catch basin at the bottom of the underpass and drain the water in the basin by pumping. Because we, now, have not obtained sufficient data on the quantity of predicable rainwater and infiltrating water in site, the capacity of the drainage equipment must be reviewed in future design implementation.

(b) Waterproof layer

The buried box culvert will be covered with waterproof layers to prevent the infiltration of groundwater.

(c) Underground utilities

In principle, it is needed to reinstall the subsurface buried pipes (sewage pipes and water supply pipes) to lay these pipes under the box culverts. As for the sewage pipes, due to the pressure and relations and the pipes that intersect with each other, special structure (such as inverted siphons) should be considered. At this stage, the Study Team have not grasped well the entire sewage plan in the city of Chengdu regarding the subsurface buried pipes,

particularly, the sewage pipes, and thus only the cost estimate of engineering work is done.

(d) Stairways and U-type concrete retaining walls

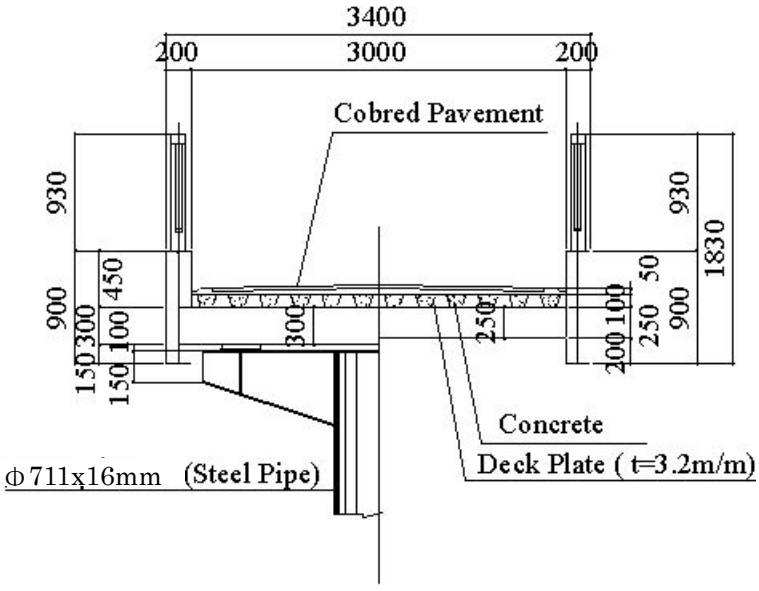
For the stairways to the box culverts and the U-type concrete retaining walls, the dimensions of the structures were also set in compliance with their standard designs.

(4) Design of Pedestrian Bridges

The cross section of the main girder of the pedestrian crossing bridges is determined on the basis of the standard design (width: 1.5m) of the bridges of the same type and same beam span (Gerber beam span of the bridge) in Japan. In addition, the difference of load setting between Japan and China regarding the dead load and the sidewalk live load is taken into consideration. The designed sidewalk live load the local structural parts of the bridge (deck plate and floor system) in China are 5.0 kpa which is the same as in Japan. However, such load on the main girder is greater than that in Japan; about 26% as much as that in Japan for the corresponding length of the bridges to be constructed in this project. This increased load is 10 % of the entire load on the bridge (dead load and live load). Through consideration of this fact, the dimensions of the main girder are determined as shown in Figure 10.3.10.

Required height of main girder is set at 900 mm (the corresponding height of standard design is H = 700 mm). For other portions of the pedestrian bridge structure, the dimensions of the structures were set on the basis of its standard design and past similar designs.

Figure 10.3.10 Cross Section of Pedestrian Bridge



10.3.4 Traffic Management Design

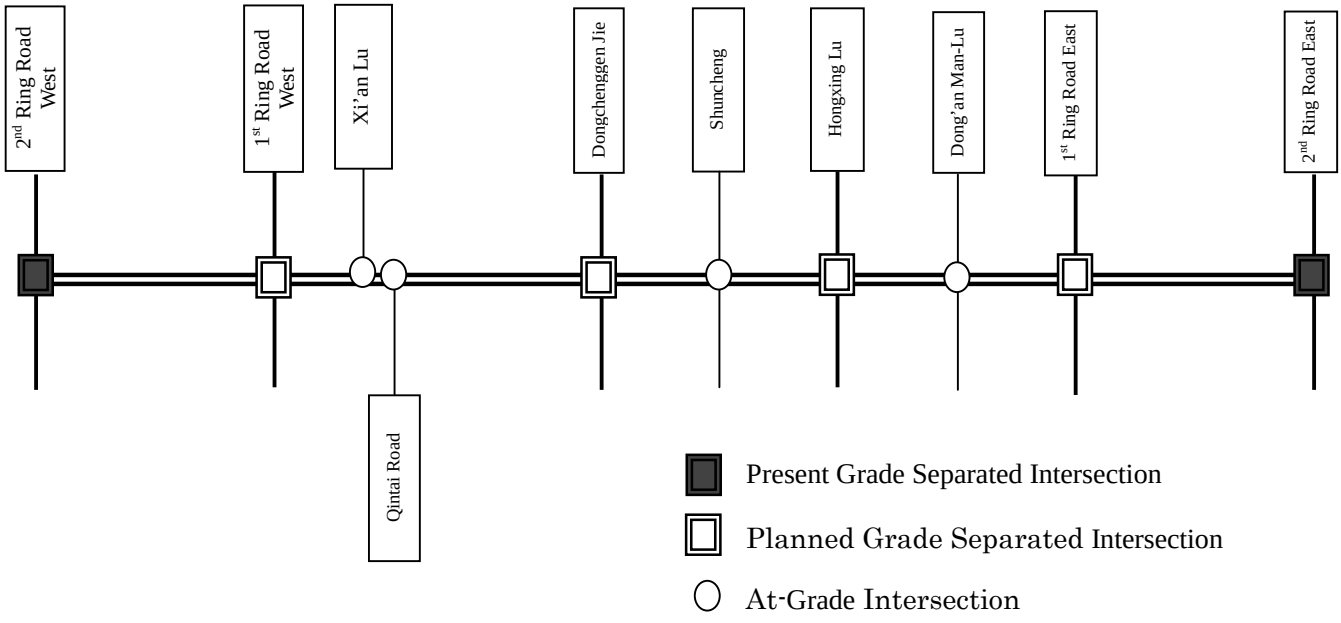
(1) Development Effects of Grade-Separated Intersection

With development in the economy, it is estimated that not only traffic demand but also the commuting bicycle traffic volume and pedestrians trips will greatly increase. Therefore traffic will easily be congested at the intersections of major roads due to the increasing traffic volume. Though the costs involved in the construction of grade-separated intersection are substantial, these flyovers are a great help in cutting down traffic congestions and in improving traffic safety. Thus, the completion of the construction of grade-separated intersections is expected to yield favorable results to social economy.

The exclusive bus lanes will be built either in outside carriageway or in bicycle lanes. This is a major point that should be considered. In this case, traffic jams due to bicycles around the crossings will be expected. Therefore it is necessary to build flyovers for bicycle traffic to keep a smooth traffic flow.

Figure 10.3.11 shows the study area along Shudu Road. The figure illustrates the ten (10) major intersections of major roads and the proposed four (4) grade-separated intersections with high traffic volume. As for the crossing of Shuncheng Jie, there are many bicycles passing on it, but it is not feasible to build a flyover there due to the underground shop.

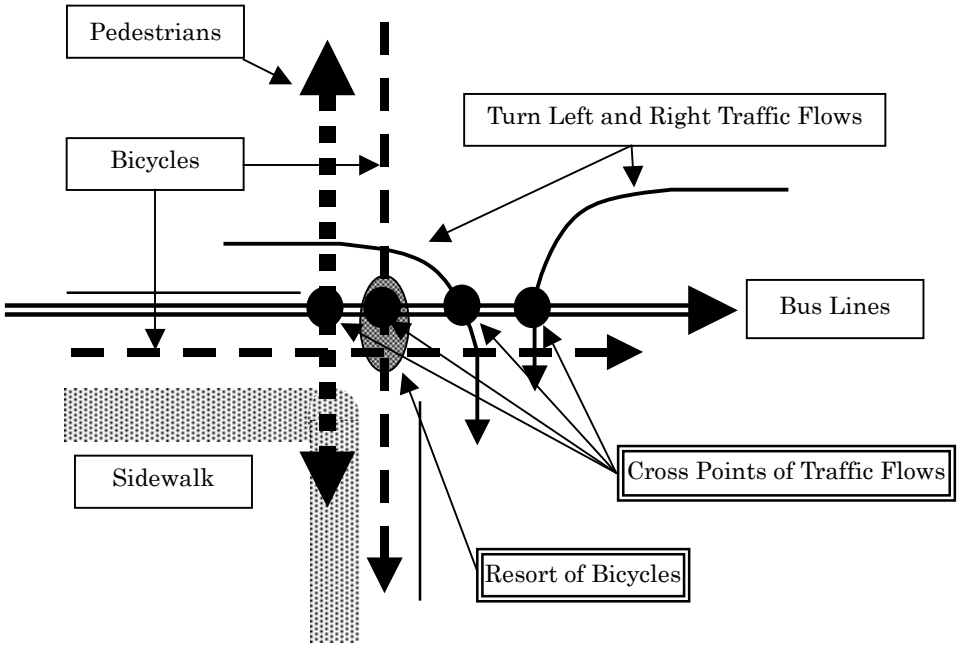
Figure 10.3.11 Location of Intersection on Shudu Road



(2) At-Grade Intersection and Exclusive Signals for Bus Traffic

At the intersection of exclusive bus lanes and bicycle lanes, sidewalks and left- or right-turning traffic lanes, there is so much traffic congestion. This results to frequent traffic accidents and traffic jams. Figure 10.3.12 shows how main traffic flows will cross each other after the exclusive bus lanes are built. There should be a good traffic flow to keep the buses moving smoothly as required.

Figure 10.3.12 Traffic Diagram for Bus and Other Vehicles

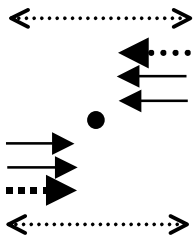
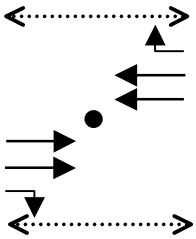
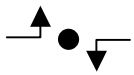
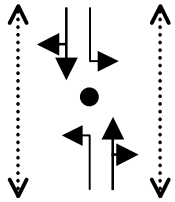
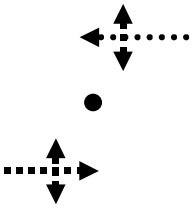


To ensure traffic safety, it is necessary to set up the exclusive signals for buses only, reducing crossings to the minimum number of traffic flows. The functions of signals for bus types only are as follows:

1) To avoid the crossing point between bus and other traffic flows when the exclusive bus lane goes straight ahead.
2) To ensure the smooth traffic flows at the intersection, when exclusive signal for buses are introduced.

As for the design of these traffic signals, a phasing system is shown in Figure 10.3.13 with signal phasing identified on the basis of traffic demand and geometric design of intersection.

Figure 10.3.13 Basic Form of Traffic Signal Lamps at the Plane Crossings

Phasing	1	2	3	4
(1) Straight Lines Only				
(2) Including Left and Right Turns		ditto	ditto	ditto
Notes:	Common Vehicles' Signal Buses' Exclusive Bicycles and Pedestrians Signal Mark of the Center of Intersection			

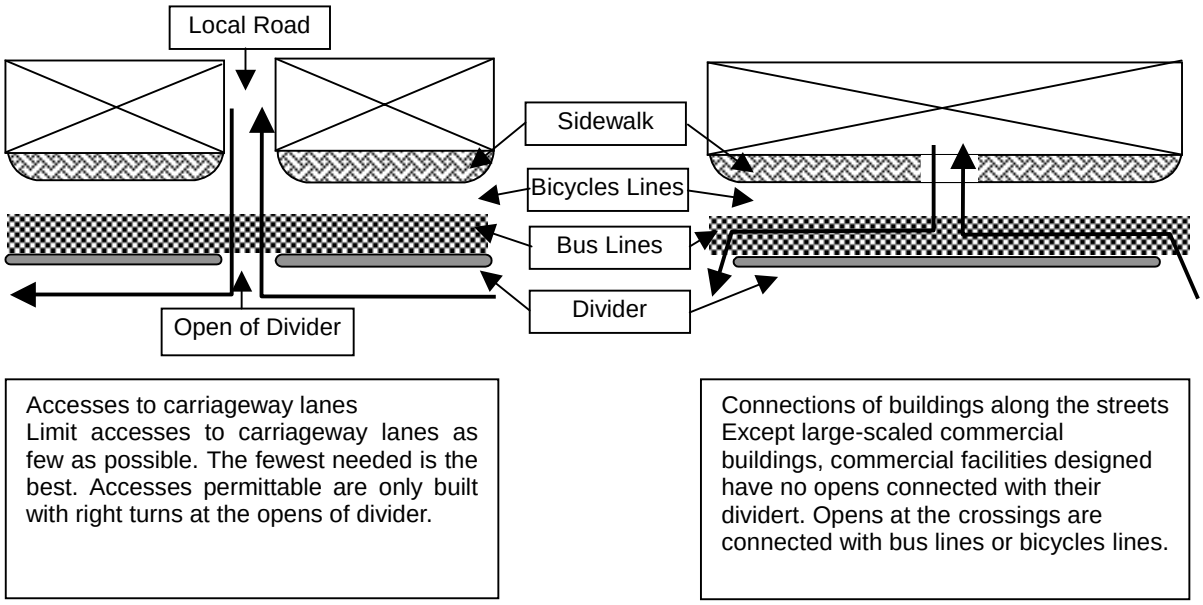
(3) Development Strategies for Access to Local Road and Land-Use along the Shudu Road

The land-use conditions along the trunk roads are widely used for commerce, department stores, residential districts, and parks. This makes the trunk road highly passable by commuting traffic, with frequent stops nearby. Thus, vehicles will either cross the exclusive bus lanes which are outside the carriageway or give up crossing, thus other vehicular traffic would influence bus operation a great deal.

Strictly speaking, exclusive bus lanes should only allow buses to use the dedicated road space. Thus, not only other types of vehicles like cars and trucks shall be prohibited for entering the bus lane but also the bicycles, pedestrians, etc. However, since roads also serve economic activities along the road, adjustments between bus traffic and private traffic should be implemented.

One underlying principle in the setting-up of exclusive bus lanes on the existing bicycle lanes is to restrict the other vehicles form coming in thus keeping the exclusive bus lanes in good condition. The details are shown in Figure 10.3.14 which shows Type B bus lane on the assumption that it can be built on the present wide bicycle lanes. This also applies to Type A bus lane with exclusive bus lanes occupying the outer part of the 6-lane trunk road.

Figure 10.3.14 Connecting Ways of Utilization of Lanes and Frontage Land



(4) Ensure Open Space for Sidewalks and Development of Bicycle Parking Area

After exclusive bus lanes are set up, all kinds of traffic would come in and take up space for non-motored vehicles except the above-mentioned access. Photo A shows that the bicycle cannot pass in the actual 1-2 meters outside greens because the growing trees cover part of the space for non-motored vehicles. Photo B shown that lanes for non-motored vehicles are filled by many tricycles waiting for passengers, not far from where there is much room where passengers get in or out of taxis and other vehicles are parking. Photo C shows the large-scale modern commercial facilities, which is the most flourish view of Zongfu Lu in Chengdu. In spite of the wide sidewalk, most of the space is taken up by bicycles for parking and pedestrians can only walk on rest room with good care, or walk on the lane for non-motored vehicle as shown in Photo D.

With the construction of exclusive bus lanes, it is very important to come up with very good measures of maximizing space utilization. Mitigating measures are formulates as follows:

1) Remove bicycle parks from sidewalks to keep enough space for pedestrians and set up new bicycle parks outside the roads.
2) Regulate tricycles passing on Zongfu Lu and set up the places for passengers to get on or off.
3) Change the places where passengers get on or off and set them up on cross roads or taxi leased parks.
4) Parking by the roadside should not be allowed.
5) Trees along the side streets should be properly maintained.

Photo A shown space
for non-motored vehicles covered by trees.

Photo B shows sidewalks taken up
by many bicycles.

Photo C shows tricycles which are waiting for
passengers on non-motored vehicle lanes.

Photo D shows pedestrians
who are crossing over sidewalk.

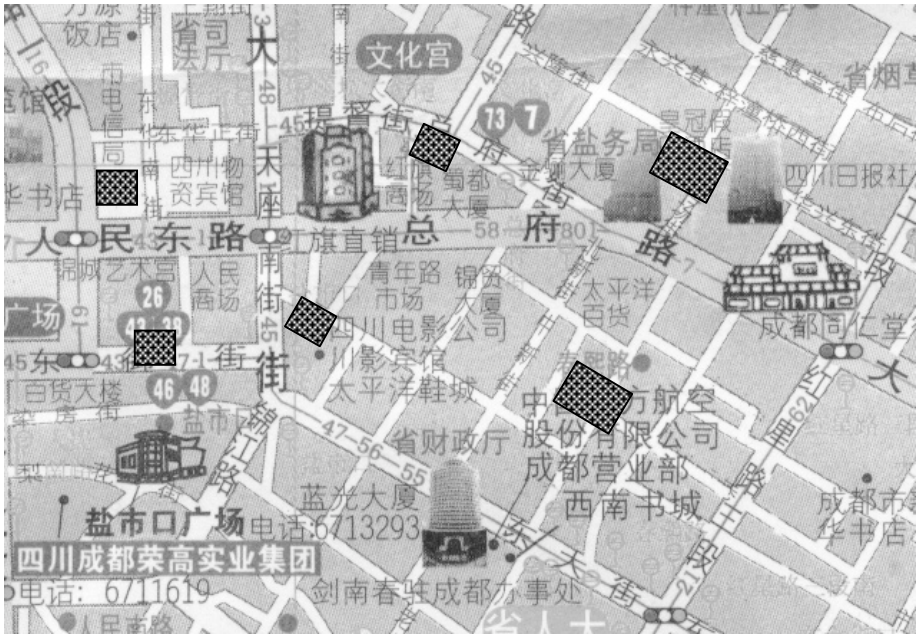
For the people in Chengdu City, bicycles are the most convenient means of transport and thus enjoy very wide ridership. With the modernization of everyday living, vehicle increases steadily. However, in the future, despite expected increase in volume, there will be no changes in bicycle traffic conditions since they are not producing pollution to the environment. With the development of this city's economy, it is anticipated that more and more people will concentrate in this central area, thus people should learn to make good use of limited public space. Moreover, the removal of obstructions from limited space, especially in the improvement of space for pedestrians, is related to the good condition of non-motored vehicles. Besides, to make possible the planning and implementation of the exclusive bus lines, the removal of bicycle parking on the sidewalks is thus inevitable.

