JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
TRANSPORT COUNCIL OF LIMA AND CALLAO
MINISTRY OF TRANSPORTATIONS AND COMMUNICATIONS OF THE REPUBLIC OF PERU

THE MASTER PLAN FOR LIMA AND CALLAO METROPOLITAN AREA URBAN TRANSPORTATION IN THE REPUBLIC OF PERU (Phase 1)

FINAL REPORT (Volume – III)

AUGUST, 2005

YACHIYO ENGINEERING CO., LTD
In Association With
PACIFIC CONSULTANTS INTERNATIONAL

Exchange Rates: October 2004

US$ 1.00 = Soles S/. 3.29

US$ 1.00 = ¥ 109.95

Preface

In response to a request from the Government of the Republic of Peru, the Government of Japan decided to conduct the Master Plan for Lima and Callao Metropolitan Area Urban Transportation in the Republic of Peru (Phase 1) and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Koichi TSUZUKI of Yachiyo Engineering Co., Ltd., to Peru, seven times between January 2004 and May 2005. In addition, JICA set up an advisory committee headed by Dr. Hisao Uchiyama, Tokyo University of Science between January 2004 and May 2005, which examined the Study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Peru and conducted a field survey in the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to officials concerned of the Government of the Republic of Peru for their close cooperation extended to the team.

August 2005

Kazuhisa MATSUOKA
Vice President
Japan International Cooperation Agency

Letter of Transmittal

August 2005

Mr. Kazuhisa MATSUOKA
Vice President
Japan International Cooperation Agency

Dear Sir:

It is a great honor for me to submit herewith the final reports of the Master Plan for Lima and Callao Metropolitan Area Urban Transportation in the Republic of Peru (Phase 1).

A study team, which consists of Yachiyo Engineering Co., Ltd. and Pacific Consultants International, and headed by myself, conducted field surveys, data analysis and planning works of the master plan study in Peru based on the terms of references instructed by the Japan International Cooperation Agency (JICA) from January 2004 to August 2005.

The study team held thorough discussions and investigations with officials concerned of the Government of Peru, accordingly, various traffic surveys, present conditions analysis, initial environmental examination, preparation of implementation program, and project evaluation. The results were compiled in the final report, main and summary volumes.

On behalf of the team, I wish to express my heartfelt appreciation to the officials concerned of the Government of Peru for their warm friendship and cooperation extended to us during our stay in Peru.

I also wish to express my sincere appreciation to JICA, Consejo de Transporte de Lima y Callao, Ministry of Transportations and Communications, the Embassy of Japan in Peru, and other concerned government authorities for their valuable advice and cooperation given to us in the course of the Study.

Yours Faithfully,

Koichi TSUZUKI
Team Leader,
The Master Plan for Lima and Callao Metropolitan Area Urban Transportation in the Republic of Peru (Phase 1)

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List of Abbreviations

¥	Yen
AASHTO	American Association of State Highway and Transportation
AATE	Autonomous Authority of the Special Project of Electric Mass Transport System for Lima and Callao
ACI	American Concrete Institute
AIT	Asian Institute of Technology
AMETUR	Metropolitan Association of Urban Transport Enterprises
Art.	Article
ASETRAP	Association of Peruvian Transport Enterprises
ASETUM	Association of Mass Urban Transportation Companies from
ASETUP	Association of Urban Transportation Companies from Peru
ASPEC	Peruvian Association of Consumers and Users
ATC	Applied Technology Council
ATLM	Lima and Callao Metropolitan Transport Authority
ATP	Automatic Train Protection System
Av.	Avenue
CBD	Central Business District
CCTV	Closed Circuit Television System Camera
CEMTU - PERU	Urban Carriers Company Corporation from Peru
CEPAL	Economic Commission for Latin American and Caribe
CEPRI	Special Committee of Private Investment Promotion
CGT	General Confederation of Transport
CIDATT	Investigation and Advisory Center of Terrestrial Transport
CNG	Compressed Natural Gas
CNSV	National Road Safety Council
COFOPRI	Commission of Informal Property Formalization
CONAM	National Environmental Council
CONATA	National Assessment Council for Real Estate
CONATRAP	National Confederation of Public Transport Companies
CONECSA	Business Consortium of Callao
CONFIEP	National Confederation of Private Business Institutions
CORDELICA	Development Corporation for Lima and Callao
CORPAC	Peruvian Corporation of Airports and Commercial Aviation
COSAC	High Capacity Segregated Corridor
COSAC I	High Capacity Segregated Corridor Phase I
CPU	Central Processing Unit
CTC	Central Train Control System
CTLC	Transport Council of Lima and Callao

DC/CD	Direct Credit
dd-S	Subtropical Desiccated Desert
DESCO	Study and Development Promotion Center
DGAC	General Direction of Civil Aviation
DGAS	General Direction of Social Environmental Affairs
DGCF	General Direction of Railway Transportation
DGCT	General Direction of Ground Circulation
DGDU	General Direction of Urban Development
DGTA	General Direction of Marine Transportation
DGTE	General Direction of Transport
DGTO	General Direction of Transit
DGTU	General Direction of Urban Transport (Callao)
DMTU	Municipal Direction of Urban Transport (Lima)
DNI	National Identification Document
dp-PT	Tropical Low-mountain Semi-dry
ds-S	Subtropical Super-dry Desert
ECAs	Environmental Quality Standard Annual Program
EIA	Environmental Impact Assessment
EIA-d	Detailed Study of Environmental Impact
EIA-sd	Semi-detailed Study of Environmental Impact
EMAPE	Municipal Toll Administration Company
ENAPU	Port Services of Peru
ENATRU	National Corporation for Urban Transport
Ex.	Express Way (Freeway)
FINVER	Finver-Callao Investment Fund
FONAM	National Environmental Fund
FONCOMUN	Municipal Compensation Fund
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse Gases
GPS	Geographical Positioning System
GRDP	Gross Regional Domestic Product
HH	Household
HOV	High Occupancy Vehicle
IBRD/WB	International Bank for Reconstruction and Development /World Bank
ICAO	International Civil Aviation Organization
IDB	Inter-American Development Bank
IEE	Initial Environmental Examination
IFC/CFI	International Finance Corporation

