Ministry of Transport,
National Authority for Tunnels
The Arab Republic of Egypt

JICA Preparatory Survey
On
Greater Cairo Metro Line No.4
In
the Arab Republic of Egypt

FINAL REPORT

Volume 1
(Feasibility Study Report 1)

JUNE 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.
JAPAN RAILWAY TECHNICAL SERVICE
NIPPON CIVIC CONSULTING ENGINEERS CO., LTD

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Exchange Rates

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Preface

In response to the request from the government of the Arab Republic of Egypt, the Government of Japan decided to conduct “JICA Preparatory Survey on Greater Cairo Metro Line No.4”, and entrusted the study and to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team consisted of Nippon Koei Co. Ltd., Japan Railway Technical Service (JARTS) and Nippon Civic Consulting Engineer Co. Ltd, headed by Mr. Hiroshi Izawa, between February 2009 to May 2010.

The team conducted field surveys at the study area and held discussions with the officials concerned of the Government of the Arab Republic of Egypt. Having completed them, now the team prepared this final report.

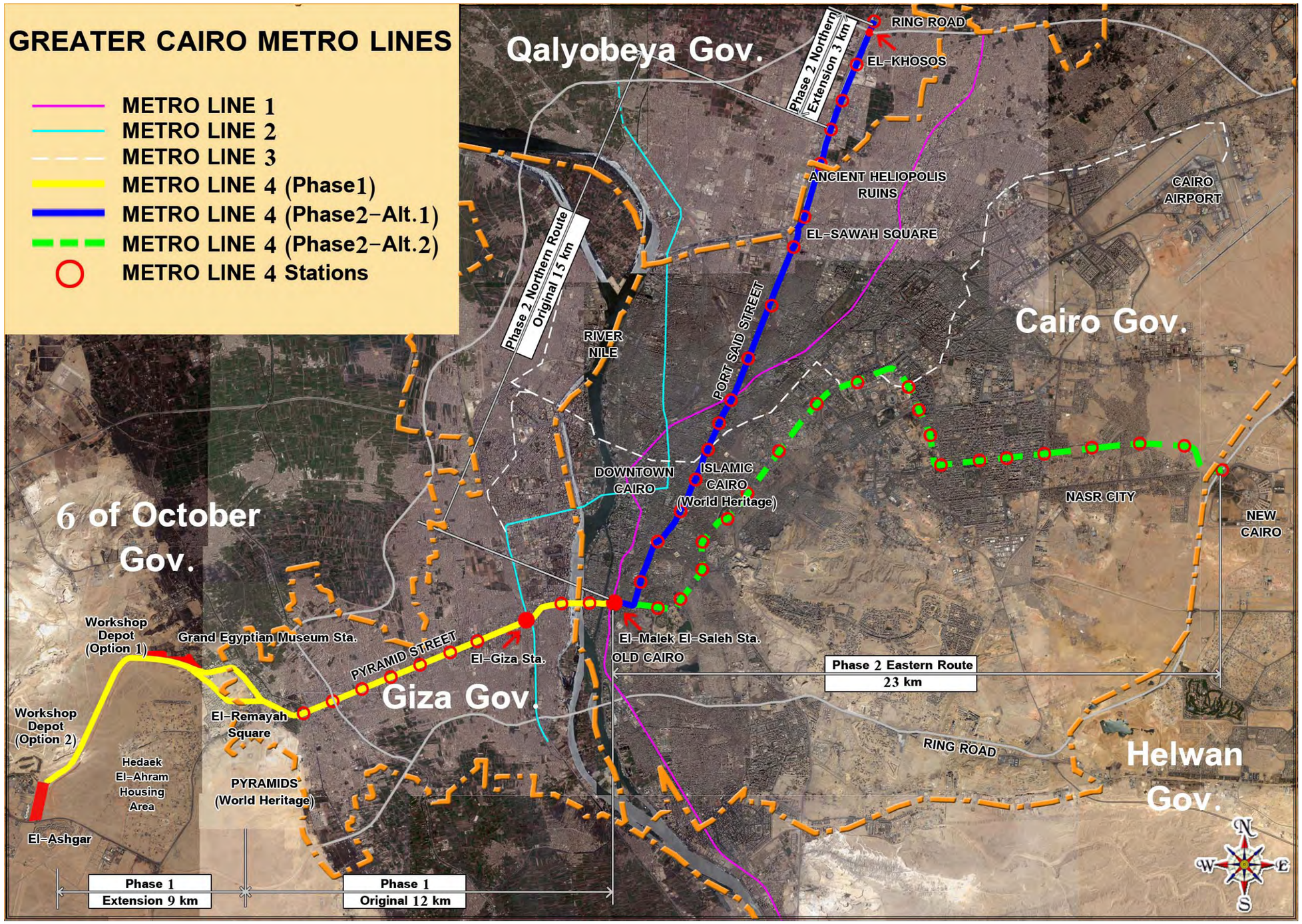
I hope that this report will greatly contribute to the construction and operation of the Metro Line No.4 for the urban transportation in Greater Cairo, as well as to enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Arab Republic of Egypt for their close cooperation to the project.

June 2010

Kiyoshi Kodera
Vice President
Japan International Cooperation Agency

LOCATION MAP of Volume 1



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GROSSARY OF ABBREVIATIONS AND MEASURING UNITS

GLOSSARY OF ABBREVIATIONS AND MEASURING UNITS

ABBREVIATIONS

A

AASHTO	American Association of State Highways and Transportation Officials
AB	Absolute Block
ABS	Automatic Block Signals
A/C	Air Conditioning
AC	Alternating Current
ACE	Arab Consulting Engineers
ACij	Access Length
ADT	Average Daily Traffic
AF	Audio Frequency
AFC	Automatic Fare Collection (system)
AfDB	African Development Bank
AG	Automatic Gate
AGT	Automated Guide-way Transit
AHU	Air Handling Unit
AM	Amplitude Modulation
am	Ante meridian
ANSI	American National Standards Institute
AREMA	American Railway Engineering and Maintenance Association
ARS	Automatic Route Setting
ASCII	American Standard Code for Information Interchange
asl	Above Sea Level
ASTM	American Society for Testing and Materials
AT	Auto Transformer
ATC	Automatic Train Control
ATO	Automatic Train Operation
ATP	Automatic Train Protection
ATS	Automatic Train Supervision
ATS	Automatic Train Stop
Ave.	Average

B

BAS	Building Automation System
BCC	Beginning of Circular Curve
BCR	Benefit Cost Ratio
BD	Basic Design
BNC	British National Connector
BP	Brake Pipe
BRT	Bus Rapid Transit
BS	British Standard
BSE	Base Station Equipment
BT	Booster Transformer
BTC	Beginning of Transition Curve

C

CA	Certification Authority
CAA	Competent Administrative Authority
CAD	Computer Aided Design
C&I	Criteria & Indicator
CAPMAS	Central Agency for Public Mobilization and Statistics
CAPW	Construction Authority for Portable Water and Wastewater
CBD	Central Business District
CBTC	Communication Based Train Control
CCIR	International Radio Consultation Committee
CCITT	Consultative Committee for International Telephone and Telegraphs
CCP	Central Control Point
CCTV	Closed Circuit Television
CCU	Central Control Unit
CCU	Communication with Central Control Unit
CD ROM	Compact Disc Read Only Memory
CDR	Compact Disc Recordable
CIP	Central Interface Panel
CENELEC	European Committee for Electrotechnical Standardization
CI	Computerized Interlocking
CICC	Contactless IC Card
CIPF	Card Initiation and Personalization Function
CIPS	Card Initiation and Personalization System
CMH	Cubic Meter per Hour
CML	Cairo Metro Line

	CMO	Cairo Metro Organization
	CMOS	Complementary Metal Oxide Semiconductor
	CNG	Compressed Natural Gas
	COP	Crew Operation Panel
	CPEE	City Unit Cable
	CPM	Critical Path Method
	CREATS	Cairo Regional Area Transportation Study
	CRT	Cathode Ray Tube
	CS	Cab Signal
	CSC	Contactless Smart Card
	CTA	Cairo Transport Authority
	CULTNAT	Cultural and National Heritage
	CV	Curriculum Vitae
	CWO	Cairo Wastewater Organization
	CWR	Continuously Welded Rail
D		
	DB	Dry Bulb (Ventilation)
	D&B	Design and Build
	DC	Direct Current
	DC	Direct Cost
	DCF	Discount Cash Flow
	DF	Depot Facility
	DIN	Deutsche Industry Norm (German Industrial Standard)
	DO	Dissolved Oxygen
	DOS	Disk Operating System
	DSRSC	Design Standards for Railway Structures and Commentary
	DWG	Drawing
E		
	E&M	Electrical and Mechanical
	ECC	End of Circular Curve
	ECM	Egyptian Company for Metro
	ECMOU	Egyptian Company for Maintaining and Operating the Underground
	ECS	Environmental Control System
	EEAA	Egyptian Environmental Affairs Agency
	EEHC	Egyptian Electricity Holding Company
	Egij	Egress Length

EGP	Egyptian Pound
EGSA	Egyptian General Survey Authority
EHF	Extremely High Frequency (mill-meter wave)
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EIRENE	European Integrated Railway Radio Enhanced NEtwork
EIRR	Economic Internal Rate of Return
ELCB	Earth Leakage Circuit Breaker
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
EMU	Environmental Management Unit (Governorate)
EMU	Electric Multiple Unit
ENIT	Egypt National Institute of Transport
ENPV	Economic Net Present Value
ENR	Egyptian National Railway
EPBM	Earth Pressure Balanced Machine
EPI	Environmental performance Indicator
ER	Electric Room
ERs	Executive Regulations
ERTMS	European Railway Traffic Management System
ETC	End of Transition Curve
ETCS	European Train Control System
ETHERNET	Computer Cabling System
EU	European Union
EUA	EU emission Allowance

F

FCC	Federal Communications Commission
FIRR	Financial Internal Rate of Return
FM	Frequency Modulation
FOB	Free On Board
FOC	Fiber Optic Cable
F/S	Feasibility Study
FS	Fail Safe
FSK	Frequency Shift Keying
FSR	Feasibility Study Report
FTP	File Transfer Protocol
FY	Fiscal Year, Financial Year

G

GARBLT	General Authority for Roads, Bridges and Land Transport
GC	General Consultant
GCA	Greater Cairo Area
GCR	Greater Cairo Region
GDP	Gross Domestic Product
GEM	Grand Egyptian Museum
GHG	Greenhouse Gas
GIS	Geographic Information System
GL	Ground Level
GNI	Gross National Income
GOE	Government of Egypt
GOJ	Government of Japan
GOPP	General Organization for Physical Planning
GPS	Global Positioning by Satellite System
GRDP	Gross Regional Domestic Product
GSM	Global System for Mobile communications
GSM-R	Global System for Mobile communications for Railways
GUI	Graphical User Interface

H

HB	Home Based
HFC	Hydro-Fluoro-Carbon
HIS	Home Interview Survey
HMI	Human Machine Interface
Hz	Hertz
hr	hour
HS	Hindrance Sensor
HTTP	Hyper Text Transfer Protocol
HVL	High Voltage Line
HVS	High Voltage Station

I

IBA	Important Bird Area
IBC	International Building Code
IBRD	International Bank for Reconstruction and Development
IC	Integrated Circuit
ICEA	Insulated Cable Engineers Association
IDC	In-Direct Cost

	IEC	International Electrotechnical Commission
	IEEE	Institute of Electrical and Electronics Engineers
	IGBT	Insulated Gate Bipolar Transistor
	IMF	International Monetary Fund
	IP	Implementation Program
	IRJ	Insulated Rail Joint
	IRR	Internal Rate of Return
	IS	Information System
	ISDN	Integrated Services Digital Network
	ISO	International Standards Organization
	IT	Information Technology
	I-Tax	Import Tax
	ITU	International Telecommunication Union
	ITV	Industrial Television
	IUCN	International Union for Conservation of Nature and Natural Resources
J		
	JARTS	Japan Railway Technical Service
	JBIC	Japan Bank for International Cooperation (former name of JICA)
	JICA	Japan International Cooperation Agency
	JIS	Japanese Industrial Standards
	JNR	Japanese National Railways
	JPY	Japanese Yen
	JST	JICA Study Team
K		
	kCal	kilo-Calory
	kV	kilo Volt
	kVA	kilo Volt Ampere
L		
	LAN	Local Area Network
	LCD	Liquid Crystal Display
	LCU	Local Control Unit
	LCX	Leaky Coaxial Cable
	LE /L.E.	Egyptian Pound
	LED	Light Emitting Diode
	LPS	Lighting and Power Station

LRT	Light Rail Transit
LRV	Light Rail Vehicle
LRU	Line Replaceable Unit
LT	Link Traffic
LV	Low Voltage
LWR	Long Welded Rail

M

MCA	Multi-Criteria Analysis
MCBF	Mean Cycle Between Failure
MCP	Manual Control Panel
MCPC	Monitoring and Control Personal Computer
MCS	Manual Control Switch
MDB	Manual Door Opening Button
M&E	Mechanical and Electrical
MDBF	Mean Distance Between Failure
MDOP	Manual Door Operation Panel
MH	Maintenance Hatch
MIL	Military Specification
min.	minute
MIS	Management Information System
MJC	Misr Japan Alled Company for Rolling Stock Maintenance and Renweal
MLIT	Ministry of Land Infrastructure, Transport and Tourism / Japan
MOH	Ministry of health (Egypt)
MOT	Ministry of Transport (Egypt)
MP	Mimic Panel
MPU	Motive Power Unit
MPU	Micro Processor Units
MRT	Mass Rapid Transit
MSEA	Ministry of State for Environmental Affairs
MSK	Minimum Shift Keying Modulation
MT	Matting Transformer
MT	Magnetic Ticket (AFC)
M4N	Metro Line 4 North section (Phase 2)
M4W	Metro Line 4 West Section (Phase 1)
MW	Mega Watt

N

NAT	National Authority for Tunnel, Ministry of Transport
NATM	New Austrian Tunneling Method
NFPA	National Fire Prevention Association
NGO	Non-Governmental Organization
NHB	Non-Home Based
NOUH	National Organization for Urban Harmony
NOx	Nitrogen Oxides
NPV	Net Present Value
N-Sta.	North line Station (Phase 2)
NUC	New Urban Community

O

OA	Outside Air (Ventilation)
OCC	Operation Control Centre
OCS	Overhead Contact System
OD / O/D	Origin and Destination
ODA	Official Development Assistance
OFC	Optical Fibre Cable
OHC	Over Head Catenary
O&M	Operation and Maintenance
OP	Operation Policy
ORC	Overhead Rigid Conductor

P

p.a.	per annum
P&L	Profit and Loss
PA	Public Announcement/ Public Address
PAP	Project Affected Person
Pax	Passenger
PBX	Private Automatic Branch Exchange
PC	Pre-stressed Concrete
PC	Personal Computer
PCP	Power Control Point
PCU	Passenger Car Unit
p/h	person per hour
PHPDT	Peak Hour Peak Direction Trips
PID	Passenger Information Display
PKI-SAM	Public Key Infrastructure - Security Access Key

	pm	post meridian
	PM	Particulate Matter
	PMSM	Permanent Magnet Synchronous Motor
	PPHPD	Passengers Per Hour Per Direction
	PPM	Planned Preventive Maintenance
	PRC	Programmed Route Control
	PRJ	Projector
	PSD	Platform Screen Door
	P.T.	Piaster
	PT	Person Trip
	PTC	Programmed Traffic Control
	PPM	Parts Per Million
	PSO	Public Service Obligation
	PVC	Poly Vinyl Chloride
	PVU	Portable Verification Unit
	PW	Permanent Way
Q		
	QA	Quality Assurance
R		
	RA	Returned Air
	RAMS	Reliability, Availability, Maintainability and Safety
	RAP	Resettlement Action Plan
	RBO	Regional Branch Offices
	RC	Reinforced Concrete
	RCS	Radio Central Control System
	Rd.	Road
	RF	Radio Frequency
	Rf	Rectifier equipment
	RH	Relative Humidity
	RI	Relay Interlocking
	Rij	Railway Length
	RL	Rail Level
	ROE	Return On Equity
	ROI	Return On Investment
	ROW	Right Of Way
	RP	Revealed Preference
	RPS	Revealed Preference Survey

RPF	Resettlement Policy Framework
RS	Rectifier Station
RS	Rolling Stock
RT	Refrigeration Tons
RTU	Remote Terminal Unit
RTRI	Railway Technical Research Institute, Japan
R/W	Read and Write

S

SA	Supply Air
SAM	Security Access Module
SCA	Supreme Council of Antiquities
SCADA	Supervisory Control and Data Acquisition
SCU	Station Control Unit
SDH	Synchronous Digital Hierarchy
SDMP	The Strategic Urban Development Master Plan Study for a sustainable Development of the Greater Cairo Region in the Arab Republic of Egypt
Sec.	Section
sec.	second
SEVP	Signal Polyethylene Vinyl Cable
SF	Stored Fare (Ticket)
SHF	Super High Frequency (centimeter wave)
SI	Systeme Internationale d'Unites (SI Unit)
SI	Sensitive Indicator
SIFE	Students in Free Enterprise
SL	Screen Line
SM	Single Mode
SO_2	Sulfur Dioxide
SOFRETU	Société Française d'études et de réalisations de transports urbains
SP	Stated Preference
SPAD	Signal Passing At Danger
SPF	Shadow Pricing Factor
SPS	Stated Preference Survey
SPT	Standard Penetration Test
SQEE	Signal Quad Polyethylene Cable
sq.m.	square meter

	SSOP	Station Staff operation Panel
	STA / Sta.	Station
	STRASYA	Standard Urban Railway System for Asia
	STEP	Special Terms for Economic Partnership
	SV	Switching Value
	S/W	Scope of Work
	SWWT	Spine Waste Water Tunnel
T		
	TAC	Track Access Charge
	TAZ	Traffic Analysis Zone
	TBM	Tunnel Boring Machine
	TD	Train Detection
	TD	Tender Document
	TDM	Time Division Multiplex
	TDMA	Time Division Multiple Access
	TEF	Tunnel Exhaust Fans
	TETRA	Terrestrial Trunked Radio
	TIS	Ticket Initialization Unit
	TOM	Ticket Office Machine
	TOR	Terms Of Reference
	TR	Ticket Reader
	TV	Television
	TVF	Tunnel Ventilation Fans
	TVM	Ticket Vending Machine
U		
	UNDP	United Nations Development Programme
	UIC	Union International des Chemins de fer (International Union of Railways)
	UPS	Uninterruptible Power Supply
	USRT	United States Refrigeration Tons
V		
	V	Volt
	VAT	Value Added Tax
	VHF	Very High Frequency
	VOC	Vehicle Operating Cost
	VOT	Value Of Travel Time
	VVVF	Valuable Voltage Valuable Frequency

W

W	Watt
WB	World Bank
WB	Wet Bulb
W/D	Workshop/Depot
W/S	Work Station
WS	Wayside Signal
WAN	Wide Area Network
WWW	World Wide Web
WYSIWYG	What You See Is What You Get

UNITS OF MEASURE

A	Ampere
Amp	Ampere
BTU	British Thermal Unit
dB	Decibel
dBA	Decibel on the 'A' weighted scale
FC	Foot-candles
g	Acceleration due to Gravity (32.2 ft/s2 =9.81 m/s2)
H	Hour
Hz	Hertz
In	Inch
J	Joule
ha	Hectare
kg	Kilogram
kHz	Kilohertz
km	Kilometer
km^2	Square Kilometer
km/h	Kilometer per hour
kWh	Kilowatt hour
kV	Kilovolt
l	Liter
L.E.	Egyptian Pound
m	Meter
m^2	Square Meter
mg/l	Milligram per Litter
MHz	Mega Hertz
min	Minute
mm	Millimeter
MW	Megawatt
MVA	Mega Volt Ampere
mV	Millivolt
ìV	Microvolt
N	Newton
NYU	Nephelometric Turbidity Unit
ppm	parts per million
RT	Refrigeration Tons

sec	Second
ug/m^3	Microgram per cubic meter
USRT	United States Refrigeration Tons
V	Volt
Vac	Volt alternating current
Vdc	Volt direct current
wt	weight
$^\circ$ C	Degree Celsius
$^\circ$ F	Degree Fahrenheit

EXECUTIVE SUMMARY OF VOLUME 1

EXECUTIVE SUMMARY OF VOLUME 1

1. Introduction

1.1 Background and Purpose of the Study

The Greater Cairo Region is the premier city in Egypt. It is rich in history and boasts of a large number of historical structures. It is the largest city in the African Continent and the Middle Eastern Region with a population of over 18 million, representing 25% of the total population of Egypt.