Management of commercial and business facilities should likewise be in charge of the provision of bicycle parking facilities on the local roads or other suitable location. However, by doing so, the very limited public land will become smaller due to the construction of these bicycle parking facilities and public parks. Thus, this issue should be studied further.

With regard to bicycle parks in the center of Chengdu and those being built by people who are in charge of commercial facilities and the relative space for bicycle parks, all need to be discussed in detail. In this study, though not discussed thoroughly, the assumption is that the extent of public parks outside the road is about 200 meters. It is planned that two large-scale public parks and two mid-scale ones in the south and north of Zongfu Lu and two in the north of Renmin Dong-Lu shall be built

With regards to bicycle parks, assuming that every bicycle takes up 2.0 square meters including pass ways and management facilities, the calculation of land area of large-scale bicycle parks is about 1,600 (40m by 40m) square meters and its construction area is about 2,000 square meters (two stories). The land area of mid-scale bicycle parks is about 400 square meters (20m by 20m) and its construction area is about 600 square meters (two stories). The proposed location of the bicycle parks are shown in Figure 10.3.15.

Figure 10.3.15 Location of Bicycle Park Lot Along the Zongfu Lu



：Bicycle Parking Lot.

10.3.5 Design of Bus Stop Facilities

Most of the existing bus stops are using outside divider. Exclusive bus lane Type A and B are recommended at previous section. The bus stops facilities will be set using the principle of outside divider.

(1) Location of Bus Stop

This project intends to have 32 bus stops on both sides of Shudu Road. These bus stops shall be located on heavy traffic area and major intersections. The distance between each other is about 500 meters.

The location of new bus stops will basically follow the existing bus stops located along the project road. When new bus stops are in plane intersection with traffic signal or grade-separated intersection, it is recommended that they be set in before the traffic signal so as to reduce effects of stopping buses to other crossing vehicles. Transfer to other bus route in plane crossing with traffic signal is achieved by underground tunnel in crossing. If there is a need to transfer to other bus route at at-grade intersections with traffic signal, the pedestrian bridge can ensure the safety of crossing road passengers.

(2) Structure of Bus Stop Facilities

1) Structure of Bus Stop in Grade-Separated Intersection

The bus stop at the grade-separated intersection will be located on the front of crossing stopping line. Its structure will make use of the upper slab of the underground tunnel (concrete under drain of box type) for both pedestrian and bicycle riders. Because the width of the road connected with underground tunnel for crossing street in crossings of the 1st Ring Road West, Dongchenggen Jie, Hongxing Lu are 4.5m (width of bicycle: 3.0m + width of pavement: 1.5m), width of bus stops in the three intersections are also designed to be 4.5m. Because the width of the road connected with grade-separated intersection in 1st Ring Road is 3.0m, the width of the bus stops is designed to be 3.0m. The bus stop length is designed at 30m in taking into consideration the case where two joint-buses (length = 18.0m) and normal bus (length = 12.0m) can be operated at the same time.

2) Structure of Bus Stop (Type A and B)

Two types of exclusive bus lanes shall be operated outside of the existing 6-lane road in Type A bus lane. The existing divider shall be widened from 1.5m to 2.0m and the bus stop will be built on the increased space. Furthermore, the divider (width = 2.0m) will be moved to the right of the bus lanes and the running bus stops in Type B bus lane shall be built using the existing bicycle lane. The lengths of platform of above two types of bus stops are both 30.0m to accommodate two buses parking at the same time. The layouts for Types A and B exclusive bus lane bus stops are shown in Figure 10.3.16 and Figure 10.3.17.

3) Analysis of Platform Length Based on Traffic Demand

According to forecast, the bus traffic demand of each road section of Shudu Road is different in 2010. The traffic volume within the Inner Ring Road will be about 3800 (pcu/d). If this data is transformed to one-hour one-traffic direction during rush hour, it is about 150 buses (bus pinnacle rate: 7.7%×3, 800×0.5). This translates to two or three buses running per minute, with buses passing at interval of about 24 seconds to 30 seconds. The basis of above number is that average passenger of each bus is 45. If average passenger of each bus is 90 during rush hour, corresponding number of buses will reduce half of above number with one or two buses passing per minute. Taking this into consideration, the length of bus stops is designed at 30.0m in this project to accommodate the two-car articulated bus (length = 18.0m) and ordinary bus (length = 12.0m) stop at the same time.

Figure 10.3.16 Bus Stop Plan for Exclusive Bus Lane Type A

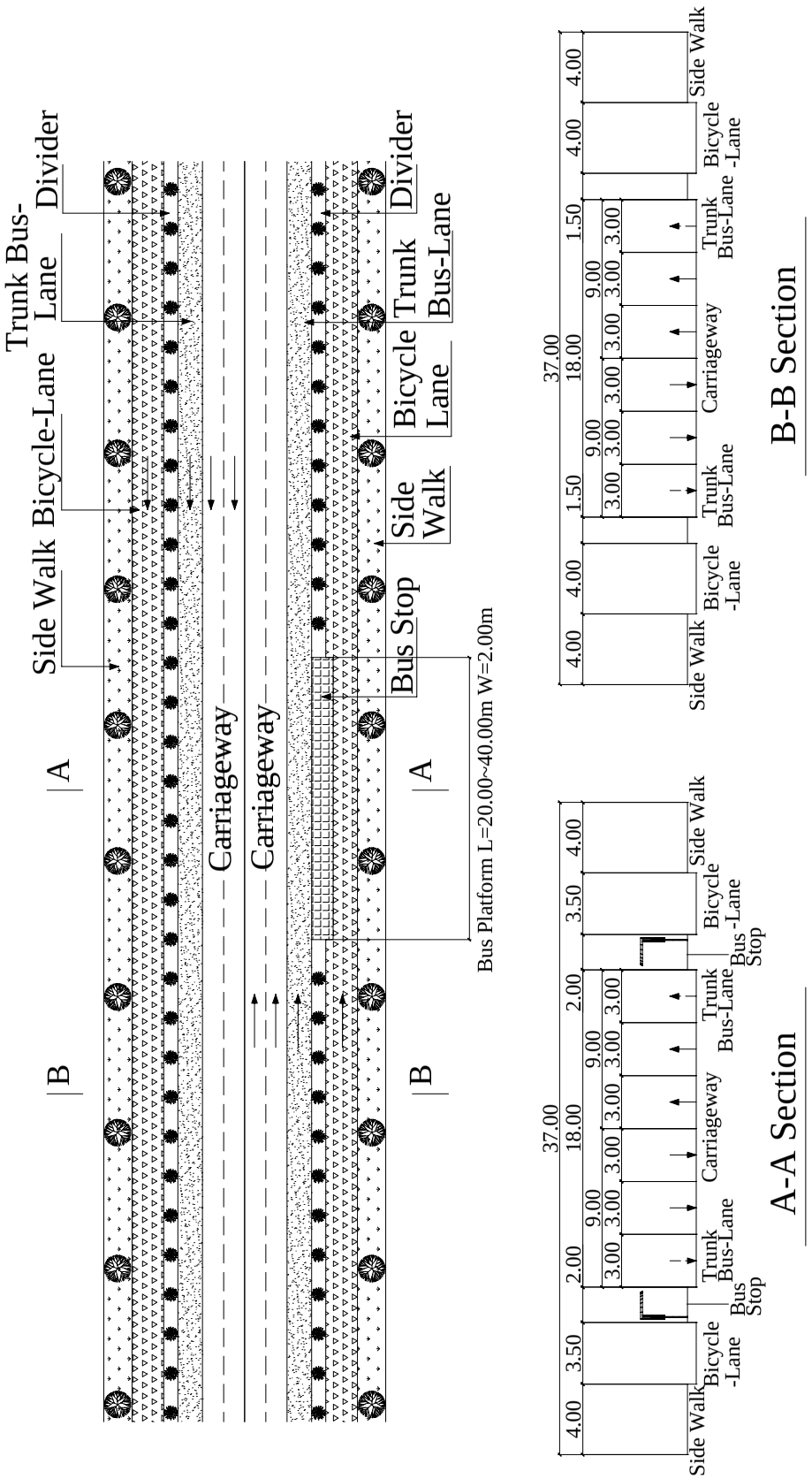
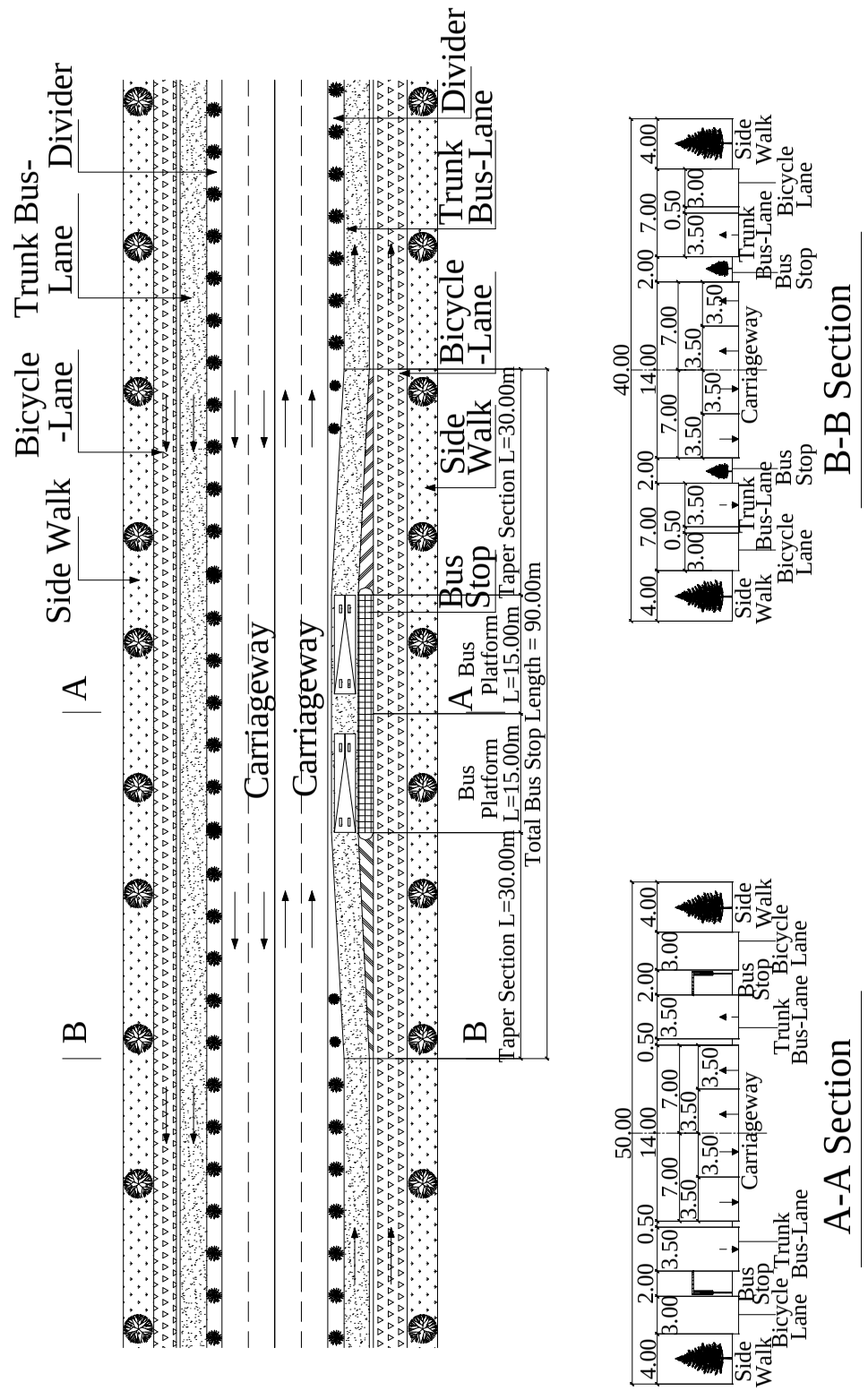


Figure 10.3.17 Bus Stop Plan for Exclusive Bus Lane Type B



10.4 Construction Plan and Project Cost Estimate

10.4.1 Construction Plan

In this section, the construction plan of the road-crossing underpass structures and pedestrian crossing bridges are described, whose design outlines were given in Section 10.3.3. The construction plan was developed on the basis of the circumstances in the construction sites, procurement of the materials and equipment for construction, environmental pollution, and sure and safe operation of construction. The construction plan comprises the matters to which attention should be paid when developing the plan, the description of selecting an optimum construction method, and the construction procedure. Items for which proper decision can be made in the scope of a normal construction method will not be described in the following.

(1) Planning considerations

1) Traffic

In the sites where we plan to construct the grade separated intersections with the Shudu Road, the daily average traffic is anticipated to be as very much as 30,000 to 35,000 vehicles a day. Thus, in the construction plan, focuses were placed on how to implement the construction so that daily traffic to be blocked by the construction will be as little as possible. The Study Team selected a construction method that allows a road width margin wide enough to pass daily traffic on the road and that minimizes the period of traffic blockade.

2) Procurement of the equipment and materials for construction

Because the planned structures are normal structures, in principle, it is assumed to use the equipment and materials for construction that can be procured in China.

3) Geology

According to the geological survey, the geological structure of the ground in the area within the First Ring Road is as follows: the ground mainly consists of the outer stratum (3 to 5 m) of reclaimed soil and the underlying Boulder Stone stratum. Boulder stones are typically 5 to 8 cm in diameter including those with the diameter of a maximum of about 12 cm which is large enough to have influence on selecting construction operating equipment. The groundwater level is about 6.0 m or less and this has little influence on the construction work as excavation to a maximum depth of 5.5 m is required for this construction work.

4) Environmental pollution during the construction

Near the proposed sites of the grade separated intersections, there are offices, hotels, and apartment houses. Thus, the noise and vibration caused by the construction should be reduced as low as possible, according to the regulation concerning such noise and vibration.

5) Sure and safe operation of construction

The construction sites are along the Shudu Road with great traffic and the intersections where the Shudu Road and the trunk road cross. Requirements of the construction plan are smooth, sure, and safe construction implementation and care should be taken so the construction has the minimum possible influence on daily traffic that will pass near the construction sites.

(2) Selection of an optimum construction method

1) Underpass structures

The road-crossing underpass structures such as box culverts and U-type retaining walls, are normal structures and special consideration is not required for their construction. Through consideration of the matters that need to pay attention when implementing the construction, an excavation method for installing the structures must be selected and incorporated into the construction plan.

To install the structures, an excavation of 5.5m is needed. Usually applicable methods of excavation to this depth are, in general, A) open cut method and B) earth retaining wall method. Although the open cut method (A) is simple operation with low cost, it demands large area for deep excavation. It is anticipated that this has great influence on daily traffic and the existing structures near the construction sites. Thus, the open cut method (A) should be applied to excavation up to 3 m. For 3 m or deeper excavation which is most part of excavation, some types of the earth retaining wall method (B) should be considered and an optimum method selected out of them.

2) Selecting an optimum earth retaining wall method

With the Boulder Stone layer excavation and the countermeasures against noise of excavation operation into consideration, the following three types of earth retaining wall methods are conceivable:

a) Sheet pile method (using pre-boring)
b) H-pile/breast-board method (using pre-boring)
c) Slurry wall method (using hand dig pile)

The Study Team evaluated the above three methods and tabulated the result in Table 10.4.1 for comparison purposes. Through this evaluation, the method b) above "H-pile/breast-board method (using pre-boring)" was selected because:

1. Method b) requires a small number of pre-boring operations and has economical advantage of reusable H-section steel.
2. Excavation by Method b) is carried out rapidly, ensuring its completion within the scheduled term of work, and operation can be performed safely.
3. Method b) uses smaller-diameter piles, reducing the excavation area and less affecting daily traffic.
4. Method b) is low watertight capability, but no problem may arise due to the low groundwater level.

The excavation plan drawing according to the H-pile/breast-board method (using pre-boring) is shown in Figure 10.4.1.

3) Pedestrian crossing bridges

Applicable to the erection of the pedestrian bridges across the Shudu Road with great daily average traffic, A) Bent method using truck crane and B) Large block method using track crane are conceivable. On the basic policy to avoid placing such structures on the road that causes traffic blockade, the Study Team chose B) the large block method using track crane. Erection operation shall be carried out at night with small traffic on the road.