IMP	Metropolitan Planning Institute
INC	National Institute of Culture
INDECI	National Institute of Civil Defense
INEI	National Institute for Statistics and Information
INVERMET	Metropolitan Investment Fund
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
LaeqT	Continuous Sound Pressure Level equivalent to that with Adjustment A
LCTA	Lima and Callao Metropolitan Transport Authority
Leq	Noise Parameter
M/C	Motorcycle
M/P	Master Plan for Lima and Callao Metropolitan Area Urban Transportation in the Republic of Peru
MEF	Ministry of Economy and Finance
MIGA/OMGI	Multilateral Investment Guarantee Agency
MML	Metropolitan Municipality of Lima
MOP	Ministry of the Presidency
MPC	Province Municipality of Callao
MTC	Ministry of Transportation and Communications
MTPE	Ministry of Work and Employment Promotion
NGO	Non-Governmental Organization
NMT	Non-motorized Transport
OD	Origin Destination
OECD	Organization for Economic Cooperation and Development
OGPP	Directorate of Management Information
OIT	Office of Technical Information
OPP	General Office of Planning and Budgets
PAR	Displaced People Return Support Program
PCU	Passenger Car Unit
PFI	Private Finance Initiative
PG/R	Progress Report
PISA	Integral Atmospheric Security Plan
PM	Particulate Matter
PNP	National Police
PPP	Public Private Partnership
PROINVERSION	Private Investment Promotion Agency
PROLIMA	Lima Historic Center Municipal Recuperation Program
PRONAA	National Program of Nourishment Assistance
PROTRANSPORTE	Investments Plan Elaboration Project for Lima's Metropolitan Transport

PROTUM	Metropolitan Urban Transport Project
PROVIAS	Special Project of Transport Infrastructure
PT	Person Trip
PTUL	Lima Urban Transport Program
RC	Reinforced Concrete
RIT	Integrated Transport Network
RTMS	Remote Detector Microwave Sensor
S/.	Soles
SAT	Tributary Administration Service
SEDAPAL	Drinking Water and Sewerage Service of Lima
SEIA	National System of Environmental Impact Evaluation
SERPOST	Postal Services of Peru
SETAME	Metropolitan Taxi Service
SITC	Southern Inter Tropical Convergence
SPM	Suspended Particulate Matter
SUNARP	National Superintendence of Public Registration
SUNAT	National Superintendence of Tributary Administration
TDM	Traffic Demand Management
TRANSMET	Metropolitan Transport Committee of Lima
TSAS	Traffic Safety Audit System
TTC	Travel Time Cost
TUPA	Unique Text of Administrative Procedure
UIC	International Union of Railways
UNESCO	United Nations Education, Science and Culture Organization
US$	American Dollar
USTDA	Feasibility Study on Urban Railway Project in Lima
UTPM	Territorial Units of Metropolitan Planning
VOC	Vehicle Operation Cost
VIVD	Video Vehicle Detection System

CHAPTER 21
Effectiveness of Traffic and Transport by Master plan

21. EFFECTIVENESS OF TRAFFIC AND TRANSPORT BY MASTER PLAN

21.1. ANALYTICAL PROCEDURE

The previous sections included the economic, financial, environmental and traffic evaluations of the Master Plan projects. This chapter analyzes the effectiveness of traffic and transport by the Master Plan.

Figure 21.1-1 shows the analytical procedures of the Master Plan in 2025, in which the relationship between the Master Plan project, transport users and criteria of development are illustrated. The public transport and private vehicle users benefit from the effects of the Master Plan projects, which are shortening of commuter hour and alleviation of traffic congestion by rendering a rapid, punctual and convenient service of mass transit system and road improvement.

In this chapter, the effectiveness of traffic and transport is analyzed in the following manner:

1) Demand analysis in the morning peak hour
2) Evaluation of fare rate
3) Influence of mass transit (trunk bus and railway) on the low-income population
4) Traffic sensitivity analysis

The demand analysis is done in the morning peak hour. Demands on the proposed trunk bus and railway systems are forecasted and these service levels in the morning peak hour are disclosed. The service frequency or headway of those transport systems must be forecasted to observe busway and railway capacities in the peak hour and to prepare the number of operated buses and coaches in the peak hour.

In the previous Chapter 20, daily traffic demand in the Master Plan is forecasted for the evaluation of the cost and benefit analysis. The demand on the road and transport facilities is forecasted without a transport fare rate. Therefore, the analysis of the fare rate and its change of demand is done to see an optimized fare rate as well as the integrated fare system which is proposed in Chapter 14, Trunk Bus Transport Sector Plan. In the analysis, the flexibility of the fare rate by Estrato E is also identified in consideration of the results of the poverty interview survey, which was carried out to clarify the transport behavior of the low income population in the study.