As the population of the Greater Cairo Region is envisaged to increase to 20 million by the year 2017 according to the SDMP Report, the Government of Egypt (GOE) is reforming the urban structure, changing from a mono-centric form to a decentralized form, notably through the development of New Urban Communities (NUCs), such as the 10th of Ramadan City and 6th October City. However, the increasing transport demand has not been accompanied by a substantial solution to urban problems such as road traffic congestion, insufficient public transportation services and air pollution.

At present two metro lines are in service and one metro line is under construction. As a long-term strategic development plan, the General Organization for Physical Planning (GOPP) has prepared “the Cairo Vision 2050”. This vision document proposes 15 metro routes as the main public transport system in the Greater Cairo Region.

Under this circumstance, GOE has decided to construct, as early as practicable, the Metro Line 4, and requested the Government of Japan (GOJ) to implement the “Development Study on Greater Cairo Metro Line No.4 Project in October 2008, by the Government of the Arab Republic of Egypt”. The Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of GOJ’s programs, has had discussions with the National Authority for Tunnels (NAT) of the Ministry of Transport and has agreed to conduct a feasibility study for the proposed Metro Line 4. The document for the Scope of Work was signed on 21st December 2008.

1.2 Implementation of the Study

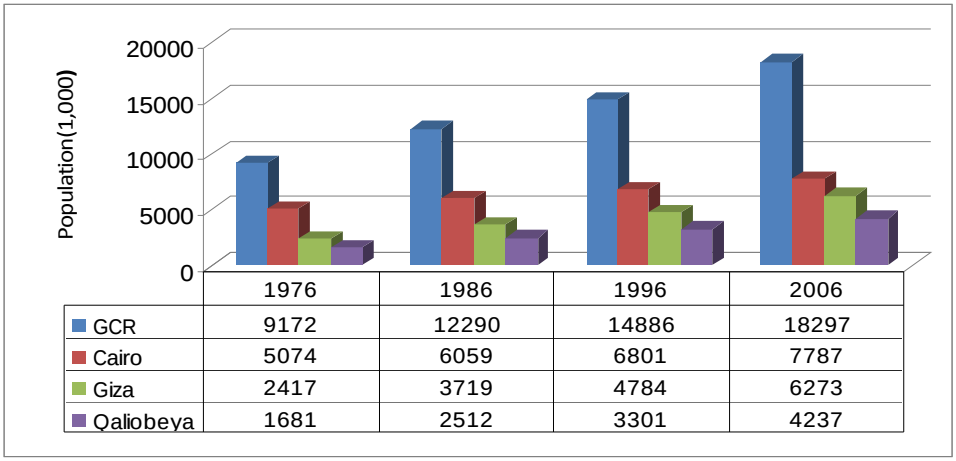
The JICA Preparatory Survey on the Greater Cairo Metro Line No.4 was undertaken in March 2009, based on the Scope of Work agreed among the NAT, the Ministry of Transport, and the JICA. The study was carried out by the JICA Study Team (JST), which is the consultant team hired by JICA for the implementation of this study. The JICA Preparatory Survey consists of the following two major studies.

- New Transportation Study on Greater Cairo Metro Line No.4, including selection of the routes for Phase 1 and Phase 2, considering future transport demand up until the year 2050.
- A complete Feasibility Study for the combined Phase 1 and Phase 2 selected route, including Preliminary Design for Phase 1, considering future transport demand up until the year 2050.

2. Collection of Data to Support Transport Demand Forecast

2.1 Population

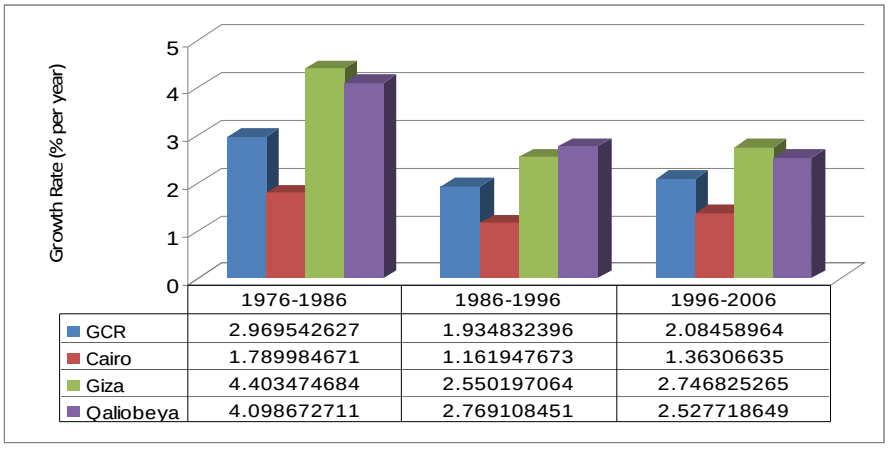
The total population of the three Cairo region governorates amounted to 18 million based on the last official census taken in 2006 (Figure 1). The growth rate was 2.08% per year in 1996-2006 (Figure 2).



	1976	1986	1996	2006
GCR	9172	12290	14886	18297
Cairo	5074	6059	6801	7787
Giza	2417	3719	4784	6273
Qaliobeya	1681	2512	3301	4237

Source: Census, CAPMAS, 2006

Figure 1 Population of Cairo, Giza, and Qaliobeya in 1976-2006



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Source: Census, CAPMAS, 2006

Figure 2 Population Growth Rate of Cairo, Giza, and Qaliobeya in 1976-2006

The estimated population of the three Cairo region governorates totalled almost 19 million as of 1st January 2008 (CAPMAS Statistical Year Book 2008), a one million increase from 2006. The populations of the Cairo, Giza and Qaliobeya governorates were estimated at 8,052,228, 6,422,982 and 4,342,678, respectively.

2.2 Employment

The growth of employment in the study area is one of the factors that has a strong influence on the growth in demand for the proposed Metro Line 4. Forecasts of employment

in the study area for Metro Line 4 were generated by the Strategic Urban Development Master Plan Study for a sustainable Development of the Greater Cairo Region in the Arab Republic of Egypt (SDMP) study for the period from 2006 to 2027.

The SDMP forecast were extended to reflect the projected growth over the longer planning timeframe adopted for the feasibility study, i.e., 2010-2050, as shown in Table 1 below.

Table 1 Feasibility Study Employment Forecast for the Study Area

Year	Labour force		Unemployment rate	No. workers	
	(1,000 persons)	Annual growth rate		(1,000 persons)	Annual growth rate
2006	4,613		7%	4,310	
2007	4,777	3.56%	6%	4,475	3.83%
2008	4,915	2.88%	6%	4,638	3.64%
2009	5,056	2.88%	6%	4,772	2.88%
2010	5,202	2.88%	6%	4,909	2.88%
2011	5,352	2.88%	6%	5,050	2.88%
2012	5,506	2.88%	6%	5,196	2.88%
2020	6,858	2.78%	5%	6,515	2.87%
2030	8,427	2.08%	5%	8,006	2.08%
2040	10,005	1.73%	4%	9,605	1.84%
2050	11,475	1.38%	4%	11,016	1.38%

Sources: SDMP study report; JICA Study Team estimates

2.3 Education

Education is also a strong indicator of the level of demand for a mass transit project. Thus, the growth in student enrolments in the study area will be a determinant of the growth in demand for Metro Line 4. Forecasts of student enrolments in the Metro Line 4 study area were generated by the SDMP study for the 2006 - 2027 period.

The SDMP forecasts were extended to reflect the projected growth over the longer planning timeframe adopted for the feasibility study, i.e., 2010-2050, as shown in Table 2 below.

Table 2 Feasibility Study Student Enrolments Forecast for the Study Area

Year	Primary students enrolled		Preparatory students enrolled		Secondary students enrolled		University students enrolled		Total students enrolled	
	(1,000 students)	Annual growth rate	(1,000 students)	Annual growth rate	(1,000 students)	Annual growth rate	(1,000 students)	Annual growth rate	(1,000 students)	Annual growth rate
2006	1,827		479		593		504		3,403	
2007	1,828	0.05%	501	4.59%	612	3.20%	519	2.98%	3,460	1.67%
2008	1,854	1.44%	532	6.14%	630	2.99%	528	1.71%	3,544	2.43%
2009	1,881	1.44%	564	6.14%	649	2.99%	537	1.71%	3,631	2.46%
2010	1,908	1.44%	599	6.14%	668	2.99%	546	1.71%	3,722	2.49%
2011	1,935	1.44%	636	6.14%	688	2.99%	555	1.71%	3,815	2.51%
2012	1,963	1.44%	675	6.14%	709	2.99%	565	1.71%	3,912	2.49%
2020	2,145	1.12%	971	4.64%	914	5.21%	646	2.72%	4,676	2.25%
2030	2,412	1.18%	1,467	4.22%	1,334	3.85%	877	3.10%	6,090	2.68%
2040	2,678	1.05%	2,127	3.78%	1,920	3.71%	1,147	2.72%	7,871	2.60%
2050	2,958	1.00%	2,959	3.36%	2,730	3.58%	1,445	2.34%	10,092	2.52%

Source: SDMP study report; JICA Study Team estimates

2.4 Gross Regional Domestic Product (GRDP)

The growth of the gross regional domestic product (GRDP) is one of the key determinants of transport demand in the study area. Thus, estimates of GRDP and GRDP per capita over the forecast period from 2010 to 2050 were necessary to support the forecast of transport demand in this area.

GRDP estimates for the feasibility study are as shown in Table 3.

Table 3 Final Feasibility Study Estimates of GRDP and GRDP per Capita Growth in the Study Area Relevant to Cairo Metro Line 4

Year	GRDP		Population		GRDP per capita	
	L.E. mill.	Av Annual Rate of Growth	000 persons	Av Annual Rate of Growth	L.E.	Av Annual Rate of Growth
2004	133,190	**4.1%**	15,415		8,640	
2005	139,184	**4.5%**	15,754	2.20%	8,835	2.3%
2006	148,648	**6.8%**	16,101	2.20%	9,232	4.5%
2007	159,202	**7.1%**	16,464	2.25%	9,670	4.7%
2008	170,665	**7.2%**	16,836	2.26%	10,137	4.8%
2009	176,808	**3.6%**	17,217	2.26%	10,270	1.3%
2010	182,113	**3.0%**	17,606	2.26%	10,344	0.7%
2011	188,942	**3.8%**	18,004	2.26%	10,495	1.5%
2012	197,444	**4.5%**	18,411	2.26%	10,724	2.2%
2020	352,138	**7.5%**	21,639	2.04%	16,273	5.4%
2030	692,708	**7.0%**	25,387	1.61%	27,286	5.3%
2040	1,240,534	**6.0%**	28,801	1.27%	43,072	4.7%
2050	2,020,700	**5.0%**	31,815	1.00%	63,515	4.0%

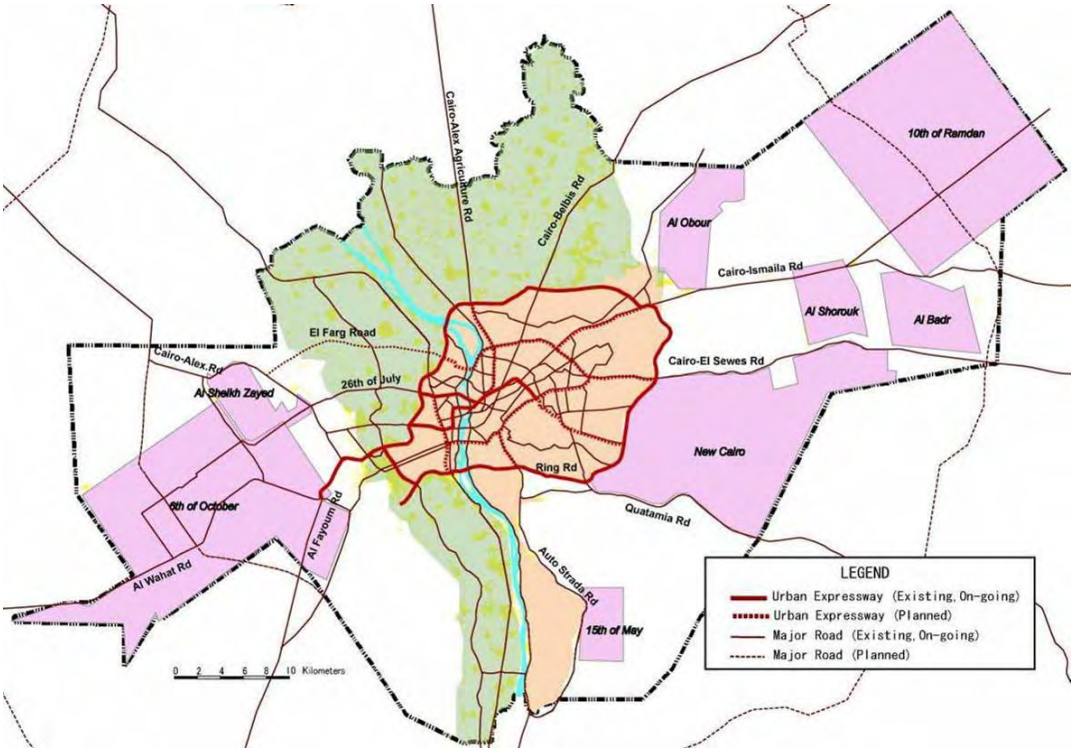
Sources:
1. UNDP and Institute of National Planning, Egypt: *Egypt Human Development Report* 2005
2. CAPMAS Mid-year Population Estimates, *Egypt Statistical Yearbook 2008*
3. International Monetary Fund: *World Economic Outlook,* April 2009
4. Strategic Urban Development Master Plan for Cairo, Volume 2 Final Report 2008
5. Consultant's estimates

Notes:
1. Population figure for 2006 derived from 2006 Population Census conducted by CAPMAS
2. Population growth rate for 2004-2006 derived from CAPMAS data for 1996 and 2006
3. Population growth rates for 2007-2030 derived from SDMP study
4. Population growth rates for 2030-2050 are consultant's estimates

3. Existing and Planned Urban Transport Network

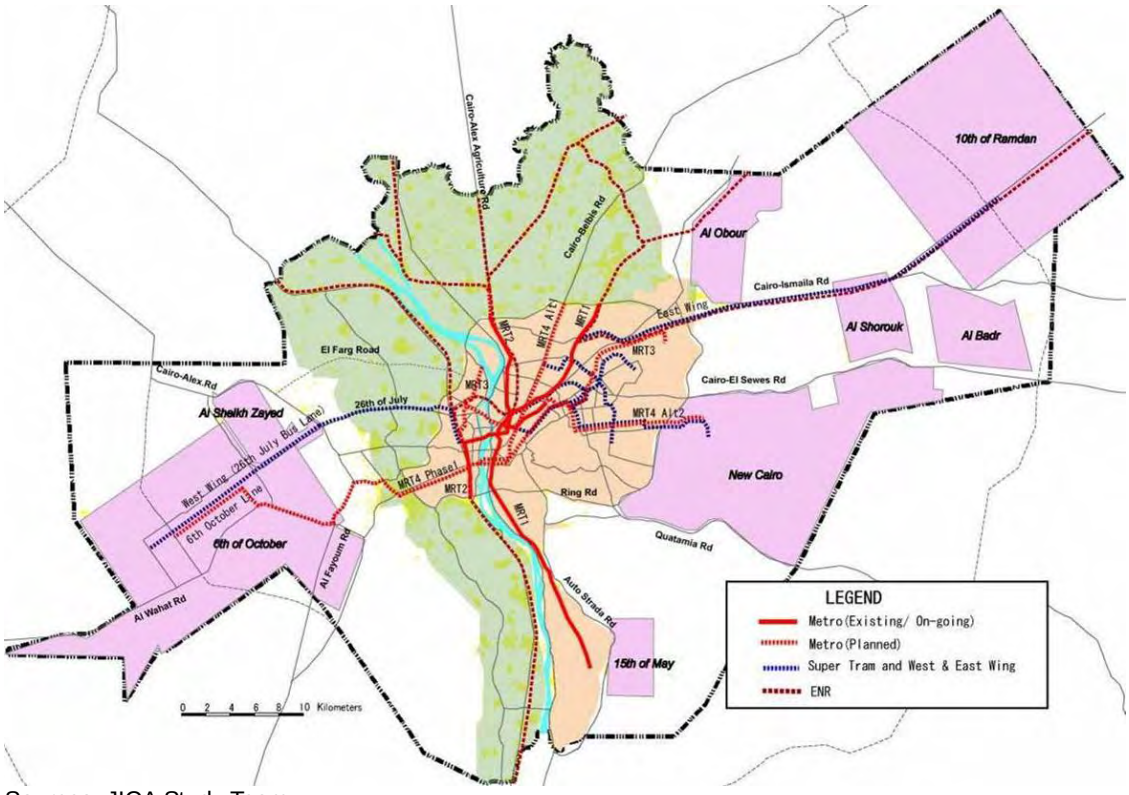
For the purpose of this feasibility study, it is necessary to describe the existing and planned urban transport network of Greater Cairo (comprising all surface and underground infrastructure) and to identify the approach and required data in order to forecast the transport demand within the future network.

Figure 3 shows the main elements of the planned urban road network superimposed on the existing network of Greater Cairo. Similarly, Figure 4 shows the existing and planned public transport networks of Greater Cairo.