Table 10.4.1 List of Earth-Retaining Wall Methods

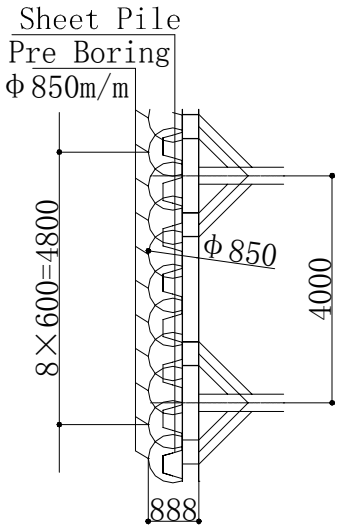
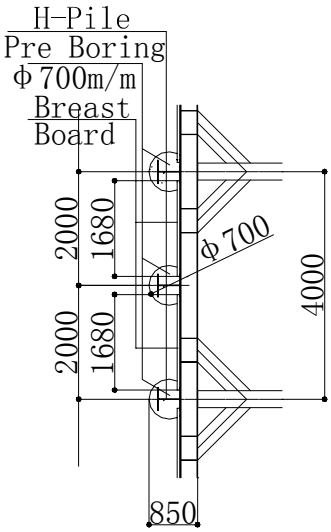
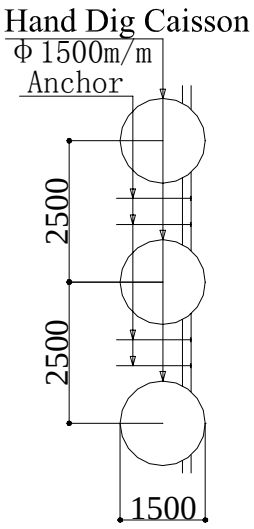
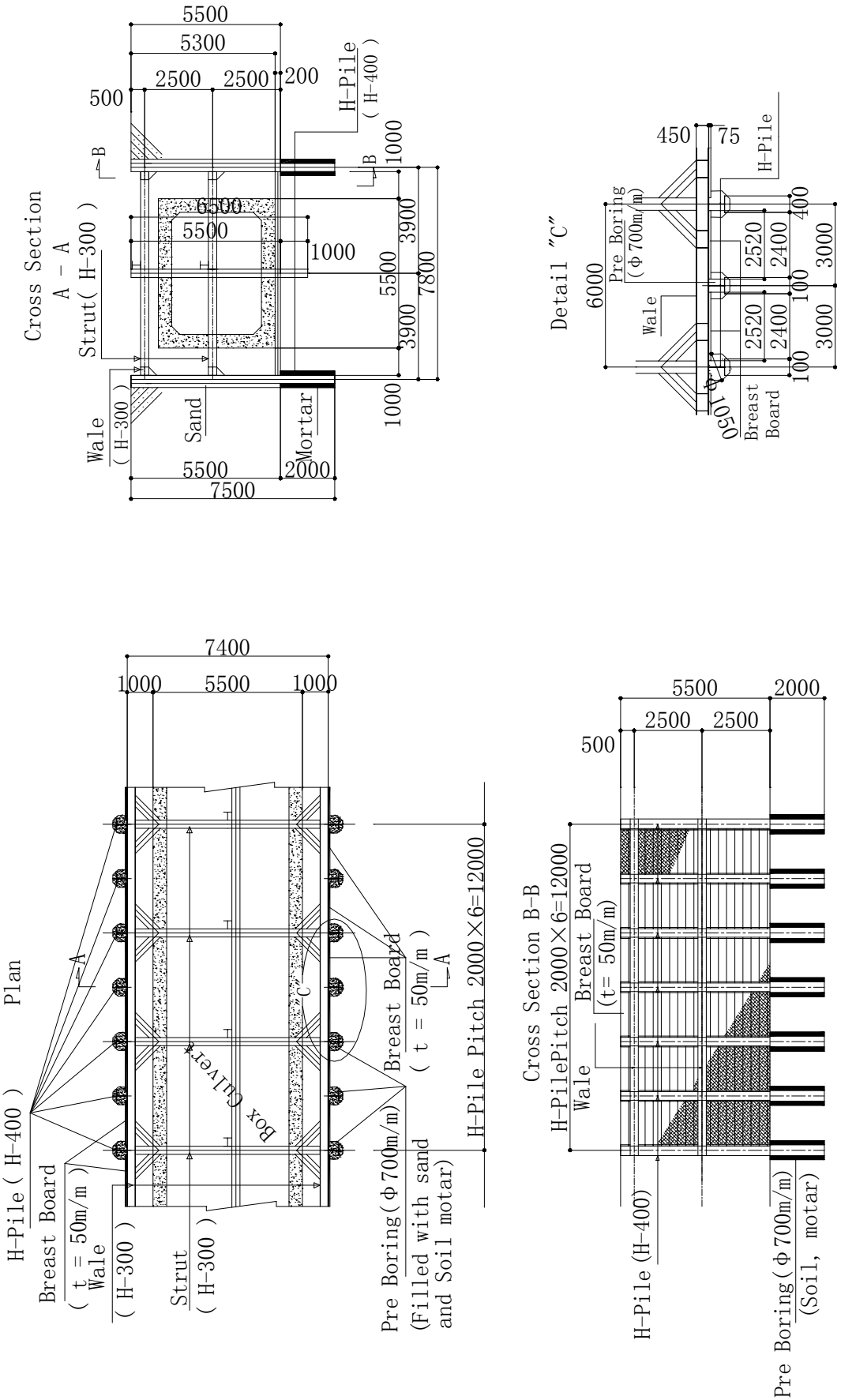
	A) Sheet pile method	B) H-pile/breast-boar method	C) Slurry wall method
Shape			
Description	Excavate Boulder Stone with rock auger for repeated re-boring and drive sheet piles to form a surround. Then, excavate the ground inside the surround, install struts, and complete excavation.	Excavate Boulder Stone with rock auger for pre-boring and dive master H-steel piles at2-m pitches.Then,excavate the ground inside the surround formed by the piles, while set breast boards in order, install struts, and complete excavation.	Dig holes by hand-dig, drive concrete piles andreinforcing bars, form a surround with the piles. Then, excavate the ground inside the surround, thereby forming walls between the piles, and complete excavation.
Advantage	-High watertight capability -Economical advantage of reusable sheet piles	-Machine-operated piling and excavation with a small number of piles, ensuring the completion within the scheduled term of work, and lower cost than the method A). -Economical advantage of highly reusable master piles.	-Not requiring heavy machinery. -Highly stiff piles, thus not requiring struts. -Commonly applied method in Chengdu in the past.
Disadvantage	-Repeated pre-boring operations are required, which is costly. -Struts are required. -Heavy machinery makes some noise during excavation, but such noise falling within the permissible range.	- Heavy machinery makes some noise during excavation, but such noise falling within the permissible range. - Struts are required.	-Term of work is long and safety during operation is in doubt. -Road width allowing passage is reduced during operation. -Materials are not reusable.
Evaluation	-A large quantity of pre-boring is disadvantageous in view of the term of work and cost. -Less affecting daily traffic. **Bad**	-Economical advantage of a small quantity of pre-boring and reusable piles. -Rapid operation ensures the completion within the scheduled term of work. -Less affecting daily traffic. **Very good**	-Method is considered disadvantageous in view of the term of work and safety -Excavation extent is wide, considerably affecting daily traffic. **Normal**

Figure 10.4.1 Structure Drawing of Temporary Earth-Retaining

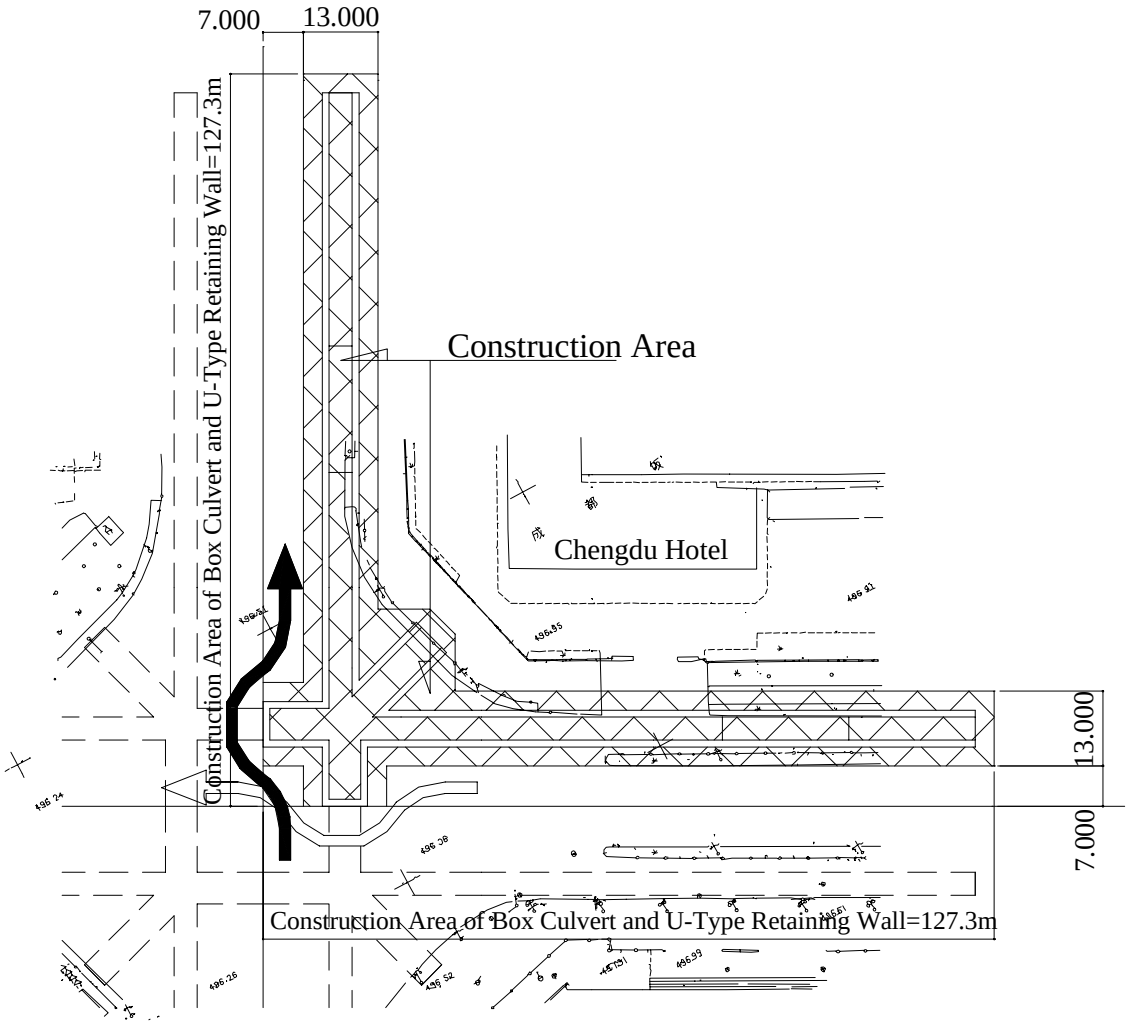


(3) Construction procedure

1) Road-crossing underpass structures

To construct the road-crossing underpass structure, it is necessary to set four stages of construction, taking care not to block the traffic at the intersections in the construction sites where great daily traffic is anticipated. For each stage, construction is carried out by about one fourth of the construction (excavation) area at a time as is shown in Figure 10.4.2. Here, with the exception of the center part of the intersection, working zones with a width of 3.3 m on either side from the edge of the earth retaining walls can be provided even if a traffic-lane width of 7 m remains. It is important to reuse the piles (H-Pile) used for excavation four times per construction work to reduce the cost of construction.

Figure 10.4.2 Construction Procedure Drawing (Phase-1)



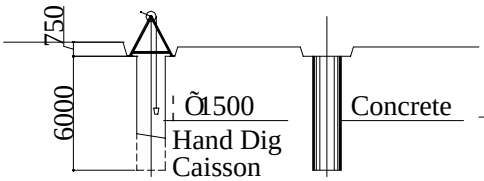
2) Erection of pedestrian crossing bridges

The construction procedure drawing of pedestrian bridge is shown in Figure 10.4.3. As described above, the piers, superstructure, and stairways of a pedestrian bridge, broken down into blocks, are carried to the site and erected by using a truck crane to be assembled at night. Erection work is carried out seven times: two times for the piers (two columns for each time); two times for the side spans; two times for the stairways; and once for the center span.

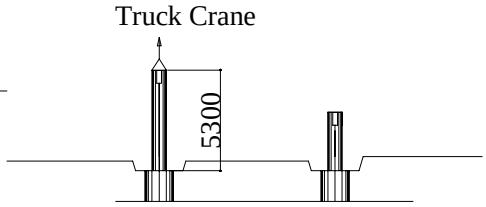
For foundation work, the Study Team chose the Hand Dig Caisson method of human-dig excavation which was commonly applied to bridge foundation in the Chengdu district in the past.

Figure 10.4.3 Construction Procedure of Pedestrian Bridge

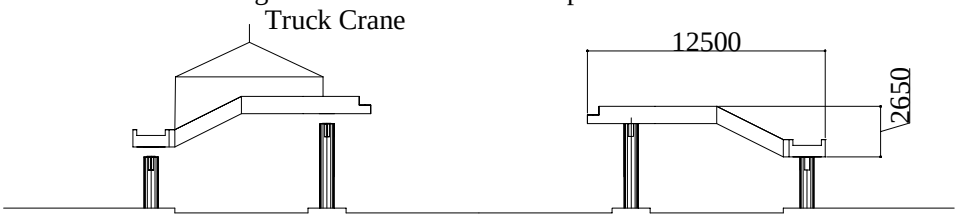
1. Foundation Piling by Human Dig



2. Large Block Erection of Piers with a Truck Crane

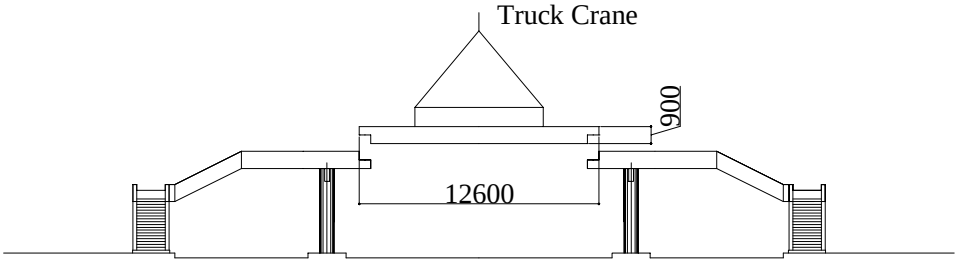


3. Large Block Erection of Side Spans with a Trunk Crane

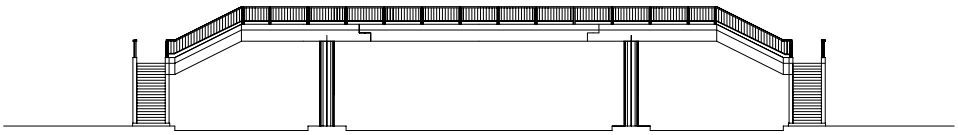


4. Large Block Erection of Stairways with a Trunk Crane

5. Large Block Erection of Center Span with a Trunk Crane



6. Construction of Bridge Surface and Guard Fence Installation



10.4.2 Quantity of Works

The quantities of major works in this project are road works and incidental road works for construction of the new trunk busway as well as the construction works of new underpasses and pedestrian bridges for improvement at intersections. Other works include the demolition of existing pedestrians, bicycle lanes, dividers, and pedestrian bridges. The items and quantities of major works are shown in Table 10.4.2. The items and quantities of all works of this project are described in Tables 10.4.3 to 10.4.7, with the summary table of quantities shown in Appendix F.

Table 10.4.2 Quantities of Major Works

Work Item		Unit	Total Quantity
Construction of New Trunk Busway	surface with color painting (type A)	㎞	1,900
	improvement of pavement (type B)	㎞	7,000
Construction of New Underpass	pedestrian, bicycle lane	No.	4
Improvement of Intersection	traffic signal	No.	18
Construction of New Bus Stop	type A	No.	8
	type B	No.	18
	type C	No.	12
	type D	No.	4
Demolition of Existing Pedestrian Bridge	W=3.0m	No.	2
Construction of Pedestrian Bridge	W=3.0m	No.	5
Improvement of Pedestrian	permeable pavement	m^2	52,000
Construction of New Bicycle Parking Place	Double stories	No.	6
Incidental Work for Road Facility	road sign, curb, etc.	m	8,900
Incidental Work for Traffic Facility	lane marking, etc..	m	8,900

(1) Quantities of Road Works

The items and quantities of road works are as follows;

- To paint the existing carriageway surface for new Primary Busway
- To construct a new stabilized base course, concrete pavement, color asphalt and curb for new Primary Busway
- To construct new frontage roads for improving at intersection
- To improve existing pedestrian with permeable pavement.

Table 10.4.3 Quantities of Road Works

Work Item			Unit	Total Quantity
New Trunk Busway				
	painting of existing carriageway surface	color painting	m^2	17,212.50
	color asphalt pavement	color asphalt (t=3cm)	m^2	42,927.50
	Concrete pavement	t=21cm	m^2	42,927.50
	Base course	asphalt stabilized(t=10cm)	m^2	42,927.50
		lime stabilized(t=14cm)	m^2	42,927.50
	Curb		m	3,460.00
New Frontage Road				
	Concrete pavement	t=21cm	m^2	11,040.00
	Base course	asphalt stabilized(t=10cm)	m^2	11,040.00
		lime stabilized(t=14cm)	m^2	11,040.00
	Curb		m	2,760.00
Pedestrian		permeable pavement	m^2	52,140.00

(2) Quantities of Related Works

The items and quantities of related works are as follows;

- To set up chatter bars and road marking for Primary Busway
- To construct bus stops and road signs for Primary Busway
- To set up guard rails, plant boxes and traffic signals for improving at intersections
- To construct new bicycle parking places

Table 10.4.4 Quantities of Related Works

Work Item			Unit	Total Quantity
Road Marking		chatter-bars	m	12,265.00
		lane marking	m	8,900.00
Road Sign		cantilever type	No.	18.00
		single column type	No.	18.00
Bus Stop				
	Type-A (including roof,chair,sign board)	W=2m,L=20m	No.	8.00
	Type-B (do)	W=2m,L=30m	No.	18.00
	Type-C (do)	W=4.5m,L=20m	No.	12.00
	Type-D (do)	W=3m,L=20m	No.	4.00
Guardrail			m	3,360.00
Planting		trees,grass	m^2	5,093.00
Traffic Signal at Intersection			No.	18.00
Bicycle Parking place(2 stories)		Type-A(floor area:2,000m^2)	No.	2.00
		Type-B(floor area:600m^2)	No.	4.00

(3) Quantities of Underpass (Tunnel Structure)

The items and quantities for underpass are as follows:

1) Permanent Work

- To construct U-type retaining wall and box culvert
- To construct entrances, stairs, and lightings and drainages facilities for underpass
- To remove and replace existing buried pipe culverts
- To make waterproofs for box culverts

2) Temporary Work

- Volume of excavation and backfilling for permanent works
- To set up H-steel pile, timbering, lagging for cofferdam

Table 10.4.5 Quantities of Underpass

Work Item			Unit	Total Quantity
Permanent Work				
	U type retaining wall	concrete work	m^3	7,329.30
	Box culvert (including drainage)	type-A(5.5×4.3m)	m	1,267.90
		type-B(4.0×4.3m)	m	317.40
	Entrance	roofs, stairs,etc.	No.	4.00
	Lighting work		m	1,787.60
	Sewerage	existing buried pipe culvert φ1.25m	m	3,730.00
	Waterproof		m^2	29,730.00
	Leveling gravel	t=10cm	m^3	1,615.40
	Leveling concrete	t=10cm	m^3	1,615.40
Temporary Work				
	Excavation	common soil	m^3	98,290.60
	Backfilling	borrowed soil	m^3	32,436.00
	Pile	H steel pile	m	19,069.90
	Timbering	wale,strut	t	2,293.80
	Lagging	lumber board (t= 5cm)	m^2	17,876.50

(4) Quantities of Pedestrian Bridge

The items and quantities for pedestrian bridges are as follows;

1) Superstructure

- Total weight and painting area for main girders, transversal beams, etc.
- Concrete volume of floors and stairways
- To set up handrails and drainages

2) Substructure

- Total weight and painting area for piers

3) Foundation

- Volume of excavation and concrete of cast in site piles

Table 10.4.6 Quantities of Pedestrian Bridge

Work Item			Unit	Total Quantity
Superstructure				
	Type-A steel girder	bridge length=34.2m	t	82.04
	Type-B steel girder	bridge length=37.2m	t	129.39
	Concrete work	floors,stairs	m^3	53.92
	Pavement	floors,stairs (t=3cm)	m^2	851.09
	Painting	including piers	m^2	5,514.90
	Handrail		m	665.50
	Drainage		m	146.00
Substructure				
	Steel pier		t	39.25
Foundation				
	Cast in site pile	earth work φ1.5m	m	135.00
		concrete work φ1.5m	m^3	280.00

(5) Quantities of Other Works

- To demolish existing bicycle lanes, pedestrians, dividers, pedestrian bridges
- To transfer existing trees and plants

Table 10.4.7 Quantities of Other Works

Work Item	Content of Works	Unit	Total Quatity
Transplanting	H=3m, D=20cm	No.	690.00
Demolition Work	existing bicycle lane	m^2	42,927.50
	existing pedestrian	m^2	63,180.00
	existing divider	m	3,460.00
	existing pedestrian bridge	Br.	2.00

10.4.3 Project Cost Estimate

(1) General

The estimation of the project costs is based on guidelines listed below used in the estimation of construction projects in China. Also, some guidelines and references being were used for estimation of construction projects in Japan were also used for this purpose.