The influence of a mass transit system, composed of trunk bus and railway systems, on the low income population is also analyzed in consideration of the results of the poverty survey. In the analysis, the fare system policy and feeder bus route network are proposed.

The traffic sensitivity analysis is done to measure the impact on travel demand on the road and transport facilities. In the sensitivity analysis, the relationship between economic growth and traffic demand is disclosed. In the Master Plan, the growth rate of GRDP/capita during a 21-year period, from 2004 to 2025, is set at 1.78 times. When the low growth rate is assumed, the travel demand on the road and transport facilities is analyzed and the modal share of private and public transport is disclosed.

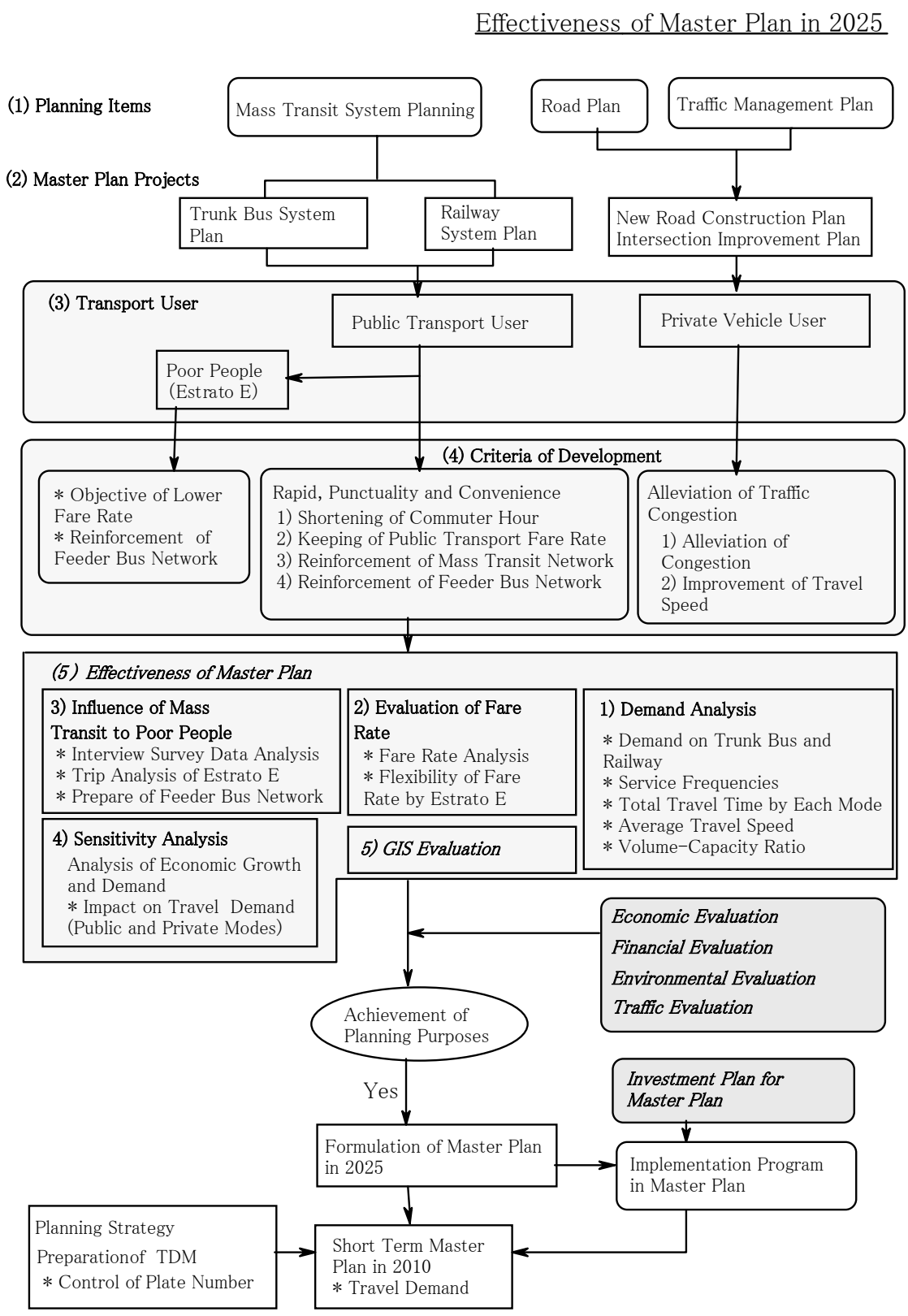


Figure 21.1-1 Analytical Procedures for Effectiveness of the Master Plan in 2025

21.2. TRAFFIC DEMAND ANALYSIS IN THE MORNING PEAK HOUR

Figure 21.2-1 shows the outline of the traffic demand analysis, which is composed of the following.

1) Peak hour travel demand analysis
2) Effectiveness of traffic and transport system

The peak hour travel demand is analyzed in the morning peak hour in the years 2004 and 2025 in the "with and without project" cases. From the peak hour analyses, the public transport service conditions such as travel time, operated bus fleets and total proceeds, are disclosed.

In this analysis, the proposed fare system, which is the integrated fare system, is considered in the traffic assignment. In the integrated fare system, the following fare rate is applied:

a) Conventional bus: S./1.0
b) Trunk Bus: S./1.5
c) Railway: S./1.5
d) To establish a fare rate of each public transport mode for transfer between public transport
   - Conventional bus to others
   - Trunk bus to railway
e) No additional fare for transfer between trunk bus lines
f) No additional fare for transfer between railway lines

Based on those analyses, shortening of commuter hour, decrease of number of bus fleets, etc. in the proposed transport system in the Master Plan are evaluated.