Sources: JICA Study Team

Figure 3 Existing and planned road network of Greater Cairo

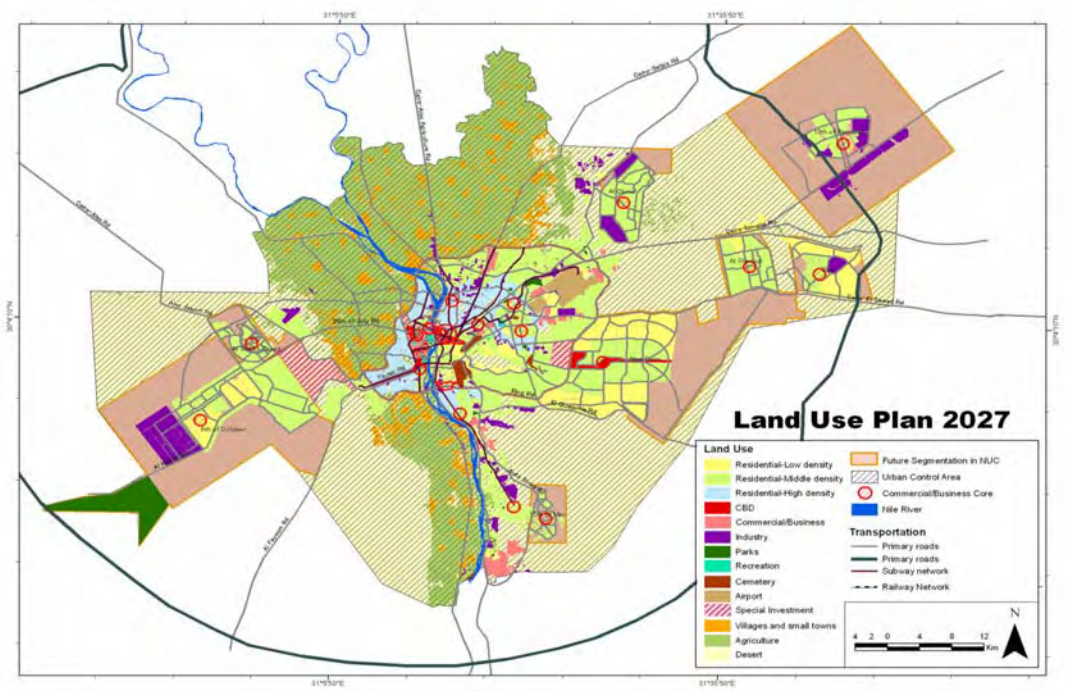


Sources: JICA Study Team

Figure 4 Existing and planned public transportation network of Greater Cairo

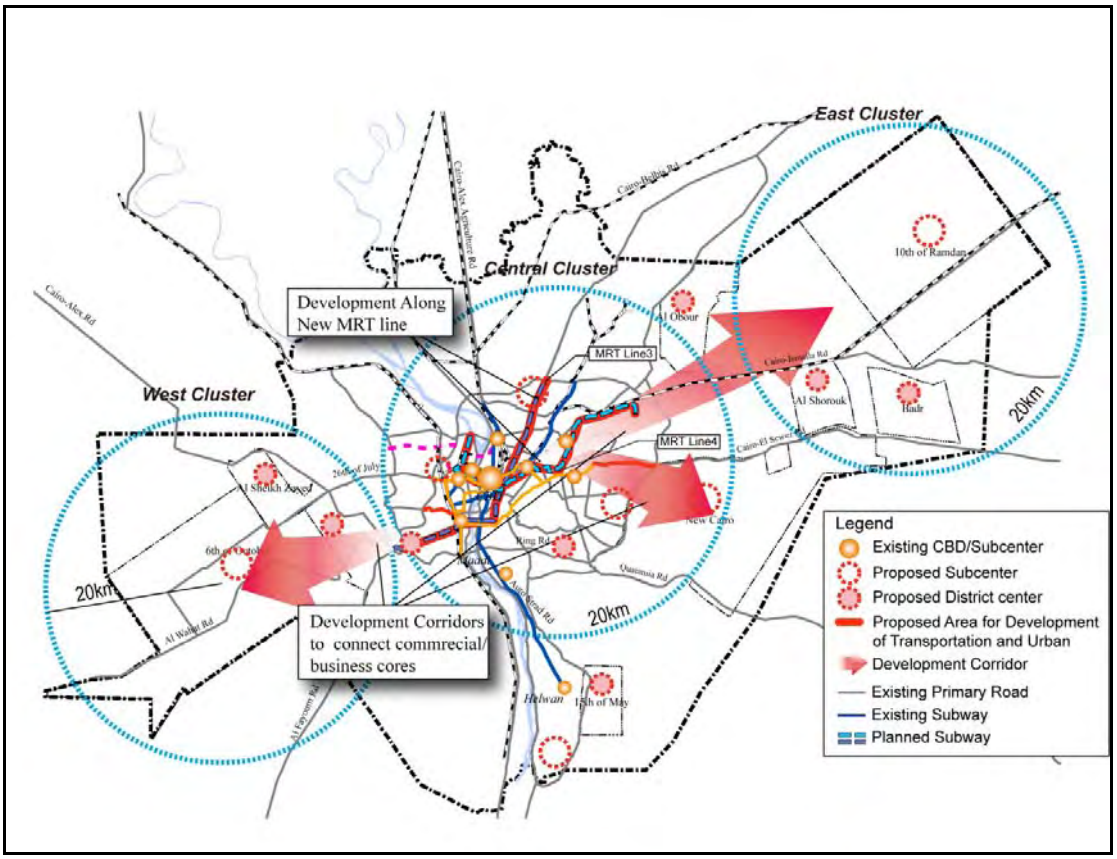
4. Urban Development Plan

Figure 5 shows the land use plan for the target year 2027, as formulated in the SDMP study report. The improvement of the transportation system will need to be coordinated with urban development. Figure 6 shows the future transport-oriented urban development. Among the urban corridors, there are three corridors that will be highly prioritized to achieve improvement of transportation system in the study area.



Source: SDMP

Figure 5 Land Use Plan 2027



Source: SDMP

Figure 6 Development Corridor

5. Preliminary Forecast of Demand for Metro Network

Based on the Cairo Regional Area Transportation Study (CREATS) by JICA and SDMP studies, the future metro demand in 2027 is summarised in Table 4 below. In terms of the future network alternatives for the Metro Line 4 Phase 2 sections, Alternative 1 involves the northward extension up to the Ring Road while Alternative 2 consists of the eastward extension up to New Cairo NUCs (New Urban Communities).

Table 4 Future Demand for Metro Network in 2027

MRT4 Alt1 (North Extension)

		Total Pax	Transfer from/to MRT Other lines	Station Boarding and Alighting	Max Section Pax / hrs/dir
					14.0%
Number of Pax	MRT All	4,126,269	0	4,126,269	
	MRT1	1,756,906	684,727	1,072,180	51,429
	MRT2	1,259,660	570,030	689,631	32,382
	MRT3	1,500,941	565,773	935,169	55,296
	MRT4 phase1	953,837	602,297	351,541	36,840
	MRT4 Phase2 Alt1	1,026,161	594,054	432,107	45,095
	MRT4 Phase2 Alt2	0	0	0	0
	26 July Busway	381,143	56,222	324,922	13,237
	6 Octber Line	488,697	167,976	320,722	24,209

MRT4 Alt2 (East Extension)

		Total Pax	Transfer from/to MRT Other lines	Station Boarding and Alighting	Max Section Pax / hrs/dir
					14.0%
Number of Pax	MRT All	4,674,984	0	4,674,984	
	MRT1	1,994,526	581,946	1,412,581	64,357
	MRT2	1,445,163	652,874	792,289	37,711
	MRT3	1,587,077	706,452	880,625	51,045
	MRT4 phase1	1,169,538	813,399	356,140	37,647
	MRT4 Phase2 Alt1	0	0	0	0
	MRT4 Phase2 Alt2	1,038,585	457,022	581,564	41,849
	26 July Busway	385,018	53,083	331,936	13,421
	6 Octber Line	489,138	169,287	319,851	24,359

Sources: JICA Study Team

6. Collection of Data

6.1 Existing Infrastructures

JICA Study Team has collected relevant existing data related to the study as follows;

- Wastewater Tunnel under the Port Said Street with branch sewage tunnels
- Other sewage tunnels
- Public utilities data along the proposed route
- Al Azhar Road Tunnel

JICA Study Team will continue to collect Information on other potential conflicting infrastructures (hard points), such as Gamrah Bridge, Al Azhar Bridge, El Haram & El Malek El Saleh Subways, etc. in the further study period.

6.2 Socio-Economic

JICA Study Team has collected and study the following legislation applies for EIA and land acquisition & resettlement in Egypt.

Table 5 List of Relevant Legislations

	Name	Description
1	Egyptian Constitution	
2	Law No. 31/1976	Public cleanliness (control of solid waste management, amends Law No. 38 of 1967)
3	Law No. 27/1978	Public water sources
4	Law No. 137/1981	Labour (control of work place safety and environment)
5	Law No. 48/1982	Protection of Nile and its waterways
6	Law No. 102/1983	Natural protection
7	Law No. 117/1983	Cultural heritage
8	Law No. 4/1994	Protection of environment
9	Law No. 12/2003	Labour
10	Law No. 9/2009	Amendment of some parts of Law No. 4/1994

Source: JICA Study Team

Table 6 List of Relevant Legislations

	Name	Description
1	Egyptian Constitution	
2	Law No. 10/1990	Regulation and procedure for expropriation of real estate in the public interest
3	Law No. 4/1994	Regulation for environmental management and mandate of EEAA
4	Law No. 12/2003	Labour Law
5	Law No. 94/2003	Establishing the National Council for Human Rights

Source: JICA Study Team

6.3 Archaeological

The final objective for this section of the feasibility study is to propose a “Risk Assessment” for buried archaeological property within the vicinity of the Metro Line 4 route alignment. In this stage, JICA Study Team has carried out the investigation and collection of information/data necessary for the analysis of archaeological assets.

6.4 Economic and Financial Analysis

JICA Study Team has collected and estimated the necessary information for economic and financial analysis as follows;

- List of road projects in 2007
- List of other transportation projects for Greater Cairo
- The physical characteristics of vehicle population
- Estimation of petroleum fuel subsidies
- Estimation of vehicle operating costs
- Travel time information and data
- Estimation of air pollution damage costs
- Number of passengers and revenue for Cairo Metro
- Project financing terms and conditions

6.5 Other Data

JICA Study Team has collected information and data related to the existing metro system and design specification and criteria.

CHAPTER 1
INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The Greater Cairo Region, which is rich in history and contains large numbers of historical structures, is the premier city in Egypt. It is the largest city in the African continent and the Middle East region with a population of over 18 million, representing 25% of the total population of Egypt. The Cairo Metro, the only specialized metro system operating in the African continent, commenced construction in 1981. Its design was based on “Plans for Construction of Cairo Metro 3 Lines”, developed by Société Française d’études et de réalisations de transports urbains (SOFRETU) in 1973 to improve road traffic congestion.

The current status of Cairo Metro is as follows:

Metro Line 1	Phase 1 (28 km) started operation in 1987. The whole line (44 km) is in full service by 1989.
Metro Line 2	Phase 1 (8 km) started operation in 1996. The whole line (21.6 km) is in full service by 2005.
Metro Line 3	Phase 1 (4.3 km) under construction, scheduled to start operation in 2011. The whole line is 34.2 km.

Metro Line 3 was proposed in the “New Public Transportation Study of the Great Cairo Area” conducted by SYSTRA in 1998-2000 and in the “Cairo Regional Area Transportation Study” (CREATS) conducted under a JICA Study in 2000-2002.

As the population of the Greater Cairo Region is envisaged to increase to 20 million by the year 2017 according to the SDMP report, the Government of Egypt (GOE) is reforming the urban structure, changing from a mono-centric to a decentralized form, notably through the development of New Urban Communities (NUCs), such as 10th of Ramadan City and 6th October City. However, the increased transport demand has not been accompanied by a substantial solution to urban problems such as road traffic congestion, insufficient public transportation services and air pollution.

As a long term strategic development plan, General Organization for Physical Planning (GOPP) has prepared the Cairo Vision 2050. This vision document proposes 15 metro routes as the main public transport system in the Greater Cairo Region.

As a consequence, GOE has decided to construct, as early as practicable, Metro Line 4 as initially proposed by CREATS, and requested the Government of Japan (GOJ) in October 2008 to implement the “Development Study on Greater Cairo Metro Line No.4 Project (Metro Line 4 Project)”. Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of GOJ’s program, has discussed with National Authority for Tunnels (NAT) of Ministry of Transport and has agreed to conduct a feasibility study for the Greater Cairo Metro Line No.4 (Metro Line 4). The document for the Scope of Work was signed on 21st December 2008.

1.2 Objective of the Study

The primary objective is to conduct a feasibility study for Greater Cairo Metro Line 4, from a depot/workshop to El Sawaha square directing the Ring Road (Exit No. 18) or Nasr City via Grand Egyptian Museum (GEM), El Giza Station of Metro Line 2 and El Malek El Saleh Station of Metro Line 1. This feasibility study will adopt suitable approaches for the mitigation of urban transport congestion and contribute to the sustainable development of the Greater Cairo Region. The following four key objectives will form the foundation of the study:

- To formulate a proposed route for Metro Line 4
- To assess the justification of the project
- To appropriately plan the project considering its technical, economical and financial, environmental and social aspects
- To carry out technology transfer to the Egyptian counterpart personnel in the course of the study

The feasibility study entitled “JICA Preparatory Survey on Greater Cairo Metro Line No. 4 in the Arab Republic of Egypt” consists of four reports. The main tasks and activities to be covered in these reports are as follows:

a) Report No. 1

- Data collection, diagnosis of the existing public transport system and urban development hypothesis;
- Collection of the relevant data about the existing and foreseen public utilities;
- Collection of the relevant socio-economic data; and
- Collection of the relevant data for preliminary design.

b) Report No. 2

- Analysis of all data collected for generation of Origin and Destination (O/D) matrices and development of a transportation study of the Greater Cairo Metro Line 4;
- Recording of all data concerning vehicles and all transport modes, conduct of field traffic survey in the study area, and review of the demand forecast; and
- Comparison and evaluation of two alternative corridors regarding Metro Line 4 alignment.

c) Report No. 3

- Preparation of design guidelines and criteria and general features of Metro Line 4 Phase 1.
- Preparation of the general design specifications of Metro Line 4.

d) Report No. 4

- Submission of the final results and the pertinent analysis showing the feasibility

of the implementation of the whole project from both economic and financial perspectives.

1.3 Study Area and Administrative Setting

The Study Area, shown in Figure 1-1, covers two phases, namely, (a) Phase 1 of the proposed Metro Line 4 that runs from a depot/workshop via GEM to El Malek El Saleh Station (with a length of about 21 km) and (b) Phase 2 which is a route between El Malek El Saleh via El Sawaha Square and the Ring Road (Exit No. 18) (with a length of about 18 km). In addition, an alternative Phase 2 route, starting from El Malek El Saleh to Nasr City (with a length of about 23 km), will be evaluated and compared with the originally proposed route.

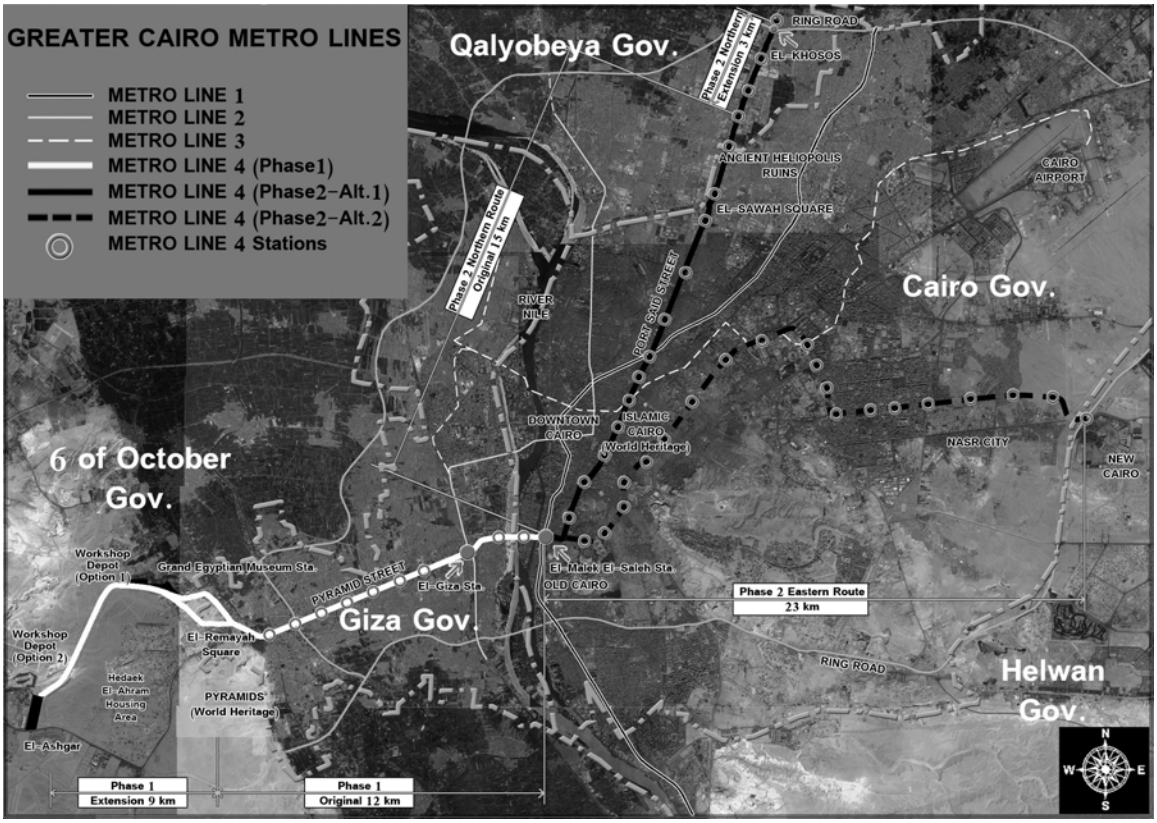


Figure 1-1 Study Area

CHAPTER 2
DATA COLLECTION, DIAGNOSIS OF EXISTING PUBLIC TRANSPORT SYSTEM AND URBAN DEVELOPMENT HYPOTHESIS

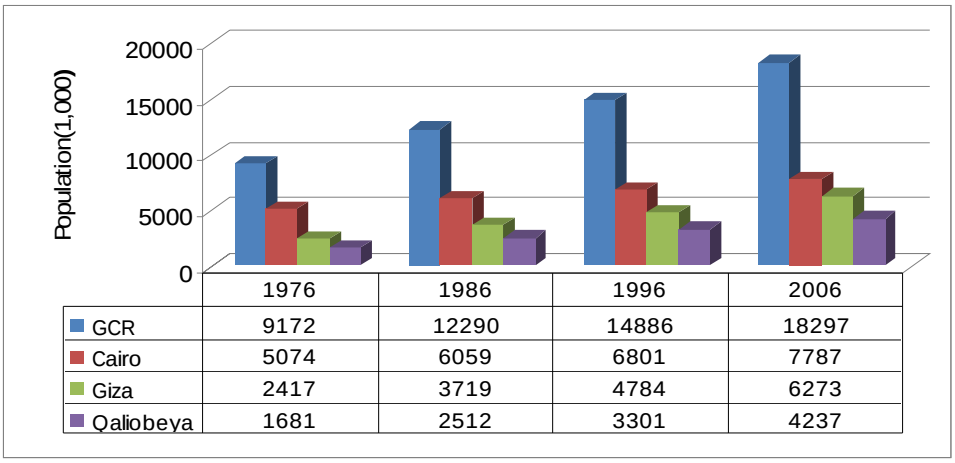
CHAPTER 2 DATA COLLECTION, DIAGNOSIS OF THE EXISTING PUBLIC TRANSPORT SYSTEM AND URBAN DEVELOPMENT HYPOTHESIS

2.1 Collection of Data to Support Transport Demand Forecast

2.1.1 Population

(1) Population in Three Governorates

The total population of the three Cairo region governorates amounted to 18 million based on the last official census taken in 2006 (Figure 2-1). The growth rate was 2.08% per year in 1996-2006 (Figure 2-2).