1) Ministry of Transportation of the People's Republic of China. "The Method of Estimation for Road Construction Project". 1996.7
2) Ministry of Transportation PRC. "The Ration of Estimation of Road Project". 1992.5
3) Ministry of Transportation PRC. "The Ration of Budget of Road Project". 1992.5
4) Department of Price of Construction Project in Chengdu. "Table of Material Price for Construction Project in Chengdu". 2000.7
5) Ministry of Construction PRC. "Cost and Expense of Construction Equipment". 1998.3
6) The Examples of Cost Estimation for Road Project. (Editor: Fengqi Xing). 1998.3
7) The Examples of Cost Estimation for Bridge Project (Editor: Fang RMB) 1999.8

Project Cost Components

This project cost is based on the estimation of road project cost in China. The project cost components are as follows:

1) Construction Cost

a. Direct Construction Cost
b. Construction Equipment Cost
c. Project Profit
d. Tax

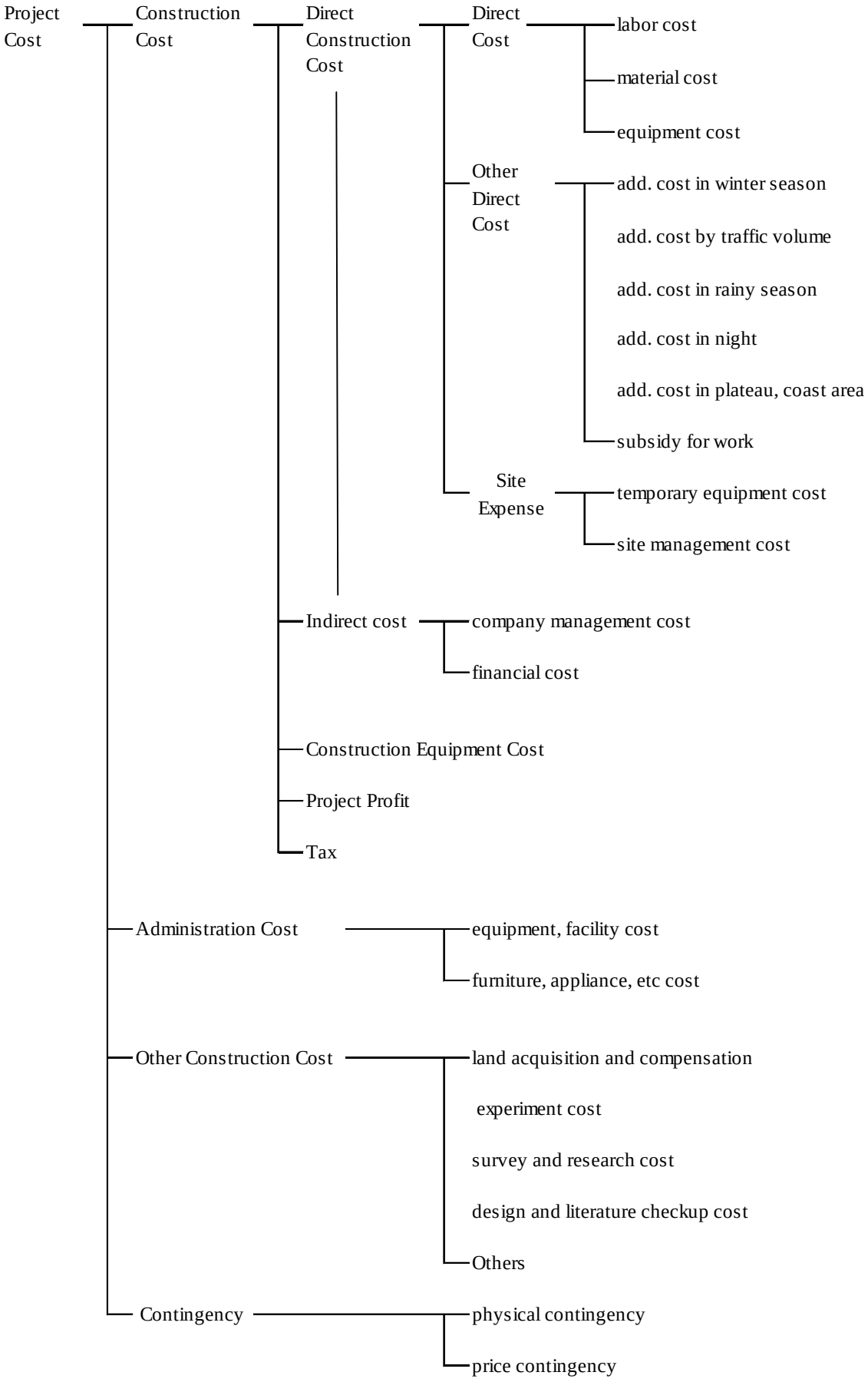
2) Administration Cost

3) Other Project Construction Cost

4) Contingency

The project cost components estimate in China is shown in Figure 10.4.4.

Figure 10.4.4 Project Cost Components Estimate in China



Content of Project Cost

1) Direct Construction Costs

The direct construction cost consists of direct cost, other direct cost, site expense and indirect cost.

a. Direct Costs

The direct costs consist of construction material costs, labor costs and construction equipment costs. The unit-prices of these direct costs are estimated based on cited references and collected data in China. The construction equipment costs include expense for depreciation, operation, installation, and maintenance. The unit-prices of direct costs are shown in Table 10.4.8.

Table 10.4.8 Unit-Prices of Labor・Material・Equipment

Item	Unit	Unit-Price (RMB)	Remarks
Labor Cost(Worker)	man·day	18.00	8hours/day
Labor Cost(Operator)	man·day	22.47	
Timber	m^3	1,064.80	
Processed Timber	m^3	1,255.50	
Reinforcement Bar(I grade)	t	2,378.00	Dia. within 10mm
Reinforcement Bar(II grade)	t	2,460.00	
Steel	t	3,000.00	
Section Steel(shaped)	t	5,000.00	
Steel Girder	t	10,000.00	Pedestrian Bridge
Ordinary Portland Cement	t	453.30	
Fine Aggregate	m^3	47.31	
Coarse Aggregate	m^3	50.05	
Borrowed Soil	m^3	5.00	
Asphalt	t	1,899.50	
Gasoline	Kg	2.90	
Diesel	Kg	2.17	
Electricity	Kw-hr	0.35	
Water	m^3	0.45	
Bulldozer(60kw)	nos·day	271.35	8hours/day
Back Hoe(0.6m3)	nos·day	457.43	
Truck(6ton)	nos·day	225.45	
Dump Truck(10ton)	nos·day	480.88	
Truck Crane(25ton)	nos·day	1,013.57	
Macadam Roller(8ton)	nos·day	208.57	
Vibrating Roller(12ton)	nos·day	464.19	
Concrete Mixer(0.4m3)	nos·day	70.04	
Concrete Truck Mixer(5m3)	nos·day	957.68	
Asphalt Finisher(8ton)	nos·day	1,145.05	
Asphalt Mixing Plant(30ton/hr)	nos·day	2,318.71	
Generator(60kw)	nos·day	316.14	

b. Other Direct Costs

The other direct costs consist of the subsidy for execution of works and the additional costs considering the condition of climate and the situation of planned construction site in the vicinity of Chengdu City. The other direct costs are estimated as total of other direct cost ratio (%) of direct cost (sum. of labor cost + material cost + equipment cost). The other direct costs of major works are shown in Table 10.4.9.

Table 10.4.9 Other Direct Costs of Major Works

Item	Additional cost caused by climate condition(%)				Subsidy(%)	Total (%)
	winter season	rainy season	night, plateau, coast area	Traffic volume per daily		
Earth Work	0.83	0.42	0.00	9.78	0.83	11.86
Road Work	0.70	0.34	0.00	3.28	1.31	5.63
Underpass and Bridge	0.68	0.29	0.00	3.22	2.26	6.45

c. Site Expenses

The site expenses consist of temporary facilities and site management costs. The site management costs are composed of basic costs and other site costs (transportation and traveling expenses for employees, utilities, etc.). The site expense is estimated as total of site expense ratio (%) of direct cost. The site expense of major works is shown in Table 10.4.10.

Table 10.4.10 Site Expenses of Major Works

Item	Temporary facilities cost ratio(%)	Site management cost ratio(%)					Total (%)
		Basic cost	Transportation cost of staple	Transportation cost for labor	Utilities cost	Traveling cost for employee	
Earth Work	2.60	3.74	0.70	0.48	0.23	0.98	8.73
Road Work	3.35	1.57	0.42	0.28	0.13	1.12	6.87
Underpass and Pedestrian Bridge	4.7	5.55	0.63	0.63	0.21	1.1	12.82

d. Indirect Costs

The indirect costs consist of contractor management cost and financial cost. The indirect cost is estimated as indirect cost ratio (%) of direct cost. The indirect cost of major works is shown in table 10.4.11.

Table 10.4.11 Indirect Costs of Major Works

Item	Management cost ratio(%)	Financial cost ratio(%)	Total(%)
Earth Work	3.32	0.33	3.65
Road Work	2.12	0.42	2.54
Underpass and Pedestrian Bridge	4.27	0.6	4.87

2) Construction Equipment Cost

This is intended to expand construction equipment and facilities. It is estimated as 3% of the direct construction cost.

3) Project Profit

The project profit is to ensure the contractor's profit from the construction project. This is estimated as 4% of the direct construction cost.

4) Tax

This is consisted of sales tax, maintenance tax and management tax of city construction. It is estimated as 3.41% of the total of the direct construction cost and project profit [(1) + (2)].

5) Administration Cost

The administration cost consists of equipment, facilities and furniture for site office. It is estimated as 10% of the construction cost [sum. of (1) direct construction cost + (2) construction equipment cost + (3) project profit + (4) tax].

6) Other Construction Costs

The other construction costs consist of land acquisition and compensation cost, research, experiment, design checkup cost, etc. It is estimated as 10% of the construction cost. There is no expense of land acquisition and compensation because there is no resettlement requirement for this project.

7) Contingency

The contingency consists of price contingency and physical contingency. It is estimated as 15% of the construction cost.

(2) Unit Construction Cost

Estimation Method of Unit Construction Cost

The unit of construction cost consists of the direct construction cost and is calculated by the unit process cost table. The table based on cited references in the previous section is generally used for estimation of construction project in China.

1) Content of unit process cost table

- Labor cost indicates the quantity of worker not including operator for construction equipment.
- Construction material cost indicates quantity of major material of work. The other small material shows the summation of quantity in RMB.
- Construction equipment cost indicates quantity of equipment including fuel cost, operation cost, maintenance cost, etc.

The unit process cost table is able to estimate the direct construction cost per unit of every work. The examples of unit process cost table are shown in Table 10.4.12 , Table 10.4.13 and all of the unit process cost table are shown in Table 10.4.14.

Table 10.4.12 Example of Unit-Process Cost Table

Excavation (machinery, common soil ）

Item	Unit	Unit-Price(RMB)
1)labor cost		
labor cost (worker)	man·day	18
2)material cost		
other material cost	RMB	—
3)equipment cost		
bulldozer(60kw)	nos·day	271.35
back hoe(0.6m3)	nos·day	457.43
truck(6t)	nos·day	225.45
other small equipment cost	RMB	
4)direct cost(1+2+3)	RMB	—
5)other direct cost（ 4×%)	%	11.86
6)site expense (4×%)	%	8.73
7)indirect cost (4×%)	%	3.65
direct construction cost(4+5+6+7)	RMB	—

Table 10.4.13 Example of Unit-Process Cost Table (continued)

asphalt pavement (t=3cm)

Item	Unit	Unit-Price(RMB)
1)labor cost		
labor cost	man·day	18.00
2)construction material cost		
asphalt	t	1899.50
fine aggregate	m^3	47.31
coarse aggregate	m^3	50.05
other material cost	RMB	161.00
3)equipment cost		
macadam roller(8t)	nos·day	208.57
asphalt mixing plant(30t/h)	nos·day	2318.71
asphalt finisher	nos·day	1145.05
tire roller	nos·day	263.58
other small equipment cost	RMB	
4)direct cost(1+2+3)	RMB	—
5)other direct cost（ 4×%)	%	5.63
6)site expense(4×%)	%	6.87
7)indirect cost(4×%)	%	2.54
direct construction cost(4+5+6+7)	RMB	—

2) Unit construction cost of work

The unit construction costs of major works are estimated based on previously estimated unit process cost table. The unit construction costs of major works are shown in Table 10.4.14 and Table 10.4.15.

Table 10.4.14 Unit Construction Costs of Major Works

Work Item	Content of Work			Unit	Unit Cost(RMB)
Road Works	Painting of existing carriageway surface		color painting	m^2	97
	Color asphalt pavement		color asphalt (t=3cm)	m^2	56
	Concrete pavement		t=21cm	m^2	151
	Base course		asphalt stabilized (t=10cm)	m^2	25
			lime stabilized (t=14cm)	m^2	20
	Curb			m	23
	Pedestrian		permeable pavement	m^2	93
Incidental Road Work	Road marking		chatter-bar	m	111
			lane marking	m	55
	Road sign		cantilever type	each	10,600
			single column type	each	2,300
	Bus stop				
		Type-A (including roof, chair)	W=2m,L=20m	each	44,700
		Type-B (〃)	W=2m,L=30m	each	67,100
		Type-C (〃)	W=4.5m,L=20m	each	100,700
		Type-D (〃)	W=3m,L=20m	each	67,100
	Guardrail		single pole, steel barrier	m	261
	Planting		trees, grass	m^2	25
	Traffic signal at intersection			each	211,000
	Bicycle parking place(2 stories)		Type-A(floor area:2,000m2)	each	806,300
			Type-B(floor area:600m2)	each	245,400
Underpass	Permanent work				
		U type retaining wall	concrete work	m^3	962
		Box culvert (including drainage)	Type-A(5.5×4.3m)	m	10,900
			Type-B(4.0×4.3m)	m	7,300
		Entrance	roofs,stairs,etc.	each	63,900
		Lighting		m	332
		Sewerage	φ1.25m	m	588
		Waterproof		m^2	202
		Leveling gravel	t=10cm	m^3	10
		Leveling concrete	t=10cm	m^3	265
	Temporary work				
		Excavation	common soil	m^3	26
		Backfilling	borrowed soil	m^3	19
		Pile	H steel pile	m	1,100
		Timbering	wale, strut	t	654
		Lagging	lumber board (t= 5cm)	m^2	29

Table 10.4.15 Unit Construction Costs of Major Works (continued)

Work Item	Content of Work			Unit	Unit Cost(RMB)
Pedestrian Bridge	Superstructure				
		Type-A steel girder	bridge length=34.2m	br.	417,900
		Type-B steel girder	bridge length=37.2m	br.	444,200
		Stairs	steel girder,transversal beam. etc.	br.	178,600
		Floor	concrete work	m^3	316
		Stairs	concrete work	m^3	490
		Pavement	floors, stairs(t=3cm)	m^2	56
		Painting	steel girders,piers	m^2	153
		Handrail		m	363
		Drainage		m	121
	Foundation·Substructure				
		Pier	steel weight	br.	105,200
		Pile	Excavation d=1.5m	m	1,200
			concrete work d=1.5m	m^3	794
Other Works	Transplanting		H=3m, D=20cm	each	201
	Demolishment of existing structure		existing bicycle lane	m^2	18
			existing pavement	m^2	12
			existing divider(W=2m)	m	31
			existing pedestrian bridge	each	256,900

(3) Estimation of Local Portion and Foreign Portion

The estimation of project cost is shared into local counterpart funding and foreign funding. The funding mix of the project cost is assumed as follows:

1) Labor Cost

The labor costs are accounted into the local counterpart funding as being practiced according to data collected.

2) Construction Material Cost

Most of major construction materials such as reinforcing bar, steel, asphalt, and cement are being produced in China. However, the volume of materials being produced is not sufficient to provide for the present demand of the construction projects. Therefore, it is assumed that some construction materials shall be imported for purposes of this project.

3) Construction Equipment Cost

The most of major construction equipment such as truck, bulldozer, and road roller are being produced in China. But the result of the survey on the construction in China reveals that large equipments such as asphalt finisher and

concrete plant are still being imported. It is assumed therefore that these large equipments shall be imported for purposed of this project.

4) Other Items

- The construction equipment cast, plan profit, and tax are items included in local counterpart funding.
- As being practiced in China, the administration costs, other construction and contingency costs are divided between local and foreign funding.

(4) Total Project Cost

The total project cost is the summation of construction cost, based unit construction cost and other expenses such as tax, administration cost, and contingency. The summary of total project cost with an indication of local and foreign counterpart funding is shown in Table 10.4.16. The detailed breakdown of project cost is given in Appendix F.

Table 10.4.16 Summary of Project Cost

(RMB 000)

Item	Unit	Total Cost	Local Portion	Foreign Portion	Remark
1.Direct Construction Cost	each	97,749	60,749	37,000	
Road Work	each	(19,643)	(12,277)	(7,366)	
Incidental Road Work	each	(12,522)	(8,882)	(3,640)	
Underpass	each	(58,156)	(34,480)	(23,676)	
Pedestrian Bridge	each	(5,137)	(32,480)	(1,861)	
Other Work	each	(2,291)	(1,834)	(457)	transplanting, demolition work
2.Consturction Equipment Cost	3.0%	2,932	2,932	0	(1)×ratio%
3.Project Profit	4.0%	3,910	3,910	0	(1)×ratio%
4.Tax	3.41%	3,467	3,467	0	(1+3)×ratio%
5.Construction Cost(1+2+3+4)		108,058	71,058	37,000	
6.Administration Cost	10.0%	10,806	9,725	1,081	(5)×ratio%
7.Other Cost	10.0%	10,806	8,104	2,701	research, experiment cost, etc. (5)×ratio%
8.Contingency	15.0%	16,209	11,346	4,863	(5)×ratio%
Project Cost(5+6+7+8)		145,878	100,233	45,645	

10.4.4 Implementation Schedule

The implementation schedule and yearly project cost are shown in Table 10.4.17.