21.2.1. PEAK HOUR TRAVEL DEMAND ANALYSIS

(1) Passenger Demand on Public Transport in the Peak Hour

Passenger demands on the public transport in the morning peak hour in 2004 and 2025 are shown in Figure 21.2-2 to Figure 21.2-6. Figure 21.2-2 shows the present traffic conditions on roads. In Figure 21.2-3, which shows the traffic volumes in 2025, the figure in the upper part shows the traffic demand in the "without project" case, in which future OD trips are assigned on the present transport network. The bottom figures show the traffic demand in the "with project" case, in which future OD trips are assigned on Master Plan networks. Figure 21.2-4 shows the difference of travel demand between the "with project" and "without project" cases. Figure 21.2-5 shows the hourly passenger volumes in 2025 on the trunk busway and railway. Figure 21.2-6 shows the passenger volumes for 2004 in the upper part and for 2025 in the bottom part, which is without the Master Plan case.

In those figures, the traffic volume on each road transport facility is drawn by a narrow band whose width is proportional to the assigned traffic volume. In the upper side figure, in Figure 21.2-5, hourly railway passenger volumes are shown in green and hourly trunk bus passenger volumes are shown in red. The conventional bus passengers are shown in the bottom.

When comparing traffic volume in the "without project" cases in Figure 21.2-3, the segments with a traffic volume-capacity ratio of over 1.0 (pink and red color) gradually increase with the progress of the years and then, in 2025, almost all the roads exceed a ratio of 1.0. When the Master Plan is developed, the segments on roads with a ratio of over 1.0 are considerably reduced as shown in the bottom figure.

Table 21.2-1 shows the total hourly number of passengers on the public transport by mode, which is the total number of public transport users, not the flow rate on transport lines. In the "without project" case in 2025, the conventional bus passengers will increase 1.46 times the volume in 2004, in contrast to 0.46 times in the "with project" case since public transport passengers divert to the trunk bus and railway system. Since the mass transit system does not occupy traffic lanes on roads, the traffic congestion on roads will be alleviated.

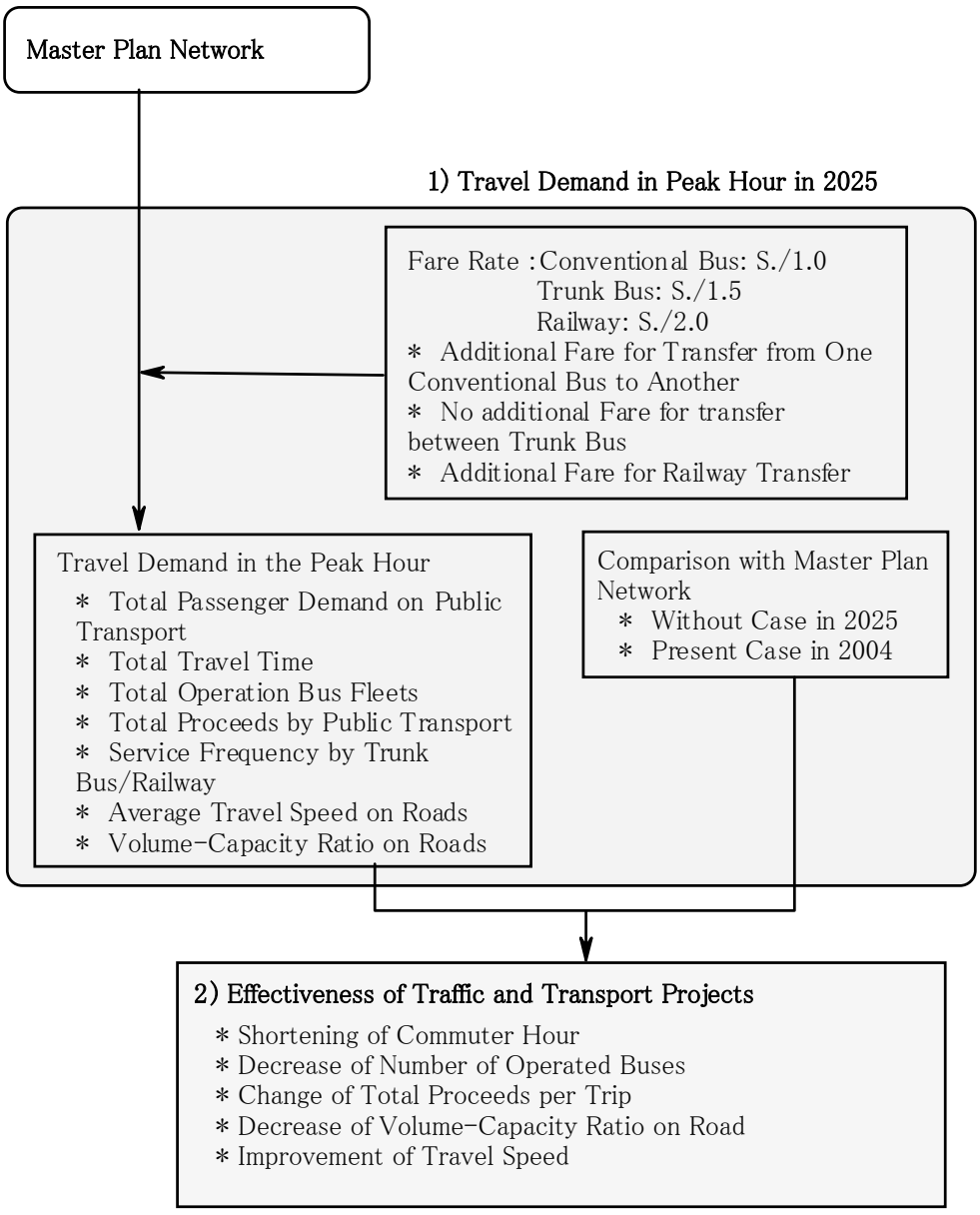


Figure 21.2-1 Procedure of Traffic Demand Analysis

Table 21.2-1 Hourly Number of Public Transport Passengers By Mode

(Unit: Passengers/hour)