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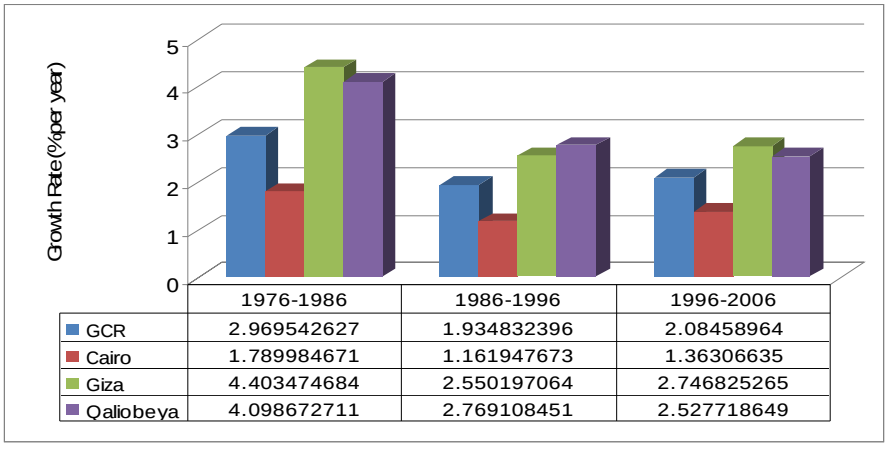
Source: Census, CAPMAS, 2006

Figure 2-1 Population of Cairo, Giza, and Qaliobeya in 1976-2006



	1976-1986	1986-1996	1996-2006
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Giza	4.403474684	2.550197064	2.746825265
Qaliobeya	4.098672711	2.769108451	2.527718649

Source: Census, CAPMAS, 2006

Figure 2-2 Population Growth Rate of Cairo, Giza, and Qaliobeya in 1976-2006

The estimated population of the three Cairo region governorates totalled almost 19 million

as of 1st January 2008 (CAPMAS Statistical Year Book 2008), a one million increase from 2006. The populations of the Cairo, Giza and Qaliobeya governorates were estimated at 8,052,228, 6,422,982 and 4,342,678, respectively.

A change in the governorate boundaries since 2008 affected the composition of the study area. However, no new official statistics are yet available for the new governorates. In any case, data based on the old governorate boundaries are still accurate and relevant for the study area.

(2) Population in the Study Area

According to the Strategic Urban Development Master Plan (SDMP) study report, the existing population in the study area was about 13 million in 1996 and had increased to 16 million by 2006 (Table 2-1). The annual growth rate was 2.22% per year, which is higher than that of the three Cairo region governorates. Higher population growth took place in the study area due partly to the attraction of people to the NUCs.

Table 2-1 Existing Population in the Study Area in 1996-2006

Governorate	Population (1,000)		Growth Rate (% per year)
	1996	2006	1996-2006
Cairo	6,801	7,787	1.36
(% within S.A.)	(100.0)	(100.0)	
Giza	3,876	5,131	2.85
(% within S.A.)	(81.0)	(81.8)	
Qaliobeya	2,207	3,059	3.32
(% within S.A.)	(66.9)	(72.2)	
Sub-total	12,884	15,977	2.18
(% within S.A.)	(86.5)	(87.3)	
10th of Ramadan	48	124	10.00
Total	13,045	16,101	2.22

Source: Census, CAPMAS, 2006

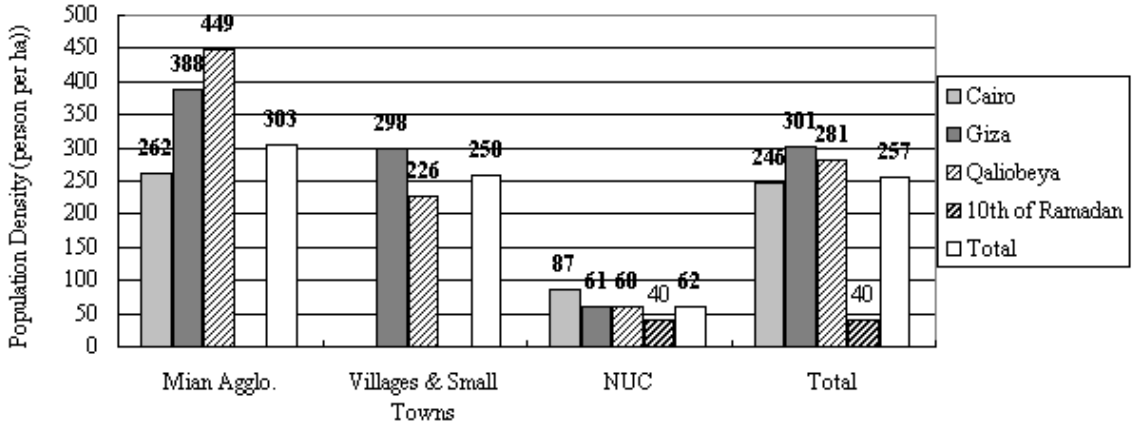
Within the study area, the NUCs recorded the highest growth rate in 1996-2006 at more than 10% per year (Table 2-2). Villages and small towns followed with a growth rate of 2.0% per year while the main agglomeration experienced a relatively low rate of 1.7% per year. Incremental population has shifted from the main agglomeration to NUCs, villages and small towns.

Table 2-2 Population Distribution by Built-up Area in the Study Area in 1996 and 2006

Governorate	Population (1,000 persons)						Growth Rate in 1996-2006 (% per year)		
	Main Agglomeration		Villages & Small (V&S) Towns		NUCs		Main Agglo-meration	V&S	NUCs
	1996	2006	1996	2006	1996	2006			
Cairo	6,678	7,540	0	0	123	246	1.2	-	7.2
Giza	2,531	3,237	1,301	1,559	47	187	2.5	1.8	14.8
Qaliobeya	1,145	1,455	1,255	1,560	1	44	2.4	2.2	46.0
10th of Ramadan	0	0	0	0	48	124	-	-	10.0
Total	10,355	12,232	2,556	3,119	218	601	1.7	2.0	10.7

Source: Census, CAPMAS, 2006

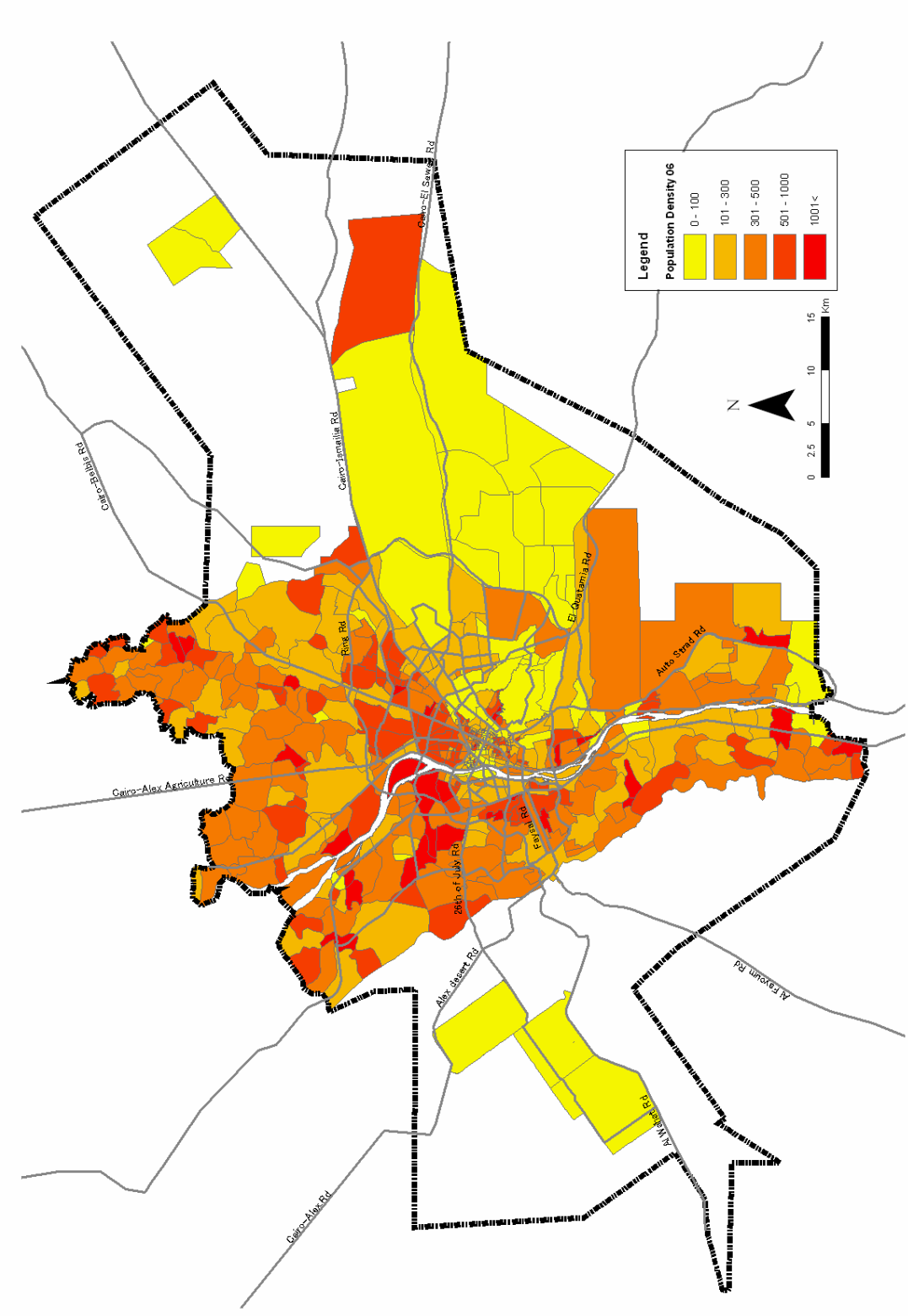
The population density in existing built-up areas within the study area was estimated at 257 persons per ha in 2006 (see Figure 2-3). The main agglomeration had an even higher density of more than 300 persons per ha, and villages and small towns followed with 258 persons per ha. In particular, the main agglomeration in Qaliobeya had an extremely high density of 449 persons per ha. NUCs had the lowest density at 62 persons per ha.



Source: Census, CAPMAS, 2006

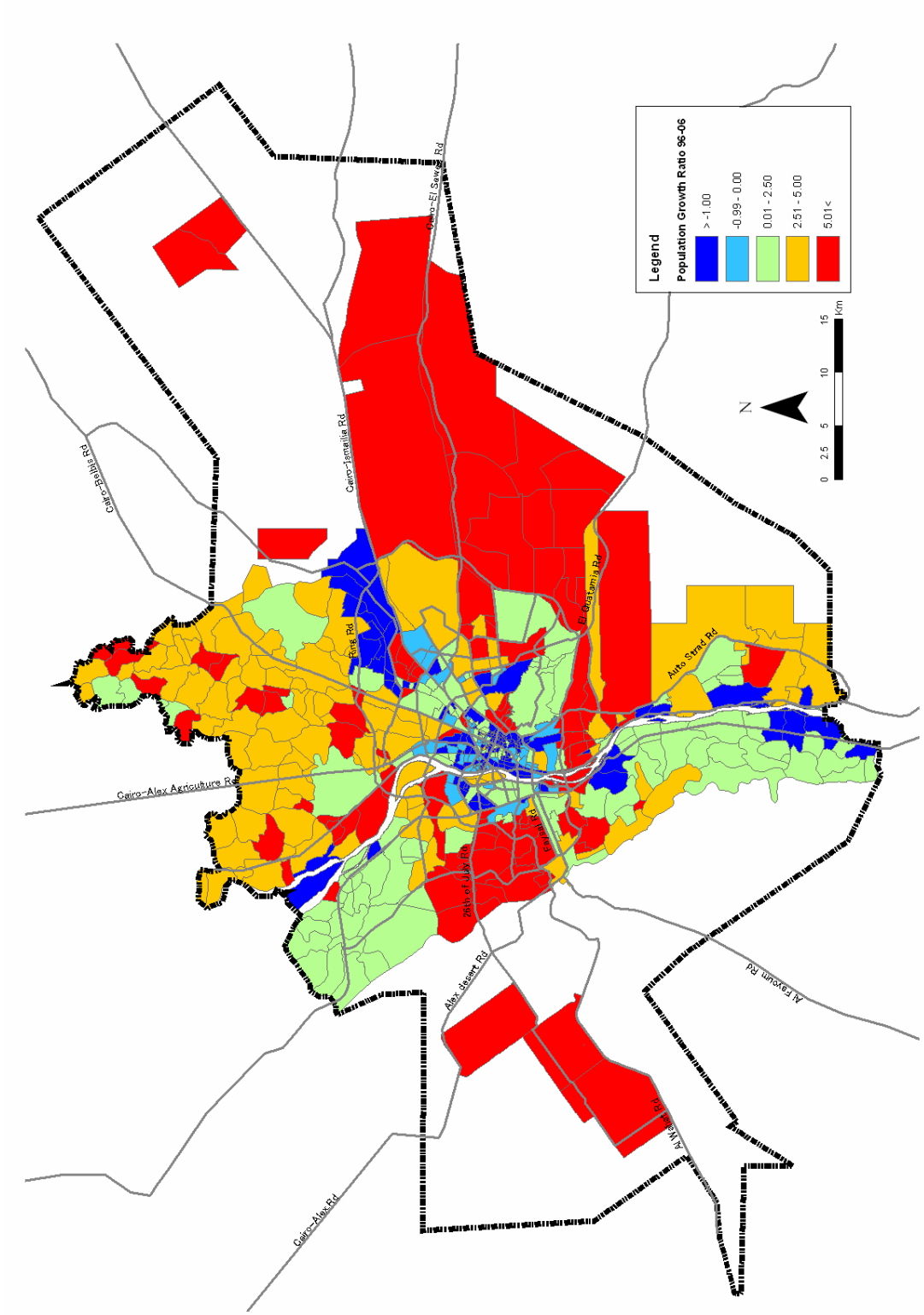
Figure 2-3 Population Density by Built-up Area in the Study Area in 2006

The population distribution by *shiakha*, which is the smallest administrative sub-division in urban areas, in 2006 is shown in Figure 2-4. Shiakhas in the main agglomeration recorded negative growth rates in 1996-2006. Meanwhile, relatively high population growth rates were observed in shiakhas outside the main agglomeration (Figure 2-5).



Source: Census, CAPMAS, 2006

Figure 2-4 Population Distribution by Shiakha in the Study Area in 2006



Source: Census, CAPMAS, 2006

Figure 2-5 Population Growth Rate by Shiakha in the Study Area in 1996-2006

Figure 2-6 shows the population density of existing built-up areas by shiakha in 2006.

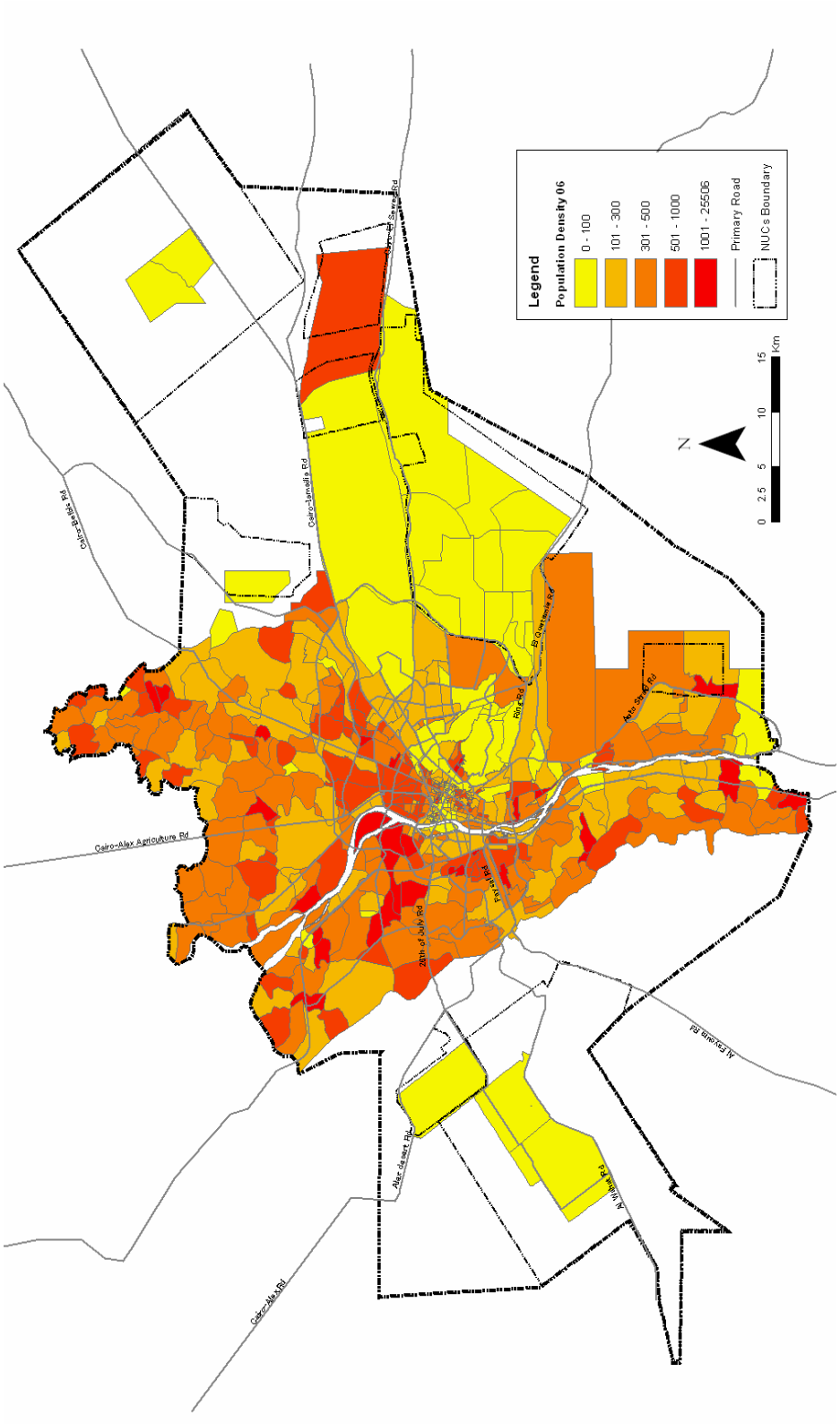
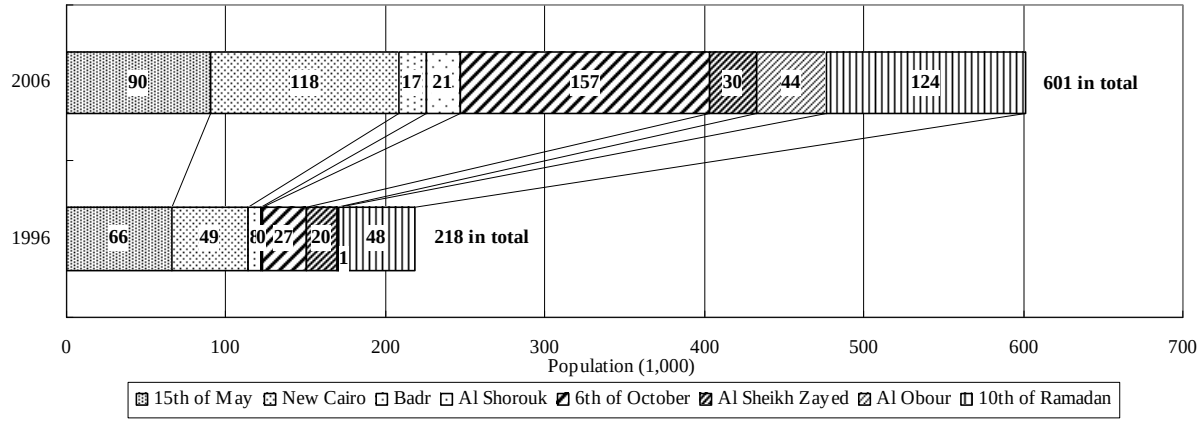


Figure 2-6 Population Density by Shiakha in the Study Area in 2006

Source: JICA study team

(3) Population in New Urban Communities (NUCs)

The existing population of NUCs was estimated at 0.6 million based on the latest census in 2006 (Figure 2-7). A high population growth rate contributed to boosting the incremental population in NUCs. The population growth for the NUCs during the 10 years between 1996 and 2006 was as high as 11%.