Table 10.4.17 Implementation Schedule and Yearly Project Cost

Item	2001	2002	2003	Remarks
	9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	
1.Resarch Design				
2.Tendering Contract				
3.Mobilization				
4.Road Works				pedestrian, etc.
5.Incidental Road Works				bus stop, etc.
6.Underpass				
Temporary Works				
Permanent Works				
Others				lighting, drainage, etc.
7.Pedestrian Bridge				
Fabrication				Steel piers, girders, etc..
Foundation Substructure				erection
Superstructure				floor,stairs,erection
8.Demobilization				
Project Cost (RMB 000)	14,587.8	43,763.4	87,526.8	Total 145,878

10.5 Environmental Impact Assessment

10.5.1 Introduction

A feasibility study for the proposed exclusive bus lane on Shudu Road was chosen to be undertaken in the Study. Thus, an evaluation of the related environmental influences to be brought about by the implementation of the said project is necessary.

(1) Procedure of Environmental Impact Assessment

Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) for the road construction/reconstruction are carried out following the procedure illustrated in Figure 10.5.1. We assigned the investigation of the outline of the evaluation to the local specialists who were chosen by the government of China and the local government of Chengdu. The local team of specialists compiled the report of the outline of the evaluation for the environmental influences. They then submitted the outline report to the environmental protection department of the government for their evaluation. Upon government's acceptance of the outline report, the local specialists started with their evaluation of the environmental influences, with their report prepared on the basis of the feasibility report. The evaluation includes the study of the present environmental situation and thorough analysis of it.

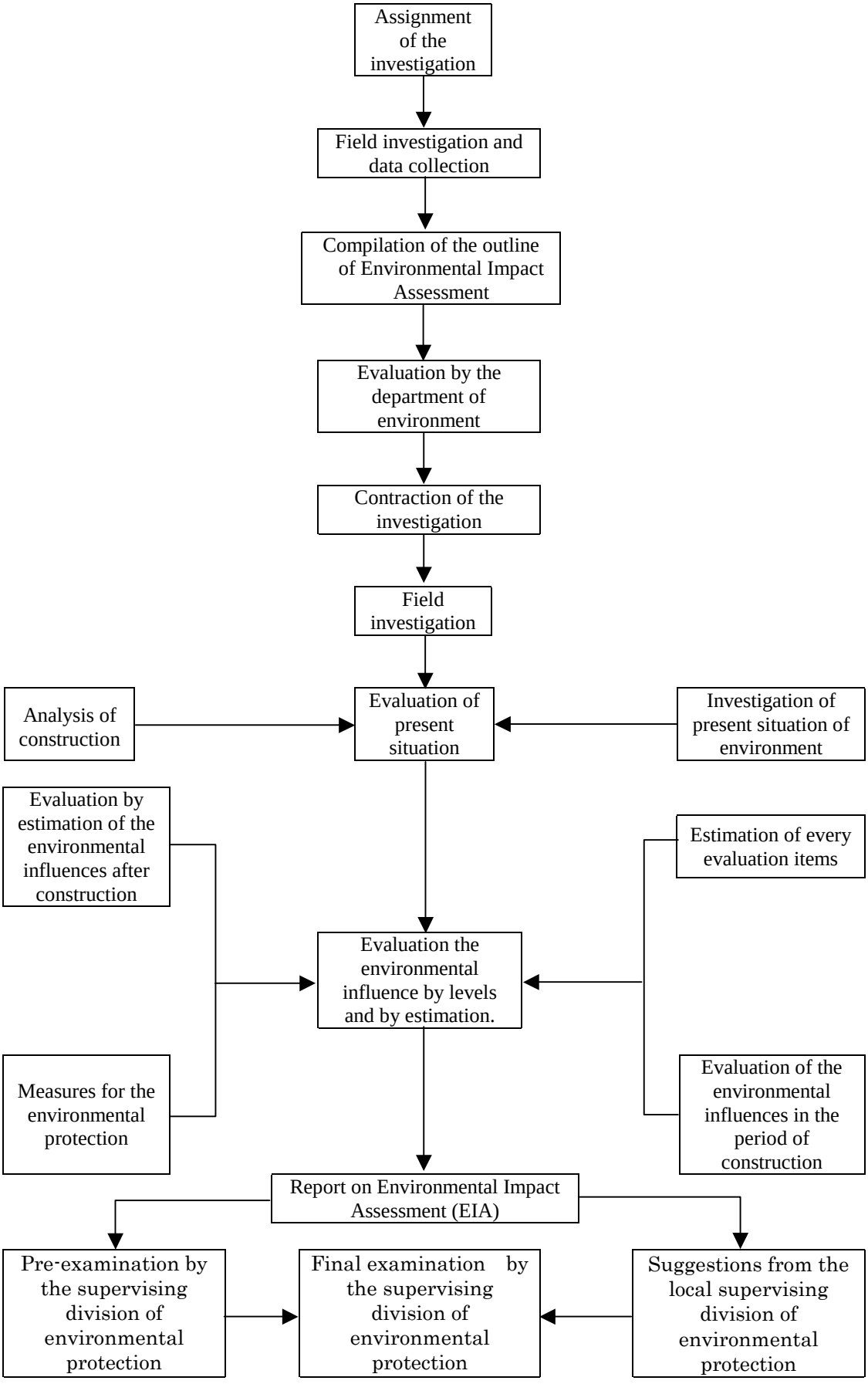
They estimated and evaluated each item in the construction period and in the 7^{th} and 15^{th} years of construction. Together with the estimation and evaluation, the local specialist team studied the process of coping with the environmental protection and proposes the solution. After putting together all the results of the evaluation, an evaluation report was compiled and submitted to the department of the environmental protection and examined in advance. The report with the comment of the department of the environmental protection then underwent the final examination by the department of the environmental protection.

(2) Purpose of the assessment

In this study we will prepare the IEE and consider the contents of EIA. The target investigation area is the Shudu Road where a feasibility study on the introduction of exclusive bus lane is being proposed.

The investigation is carried out on the basis of evaluation standard of the environmental influences of road construction.

Figure 10.5.1 Procedure for the Evaluation of the Environmental Influences



10.5.2 Forecasted Traffic Volume

The exclusive bus lane of Shudu Road will be completed and operated in 2004. Traffic volume forecasting was worked out for seven years and fifteen years. Table 10.5.1 shows the present volume of traffic (PCU: day). Table 10.5.2 shows the traffic volume in 2011 after the exclusive bus lane is introduced (PCU: day); with a comparison of traffic volume "with project" and "without project" scenarios. Table 10.5.3 shows the forecast traffic volume in 15 years after the exclusive bus lane is introduced, also under the two different cases (PCU: day).

Table 10.5.1 Present Traffic Volume on Shudu Road in 2001

Link	Distance (m)	Name of Road	Present Traffic Volume (PCU/d) -Year of 2001			
			Car	Buses	Bicycles	Total No. of Motorized Vehicles
442	676	Qingjiang Dong-Lu	26,100	1,100	29,500	27,200
43	663	Qingjiang Dong-Lu	24,400	1,200	39,200	25,600
42	205	Qingjiang Dong-Lu	22,800	1,600	53,500	24,400
41	376	Qingjiang Dong-Lu	22,800	1,600	48,200	24,400
40	560	Shiergiao Lu	25,800	1,400	40,800	27,200
39	158	Tonghuimen Lu	25,900	1,400	24,300	27,300
38	872	Jinhe Lu	30,000	1,500	44,300	31,500
37	354	Shaocheng Lu	29,200	1,600	50,800	30,800
36	193	Shaocheng Lu	29,000	1,500	49,000	30,500
35	340	Renmin Lu of east	38,100	1,900	49,500	40,000
34	314	Tianfu Square	37,600	1,100	30,600	38,700
26	337	Renmin Lu of east	37,100	1,700	51,700	38,800
27	609	Zongfu Lu	31,700	1,500	53,600	33,200
28	456	Zongfu Lu	32,800	1,500	52,500	34,300
29	688	Daci Temple Lu	32,300	1,500	50,200	33,800
1071	155	Tianxian Bridge	32,500	1,400	45,300	33,900
1072	749	Dongfeng Lu	32,500	1,400	36,100	33,900
30	466	Shuinianhe Lu	32,500	1,000	37,900	33,500
410	639	Shuinianhe Lu	32,500	1,000	34,000	33,500
31	416	Shuinianhe Lu	30,600	800	36,500	31,400

Table 10.5.2 Predicted Traffic Volume of Exclusive Bus Lane after 7-Year Operation, 2011

(PCU/d)

Link	Distance (m)	Name of Road	Year of 2011 Do-Nothing				Year of 2011 (7-Year Operation)			
			Car	Buses	Bicycles	Total No. of Motorized Vehicles	Car	Buses	Bicycles	Total No. of Motorized Vehicles
9	676	Qingjiang Dong-Lu	35,800	1,000	27,900	36,800	25,900	1,800	21,400	27,700
43	663	Qingjiang Dong-Lu	32,800	1,100	37,500	33,900	31,700	2,000	23,600	33,700
42	205	Qingjiang Dong-Lu	29,900	1,400	51,100	31,300	37,500	2,700	47,600	40,200
41	376	Qingjiang Dong-Lu	29,900	1,400	46,100	31,300	37,000	2,800	47,600	39,800
40	560	Shiergiao Lu	33,000	1,300	38,500	34,300	34,800	2,600	31,300	37,400
39	158	Tonghui Entrance Lu	34,100	1,300	30,500	35,400	26,500	2,600	31,800	29,100
38	872	Jinhe Lu	35,600	1,300	40,700	36,900	31,900	2,600	32,300	34,500
37	354	Shaocheng Lu	43,000	1,400	44,800	44,400	39,800	2,900	42,000	42,700
36	193	Shaocheng Lu	42,600	1,400	48,600	44,000	39,300	2,900	45,500	42,200
35	340	Renmin Dong-Lu	52,900	1,600	50,200	54,500	40,400	4,500	47,100	44,900
34	314	Tianfu Square	49,300	1,800	30,100	51,100	39,700	4,600	27,200	44,300
26	337	Renmin Dong-Lu	45,700	2,000	50,400	47,700	38,900	4,700	45,100	43,600
27	609	Zongfu Lu	43,600	2,000	48,300	45,600	36,800	4,300	37,900	41,100
28	456	Zongfu Lu	55,400	1,900	64,200	57,300	43,900	4,200	43,800	48,100
29	688	Daci Temple Lu	41,700	1,600	42,200	43,300	34,500	3,400	35,500	37,900
1071	155	Tianxian Qiao	34,200	1,600	40,500	35,800	33,500	3,300	31,900	36,800
1072	749	Dongfeng Lu	33,600	1,600	35,100	35,200	33,100	3,300	32,100	36,400
30	466	Shuinianhe Lu	37,400	1,100	34,600	38,500	36,900	2,400	31,000	39,300
410	639	Shuinianhe Lu	37,400	1,100	33,600	38,500	35,700	2,400	31,200	38,100
31	416	Shuinianhe Lu	40,000	1,000	34,300	41,000	36,300	2,200	30,400	38,500

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Table 10.5.3 Predicted Traffic Volume of Exclusive Bus Lane after 15-Year Operation, 2019

(PCU/d)

Link	Distance (m)	Name of Road	Year of 2019 Do-Nothing				Year of 2019 (15-Year Operation)			
			Car	Buses	Bicycles	Total No. of Motorized Vehicles	Car	Buses	Bicycles	Total of Motorized Vehicles
442	676	Qingjiang Dong-Lu	42,800	900	27,200	43,700	30,900	2,500	20,900	33,400
43	663	Qingjiang Dong-Lu	39,000	1,000	36,200	40,000	37,600	2,800	22,800	40,400
42	205	Qingjiang Dong-Lu	35,200	1,200	49,300	36,400	40,100	3,800	45,900	43,900
41	376	Qingjiang Dong-Lu	35,200	1,200	44,600	36,400	40,200	4,000	43,500	44,200
40	560	Shiergiao Lu	38,300	1,200	36,800	39,500	40,400	3,800	41,100	44,200
39	158	Tonghui Entrance Lu	40,200	1,200	34,900	41,400	41,100	3,800	36,300	45,900
38	872	Jinhe Lu	46,600	1,100	39,200	47,700	41,800	3,700	37,000	45,500
37	354	Shaocheng Lu	53,100	1,200	40,300	54,300	49,100	4,200	37,700	53,300
36	193	Shaocheng Lu	52,900	1,300	40,100	54,200	48,800	4,300	37,500	53,100
35	340	Renmin Dong-Lu	63,600	1,300	42,500	64,900	48,700	5,800	40,000	54,500
34	314	Tianfu Square	57,700	1,800	46,000	59,500	46,400	5,900	41,600	52,300
26	337	Renmin Dong-Lu	51,900	2,300	49,400	54,200	44,200	6,000	44,200	50,200
27	609	Zongfu Lu	52,200	2,400	61,100	54,600	44,000	5,200	47,900	49,200
28	456	Zongfu Lu	66,900	2,300	72,800	69,200	55,000	5,100	49,600	60,100
29	688	Daci Temple Lu	48,600	1,700	36,300	50,300	40,200	3,600	30,200	43,800
1071	155	Tianxian Qiao	35,400	1,700	36,900	37,100	34,600	3,500	29,100	38,100
1072	749	Dongfeng Lu	34,400	1,700	34,400	36,100	33,900	3,500	29,000	37,400
30	466	Shuinianhe Lu	41,000	1,200	32,200	42,200	40,400	2,600	28,800	43,000
410	639	Shuinianhe Lu	41,000	1,200	33,200	42,200	39,100	2,600	28,900	41,700
31	416	Shuinianhe Lu	46,900	1,200	32,700	48,100	42,600	2,600	29,000	45,200

,,

10.5.3 General Conditions of Environment along the Road

(1) Social Conditions

Shudu Road is regulated as an environmentally protected area. Thus it should be coordinated while taking into consideration its ancient heritage and the landscape along the road. Shudu Road should be an important east-west main road, and development should be in accordance with its history and culture.

Present situation of land utilization along Shudu Road is shown in Table 10.5.4. Its features are as follows:

1) Residential area and public facilities are in the areas in the west sides of Tianfu Square.
2) Public facilities are in the central area.
3) Commercial area is in the east-side of Tianfu Square.
4) There are many residential areas in the east of Funan River.

Shudu Road is located in the Qingyang and Jinjiang Districts of Chengdu City. Table 10.5.5 shows the population and the number of schools in six districts, of Jinjiang and Qingyang Districts. Table 10.5.6 shows the situation of population employment along Shudu Road. There are many schools, commercial facilities and government facilities in these districts. Thus the road is very important for the movement of people and goods.

Chengdu is an old city that was first built more than 2000 years ago. It has many historic and cultural heritages. Chengdu government also makes great efforts to protect its cultural heritage. There are many historical sites and places of cultural heritage along Shudu Road, as shown in Table 10.5.7.

Table 10.5.4 Present Land-Use along Shudu Road

Distance from starting point	Names of Roads	On the right side of the Road	On the left side of the Road
0-550	Intersection of Qingjiang Dong-Lu and Shiren Nan-Lu	Public land (for public facilities)	Industrial land
550-800	Intersection of Qingjiang Dong-Lu and Caotang Bei-Lu	Residential area	Public land (for public facilities)
800-950	Qingjiang Dong-Lu	Residential area Chengdu Electricity College	Public land (for public facilities)
950-1225	Intersection of Qingjiang Dong-Lu and Huanhua Bei-Lu	Public land (for public facilities) Sichuan Water Conservancy and Electricity Graduate School	Public land (for public facilities) Chengdu Educational Institute
1225-1800	Intersection of Qingjiang Dong-Lu and Modihe Qiao	Commercial land (for business and dwelling) Sichuan People's Hospital	Public land (for public facilities) Sichuan Broadcast and Electron University
1800-1900	Intersection of Qingjiang Dong-Lu and Section2 of the 1st Ring Road	Public land (for public facilities)	Public land (for public facilities) Sichuan Education Exchange Center
1900-2475	Intersection of Shierqiao Lu and Xi'an Nan-Lu	Commercial land (for business and dwelling)	Public land (for public facilities) Chengdu Traditional Chinese Medicine University and Subsidiary Hospital
2475-2950	Intersection of Tonghuimen Lu and Xia-Tongren Lu	Public planting places Qintai Lu (Shierqiao-Tonghuimen) Commercial land (for business and dwelling)	Commercial land (for business and dwelling)
2950-3550	Intersection of Jinsha Lu, Changchun Shang-Jie and Xiao Nan-Jie	Commercial land (for business and dwelling)	Commercial land (for business and dwelling) Jinhe Hotel
3550-3900	Intersection of Shaocheng Lu and Citang Jie	Public planting places Renmin Park	Public land (for public facilities)
3900-4075	Intersection of Shaocheng Lu and Dongchenggen Nan-Jie	Public land (for public facilities)	Public land (for public facilities)
4075-4425	Intersection of Renmin Xi-Lu and Renmin Zhong-Lu Xi Yi-Duan	Public land (for public facilities)	Public land (for public facilities)
4425-4750	Intersection of Renmin Xi-Lu and Renmin Zhong-Lu Dong Yi-Duan	Public planting places(Tianfu Square)	Public land (for public facilities) City Government
4750-5025	Intersection of Renmin Xi-Lu and Shuncheng Jie	Public land (for public facilities)	Public land (for public facilities)
5025-6100	Intersection of Zongfu Lu and Hongxing Lu	Public land (for public facilities)	Public land (for public facilities) Economic and Commercial Center
6100-6800	Intersection of Dacisi Lu and Tianxianqiao Binhe Lu	Commercial land (for business and dwelling)	Commercial land (for business and dwelling)
6800-7700	Intersection of Dongfeng Lu and Section3 of the 1st Road East	Commercial land (for business and dwelling) Fuhe River	Commercial land (for business and dwelling) Fuhe River Dongfeng Road living district
7700-7850	Intersection of Shuinianhe Lu and Shuinianhe Nan-Yi-Jie	Public land (for public facilities)	Public land (for public facilities) Chengdu Hotel
7850-8200	Intersection of Shuinianhe Lu and Shuinianhe Nan-Si-Jie	Residential area Shuinianhe South living district	Residential area Shuinianhe living district
8200-8670	Intersection of Shuinianhe Lu and Shuanglin Lu	Industrial land	Residential area Shuinianhe living district
8670-8800	Intersection of Shuinianhe Lu and Jinghua Lu	Industrial land	Public land (for public facilities)
8800-8900	Intersection of Shuinianhe Lu and Jinghua Nan-Lu	Residential land	Residential area

Note: The origin is the intersection of Shudu Road and section2 of the 2nd Ring Road West

Table 10.5.5 Population and Number of Schools in Jinjiang District and Qingjiang District along Shudu Road

	Population	Schools				
		Primary Schools	Middle Schools	Vocational Schools	Secondary Technical Schools	University
Jinjiang District	388,600	54	22	3	4	2
Qingyang District	459,300	57	24	4	10	3
Urban district	2,427,200	301	119	20	31	21
The whole Chengdu City	10,035,600					
Notes	Year of 1999	Year of 1999				

Table 10.5.6 Employment Situation in the Central Districts

	Employment Situation in Industries				
		Primary Industries	Second Industries	Tertiary Industries	Total
Urban District	108,100	442,100	523,200	1,073,400	
	(percent)	10.1	41.2	48.7	100.0
Chengdu City	2,538,900	1,433,600	1,650,700	5,623,200	
	(percent)	45.1	25.5	29.4	100.0

Note: Year of 1999

Table 10.5.7 Historical and Cultural Heritages along Shudu Road

Culturally Protected Area	Place
1. Environment-coordinated area	The whole Shudu Road
2. Tall building – restricted area	On the right side of 1800-2700, Modihi Qiao-Tonghuimen
3. Key reservations of cultural relics and historic sites	On the right side of 2300-2500, Near Chengdu Archaeological Graduate School
4. On the west edge of the old city : historic sites, ancient cultural street, park and traditional culture activities	Near 2600 and Tonghuimen
5. Historic buildings and historical and memorial buildings	Near the left side of 2900
6. Shaocheng-structured reservations	The left side of 2700-4075
7. Jiangjunyamen: entrance to Shaocheng, park, revolutionary	Near 3550
8. Rehmin park: environment-coordinating districts, revolutionary historic sites and memorial buildings	The right side of 3550-3900
9. People's Sqare: political and cultural center in history, symble of famous city	About 4425-4725
10. Commercial center: modernized commercial mansions and commercial foot-districts	Near 5650-5800
11. Dacheng structural reservation	The left side of 5500-6800
12. Key reservations of cultural relics and historic sites (Dacisi Temple)	The left side of 6350-6600
13. On the east edge of the old city: Jiang Qiao, historic sites, traditional commercial and historical streets	Near 6800
14. Landscape-limited district (along Fuhe River)	Near 6800-6950

(2) Natural Condition

1) Land ands Soil

Chengdu is located in the center of Sichuan Basin. Its average sea level is 500 meters. Shudu Road begins from the west (Qingjiang Lu and 2nd Ring Road East) with sea intersection of level of 505 meters, and end in the east (Shuinianhe intersection of East and Huanan) with sea level of 496 meters.