Mode	2004	2025			2025/2004		2025
		With Project	Without Project	With Project/Without Project	With Project	Without Project	Composition Ratio With Project
Conventional Bus	1,512,716	702,464	2,212,095	0.32	0.46	1.46	0.28
Trunk Bus	-	1,119,130	-	-	-	-	0.45
Train	-	678,901	-	-	-	-	0.27
Total	1,512,716	2,500,495	2,212,095	1.13	1.65	1.46	1.00

Note: Trip means a trip is counted every transfer, when a passenger transfers from one mode to another.

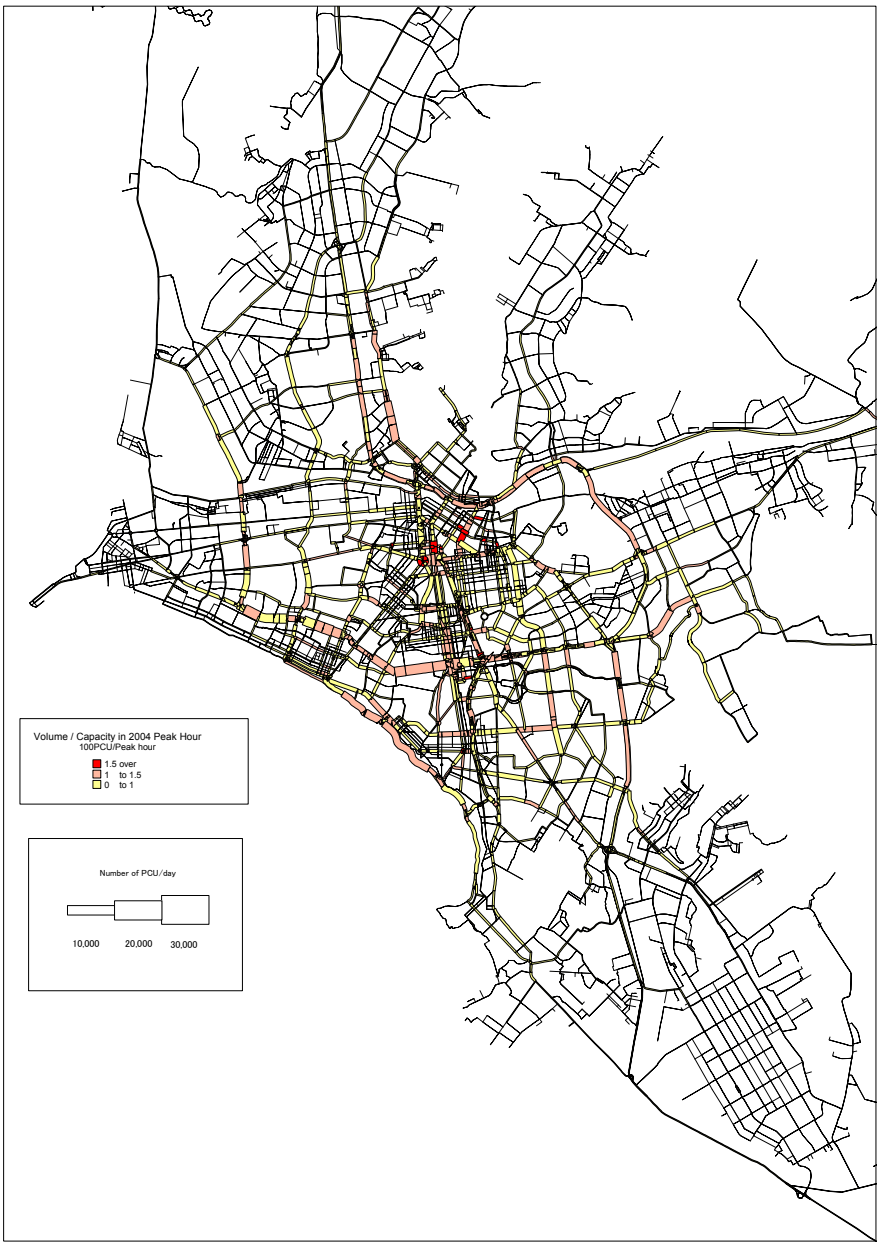
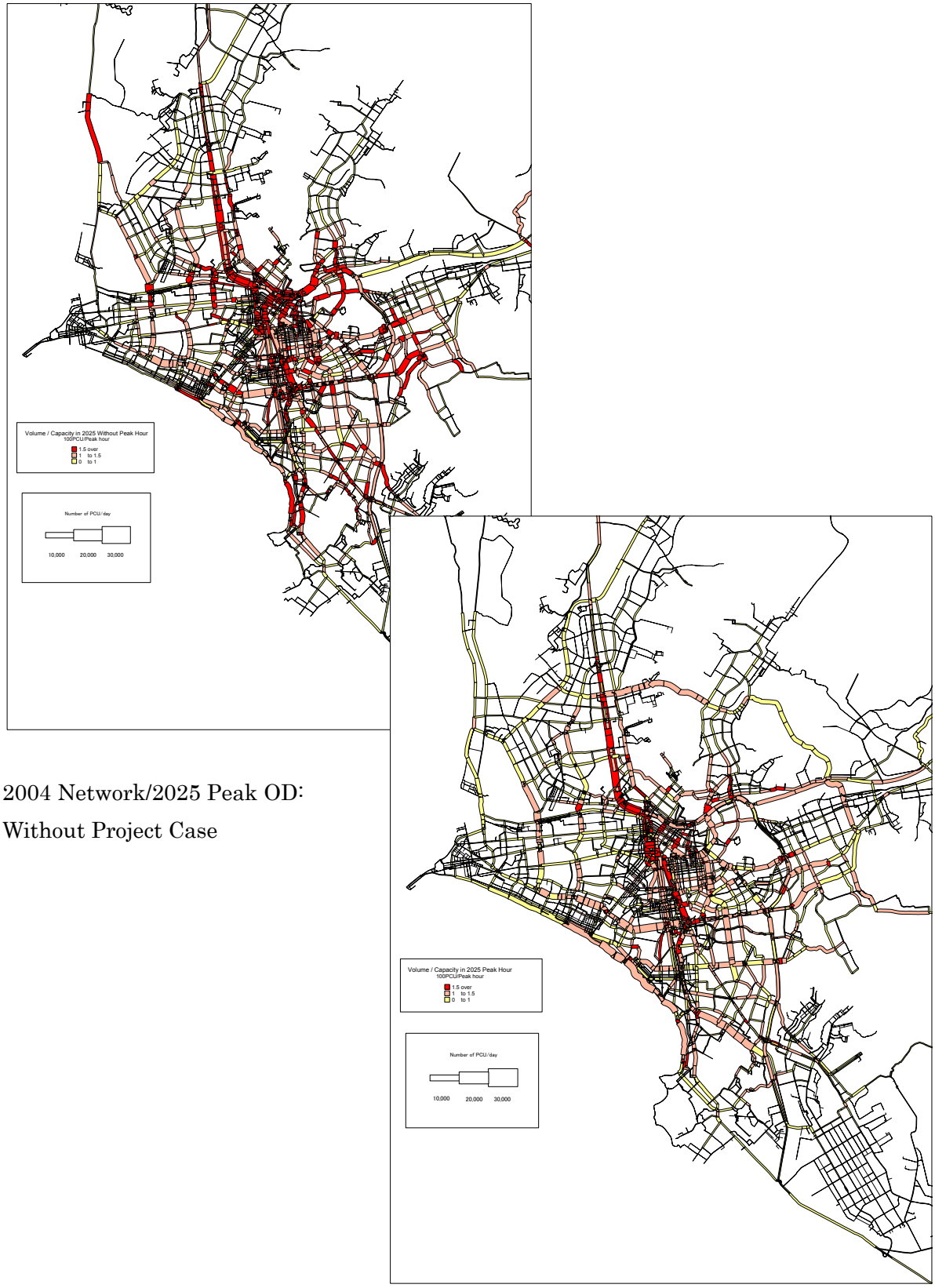