Source: Census, CAPMAS, 2006

Figure 2-7 Existing Population by NUC in 1996 and 2006

(4) Population Growth Forecast for Study Area

Forecasts of the population of the study area for Line 4 were generated by the SDMP study for the period from 2006 to 2027. These forecasts are given in Table 2-3 below.

Table 2-3 SDMP Population Growth Forecast for Study Area[1]

Year	Total Population (thousand persons)	Annual Growth Rate
2006	16,101	2.22%
2007	16,464	2.25%
2012	18,411	2.26%
2017	20,369	2.04%
2027	24,192	1.61%

Source: SDMP study report

[1] The study area on which the SDMP forecast was based comprises: the Cairo and Qaliobeya governorates; part of Giza governorate and 10th of Ramadan NUC.

The SDMP population forecast is based on population data from the 2006 census. The growth rate shown that year (2.22%) represents the average annual growth between the census years of 1996 and 2006. The growth rate of 2.25% assumed to apply in 2007 was based on population projections by the Cairo Demographic Centre in 2001, while growth rates for subsequent years were estimated by the consultants.

The re-basing of the feasibility study on the 2010-2050 period required that the population forecasts be extended over this period. For the 2006-2030 period, the assumed growth rates are identical to those assumed in the SDMP study report. For subsequent years, however, it was assumed that population growth would reduce to a rate of about 1% by

2050. The resulting population growth forecast for the study area up until 2050 is given in Table 2-4.

Table 2-4 Feasibility Study Population Forecast for Study Area

Year	Population	
	1000 persons	Av Annual Rate of Growth
2006	16,101	2.22%
2007	16,464	2.25%
2008	16,836	2.26%
2009	17,217	2.26%
2010	17,606	2.26%
2011	18,004	2.26%
2012	18,411	2.26%
2020	21,639	2.04%
2030	25,387	1.61%
2040	28,801	1.27%
2050	31,815	1.00%

Sources: SDMP study report; Consultant's estimates

Notes:
1. Population figure for 2006 from 2006 Population Census
2. Population growth rate for 2004-2006 from CAPMAS
3. Population growth rates for 2007-2030 derived from SDMP study
4. Population growth rates for 2030-2050 are consultant's estimates

2.1.2 Employment

The growth of employment in the study area is one of the factors that have a strong influence on the growth in demand for the proposed Metro Line 4. Thus, the collection of data relating to the growth of employment was one of the priority tasks for the first stage of the feasibility study.

Forecasts of employment in the study area for Metro Line 4 were generated by SDMP study for the period from 2006 to 2027. These forecasts are given in Table 2-5 below.

Table 2-5 SDMP Employment Growth Forecast for the Study Area

Year	Labour force		Unemployment rate	No. workers	
	(1,000 persons)	Annual growth rate		(1,000 persons)	Annual growth rate
2006	4,613		7%	4,310	
2007	4,777	3.56%	6%	4,475	3.83%
2012	5,506	2.88%	6%	5,196	3.03%
2017	6,316	2.78%	5%	5,982	2.86%
2027	7,761	2.08%	5%	7,378	2.12%

Source: SDMP study report

The SDMP employment forecast is based on labour force, employment and unemployment data from the 2006 census. The number of persons comprising the labour force and the unemployment rate in 2006 were derived from the census and these figures were projected

for succeeding years by the consultants. The growth in the labour force is expected to decline from 3.5% per year in 2007 to just over 2% by 2027, while the unemployment rate is expected to decline from 7% to 5% over the same period.

The SDMP forecasts were extended to reflect the projected growth over the longer planning timeframe adopted for the feasibility study, i.e., 2010-2050, as shown in Table 2-6 below.

Table 2-6 Feasibility Study Employment Forecast for the Study Area

Year	Labour force		Unemployment rate	No. workers	
	(1,000 persons)	Annual growth rate		(1,000 persons)	Annual growth rate
2006	4,613		7%	4,310	
2007	4,777	3.56%	6%	4,475	3.83%
2008	4,915	2.88%	6%	4,638	3.64%
2009	5,056	2.88%	6%	4,772	2.88%
2010	5,202	2.88%	6%	4,909	2.88%
2011	5,352	2.88%	6%	5,050	2.88%
2012	5,506	2.88%	6%	5,196	2.88%
2020	6,858	2.78%	5%	6,515	2.87%
2030	8,427	2.08%	5%	8,006	2.08%
2040	10,005	1.73%	4%	9,605	1.84%
2050	11,475	1.38%	4%	11,016	1.38%

Sources SDMP study report; Consultant's estimates

2.1.3 Education

As is the case with employment, education is also a strong indicator of the level of demand for a mass transit project. Thus, the growth in student enrolments in the study area will be a determinant of the growth in demand for Metro Line 4.

Based on the 2006 Census, forecasts of student enrolments in the Metro Line 4 study area were generated by SDMP study for the 2006-2027 period. These forecasts are given in Table 2-7 below.

Table 2-7 SDMP Student Enrolment Growth Forecast for the Study Area

Year	Primary students enrolled		Preparatory students enrolled		Secondary students enrolled		University students enrolled		Total students enrolled	
	(1,000 students)	Annual growth rate	(1,000 students)	Annual growth rate	(1,000 students)	Annual growth rate	(1,000 students)	Annual growth rate	(1,000 students)	Annual growth rate
2006	1,827		479		593		504		3,403	
2007	1,828	0.05%	501	4.59%	612	3.20%	519	2.98%	3,460	1.67%
2012	1,963	1.44%	675	6.14%	709	2.99%	565	1.71%	3,912	2.49%
2017	2,075	1.12%	847	4.64%	914	5.21%	646	2.72%	4,482	2.76%
2027	2,333	1.18%	1,281	4.22%	1,334	3.85%	877	3.10%	5,825	2.66%

Source: SDMP study report

These forecasts of enrolments reflect expectations as to the population growth (see Section 2.1.1 above) and the student enrolment rate for the four levels of education relevant in Egypt. The overall growth in student enrolments reflects an increasing rate of enrolments[1]

[1] The enrolment rate is computed as the number of students enrolled as a percentage of all persons within the eligible age group.

at all levels above primary education however a declining population growth rate.

The SDMP forecasts were extended to reflect the projected growth over the longer planning timeframe adopted for the feasibility study, i.e. 2010-2050, as shown in Table 2-8 below.

Table 2-8 Feasibility Study Student Enrolments Forecast for the Study Area

Year	Primary students enrolled		Preparatory students enrolled		Secondary students enrolled		University students enrolled		Total students enrolled	
	(1,000 students)	Annual growth rate	(1,000 students)	Annual growth rate	(1,000 students)	Annual growth rate	(1,000 students)	Annual growth rate	(1,000 students)	Annual growth rate
2006	1,827		479		593		504		3,403	
2007	1,828	0.05%	501	4.59%	612	3.20%	519	2.98%	3,460	1.67%
2008	1,854	1.44%	532	6.14%	630	2.99%	528	1.71%	3,544	2.43%
2009	1,881	1.44%	564	6.14%	649	2.99%	537	1.71%	3,631	2.46%
2010	1,908	1.44%	599	6.14%	668	2.99%	546	1.71%	3,722	2.49%
2011	1,935	1.44%	636	6.14%	688	2.99%	555	1.71%	3,815	2.51%
2012	1,963	1.44%	675	6.14%	709	2.99%	565	1.71%	3,912	2.49%
2020	2,145	1.12%	971	4.64%	914	5.21%	646	2.72%	4,676	2.25%
2030	2,412	1.18%	1,467	4.22%	1,334	3.85%	877	3.10%	6,090	2.68%
2040	2,678	1.05%	2,127	3.78%	1,920	3.71%	1,147	2.72%	7,871	2.60%
2050	2,958	1.00%	2,959	3.36%	2,730	3.58%	1,445	2.34%	10,092	2.52%

Source: SDMP study report; Consultant's estimates

2.1.4 Gross Regional Domestic Product (GRDP)

The growth of the gross regional domestic product (GRDP) is one of the key determinants of transport demand in the study area. Thus, estimates of GRDP and GRDP per capita over the forecast period from 2010 to 2050 were necessary to support the forecast of transport demand in this area.

GRDP estimates were prepared for the SDMP study in 2008 with a forecast period ending in 2027. These estimates are summarized against estimates of population growth for the study area in Table 2-9 below.

Table 2-9 GRDP and Population Estimates from SDMP Study

Year	Population		GRDP		GRDP per capita (LE)
	'000 persons	Ave. annual growth rate	LE million	Ave. annual growth rate	
2006	16,101	2.22%	164,372	-	10,209
2007	16,464	2.25%	177,521	8.0%	10,782
2012	18,411	2.26%	260,837	8.0%	14,,167
2017	20,369	2.04%	365,837	7.0%	17,960
2027	24,192	1.61%	670,757	6.0%	27,726

Source: Table 3.3.1, SDMP study, Vol. 2, Final Report

The SDMP estimates of GRDP were derived from the 2003/2004 base year estimates by United Nations Development Programme (UNDP) of GRDP per capita for the three governorates comprising the study area.[2]

Several significant changes in the economic climate and in the assumptions related to long term economic growth in Egypt have occurred since the SDMP estimates were prepared. Thus, it became necessary to review these estimates in relation to the following:

[2] The source of the UNDP data was the *Egypt Human Development Report 2005.* The three governorates for which an average GRDP per capita was calculated were Cairo, Giza and Qaliobeya.

- Revisions to the mid-year population estimates of CAPMAS, which are available in the Statistical Yearbook of Egypt for 2008;
- The changed circumstances of national economic growth in Egypt after the onset of the current global economic crisis in the second half of 2008; and
- The assumptions of Vision 2050 with respect to long term economic growth in Egypt.

It was first necessary to re-calculate the base year (2003/2004) estimate of the GRDP per capita used as the basis for the SDMP estimates, to reflect the latest mid-year population estimate of CAPMAS, as shown in Table 2-10.

Table 2-10 Re-calculation of Base Year GRDP per capita

Governorate	Population 2003/04[1]	GRDP per capita 2003/04[2] (L.E.)	GDRP (L.E.mill.)
Cairo	7,707,866	11,277	86,924
Giza	5,576,623	6,825	38,060
Qaliobeya	3,836,211	5,980	22,941
Total	***17,120,700***	***8,640***	***147,925***

Notes

1. Table No.2-4 Estimates of Mid-year Population, by Governorate (1996-2007), CAPMAS *Statistical Year Book* December 2008.

2. Table G2 Profile of Human Development, UNDP and Institute of National Planning, Egypt: *Egypt Human Development Report 2005*

The base year GRDP estimate was then inflated in line with the actual growth in the national gross domestic product (GDP) up until 2008, and then subsequently at the growth rate assumptions used in the SDMP study. (The SDMP consultants used rate assumptions from the 6th Five-Year Plan for the 2009-2012 period and their own assumptions reflecting an expectation of growth at slower rates after 2012 for the 2013-2027 period). The resulting revision of the SDMP estimates is given in Table 2-11.

Table 2-11 Adjustment of SDMP Estimates for Actual GDP Growth 2004-2008

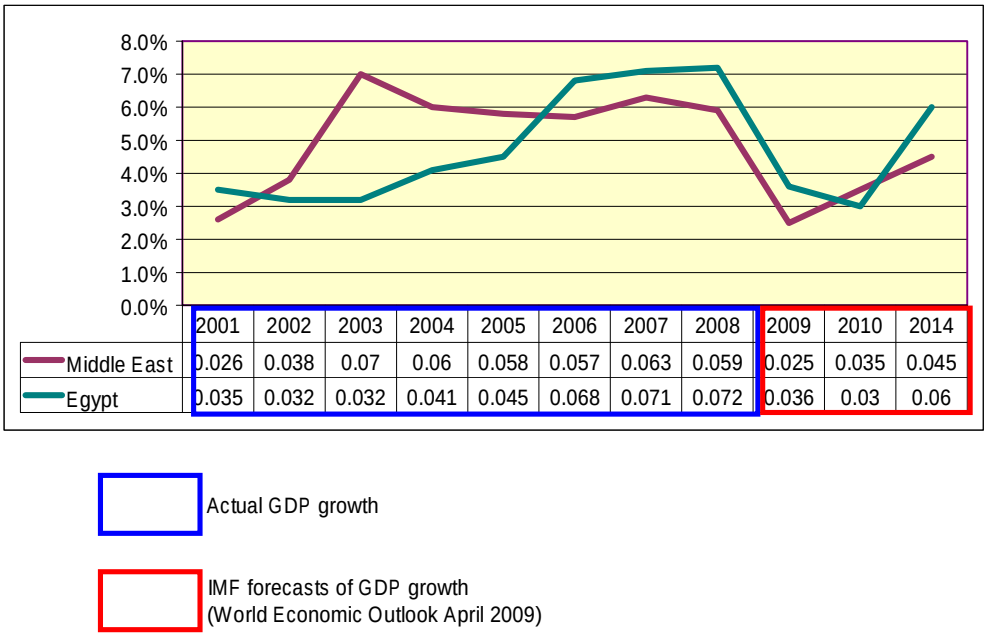
Year	GRDP		Population		GRDP per capita		Actual and forecast national GDP growth	
	L.E. mill.	Av Annual Rate of Growth	000 persons	Av Annual Rate of Growth	L.E.	Av Annual Rate of Growth	%	Source
2004	133,190	4.1%	15,415	2.20%	8640		**4.1%**	**(1)**
2005	139,184	4.5%	15,754	2.20%	8835	2.3%	**4.5%**	**(1)**
2006	148,648	6.8%	16,101	2.20%	9232	4.5%	**6.8%**	**(1)**
2007	159,202	7.1%	16,464	2.25%	9670	4.7%	**7.1%**	**(1)**
2008	170,665	7.2%	16,836	2.26%	10137	4.8%	**7.2%**	**(1)**
2009	184,318	8.0%	17,217	2.26%	10706	5.6%	**3.6%**	**(2)**
2010	199,063	8.0%	17,606	2.26%	11307	5.6%	**3.0%**	**(2)**
2011	214,988	8.0%	18,004	2.26%	11941	5.6%	**3.8%**	**(3)**
2012	232,187	8.0%	18,411	2.26%	12611	5.6%	**4.5%**	**(3)**
2020	398,941	7.0%	21,639	2.04%	18436	4.9%	**7.0%**	**(4)**
2030	714,442	6.0%	25,387	1.61%	28142	4.3%	**6.0%**	**(4)**
2040	1,279,457	6.0%	29,783	1.61%	42959	4.3%	**6.0%**	**(4)**
2050	2,291,313	6.0%	34,941	1.61%	65577	4.3%	**6.0%**	**(4)**

(1) IMF actual. Actual GDP growth as recorded in *IMF World Economic Outlook,* April 2009.
(2) IMF forecast of GDP growth in 2009, 2010 and 2014, as given in *IMF World Economic Outlook,* April 2009..
(3) IMF forecast for period 2009-2014 extrapolated for intervening years 2011 and 2012.
(4) JST Consultant forecast of GDP growth for period 2020-2050 assumes that growth will stabilize at 6% p.a.

Finally, it was necessary to adjust the SDMP estimates to reflect the changed conditions of

economic growth in Egypt after the onset of the global financial crisis in late 2008, as well as to reflect the recently available assumptions from Cairo Vision 2050 as regards long term economic growth.

The International Monetary Fund (IMF) has recently updated its global forecasts of economic growth in April 2009.[3] While the impact of the global economic crisis on Egypt has been relatively restrained, the IMF still projects that Egypt's GDP growth will fall by half in 2009 (from 7.2% in 2008 to 3.6% in 2009), as shown in Figure 2-8. The IMF further expects the GDP growth in Egypt to fall to 3.0% in 2010 before starting recovery and return to moderate growth rates of 6% or more by 2014.



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2014
Middle East	0.026	0.038	0.07	0.06	0.058	0.057	0.063	0.059	0.025	0.035	0.045
Egypt	0.035	0.032	0.032	0.041	0.045	0.068	0.071	0.072	0.036	0.03	0.06

Figure 2-8 Real GDP Growth Trends (2001-2008) and Forecasts (2009-2014), Egypt and Middle East

Cairo Vision 2050 documents were provided to JICA Study Team by the General Organization for Physical Planning (GOPP) of the Ministry of Housing, Utilities and Urban Development. These documents indicate a long term economic growth assumption of not less than 7.5% per annum up to the end of the feasibility study forecast period in 2050.

While this is a comparatively high rate of growth, especially when considered in the context of the current global economic crisis, it is only marginally higher than the growth rates which were actually achieved before the crisis hit. Whether such a high rate of growth is sustainable for Egypt over a 40-year time horizon is, however, debatable. It is expected that the economy will reach maturity by 2050 so that it has been assumed (for the purpose of the GRDP forecast) that growth will begin to taper off during the last 20 years of the

[3] IMF: *World Economic Outlook April 2009 "Crisis and Recovery"*

forecast timeframe.

The resulting GRDP estimates for the feasibility study are as shown in Table 2-12 below. Owing to the adjustment process described above, they are somewhat lower than the SDMP numbers in the early part of the forecast period but are fairly close to the SDMP projection by 2027 (the end of the forecast period adopted for the SDMP).