As for the soil in the center of Shudu Road, namely Tianfu Square, there are backfilled soil 0-6 meters underground, alluvial pebble 6-25 meters underground and clay below 25 meters underground.

Starting around the western side are backfilled soil 0-2 meters underground and pebbles with clay 2-12 underground and clay below 12 meters underground – Ground the west of Shudu Road.

2) Climate

The climate in Chengdu is moderate. The annual average temperature is 16.4 degree, annual average wind-speed is 1.4 m/sec and annual rainfall is 906mm. However, there's much heavy rain from June to September, especially in July. After the rainy season, water does not easily dry up, leaving most roads including in Chengdu City, Shudu Road included, very flooded.

3) Plants and Animals

Chengdu City is working towards becoming a green city in order to bring healthy and comfortable life to its citizens. Ginkgo is the symbol of the city. Chengdu government is presently promoting the planting of trees on side streets in accordance with the plans for the greening of the present environment. There are at present trees lining the side streets, most of which are ginkgo, rubber trees, nanmu trees, and willows.. The pictures on the next page (Figures 10.5.2 and 10.5.3) demonstrate the sidewalk near the intersection of Shudu Road and Dongfeng Lu.

4) Water Conservation and Hydrology

Shudu Road is crossing Modi River, Shierqiao River and Fuhe River. Chengdu government strictly prohibits people from draining polluted water and the dumping of garbage in the rivers.

However, these rivers are still in danger due to poor drainage system especially during rainy season (June to September) when it rains heavily. During this time, floodwater increases faster than water being drained into the road drainage system and the rivers. The roads therefore become flooded.

Water level of the subterranean water of Shudu Road is speculated at 7 meters as it was 7 meters in the northern bus stop. Tianfu Square and the southern bus stop in April, 1999. This figure is based on a dry season, thus water level will certainly increase during the rainy season.

5) Landscape

Trees are planted along the roads and rivers converging very well with its historical and cultural aspect.

Figure 10.5.2 Photo along the Pavement of Shudu Road

(Photo show trees along the pavement of Shudu Road.
Evergreens improve the city landscape.)

Figure 10.5.3 Photo along Shudu Road near Dongfeng Lu

(Trees along the street on Shudu road near Dongfeng Lu.)

(3) Air Pollution and Noise

As discussed in the previous section, the Sichuan basin is often covered with fog because of the bad air stream. In addition, pit coal particulates from factories are mostly floating in the air. The concentration of Total Suspended Particles (TSP) is high.

During the Initial Environmental Examination (IEE) conducted last 13-14 August 2000, the area within the 2nd Ring Road was evaluated. Figure 10.5.4 indicates the noise level at Chengbai Company along Shudu Road on the same day. The density of nitrogen oxide and sulfur oxide are shown in Figure 10.5.5. The density of carbon monoxide is shown in Figure 10.5.6. The density of TSP is shown in Figure 10.5.7

Figure 10.5.4 Air and Noise Pollution Levels at Chengbai Company along Shudu Road

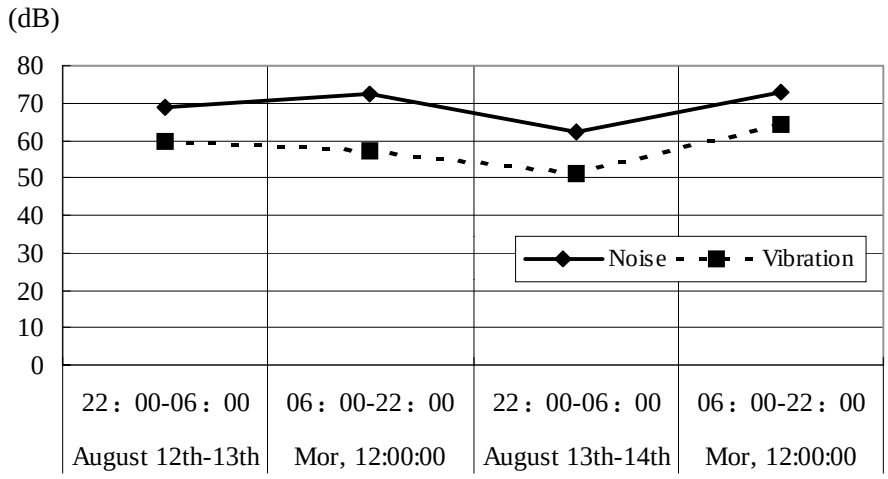


Figure 10.5.5 Density of Nitrogen Oxide and Sulfur Oxide at Chengbai Company along Shudu Road

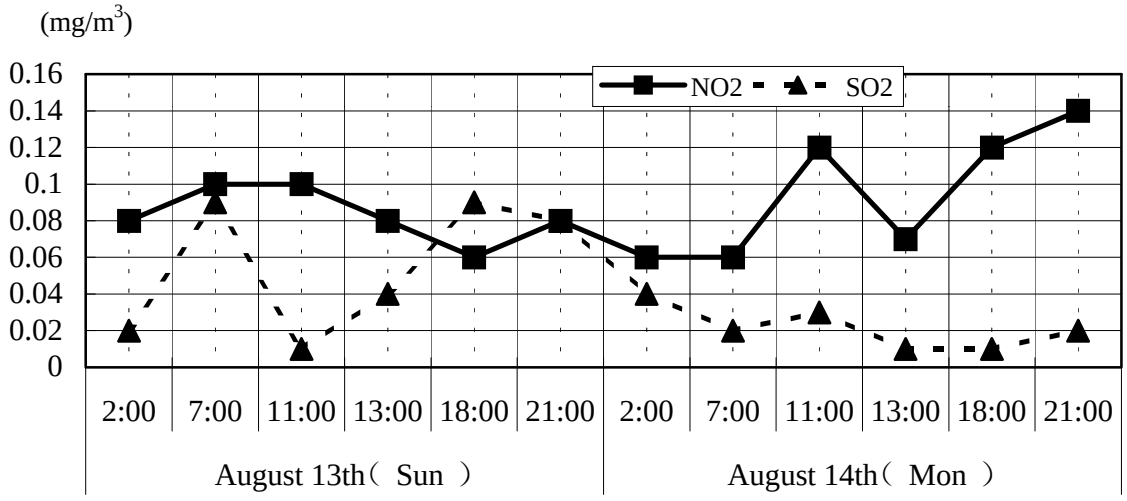


Figure 10.5.6 Density of Carbon Monoxide at Chengbai along Shudu Road

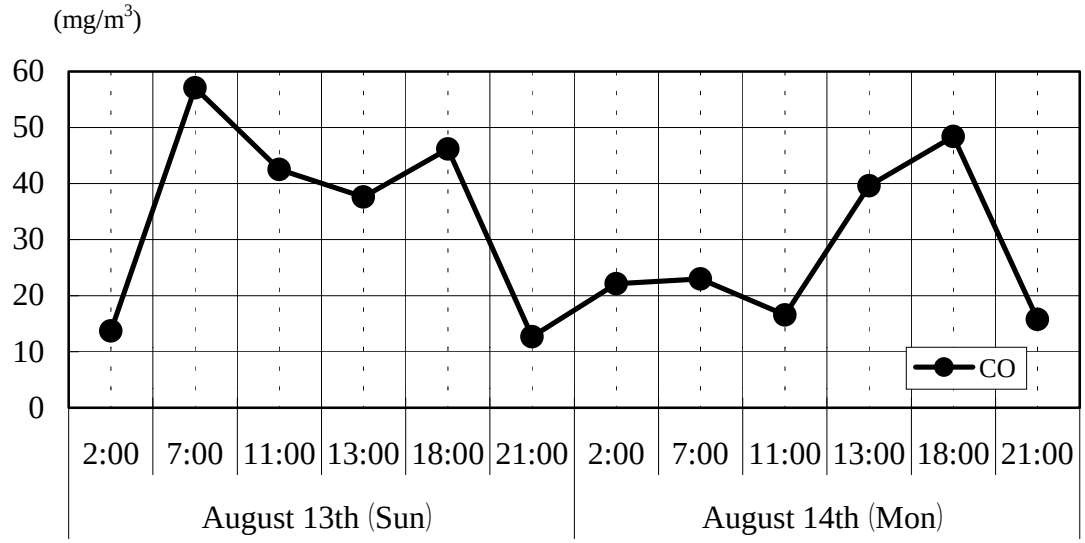
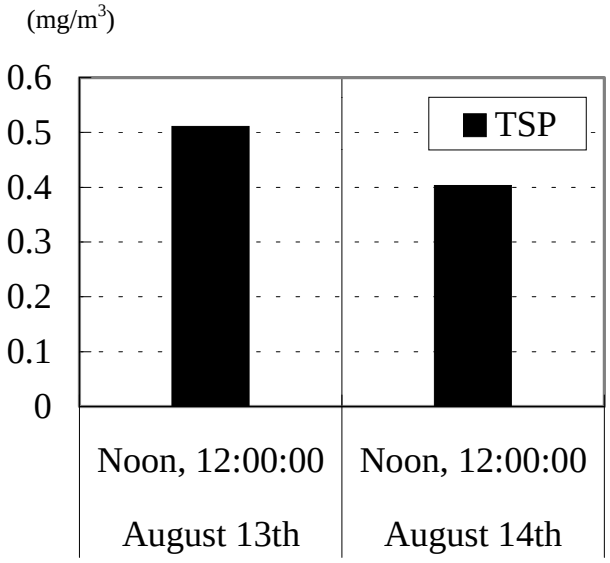


Figure 10.5.7 Density of Total Suspended Particulate at Chengbai Company along Shudu Road



10.5.4 Selection of the Influence Factor of Environment

The main purpose of the plan of introducing exclusive bus lanes on Shudu Road is to increase traffic share rate of buses by improving Shudu Road. There is no need to widen the present roads extensively. Therefore acquisition of land and relocation of houses along the road seldom happens. As for the trees along the road, a plan has to be devised on the management of trees along the road (about 7725-7850 meters) in order to improve the landscape and to maximize the use of land along the road.

In the period of construction in rainy season, soil and residual soil of construction will sometimes flow into Fuche River, Modi River and Shierqiao River and affect worse to the environment then the soil from waste sol plant does.

The influence to ground water is supposed to be caused by excavation of roads and tunnels. The influence for the environment is unavoidable because water level of ground water in dry season is about 7 meters underground, but it rises high in rain season.

Residual soil from excavation work is often washed away by the rain and flow into Fuche River, Modi River and Shierqiao River. These polluted water affect the quality of rivers. Thus, extra caution should be taken during excavation to minimize residual soil which can adversely affect the river system. In addition, exhaust gas and noises from excavators and cars can also affect the environment.

The operation of exclusive bus lanes will enhance movement of people and goods, thus is expected to improve political and economical activities along Shudu Road. The introduction of the exclusive bus lanes will stimulate the economic activities as people can easily access places they want to visit. However, it is also expected that there will be an increase in the noise level and there will also be degradation of air quality due to the increasing number of cars.

In so far as the environmental issues are concerned, tree planting along the side streets is not only good for the people but also improves the air quality and decrease the noise level thus improving the living conditions along the street.

The construction of the underpass at the intersection will improve not only the flow of buses, cars and bicycles but as well as the landscape of Chengdu. However, the effect of ground water must be considered together with the possibility of flooding in the underpass when there is a heavy rain.

With regard to these points, both the environmental impact factors from the EIA guidelines in China and the evaluation items are chosen as listed in Table 10.5.8 (Law of road construction (draft), attached Table 2: JTJ005-96). Environmental Impact Assessment for Environmental Impact factors following the environmental guide of Japan International Cooperation Agency (JICA), is also considered in Table 10.5.9.

Table 10.5.8 Selection of Environmental Impact Assessment Factors

Environmental Resource \ Construction Action		Before Construction		During Construction Period						During Operation Period			
		Land Occupation	Relocation	Disposal of Waste Soil	Road Bed	Road Surface	Underpass-Excavating	Material-Transporting	Operating Machine	Transportation	Tree-Planting	Redevelopment	Underpass
Social Development	Employment opportunity									□		□	
	Travelling and moving									□		□	○
	Industrial and agriculture									□		□	
	Water conservation			●		●							■
	Land utilization	□								□		□	
Material Resource	Land quality			●	●		●						
	Hydrology of land surface				●		●						■
	Water quality land surface			●			●						■
	Water and soil preservation				●								
Ecological Resource	Land plants	●									□		
	Land animals										□		
Life Resource	Environment noise							●	●	■	□		
	Air quality							●	●	■	□		
	Environment of residential area										□		
	Scene	□									□		□

Notes: □：long-term favorable effect ○：short-term favorable effect
■：long-term unfavorable effect ●：short-term unfavorable effect

Table 10.5.9 Selected EIA Items Accompanied by Introducing Exclusive Bus Lane along Shudu Road

Items of the Influence of Environment			Evaluation	Reasons
Social Environment	1	Relocation	D	No need to occupy new land and relocation.
	2	Economic activities	B	Political and economic activities will increase in accordance with the number of people and goods.
	3	Transport and living Facilities	B	It is convenient for people to go to work or school by controlling transportation stream in order.
	4	Division area	D	Introducing exclusive lane to present road does not bring about area division.
	5	Archaeological and cultural property	B	Improvement of the present road brings no influence on sites of ancient cultural remains and cultural legacy along the roads. It is likely to discover buried cultural property when excavating under path for bicycles.
	6	Water –right and commonage	D	Improvement of the present road has nothing to do with the right of water.
	7	Health and hygiene	C	Garbage from residential area and shops along the road is thrown to sidewalk and lines for motor vehicles, thus personal hygiene is threatened.
	8	Wastes	B	Waste soil and material and dirty soil from field of construction increase, wastes from streets of residential area and shops also increase with emergence of all kinds of economic activities.
	9	Disaster (hazard)	C	Bicycles under path are drowned with heavy rain after being put into use.
Natural Environment	10	Topography and geology	D	Improvement of the road doesn't need to change land on a large scale.
	11	Soil erosion	D	Improvement of the road doesn't result in land erosion.
	12	Underground water	C	It is likely to bring influence on subterranean water in excavating bicycle tunnels.
	13	River current	D	Improvement of the road brings no change to rivers around.
	14	Sea area	D	Rearrangement of traffic in cities inland has nothing to do with environment on seaboard and seas.
	15	Flora and fauna	B	It is unnecessary to transplant trees on street-side for reconstruction of main roads. If some trees need transplanting, we should discuss its necessity and measures.
	16	Weather	D	Improvement of the road brings no influence on weather around.
	17	Landscape	C	Improvement of the road brings no effect to scenery. If trees on street-side need transplant, we should discuss further.
Environmental Pollution	18	Air pollution	A	Introducing bus exclusive lane results in the increase of traffic volume of motor vehicles. Tail exhaust from motor vehicles will deteriorate air.
	19	Water quality	B	Silt will come out from waste soil of construction. If it rains heavily, water drained away from roads will degrade water quality.
	20	Soil pollution	C	It's considered that gasoline with lead will pollute soil if used.
	21	Noise and vibration	A	Introducing exclusive bus lane will increase traffic volume of motor vehicles. Traffic noise tends to be increased as well.
	22	Land subsidence	D	Land bed won't go down in the reconstruction of present roads.
	23	Bad smell	C	Bad smell from car exhaust will be more generated according to the traffic increase accompanied with the improvement of bus exclusive lane.

Note: Criteria of evaluation
A: Big impact
B: Small impact
C: uncertain (Discussion is needed. The item includes the cases where the degree of impact will be turned out clearly in the course of the project).
D: almost no impact, the item is disregarded from the EIA object.

10.5.5 Present Environmental Situation

(1) Social Environment

The Shudu Road traverses Jingjiang District and Qingyang District, a political and cultural center. Population and its growth rate in these districts are shown in Table 10.5.10. Compared to six central districts, more population is concentrated in the two districts but its growth rate is decreasing. However, population of the whole city and the six central districts is increasing and it shows that people are moving from the central old city to suburban areas.