Figure 21.2-2 Peak Hour Traffic Demand of All Modes (2004 Network/2004 Peak Hour OD)



2004 Network/2025 Peak OD: Without Project Case

With Project Case

Figure 21.2-3 Peak Hour Traffic Demand of All Modes (2004 Network/2025 Peak OD: Without Project Case for Upper Part, and 2025 Network/2025 Peak OD Table: With Project Case for Bottom Part)

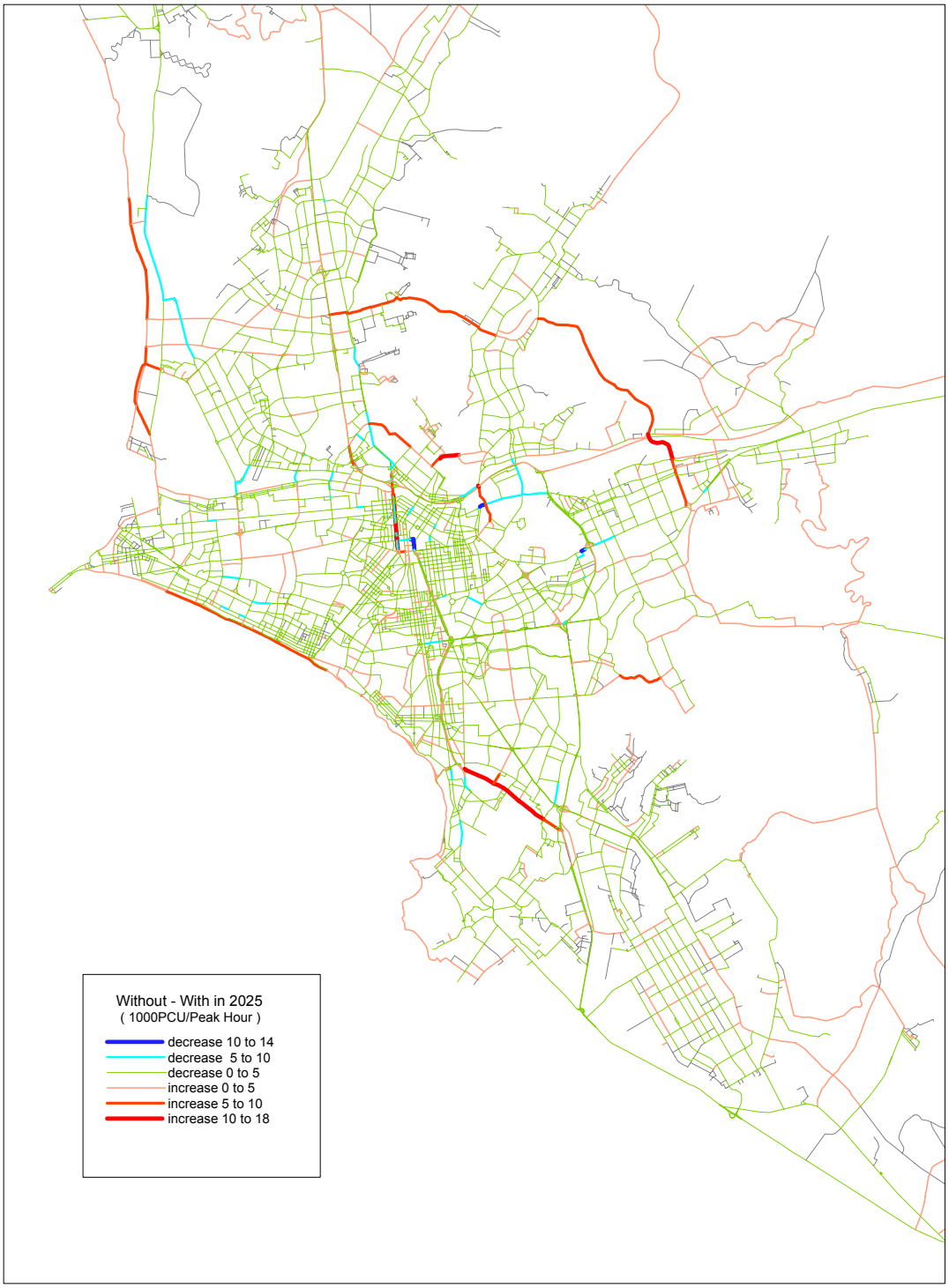
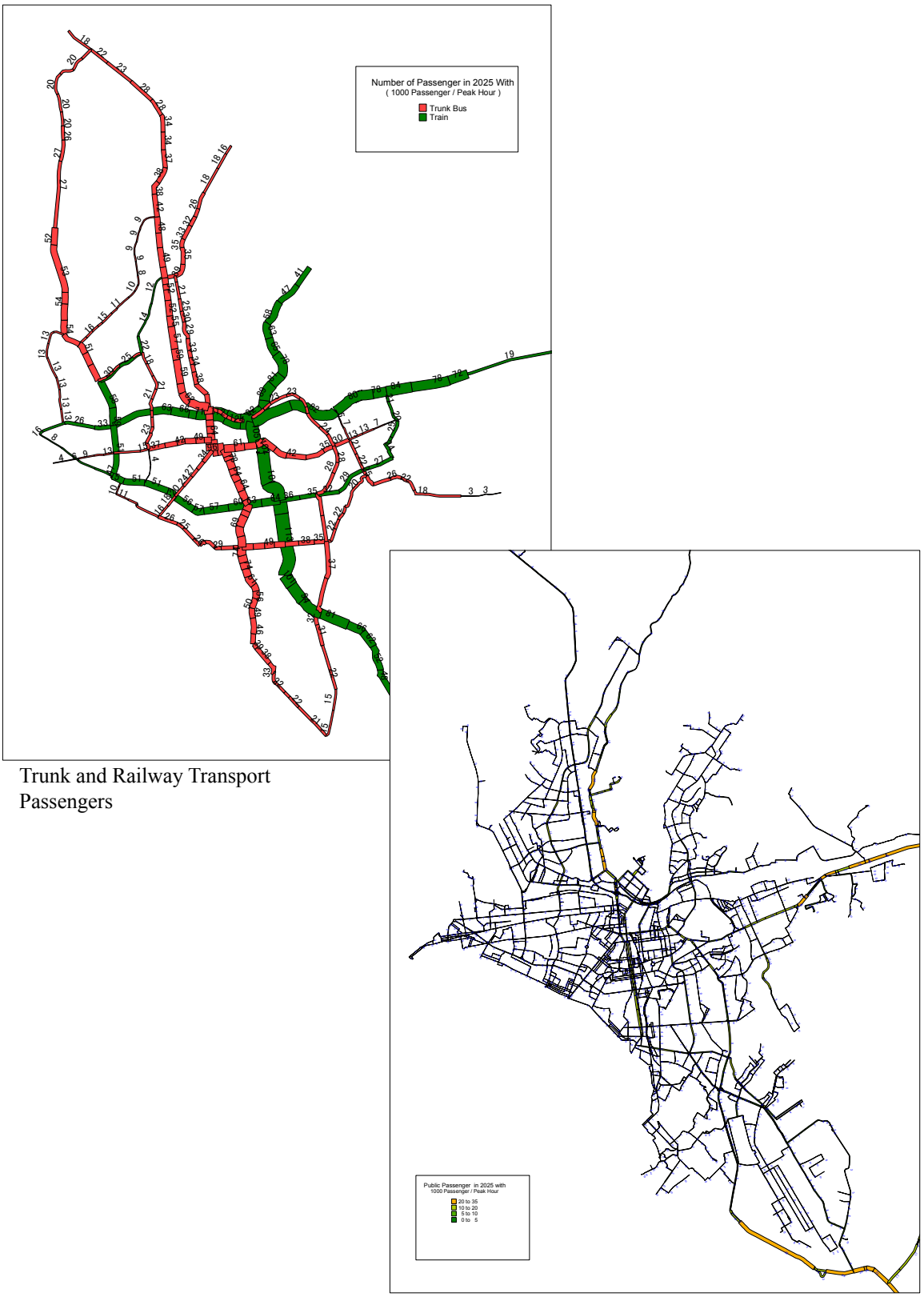