Table 2-12 Final Feasibility Study Estimates of GRDP and GRDP per Capita Growth in the Study Area Relevant to Cairo Metro Line 4

Year	GRDP		Population		GRDP per capita	
	L.E. mill.	Av Annual Rate of Growth	000 persons	Av Annual Rate of Growth	L.E.	Av Annual Rate of Growth
2004	133,190	**4.1%**	15,415		8,640	
2005	139,184	**4.5%**	15,754	2.20%	8,835	2.3%
2006	148,648	**6.8%**	16,101	2.20%	9,232	4.5%
2007	159,202	**7.1%**	16,464	2.25%	9,670	4.7%
2008	170,665	**7.2%**	16,836	2.26%	10,137	4.8%
2009	176,808	**3.6%**	17,217	2.26%	10,270	1.3%
2010	182,113	**3.0%**	17,606	2.26%	10,344	0.7%
2011	188,942	**3.8%**	18,004	2.26%	10,495	1.5%
2012	197,444	**4.5%**	18,411	2.26%	10,724	2.2%
2020	352,138	**7.5%**	21,639	2.04%	16,273	5.4%
2030	692,708	**7.0%**	25,387	1.61%	27,286	5.3%
2040	1,240,534	**6.0%**	28,801	1.27%	43,072	4.7%
2050	2,020,700	**5.0%**	31,815	1.00%	63,515	4.0%

Sources:
1. UNDP and Institute of National Planning, Egypt: *Egypt Human Development Report* 2005
2. CAPMAS Mid-year Population Estimates, *Egypt Statistical Yearbook 2008*
3. International Monetary Fund: *World Economic Outlook,* April 2009
4. Strategic Urban Development Master Plan for Cairo, Volume 2 Final Report 2008
5. Consultant's estimates

Notes:
1. Population figure for 2006 derived from 2006 Population Census conducted by CAPMAS
2. Population growth rate for 2004-2006 derived from CAPMAS data for 1996 and 2006
3. Population growth rates for 2007-2030 derived from SDMP study
4. Population growth rates for 2030-2050 are consultant's estimates

2.2 Diagnosis of Existing Urban Transport System and Forecasting of Future Transport Demand

For the purpose of this feasibility study, it is necessary to describe the existing and planned urban transport network of Greater Cairo (comprising all surface and underground infrastructure) and to identify the approach and required data in order to forecast the transport demand within the future network.

2.2.1 Description of Existing and Planned Urban Transport Network

(1) Definition of the "With" and "Without" Project Cases

Evaluation of the economic benefits of the construction of Metro Line 4, as is the case with any major transport project, requires the definition of a "Without" project as well as a "With" project case. The definition of (and rationale for) these cases will be described in Section

4.4.1, which deals with the economic appraisal of the project. However, they are briefly required in order to measure both the reduction in road traffic circulation resulting from Metro Line 4 project and the associated economic benefits (which are measured as the difference between the economic or resource costs of the two cases).

Thus, the "Without" project case assumes an urban transport network comprised of the existing "in service" surface and underground transport infrastructure, supplemented by all projects (except of course Metro Line 4 project) which are likely to be built during the timeframe used for the analysis of Metro Line 4 project (i.e., 2010-2050). These include projects with committed funding, or those likely to be committed funding to enable these projects to proceed. The "With" project case is the result of adding Metro Line 4 project to the "Without" case.

(2) Main Features of the Existing Urban Transport Network

As might be expected, road transport is the dominant urban transport mode in the Greater Cairo Area (GCA) and the paved road network of the GCA, estimated at 24,000 km for the combined three main population concentrations of Cairo, Giza and Qaliobeya, comprises 29% of the country's network of 83,000 km of paved roads.

The chronic congestion of Cairo's streets is largely explained by the fact that the city has a small proportion of its total urbanized area of about 4,200 km^2 allocated to road space while its vehicle population has recently been growing in double digit figures. In Cairo, this proportion is about 5%, when it is more than 20% in Sao Paulo, Delhi and the megacities of the western world, more than 10% in Bangkok and over 5% in Shanghai and Calcutta.[4]

In Cairo, the development of road infrastructure has not been able to keep pace with the growth in the motor vehicle population and with motorization rates generally. Between December 2006 and December 2008, the combined vehicle population of the three governorates comprising the study area grew by an average of 11% per year[5] while the motorization rate for the study area grew from about 99.8 motor vehicles per thousand persons in 2006 to 115.8 motor vehicles per thousand persons in 2008.

Approximately 93% of the total length of paved roads in the study area are local roads under local government management while the balance are larger roads, including expressways and multi-lane highways under the management of the General Authority for Roads, Bridges and Land Transport (GARBLT). The major roads in the GCA that have a substantial impact on traffic distribution within the study area are the Ring Road and the 26th July Corridor, which connects downtown Cairo with Giza and the Pyramids, as well as with the 6th October and Shaik Zayed NUCs.

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[4] Cairo's road share estimated from data on urban area and road length from the Egypt Statistical Yearbook of December 2008. Road shares from other cities extracted from a presentation by Surya Raj Acharya (Senior Researcher with the Institute for Transport Studies) at a Conference on Public Transport for Sustainable Mobility for Asian Cities on 10th May 2005.

[5] From 1,771,558 vehicles in 2006 to 2,179,236 vehicles in 2008 (motor vehicle registrations data from CAPMAS)

Construction of the Ring Road started in the late 1980s but today, it is still a semi-circular road since its southwest section remains to be built (although construction work on this last section is now underway).

The 15th May Bridge in the Zamalek Area provides access to the 26th July Road. However, access through this bridge presents a major problem since the southwest portion of the Ring Road is not yet connected. Construction of the missing portion of the Ring Road is an on-going project which may be expected to relieve future traffic congestion leading to the 26th July Corridor.

In addition, there is an on-going project to upgrade the 26th July Corridor. Alternative access to the 6th October and Shaik Zayed NUCs from Cairo is available via the Alexandria Desert Road and Al Wahaat Road. However, both of these roads connect at El Remayah Square, where severe traffic congestion occurs. A project to improve El Remayah Square, taking into consideration the need for traffic management during the construction of Grand Egyptian Museum (GEM), will soon commence.

El Giza Square, including Murad Street, constitutes another substantial traffic bottleneck, which is being addressed by the on-going road improvement program for the Western Development Corridor. While some of these works have already started and others will start soon, the existing access roads in the Western Development Corridor are presently limited to the 26th July Road and the Ring Road Extension to the 6th October Road.

The Metro network and the Heliopolis Tram are other components of the existing urban transport infrastructure in Greater Cairo.

At present, two lines of the Greater Cairo Metro are in service, namely, Metro Line 1 running along a north-south axis east of the Nile River from El Marg to Helwan and Metro Line 2 running from northeast to southwest across the Nile River from Shubra to El Monib. The first two phases of Metro Line 3, which runs along an east-west axis, are currently under construction and scheduled for completion in 2011 and 2013, respectively. The first phase, with a length of 4.3 km and 5 stations, runs from Attaba to Abbasia while the second phase, with a length of 7.12 km and 4 stations, runs from Abbasia to Al Ahram.

The Heliopolis Tram is an old system (constructed in the early 20th century) which essentially serves the local transport needs in Heliopolis and northeastern Cairo. GOPP of the Ministry of Housing, Utilities and Urban Development plans to substantially upgrade and modernize the system and to extend it to the southeast. This is known as the Heliopolis Super Tram project.

(3) Planned Urban Transport Network

Figure 2-9 shows the main elements of the planned urban road network superimposed on the existing network of Greater Cairo. Similarly, Figure 2-10 shows the existing and planned public transport networks of Greater Cairo. The use of the term “planned” is meant to indicate all projects which are either currently under construction or for which there is, or is

likely to be, a commitment by the government to construct in the future.

A total of 16 road construction projects were identified in the SDMP study report to be either under construction or under detailed planning in 2007. These projects, which include the major traffic relief projects described above, as well as the completion of both the Inner and Regional Ring Road projects, have been listed in Section4.4.1 of this report.

Five additional projects were identified during the meetings with the GOPP as being “in progress” or committed and therefore likely to be implemented within the forecast timeframe (2010-2050) adopted for the Metro Line 4 project. These include the following:

- East Wing Railway of the Egyptian National Railway (ENR);
- Exclusive busway system planned for the 26th July corridor;
- Heliopolis Super Tram project, involving system upgrading and extension to New Cairo NUC;
- Elevated Urban Tollway project in eastern Cairo; and
- 6 road projects around GEM and El Remayah Square aimed at relieving local traffic congestion.

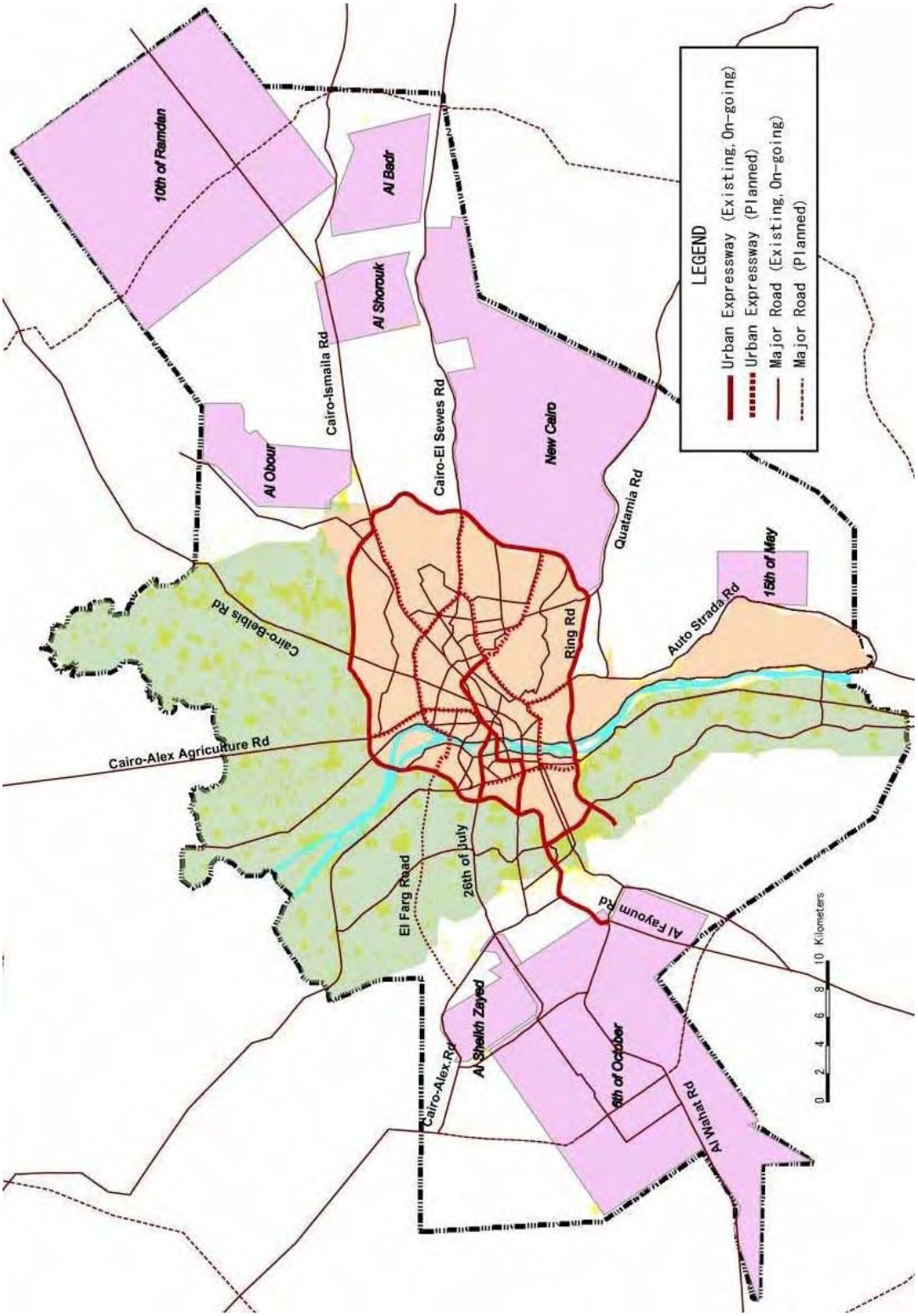


Figure 2-9 Existing and planned road network of Greater Cairo

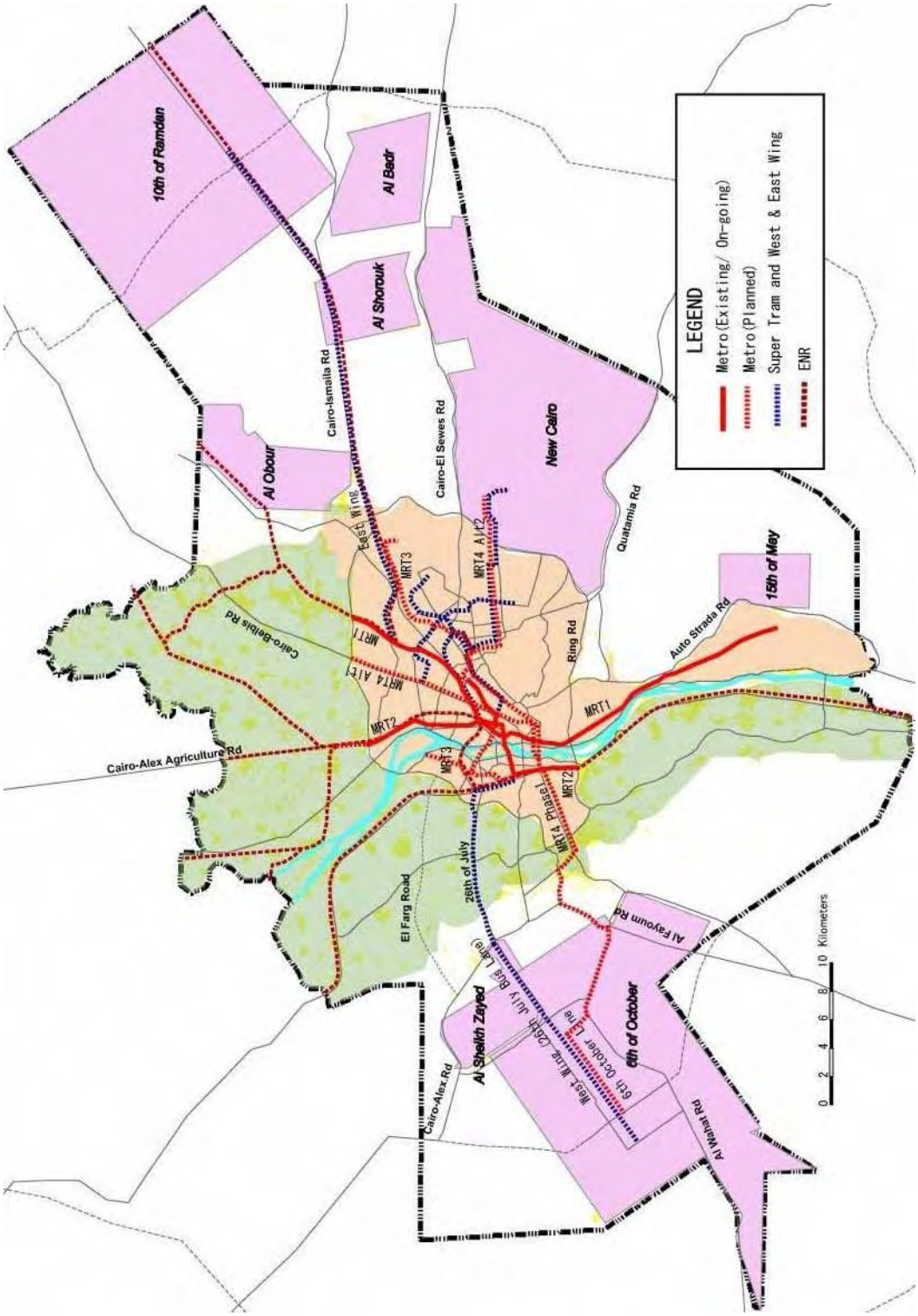


Figure 2-10 Existing and planned public transportation network of Greater Cairo

2.2.2 Approach to and Data Collected for the Transport Demand Forecast

(1) Preliminary Demand Forecasting for Future Metro Network

Based on the previous demand forecasting models and O/D matrices developed for the SDMP study, the future Metro demand in 2027 was studied. In terms of the future network alternatives for Metro Line 4 phase 2 sections, Alternative 1 involves the northward extension up to the Ring Road while Alternative 2 consists of the eastward extension up to New Cairo NUC.

The final demand forecast will extend the projections to 2050, although the methodology to be used will be the same as described here (and as used in the SDMP study). For this purpose, it will be necessary to update the OD matrices used as the basis for the forecast in the SDMP study. This was achieved through traffic count and screen line surveys undertaken in June 2009.

(2) Transportation Demand Modelling

The transportation models applied for the study will follow the four step approach built by the JICA CREATS and SDMP studies (as shown in Figure 2-11).

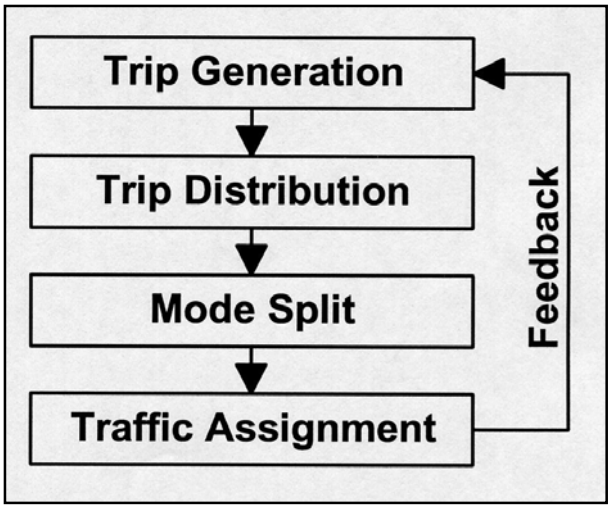


Figure 2-11 Concept of the Four Step Approach

Figure 2-12 shows the transportation mode hierarchy used for modal split modelling. As a first step, trips by all modes are split into Private and Public Modes by applying the CREATS Model. Next, Public Mode trips are divided into Metro (Metro, 6th October Line and Bus-way) and Bus (Public Bus, Mini Bus and Shared Taxi).

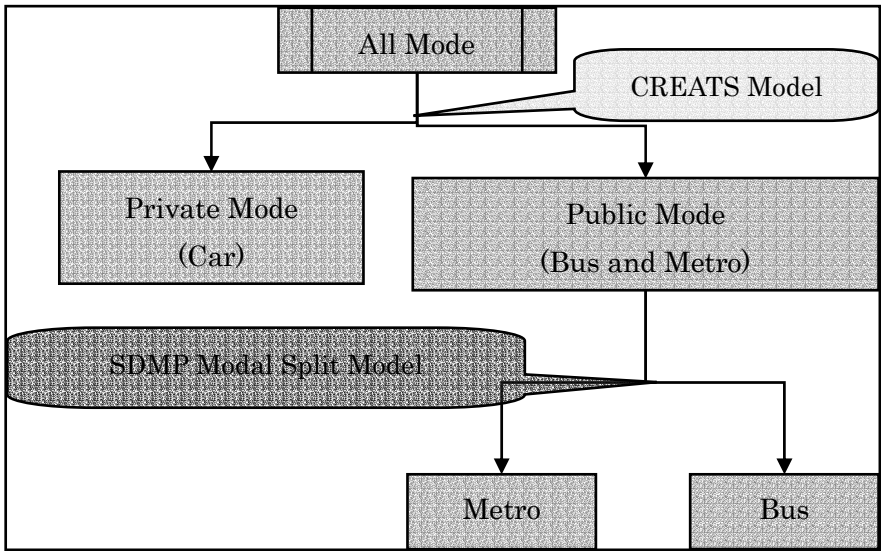


Figure 2-12 Modal Split Model Mode Hierarchy

Travel time and accessibility of railway stations (i.e. (access + egress) / railway)), based on CREATS interview survey results, are selected as explanatory variables of the SDMP modal split model (see Figure 2-13 below).