Table 10.5.10 Population Trend in Jinjiang District and Qingyang District

	Population ('000)				Growth rate (%)			
	1996	1997	1998	1999	1997	1998	1999	1997-1999
Jinjiang District (A)	394	393	393	389	-0.30	0.03	-1.07	-0.45
Qingyang District (B)	458	458	460	459	-0.07	0.39	-0.07	0.09
Six central districts (C)	2,322	2,360	2,392	2,427	1.66	1.32	1.49	1.49
The whole city (D)	9,807	9,892	9,970	10,036	0.86	0.79	0.66	0.77
(A+B)/C (%)	36.7	36.1	35.7	34.9				
(A+B)/D (%)	8.7	8.6	8.6	8.4				

Source: Statistic Department.

Table 10.5.11 shows GRDP, per capita GRDP and average income. As for GRDP, it is 35 % lower in the six central districts than in the two districts. Furthermore, GRDP is increasing at the rate of 11%, which is not surprising given that the two districts are political, economic and business centers of Chengdu City. For this reason, improvement of the Shudu Road contributes to economic activities in the center of Chengdu City.

Table 10.5.11 GRDP, per capita GRDP and Average Income in Jinjiang District and Qingyang District,1998

	GRDP (bill. RMB)	Growth Rate (%)	Per Capita GDP (RMB)	Average Income (RMB)
Jinjiang District	7.41	11.6	18,852	7,670
Qingyang District	7.67	11.1	16,681	7,515
The Central District	49.57		20,860	7,408
Chengdu City	110.26		11,103	6,446
Sichuan Province	358.03		4,319	5,127
China	7,939.57		6,392	5,425

Source: Chengdu yearbook, 1999

As shown in Figure 10.5.8, parking facilities for bicycles set up in front of shops and departments along Zongfu Lu have negative effect on pedestrians' movement, traffic safety and city landscape, from the viewpoint of transport and public facility.

Figure 10.5.8 Parking Facility on Sidewalk

In terms of historical heritage, there are historical and cultural sites along the Shudu Road. But since the exclusive bus lane project along the Shudu Road shall make full use of the existing transport facilities, it will thus have little impact on the historical and cultural sites. However, some historical heritage can be found by underpass projects, e.g., at the west section II of the 1st Ring Road, at Dongchenggen Jie, at Hongxing Lu, and at the east section III of the 1st Ring Road). It is, if any, recommended to think of how to deal with it in advance.

The section between the 1st Ring Road and the 2nd Ring Road in the west and east is mainly dominated by residential area. Solid waste on the Shudu Road comes from the residential area and has negative impact on health and sanitation. In addition, as shown in Figure 10.5.9, Qingjiang Lu which is under reconstruction, has waste soil piling on the sidewalk which affects city landscape and the safety of pedestrians.

Figure 10.5.9 Waste Soil Piling on Sidewalk and Invasion of Construction Site to Sidewalk

(2) Natural Environment

Data on underground water level in the center of the Chengdu City is summarized in Table 10.5.12. Water level was measured at 7 m down on the Shudu Road in dry season. Since rainfall is 320 millimeter in the month of July and 42 millimeter in April, the water level is expected to be 42 centimeters up at most. On the other hand, the underpass project for bicycles is planned to be 5.5 meters down and its impact on the underground water is expected to be very minor.

Table 10.5.12 Data on Underground Water in the Center of the Chengdu City

Point of Measurement	Underground Water level (m)	Day of Measurement
North station	6.8	Oct.16-8,1993
Tianfu Square	7.3	April 8-13, 2000
South station	7.5	April 15-18,2000

Chengdu City has been exerting their efforts to achieve their goal of a green city and a historical and cultural city. Tree-planting project extends to most places along streets and parks. Trees on Shudu Road, as shown in Figure 10.5.10～11, not only make the city more beautiful but also provide people and drivers with well-managed quality environment.

In addition, planting trees contribute to improvement of air quality by absorbing air pollutants such as CO2, NOx, SO2 and reducing traffic noise.

Figure 10.5.10 Prototype Street Trees

Figure 10.5.11 Planting Trees on Separator of Bicycle and Car

Most trees on Shudu Road are composed of evergreens and hollies. In addition, deciduous trees and crape myrtles are also found here. It is estimated that tall and big trees are about 3,000 trees and short and small trees are 1,300 trees. Based on these, absorbing amount of air pollutants was estimated in Table 10.5.13.

Table 10.5.13 Estimated Annual Absorbing Amount of CO_2

(Unit: kg)

Diameter (cm)	Height of Trees (m)	Deciduous Trees with Large Leave	Evergreens with Large Leave	Medium or Small Trees
3	2-2	32	21	5
5	3-3	70	53	14
10	4-5	250	180	53
15	6-7	530	320	140
20	8-10	700	530	
25	10-13	1100	700	

Source: Manual on Air-cleaning and Tree-planting

Based on this table:

Absorbing amount of tall trees (average diameter of breast: 15 centimeter) becomes: 320kg × 3000 = 960000kg = 960 ton

Absorbing amount of short trees (average diameter of breast: 5 centimeter) becomes: 14kg × 1300 = 18200kg = 18.2 ton

As a result, total absorbing amount of CO_2 along the Shudu Road amounts to about 1,000 ton in a year.

Problem is that trees remain without enough cutting, weeding, fertilizing and watering. Sometimes long branches become an obstacle to the movement of pedestrians and bicycle users. It is recommended to make proper cuttings for better pedestrians' and bicycle users' movement.

(3) Air Pollution and Noise

Because Chengdu City lies in Sichuan basin, smog and fog appears almost every day, obstructing one's vision below one kilometer as shown in Figure 10.5.12. However, during the Lunar New Year Festival, smog and fog disappeared primarily due to the factories' stop operation. Thus, it just shows that major causes of air pollution are pollutants from the factories in Chengdu City, aside from other geometric reasons.

Figure 10.5.12 Air Pollution in the Chengdu City

To assess the present level of air pollution along Shudu Road, air pollutant density such as those of CO, SO_2, NO_X and TSP were measured last February 7-9 at the Chinese Medicine College, People's Park, Dongfeng Bridge, and at the intersection of Shuangqiao.

In China, ambient quality guideline for air pollutants at standard III is as follows:

CO: 6.0 mg/m^3

SO_2: 0.25 mg/m^3

NO_2: 0.30 mg/m^3

Table 10.5.14 shows CO emission density measured on the Shudu Road and it is much lower than that in summer.

Table 10.5.15 shows NOx emission density measured on the Shudu Road, which is almost the same as that in summer. Higher density is found at the entry of the People's Park during heavy traffic.

Table 10.5.16 shows TSP emission density measured on Shudu Road. Higher density is found at the Dondfeng Bridge and at the intersection of the Shuangqiao mainly because of a lot of factories.

Figure 10.5.13 shows estimated CP emission density based on CL4 model. Base density was assumed at 4.9 mg/m^3 from the survey in August. Analysis results show as point is far from roadside, average density becomes less. Nevertheless, the density is still high within the extent of 80 meters on the west section of the Renming Road.

Table 10.5.14 Present CO Emission Density on the Shudu Road

(Unit: mg/m^3)

Place	Feb. 7 (Wed.)				Feb. 8 (Thurs.)				Feb. 9 (Fri.)				Ave.
	08	11	16	22	08	11	16	22	08	11	16	22	
Chinese Medicine Col.	7.50	2.50	1.25	2.50	1.25	5.00	3.75	1.25	2.50	1.25	0.63	0.63	2.50
Renmin Park	6.25	2.50	2.50	2.50	2.50	2.50	0.63	0.63	0.63	1.25	0.63	0.63	2.00
Dongfeng Da-Qiao	8.75	5.00	2.50	2.50	0.63	0.63	0.63	0.63	1.88	1.25	1.25	1.88	1.93
Shuangqiao Intersection	3.75	2.50	2.50	2.50	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.77

Table 10.5.15 Present NOx Emission Density on the Shudu Road

(Unit: mg/m^3)

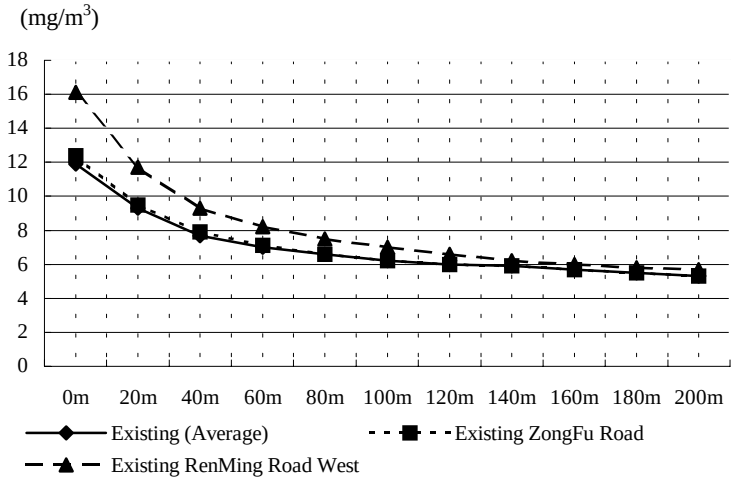
Place	Feb. 7 (Wed.)				Feb. 8 (Thurs.)				Feb. 9 (Fri.)				Ave.
	08	11	16	22	08	11	16	22	08	11	16	22	
Chinese Medicine Col.	0.15	0.10	0.06	0.05	0.07	0.08	0.07	0.11	0.07	0.10	0.06	0.12	0.09
Renmin Park	0.16	0.09	0.22	0.08	0.07	0.07	0.08	0.07	0.06	0.11	0.07	0.09	0.10
Dongfeng Da-Qiao	0.08	0.10	0.12	0.09	0.07	0.09	0.10	0.11	0.09	0.12	0.11	0.05	0.09
Shuangqiao Intersection	0.09	0.07	0.08	0.09	0.09	0.09	0.08	0.07	0.05	0.06	0.08		0.08

Table 10.5.16 Present TSP Emission Density on the Shudu Road

(Unit: mg/m^3)

Place	Feb. 7 (Wed.)	Feb. 8 (Thurs.)	Feb. 9 (Fri.)	Ave.
Chinese Medicine Col.	0.347	0.282	0.350	0.326
Renmin Park	0.282	0.192	0.326	0.267
Dongfeng Da-Qiao	0.522	0.223	0.425	0.390
Shuangqiao Intersection	0.335	0.235	0.571	0.380

Figure 10.5.13 Estimated CO Emission Density



10.5.6 Evaluation of the Predicted Influence on Environment

(1) Social Environment

1) Economic Activities

(The period of operation)

Providing exclusive bus lane would not only contribute to the enhancement of movement of both passengers and goods but shall also increase employment opportunities and viable regional economy. For example, it could increase accessibility to public facilities. There has been a plan to establish a park on the right side of the Shudu Road which was used as a site for clothing factory in the past. This public facility will not be limited to the neighboring community anymore. Instead, the exclusive bus lane could enhance accessibility to the park and encourage more people to enjoy its facilities. It is expected that the number of visitors will double in the future as compared with the present number. Similarly, the project to introduce an exclusive bus lane will have positive impact on economic and urban activities and details of economic analysis are described in Chapter 10.6.

2) Transport

(The period of construction)

The project of the exclusive bus lane will make full use of existing transport facilities, for example, by dividing bicycle lanes with the width of 7 m into an exclusive bus lane with the width of 3.5 m and a bicycle lane with the width of 3.5 m respectively. At the same time, the sidewalk with the width of 4-5m will be replaced with permeable material. For this reason, it is expected that there will be no serious impact on such transport concerns. However, some valuable matters can be learned from recent experiences. For example, the project intends to provide bicycle lane and pedestrian space on the Qingjiang East Road. This often brings serious traffic congestion, due mainly to failure in acquiring temporary bicycle lane and pedestrian space and, as a result, separating various modes. This experience demonstrates the importance of assuring space for both bicycle and pedestrian temporarily specially during construction period. Also, this kind of experience will be fully reflected on the project and shall help reduce negative impact on the project as much as possible.

(The period of operation)

Bicycle parking facilities especially in the CBD often dominates the sidewalks. These facilities often block the smooth movement of pedestrians and are at times compromising pedestrian safety. Establishment of off-street parking facility for

bicycle may be recommended to ensure pedestrians' movement and safety. The proposed projects will accompany the supply of new off-street parking facility for bicycle and secure the pedestrians' movement and safety. For this reason, the project is expected to bring substantial benefit especially to the pedestrians.

3) Historical Heritage

(The period of construction)

The list of historical and cultural heritage in Chengdu City is summarized in Table 10.5.7. As the project to introduce exclusive bus lane is planned to make full use of existing transport facility, impact of the project on the historical heritage will be quite marginal. It should be, however, noted that, in order to secure bicycle and pedestrian movement, underpass will be provided 5 meter down at intersections of the west section of the 1st Ring Road, Dongchenggen Road, Hongxing Road and the east section of the 1st Ring Road and it could have impact on the historical heritage. However, being covered with alluvial soils of 7 meters, Chengdu City is expected not to have any historical heritage by this project. However, it needs to give up the construction and ask for concerned agencies' cooperation, if any.

4) Solid Waste

(The period of construction)

Replacement of the pavement of bus lane, new sidewalk pavement with the permeable material and underpass project will accompany waste soil of about 89,000 m^3 in all. The waste soil is now planned to be disposed around the Outer Ring Road. Therefore, its impact will be quite marginal. However, temporarily dumped waste soil on the construction site could negatively affect pedestrian's movement, deteriorate the neighboring environment and contaminate water source. For this reason, the waste soil should be immediately disposed through a set of disposal processing such as excavating and immediate transporting by truck. This is expected to reduce negative impact as much as possible.

5) Health and Sanitation

(The period of Construction)

Solid waste by residents would deteriorate the neighboring environment and the beauty of the city. To deal with this problem, it may be recommendable to fence the construction site to prevent the residents from entering the construction site.

(The period of Operation)

The city government has exerted efforts to keep the city clean, green and

beautiful. Thus, partly due to these efforts, the city government can manage to keep the city clean. However, solid waste from residential and commercial areas such as restaurants and shopping centers could deteriorate the environment. Therefore, more efforts should be given to keep the city clean and beautiful such as increasing the number of garbage collection, introduction of the fine system and strengthening cleaning campaign.

(2) Natural Environment

1) Ecology

(The Period of Construction)

The introduction of the exclusive bus lane will have minor impact on planted trees since the project shall be making full use of the existing transport facilities. The 140 planted trees at the intersection of the east section of the 1st Ring Road and near Chengdu Hotel, as shown in Figure 10.5.14, are planned to be transplanted to both sides of the new sidewalks for the sake of the provision of the exclusive bus lane, bicycle lane and the underpass projects. Thus, with the rearrangement of planting trees, sidewalks will be paved with new permeable material and this can provide better condition to the growth of the trees.

Figure 10.5.14 Trees to be Transplanted

(The period of Operation)

Change of the pavement material will function as a catalyst to the growth of the planting trees because water supply capacity increases from about 2 tons per year (1.5 x 1.5 square meters) to about 14 tons per year (4 x 4 square meters). As a result, the project will have positive impact on ecological system.

2) Underground Water

(The period of construction)

An underground water level is estimated at about 7 meters around Shudu Road while underpass for bicycle and pedestrian is planned to be 5 meters down. The underground water level will go up about 30 cm even in the rainy season because rainfall usually becomes 300 mm per month in the rainy season. Therefore, the project will have minor impact on the underground water.

3) Landscape

(The period of construction)

Waste soil could have negative impact on the neighboring area in terms of landscape. Therefore it is recommended to dispose the waste soil immediately as possible and fence the construction site especially in the historical heritage areas.

(The period of operation)

Permeable pavement will have positive impact on the planting trees. It can also contribute to better landscape. It should be noted, however, that more efforts should be given to the management and maintenance of the planting trees.

(3) Air Pollution

Impact of the introduction of the exclusive bus lane on CO emissions mainly emitted from motorized vehicles was evaluated using the CL14 which were developed for the environmental evaluation. The simulation is assumed that the base year is 2001, the exclusive bus lane will be introduced in 2004 and the 7^{th} year and the 15^{th} year after introducing the exclusive bus lane are years 2011 and 2019 respectively.

Figure 10.5.15 shows CO emission density (mg/m^3) emitted on the adjacent area of the Shudu Road with the interval of 20 meters for the present situation in 2001, introduction of the exclusive bus lane in 2011 and 2019 respectively. Analysis results show CO emission density will apparently spread and increase over 120 m far from the road.

Figure 10.5.16 shows CO emission density (mg/m^3) on the adjacent area of the Shudu Road for the present situation in 2001, “Do-nothing” case and introduction of the exclusive bus lane in 2011 respectively and Figure 10.5.17 shows for the present situation in 2001, “Do-nothing” case and introduction of the exclusive bus land in 2019 respectively. Analysis results point out that the introduction of the exclusive bus lane could bring the reduction of CO emission density in the future.

In addition, the analysis was especially done on the Zongfu Road and the west section of the Renmin Road where a number of traffic takes place. Figure 10.5.18 shows CO emission density (mg/m^3) on the Zongfu Road for the present situation in 2001, "Do-nothing" case and introduction of the exclusive bus lane in 2014 respectively and Figure 10.5.19 shows CO emission density (mg/m^3) on the same place for the same cases in 2019. On the other hand, Figure 10.5.20 shows shows CO emission density (mg/m^3) on the west section of the Renmin Lu for the present situation in 2001, "Do-nothing" case and introduction of the exclusive bus lane in 2014 respectively and Figure 10.5.21 shows CO emission density (mg/m^3) on the same place for the same cases in 2019.

Analysis results indicate that CO emission reduction is more effective on the Zongfu Lu and the west section of the Renmin Lu than on the Shudu Road. It is because the introduction of the exclusive bus lane brought substantial reduction of private cars on the section with heavy traffic whereas minor reduction or increase of private cars on the section with light traffic at present.

CO emission estimation is based on the IPCC Guideline (1996). Table 10.5.17 shows reduction of CO_2 emissions on the Shubu Road by introduction of the exclusive bus lanes. The analysis results point out that the exclusive bus lanes could contribute to the reduction of 4,700 tons and 5,300 tons in 2014 and in 2019 respectively in terms of CO_2 emission.

In conclusion, the exclusive bus lane service has a potential to substantially reduce vehicle emissions in the future.