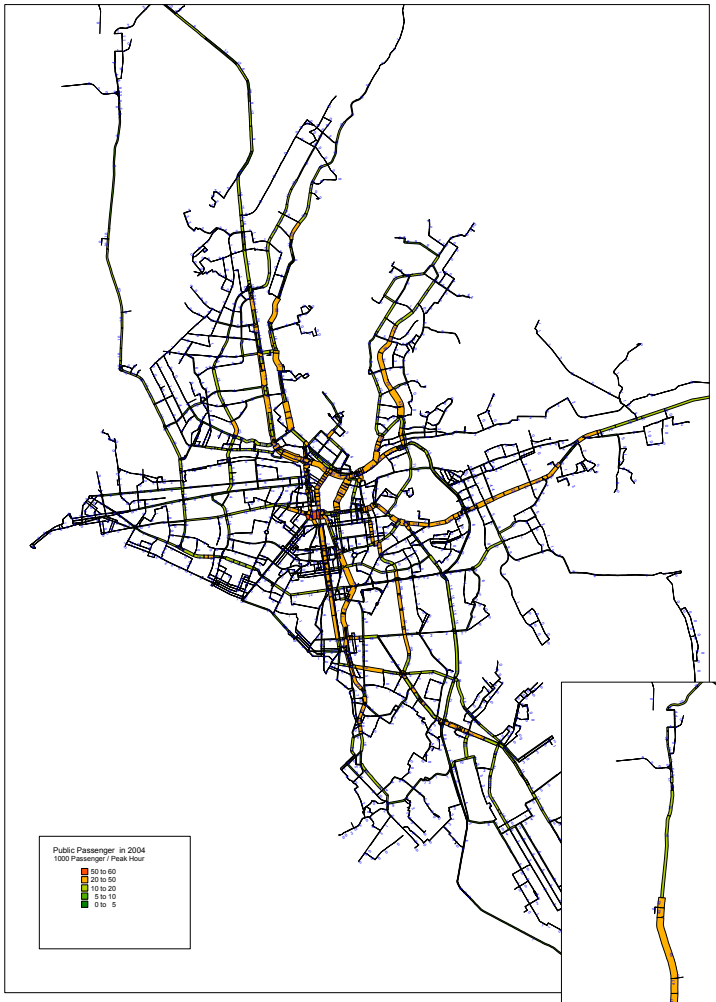
Figure 21.2-4 Difference of Peak Hour Travel Demand between “With Project” and “Without Project” Cases



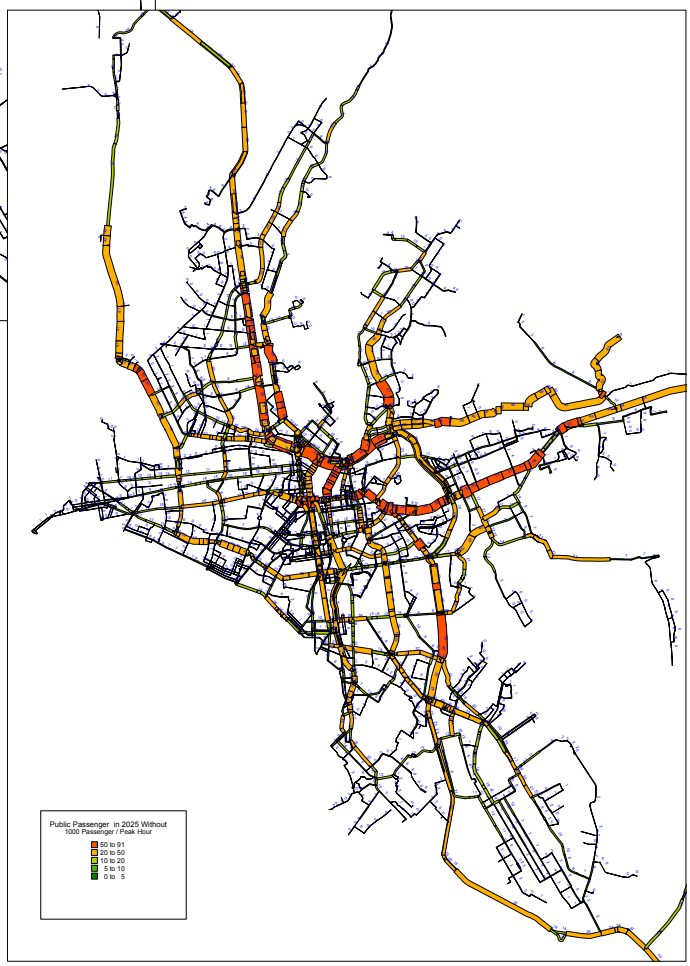
Trunk and Railway Transport Passengers

Conventional Bus Passengers

Figure 21.2-5 Peak Hour Traffic Demand by Trunk and Railway Transport for Upper Part and by Conventional Bus for Bottom Part (2025 Network/2025 Peak OD)



2004 Public Transport Passengers



2025 Public Transport Passengers (Without Project)

Figure 21.2-6 2004 Peak Hour Traffic Demand of Public Transport for UpperPart, and 2025 Peak Hour Traffic Demand (Without Project Case) for Bottom Part