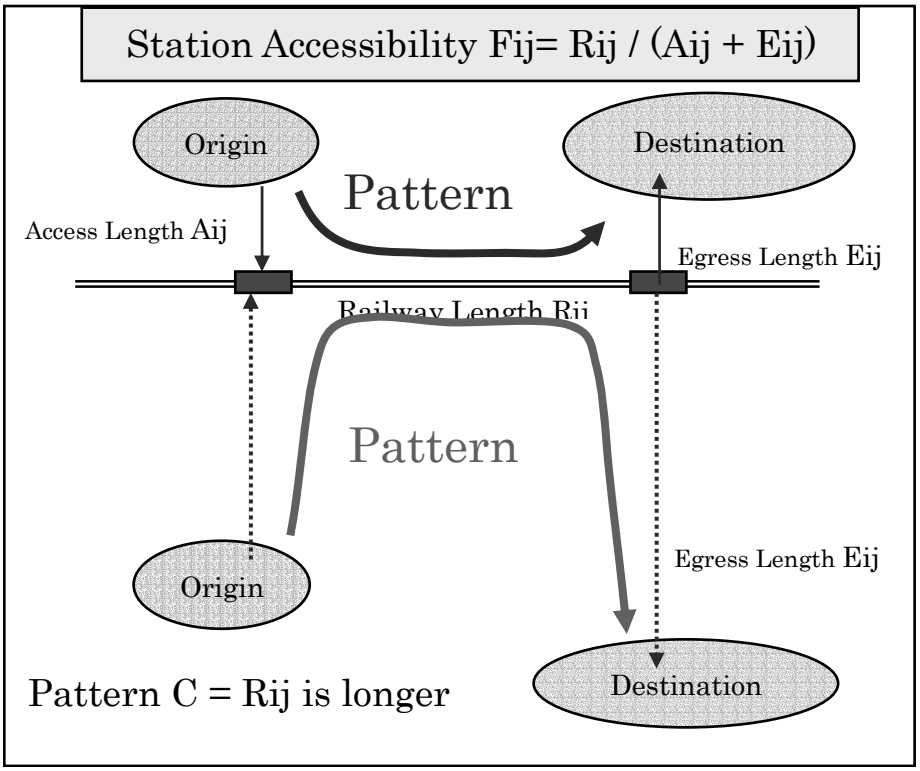


Figure 2-13 Concept of Metro Station Accessibility

(3) Results of Preliminary Demand Forecast for Metro Network

The future Metro demand in 2027 is summarized in Table 2-13 below.

Table 2-13 Future Demand for Metro Network in 2027

MRT4 Alt1 (North Extension)

		Total Pax	Transfer from/to MRT Other lines	Station Boarding and Alighting	Max Section Pax / hrs/dir
					14.0%
Number of Pax	MRT All	4,126,269	0	4,126,269	
	MRT1	1,756,906	684,727	1,072,180	51,429
	MRT2	1,259,660	570,030	689,631	32,382
	MRT3	1,500,941	565,773	935,169	55,296
	MRT4 phase1	953,837	602,297	351,541	36,840
	MRT4 Phase2 Alt1	1,026,161	594,054	432,107	45,095
	MRT4 Phase2 Alt2	0	0	0	0
	26 July Busway	381,143	56,222	324,922	13,237
	6 Octber Line	488,697	167,976	320,722	24,209

MRT4 Alt2 (East Extension)

		Total Pax	Transfer from/to MRT Other lines	Station Boarding and Alighting	Max Section Pax / hrs/dir
					14.0%
Number of Pax	MRT All	4,674,984	0	4,674,984	
	MRT1	1,994,526	581,946	1,412,581	64,357
	MRT2	1,445,163	652,874	792,289	37,711
	MRT3	1,587,077	706,452	880,625	51,045
	MRT4 phase1	1,169,538	813,399	356,140	37,647
	MRT4 Phase2 Alt1	0	0	0	0
	MRT4 Phase2 Alt2	1,038,585	457,022	581,564	41,849
	26 July Busway	385,018	53,083	331,936	13,421
	6 Octber Line	489,138	169,287	319,851	24,359

(4) Preliminary Person-km and Person-hour Forecasts for “With” and “Without” Project in 2027

For future discussion and evaluation of alternatives, “with” and “without” project forecasts of transport demand were conducted. These forecasts are based on the future urban transport network as previously described in Section 2.2.1.

From the viewpoint of demand, impacts on the number of trips, total person-km and person-hour are estimated, as shown in Table 2-14.

Table 2-14 With and Without Analysis for Metro Line 4 Phase 2 Alternatives

METRO Lin4 Alternative 1 (North Extension)

		unit	With	Without	With - W/O
No of Trip	Pax Car	person	6,606,659	6,606,659	0
	Bus + Tram	person	12,825,202	13,183,740	-358,538
	Acc. Shared Taxi	person	1,561,869	1,466,109	95,760
	MRT	person	4,126,269	3,870,111	256,158
	Total	person	25,119,998	25,126,619	
Person * km	Pax Car	Person * km	121,912,669	121,907,180	5,489
	Bus + Tram	Person * km	158,839,807	163,058,535	-4,218,728
	Acc. Shared Taxi	Person * km	4,691,764	5,050,966	-359,202
	MRT	Person * km	81,680,093	74,328,306	7,351,787
	Total	Person * km	367,124,333	364,344,987	2,779,346
Person * hrs	Pax Car	Person * hrs	5,350,303	5,354,570	-4,266
	Bus + LRT	Person * hrs	6,741,607	6,937,954	-196,347
	Acc. Shared Taxi	Person * hrs	209,463	225,258	-15,795
	MRT	Person * hrs	2,447,882	2,239,260	208,622
	Total	Person * hrs	14,749,255	14,757,041	-7,786

METRO Lin4 Alternative 2 (East Extension)

		unit	With	Without	With - W/O
No of Trip	Pax Car	person	6,606,659	6,606,659	0
	Bus + Tram	person	12,083,364	13,183,740	-1,100,376
	Acc. Shared Taxi	person	1,759,775	1,466,109	293,666
	MRT	person	4,674,984	3,870,111	804,873
	Total	person	25,124,782	25,126,619	
Person * km	Pax Car	Person * km	121,841,024	121,907,180	-66,156
	Bus + Tram	Person * km	148,714,712	163,058,535	-14,343,823
	Acc. Shared Taxi	Person * km	5,220,344	5,050,966	169,378
	MRT	Person * km	87,591,617	74,328,306	13,263,311
	Total	Person * km	363,367,698	364,344,987	-977,290
Person * hrs	Pax Car	Person * hrs	5,340,488	5,354,570	-14,082
	Bus + LRT	Person * hrs	6,309,100	6,937,954	-628,854
	Acc. Shared Taxi	Person * hrs	234,404	225,258	9,146
	MRT	Person * hrs	2,646,712	2,239,260	407,452
	Total	Person * hrs	14,530,704	14,757,041	-226,337

Note1: Acc. Shared Taxi: Access from origin/destination to MRT Station
Note2: Pax Car includes Passenger car, Taxi, Pick up and Truck
Note3: This table shows the preliminary demand forecast.

2.3 Description of the Government Policy and Priorities for Urban Development in the Study Area

2.3.1 Overview of Urban Development

(1) Legal Frame and Organization for Urban Planning and Development

Law No. 3 of 1982 establishes the legislative structure for urban planning and Law No. 106 of 1976 provides the executive regulations for building works.

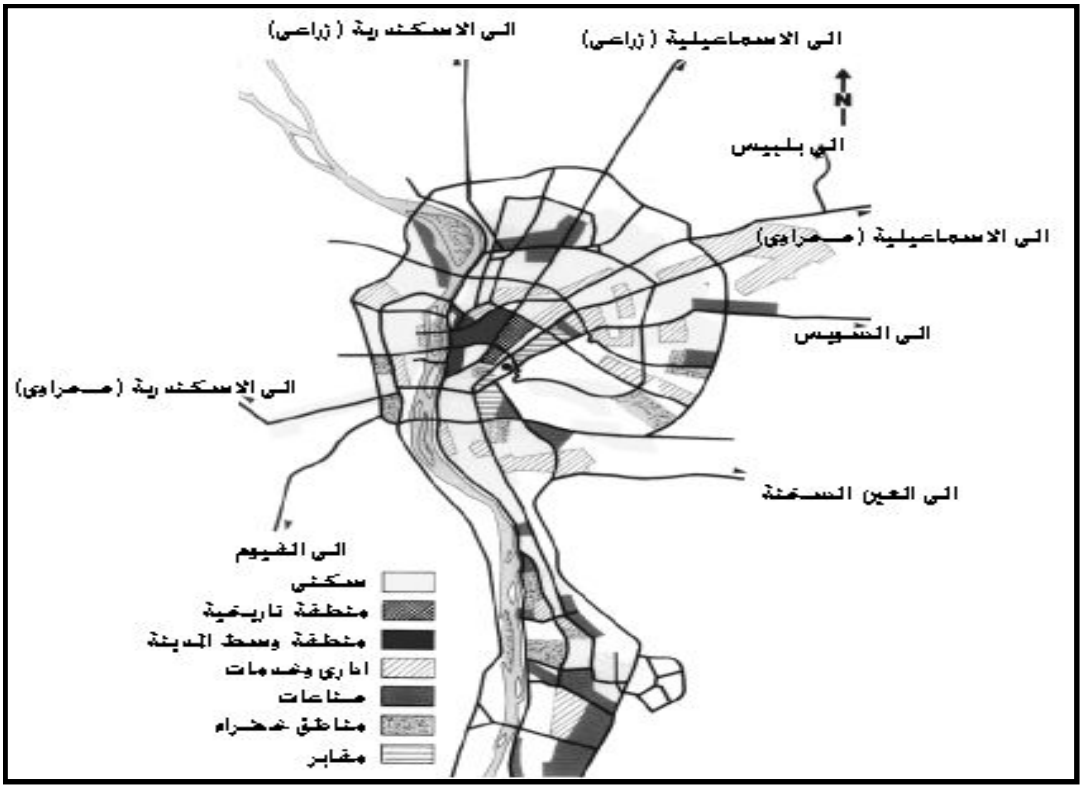
GOPP of the Ministry of Housing, Utilities and Urban Development (MOHUUD) is the responsible body for formulating the general policy for planning and sustainable urban development, setting up plans and programs for this purpose at the national and regional levels, and revising urban plans at the local level.

In each economic region of the country, a regional centre under GOPP is responsible for planning and urban development. The regional centre provides technical support to the departments in governorates and follows up the implementation of the plans of cities and villages. The Greater Cairo Region Urban Planning Centre (GCRUPC), which is the relevant regional centre, takes responsibility for the Greater Cairo Region.

(2) Master Plan

The first urban master plan of Cairo was formulated in 1956. This plan proposed 6 suburban communities, of which Helwan New Town in the south was realized. Among the two proposed suburban developments, Nasr City materialized.

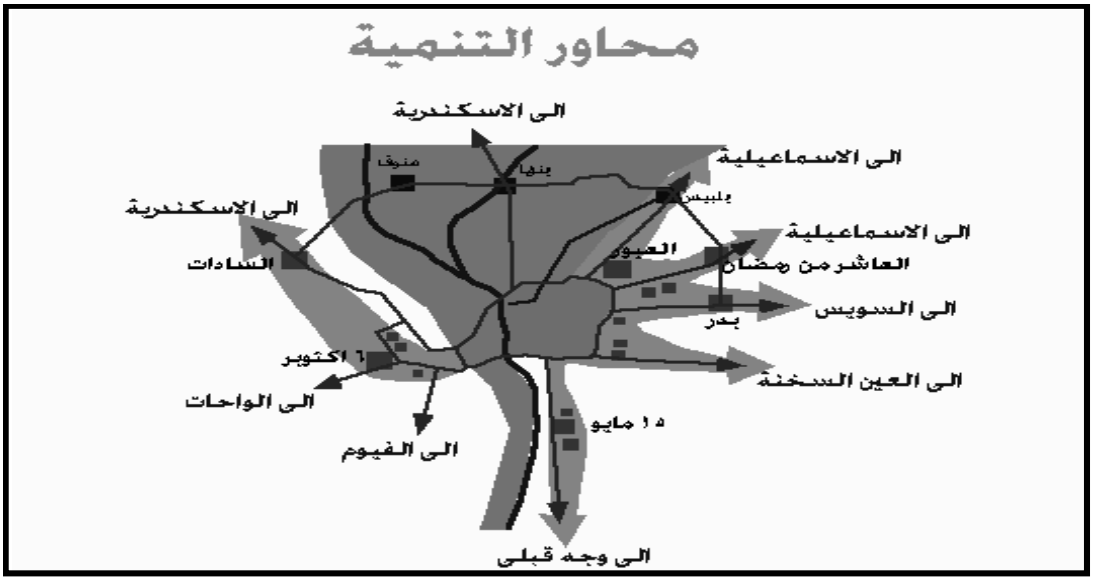
The Master Plan of 1970 was formulated at a time when the urban areas of GCR were going through drastic changes and rapid expansion. The plan was approved in 1973 (Figure 2-14). The target population was set for the year 1990, with the projected population in the range of 14.7 to 16.0 million. The plan proposed new urban communities outside existing urban areas in order to accommodate the rapidly growing population and defined the ring road as the outward boundary for urbanization of the city agglomeration. Four NUCs, namely 6th October in the west, 10th of Ramadan and El-Obour in the east and 15th May in the south, were established following this master plan.



Source: SDMP

Figure 2-14 Master Plan of 1973

The third master plan was formulated in 1982 and estimated the increase in population up to the year 2000 at 16.0 to 16.5 million. The planned population in NUCs in 2000 was set at 900,000. This master plan proposed five Urban Corridors to connect Cairo with external cities, namely: 1) Alexandria; 2) Suez; 3) Sokhna; 4) Ismailia; and 5) Upper Egypt in the south (Figure 2-15).



Source: SDMP

Figure 2-15 Corridors in the Master Plan of 1982

The revised plan of 1991 was based on the work of GOPP (Figure 2-16). The Ring Road proposed in the master plan of 1982 was almost complete by this time. In the revised plan, 4 million people would be accommodated in the NUCs, while the remaining 12 million was forecast for the existing agglomeration.

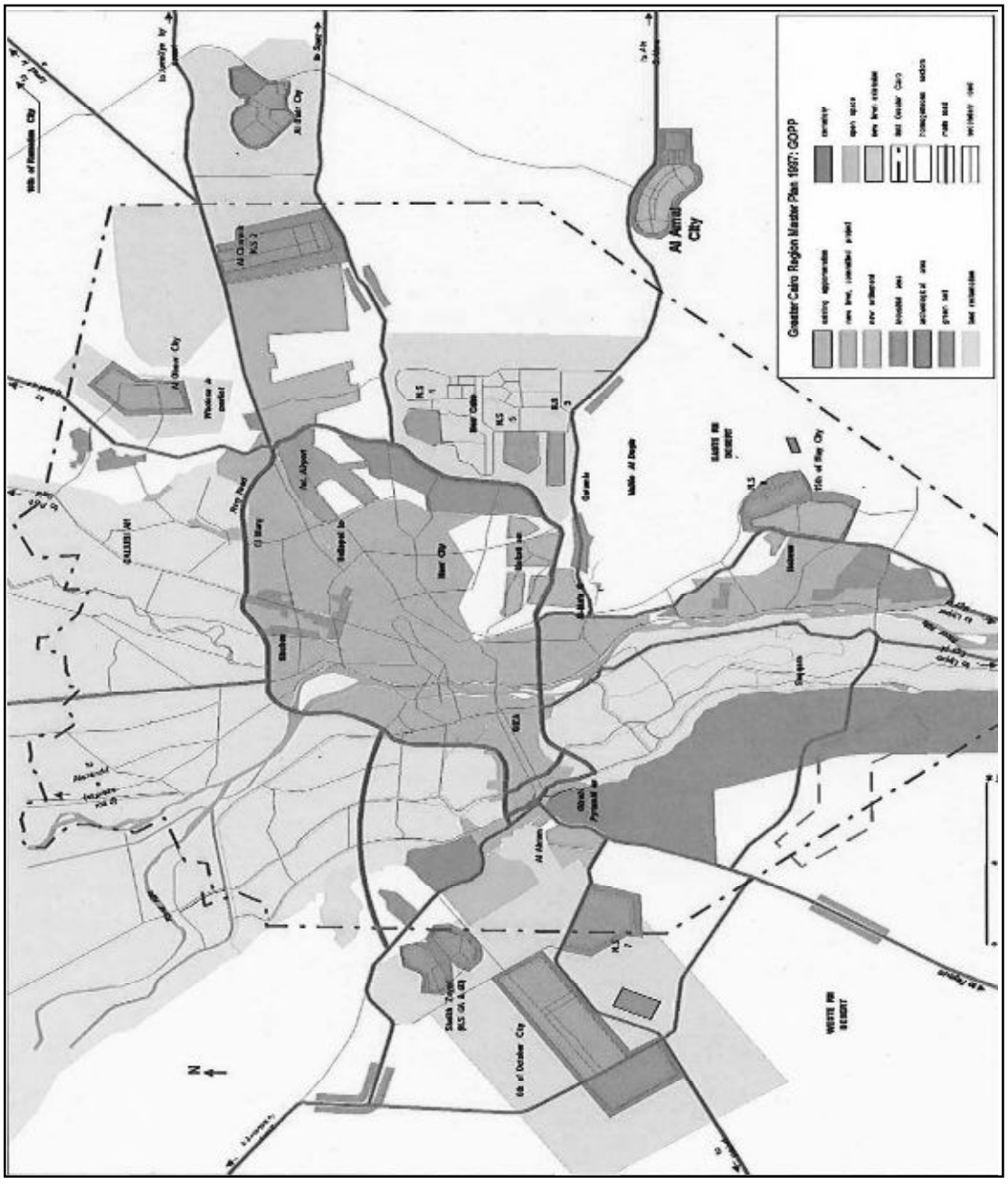
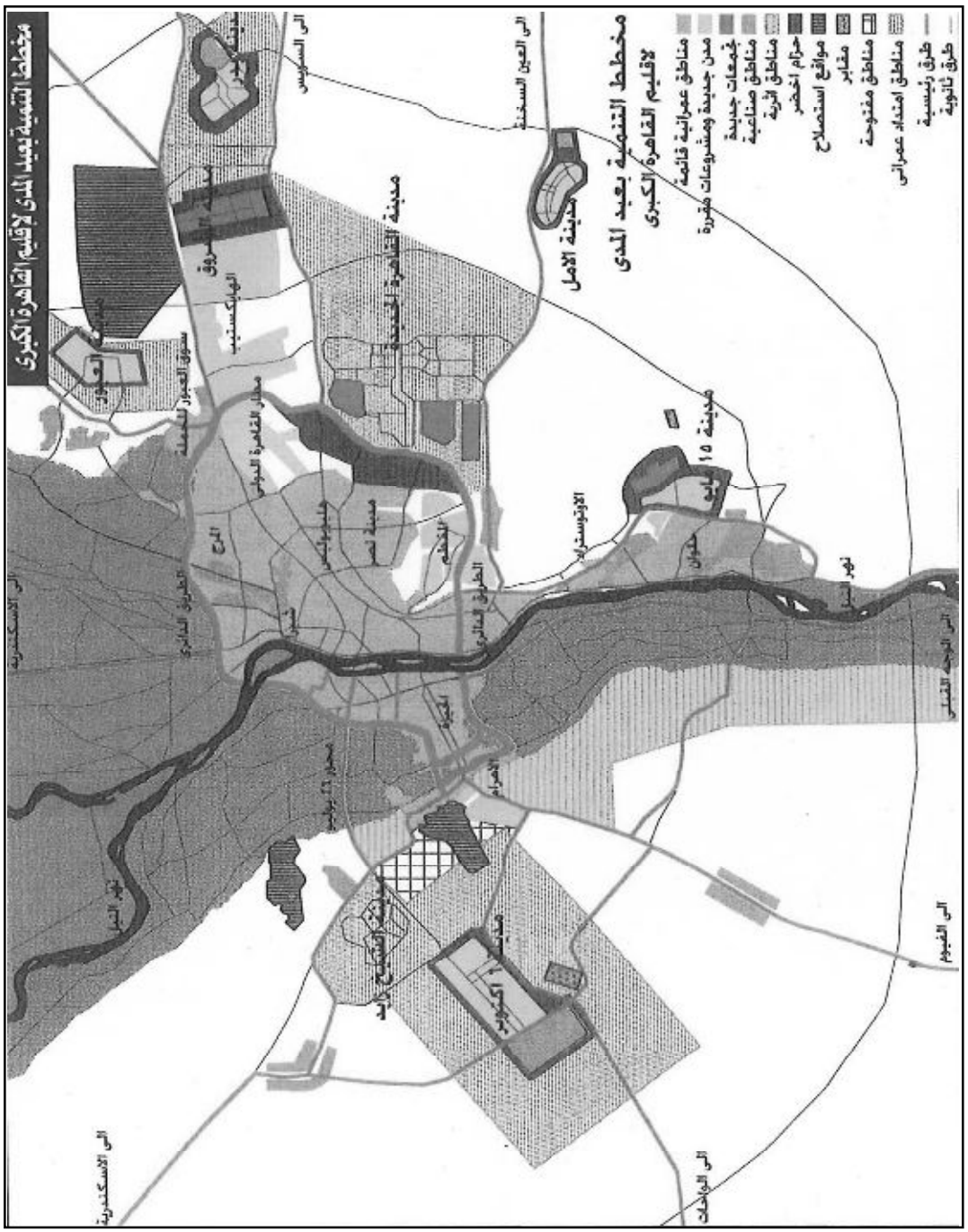


Figure 2-16 Master Plan of 1991

Source: SDMP

The master plan of 1997 is the current ongoing plan (Figure 2-17). A new population target of 24 million was adopted for the target year of 2020. The population of the Greater Cairo Region in 2000 was assumed to be 16 million and the projected increase up to 2020 would be 8 million. Out of the increase of 8 million, 5.8 million were expected to be accommodated in the NUCs, and the remaining 2.2 million in the existing urban conglomeration. This plan thus accelerated the construction of NUCs outside the ring road, which by then has almost been completed, and an outer ring road was contemplated for

future implementation.