Figure 10.5.15 Change in CO Emission Density on the Shudu Road (Existing, Operated in 2011 and Operated in 2019)

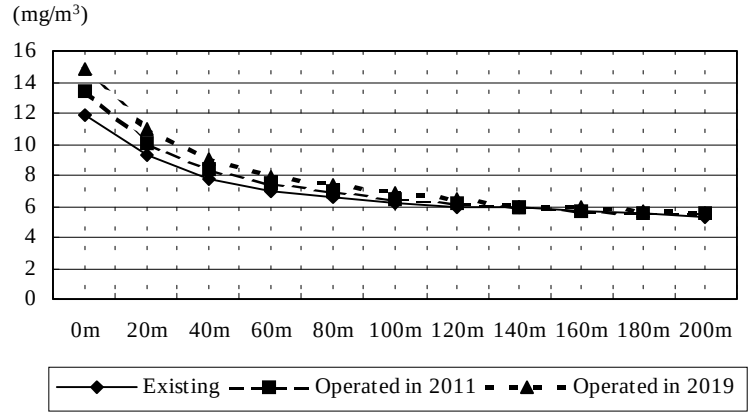


Figure 10.5.16 Change in CO Emission Density on the Shudu Road (Existing, Not Operated in 2011 and Operated in 2011)

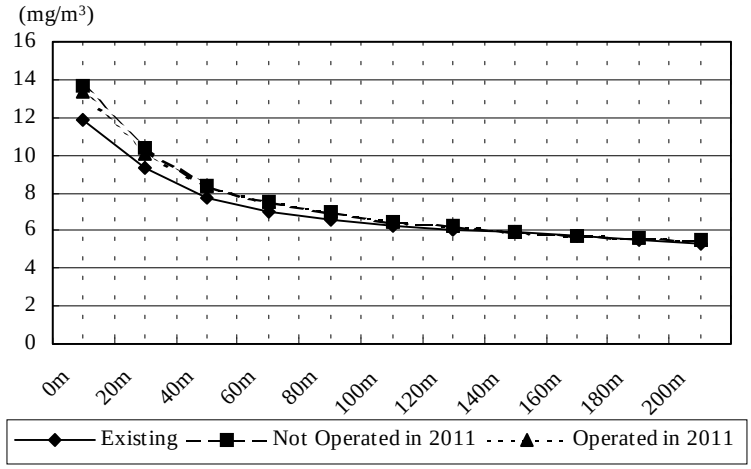


Figure 10.5.17 Change in CO Emission Density on the Shudu Road (Existing, Operated in 2019 and Operated in 2019)

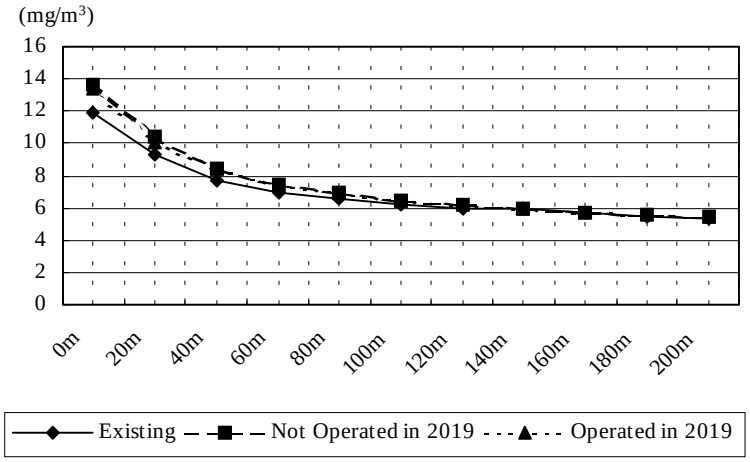


Figure 10.5.18 Change in CO Emission Density on the Zongfu Road (Existing, Not Operated in 2011 and Operated in 2011)

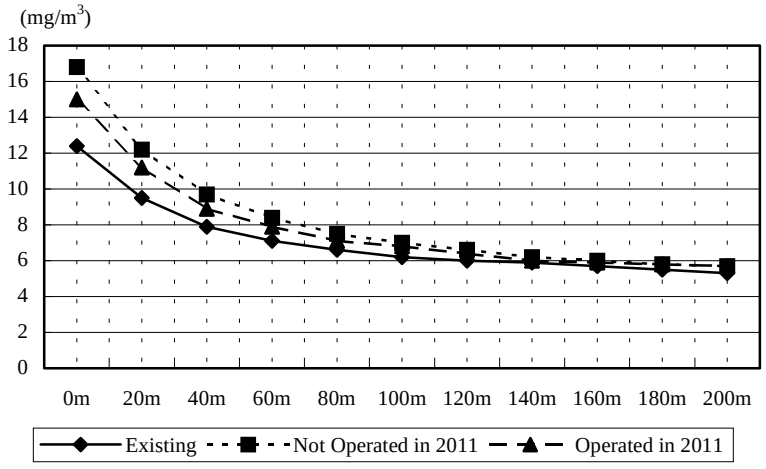


Figure 10.5.19 Change in CO Emission Density on the Zongfu Road (Existing, Not Operated in 2019 and Operated in 2019)

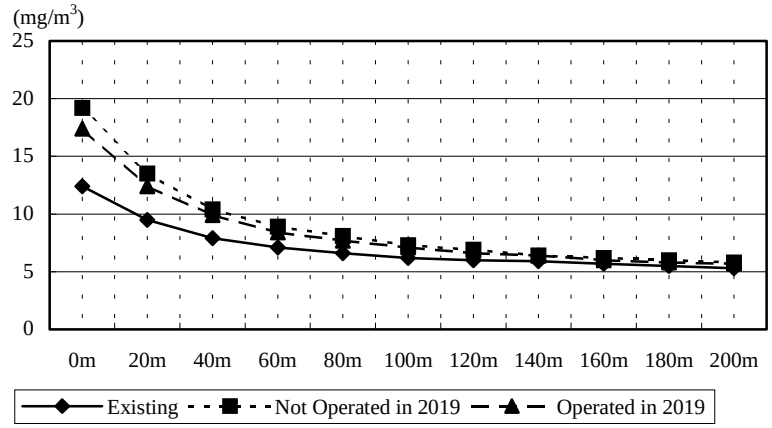


Figure 10.5.20 Change in CO Emission Density on the West Section of the Renmin Road (Existing, Not Operated in 2011 and Operated in 2011)

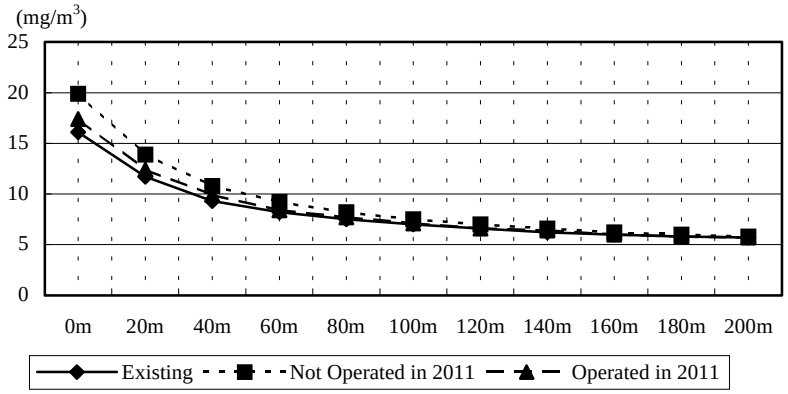


Figure 10.5.21 Change in CO Emission Density on the West Section of the Renmin Road (Existing, Not Operated in 2019 and Operated in 2019)

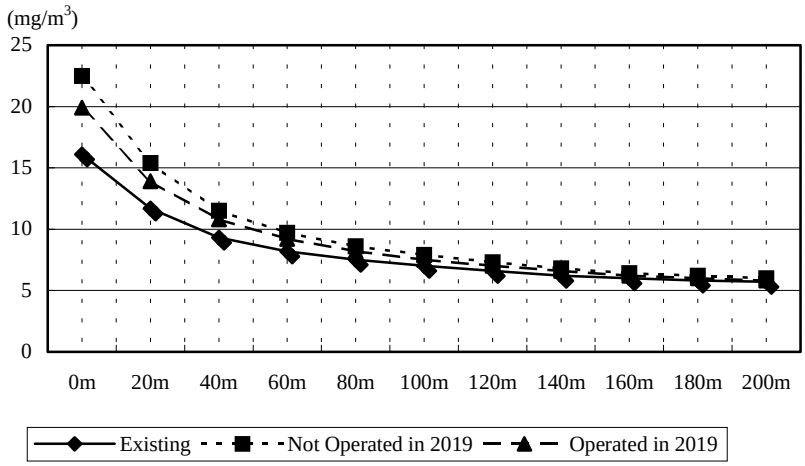


Table 10.5.17 CO_2 Emissions

(Unit: 1,000 tons)

	Annual CO_2 Emissions	Difference
The Present Situation	73.2	
"Do-nothing" Case in 2011	94.3	4.7
Introduction of Exclusive Bus Lane in 2011	89.6	
"Do-nothing" Case in 2019	111.4	5.3
Introduction of Exclusive Bus Lane in 2019	106.1	

Note: Calculated based on IPCC Guidelines (1996)

10.5.7 Environment Conservation Strategy and Its Monitoring

(1) Sewerage and Water Pollution

The ground level in some sections of Shudu Road is relatively lower than other places and they are thus often swept down especially in the rainy season due to lack of sewerage process facility. A comprehensive sewerage process system is therefore urgently needed.

Water pollution in the river traversing the Shudu Road is especially severe. It is mainly caused by polluted water from houses, restaurants, factories and so on. To deal with this problem, it needs to provide the sewerage process facility, clean the polluted water and strictly monitor and manage solid waste disposal.

(2) Ecology

The following measures are needed for the management and maintenance of the planting trees.

- Trimming;
- Arranging;
- Fertilizing;
- Irrigating; and
- Watering

(3) Air Pollution

A monitoring center needs to be set up around the Shudu Road which can provide information on air pollution in order to improve the environment and make people understand and appreciate the importance of the environment.

Alternative locations for the monitoring center are:

- Intersection of the west section of the Second Ring Road;
- Tenfu Square; and
- Intersection of the Hongxing Road

Emission pollutants for monitoring are:

- CO or CO_2
- NO_X
- TSP
- Noise

In order to reduce the vehicle emission and enhance the environmental quality, more effective and strict measures should be taken, e.g., traffic control and strict regulation on labor hour or factory site. To do so, cooperation of concerned government agencies and the preparation of a comprehensive master plan to improve the environment are needed.

10.6 Economic Evaluation

The East-West Primary Busway Project (Exclusive Bus Lanes on Shudu Road) is evaluated economically in this section. The methodology is basically the same as adopted in Section 9.2 for the Master Plan. The major differences are:

- Exclusion of taxes and transfers to convert the financial cost into the economic cost is done more accurately, as the project cost has been estimated in more detail.
- The construction is assumed to start in 2002 and to be completed in 2003. Operation will start in the beginning of 2004.
- Considering the possibility for a subway to be constructed along Shudu Road after 2010 (proposed as Line No.2), the evaluation period of the Project is 10 years from 2001 to 2010. This means that the evaluation is done on the safety side.

10.6.1 Economic Cost

Table 10.6.1 shows the result of converting financial cost to economic cost of the project. In the direct construction cost, material cost and machine/equipment cost share 66% and 22%, respectively in financial terms. As value-added tax of 17% and sales tax of 10% are included in these items, the economic cost was calculated by excluding these taxes. For indirect cost items, the economic cost was derived by multiplying the same ratio as the financial cost by the direct construction cost. For taxes, however, the entire amount which corresponds to 3.41% of the direct construction cost was excluded from the economic cost. Further, for the contingency which is 15% of the total construction cost, 50% was excluded to calculate the economic cost, as this is understood to be a reserve for price inflation (the remaining 50% is for changes on design). The total economic cost of the Project was consequently estimated at RMB 110.146 million or 76% of the total financial cost.

Table10.6.1 Economic Cost of the East-West Primary Busway Project

(RMB 000)

	Financial Cost	Economic Cost
• Direct Construction Cost	97,749	79,472
-Labor	11,779	11,779
-Material	64,800	51,024
-Machine/Equipment	21,170	16,669
• Cost for Technical and Facility Implementation	2,932	2,384
• Profit	3,910	3,179
• Tax	3,467	0
CONSTRUCTION COST TOTAL	108,058	85,035
• Project Administration Cost	10,806	8,503
• Miscellaneous	10,806	8,503
• Contingency	16,209	8,104
PROJECT COST TOTAL	145,878	110,146
PROJECT COST BY YEAR		
2001	14,588	11,015
2002	43,763	33,044
2003	87,527	66,088

The allocation of the project cost will be 10% in 2001 (for design and other preparatory works), 30% in 2002 and 60% in 2003 as described in the previous section.

10.6.2 Economic Benefit

The economic benefit brought about by the Project is the savings of the total transport cost in the Study Area which is the sum of vehicle operating cost and passenger time cost. This was estimated based on the results of traffic assignment as shown in Table 10.6.2. Only for the opening year of 2004, the economic benefit was estimated at RMB 143 thousand /day or RMB 52.3 million/year, which accounts for about one half of the total investment. The benefits will increase by 3 times in 2010. Out of the total benefit, 2/3 is owing to the reduction of vehicle operating cost and 1/3 to the reduction of passenger time cost.

Table 10.6.2 Economic Benefit of the East-West Primary Busway Project

(RMB 000/day)

Case		2004	2010
Without Project	Vehicle Operating Cost	6,987	7,660
	Passenger Time Cost	1,627	3,614
	Total	8,614	11,274
With Project	Vehicle Operating Cost	6,895	7,406
	Passenger Time Cost	1,576	3,429
	Total	8,470	10,835
Economic Benefit	Vehicle Operating Cost	92	254
	Passenger Time Cost	51	185
	Total	143	439

10.6.3 Result of Economic Evaluation

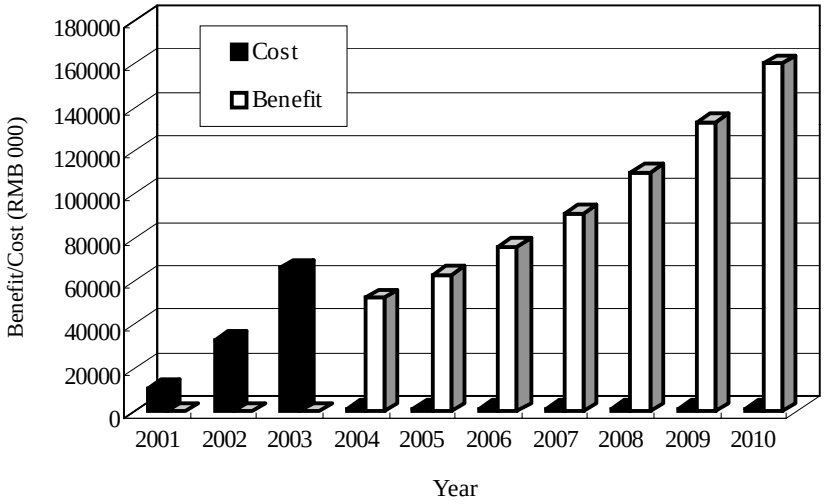
The stream of economic cost and benefit of the Project is presented in Table 10.6.3. The cost after 2004 is for the maintenance and operation of the facility and is assumed to be 1% yearly of the total project cost. Discount rate was set at 12% a year, which is usually used in China. Figure 10.6.1 shows the cost and benefit of the Project by year.

Table 10.6.3 Benefit/Cost Stream of the East-West Primary Busway Project

(RMB 000)

Year	Cost	Benefit	Net Benefit	Discounted Cash Flow		
				Cost	Benefit	Net Benefit
2001	11,015		-11,015	11,015	0	-11,015
2002	33,044		-33,044	29,503	0	-29,503
2003	66,088		-66,088	52,685	0	-52,685
2004	1,101	52,341	51,240	784	37,255	36,471
2005	1,101	63,073	61,972	700	40,084	39,384
2006	1,101	76,006	74,904	625	43,128	42,503
2007	1,101	91,590	90,489	558	46,402	45,844
2008	1,101	110,370	109,269	498	49,926	49,428
2009	1,101	133,001	131,899	445	53,717	53,272
2010	1,101	160,272	159,170	397	57,796	57,398
Total	117,856	686,652	568,796	97,210	328,308	231,098

Figure 10.6.1 Benefit/Cost Stream of the East-West Primary Busway Project



Based on the cash flow above, the economic internal rate of return (EIRR) was calculated at 49.1%. The proposed project is proven to be highly feasible economically. The benefit/cost ratio (BCR) is 3.4, and the net present value (NPV) is 231.1 million which is more than double of the total investment. The proposed project focuses on the modification of the cross-section of existing roads. Its characteristics are rather of a "Software". Thus it does not require a huge investment on physical infrastructure while its impact on traffic flows is remarkable. This is the reason why the economic evaluation of the Project resulted highly favorable.

10.6.4 Sensitivity Analysis

Table 10.6.4 analyzes the impact of possible changes in cost and benefit on the evaluation results. As presented, the EIRR is still high at 34.6% and the Project is economically feasible, even if the project cost increases by 50%. The point when the Project becomes not economically feasible (i.e., the EIRR becomes less than 12%) is when the project cost soars by 238% (3.38 times). Since it is unrealistic that the project cost becomes more than 3 times of the estimate of this study, the economic feasibility of the proposed project is stable enough against the cost increase.

Likewise, the economic viability of the Project is guaranteed against the possible reduction of the economic benefit; the EIRR is higher than 12% if the benefit decreases by 50%, and goes down to 12% only when 70% of the estimated benefit is lost. In other words, the Project is worth implementing economically even based only on the savings in passenger time cost, neglecting that in vehicle operating cost.

The demand forecast of this study assumes a considerable percentage of bicycle and car users to shift to bus use, as mentioned in Chapter 5. More specifically, 17% of bicycle trips and 22% of car trips are forecast to shift to bus use. These are not only forecasted values based on the Modal Split Model of this study but the target values for public transport planning to achieve an improvement of bus services that enables a modal shift this extent.

If the assumed modal shift is not realized, the EIRR of the Project decreases to 26.9%. Although this is considerably lower than the base case, it is still higher than the 12% threshold. Thus, the economic viability of the proposed project is again guaranteed in this extreme case.

Table 10.6.4 Sensitivity Analysis on Economic Feasibility of the East-West Primary Busway Project

Case		EIRR (%)	BCR	NPV (RMB million)
1	Base	49.1	3.4	231.1
2	Cost Increase			
	by 50%	34.6	2.3	182.5
	by 100%	25.8	1.7	133.9
	by 200%	14.9	1.1	36.7
	by 238%	12.0	1.0	0.0
3	Benefit Decrease			
	by 20%	40.8	2.7	165.4
	by 40%	31.3	2.0	99.8
	by 60%	19.6	1.4	34.1
	by 70%	12.0	1.0	0.0
4	No Modal Shift	26.9	1.8	73.5