Source: SDMP

Figure 2-17 Master Plan of 1997/2000

(3) Urban Development Principles

Past master plans have embodied the basic principles for urban development, as shown below:

- Protection of agricultural areas;
- Opening near desert land for urbanization;

- Improvement of industrial and business location policy;
- Improvement of transport efficiency;
- Maximization of the use of existing infrastructure;
- Protection of archaeological and historical heritage and main support to tourism development;
- Limitation of the continuous expansion of the Greater Cairo Region;
- Supply of alternative development zones to informal settlements;
- Reorganization of the urban fabric to improve access to public services;
- Increase of dwelling connections to utility networks;
- Rehabilitation of ancient old neighborhoods;
- Protection of water resources; and
- Control of air pollution.

2.3.2 Existing Land Use

(1) Changes in Urbanized Area

In the SDMP study report, changes in the urbanized part of the study area between 2001 and 2007 were analyzed by using Landsat images from 2001 to 2007.

The results of this analysis showed that an area of 12,600 ha was urbanized between 2001 and 2007 in various parts of the study area. At the same time, there was a reduction of 13,100 ha in desert land and 1,100 ha in open space (see Table 2-15).

One noticeable phenomenon was the loss of agricultural land. Between 2001 and 2007, there was a reduction in the stock of agricultural land from 82,500 ha in 2001 to 80,500 ha in 2007. The loss of agricultural land accounts for about 2.5% of the total agricultural area in the study area. This represents a substantial loss.

Table 2-15 Land Area by Land Cover Categories in 2001 and 2007

Land Cover Category	Area (ha)		Change in 2001-2007 (ha)
	2001	2007	
Built-up area	57,200	69,800	+12,600
Agriculture	82,600	80,500	-2,100
Bare Land	1,400	5,100	+3,700
Desert	285,700	272,600	-13,100
Water	3,400	3,400	0
Open Space	6,200	5,100	-1,100
Total	436,500	436,500	-

Note: Built-up area includes urban area, airport, and cemetery.
Source: SDMP

The conversion of land to urban use between 2001 and 2007 was assessed by previous type of use (see Table 2-16). The largest area of urban land (6,740 ha) was converted from desert, followed by open space (3,300 ha) and agriculture (2,400 ha). However, it should be noted that the decrease in open space does not necessarily mean a sacrifice of green area but urbanization on unused land near or on the fringe of the urban agglomeration.

Table 2-16 Area which was Converted into Urban Area in 2001-2007

Land Cover Category	Area (ha)	Share (%)
Agriculture	2,400	19.2
Bare Land	60	0.5
Desert	6,740	53.0
Water	100	0.8
Open Space	3,300	26.5
Total	12,600	100

Source: SDMP

(2) Existing Land Use

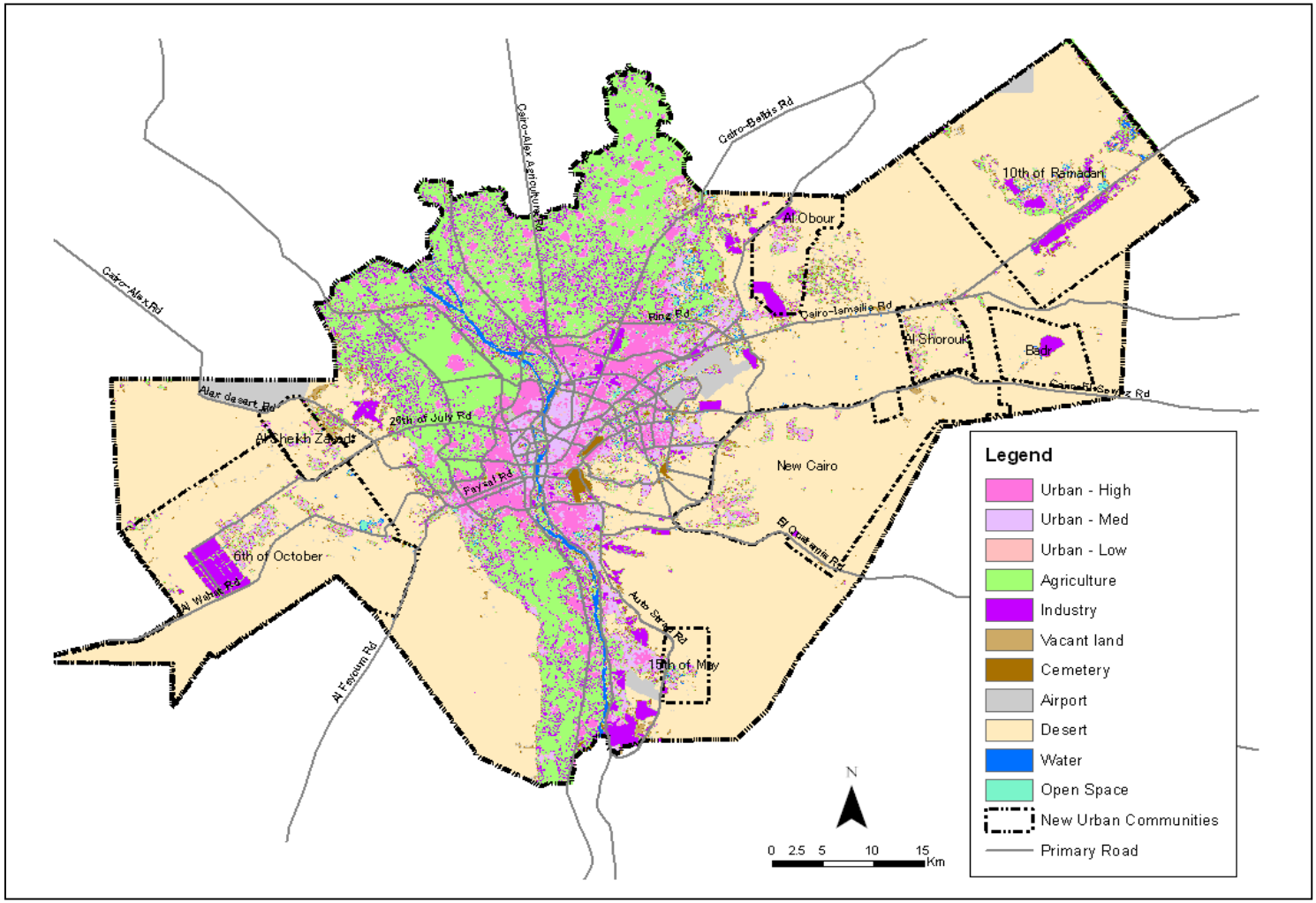
Figure 2-18 shows the current land use in the study area, as assessed in the SDMP study report. Eleven land use categories are classified and urban areas are mainly concentrated within the main agglomeration surrounded by the Ring Road. The northeast part of the main agglomeration has grown as a result of the urban area encroaching upon agricultural land.

Industrial areas are concentrated in the northern part of the urban area, such as Shubra and Shubra El Kheima, and the southern part of the main agglomeration, such as south of Helwan and the industrial areas of Hawamdeya and Bodrashine. These industrial areas are located adjacent to residential areas and need more consideration regarding improvement of the environment for residents. Some residential areas are observed to be inside the industrial areas.

In the central part of the main agglomeration, a major cemetery, which has expanded over time, is located and surrounded by the urban areas. Currently, the cemetery occupies a large tract of land in the urban area.

Green and open spaces in the main agglomeration are very sparse considering the size of the current population that resides in the area. The development of green and open spaces is difficult due to the shortage of available land within high-density built-up areas.

NUCs have not been fully developed yet. Among the NUCs, 6th October, which is located in the western part of the study area, 10th of Ramadan and 15th May, which are respectively located in the eastern and southern parts of the study area, are growing at a relatively fast rate.



Source: SDMP

Figure 2-18 Existing Land Use

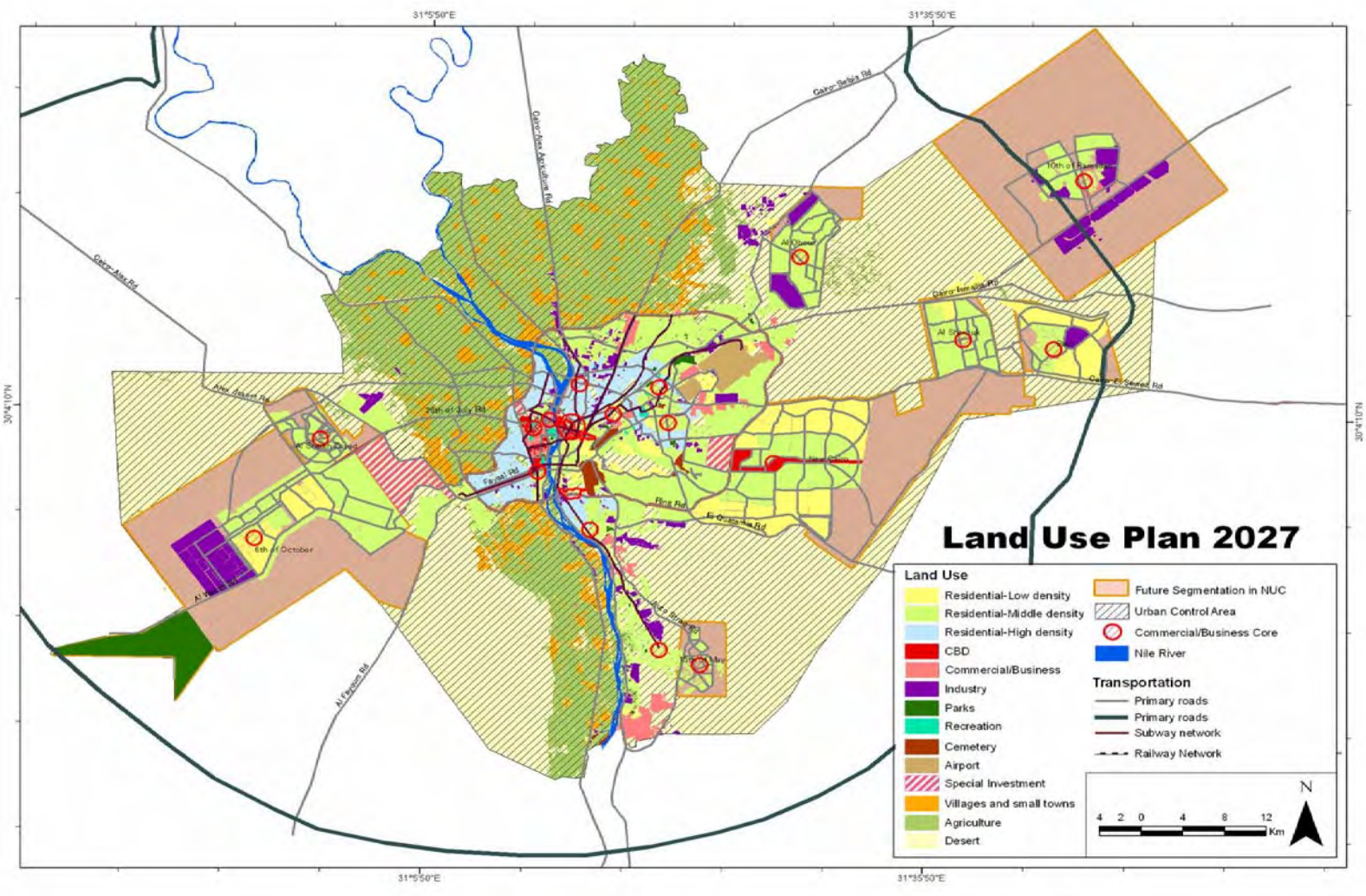
(3) Land Use Plan

Figure 2-19 shows the land use plan for the target year 2027, as formulated in the SDMP study report. The land use plan indicated 16 land use categories, which are defined in Table 2-17.

Table 2-17 Definition of Land Use Categories

Land Use Category		Definition
Residential	Low density	Residential area with less than 100 persons per ha
	Middle density	Residential area with less than 300 persons per ha
	High density	Residential area with more than 300 persons per ha
Commercial	Neighbourhood commercial	The area includes commercial and business functions which serve the neighbourhood
	Central business district	The area includes major commercial and business functions incorporated in a central business district
Green and Open Space	Park	The area includes public parks, such as district and neighbourhood parks.
	Recreation	The area includes semi-private or private recreation facilities, including stadium and athletic fields.
	Cemetery	The area includes major cemeteries.
Airport		The area includes civil airports.
Special Investment		The area includes special investment zones such as government relocation, tourism investment, and housing investment.
Villages and Small Towns		The area includes villages and small towns outside the main agglomeration.
Agriculture		The area includes agricultural land.
Desert		The area includes desert.
Area for future development in NUCs		The area for future development within NUCs.
Area for development control		Area which is controlled for any development activities. Existing condition can be permitted to continue.
Nile River		The area for Nile River

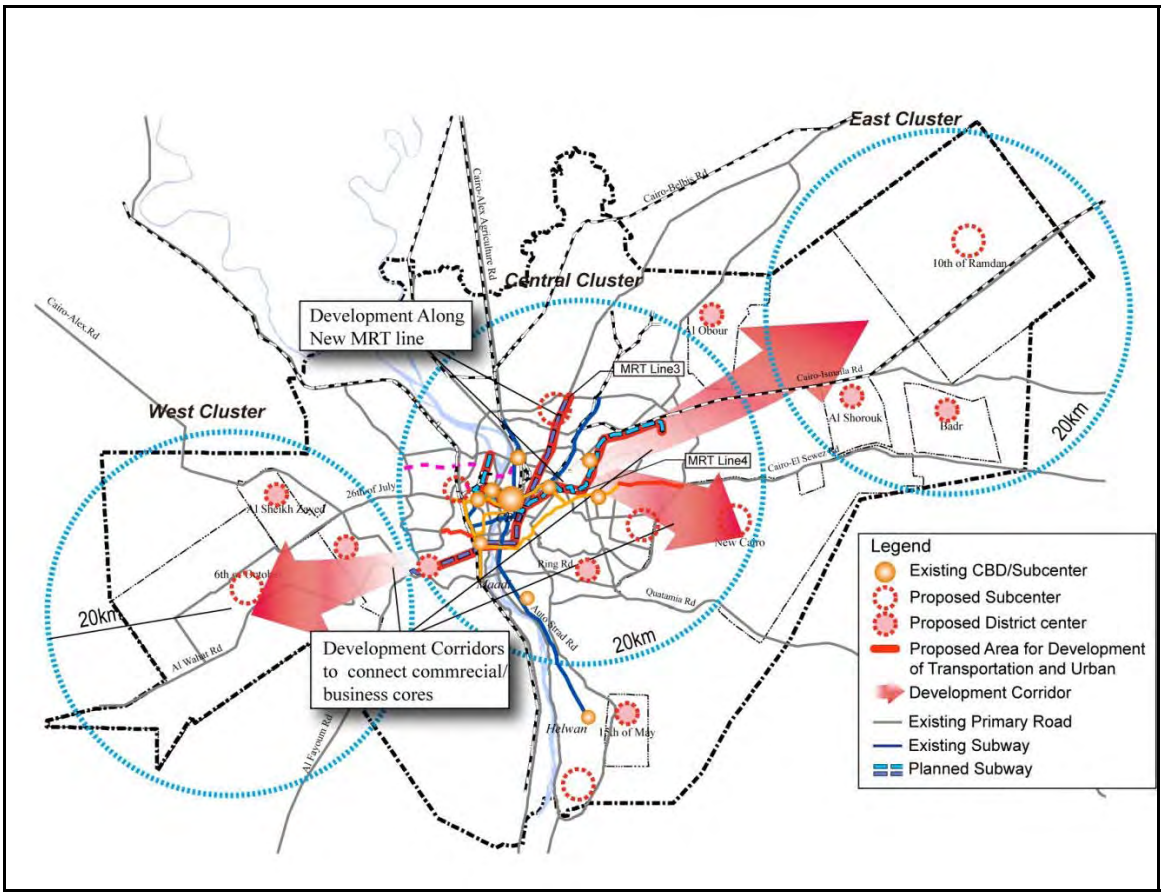
Source: SDMP



Source: SDMP

Figure 2-19 Land Use Plan 2027

The improvement of the transportation system will need to be coordinated with urban development. Figure 2-20 shows the future transport-oriented urban development. Among the urban corridors, there are three corridors that will be highly prioritized to achieve improvement of transportation system in the study area. The east and west urban clusters should be given priority for transport-oriented development since NUCs interlinked by the three development corridors have developed rapidly in the decade up until 2006. These clusters will be the main vehicles to cater to the incremental population in the study area. In addition, the new business and commercial areas should be enhanced in the central urban cluster. New Cairo NUC will be the key area to be encouraged to accommodate the incremental population in the main agglomeration.



Source: SDMP

Figure 2-20 Development Corridor