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

FINAL REPORT
Volume 3 (Feasibility Study Report 3/4)
1 of 2

JUNE 2010

JAPAN INTERNATIONAL COOPERATION AGENCY
NIPPON KOEI CO., LTD.
JAPAN RAILWAY TECHNICAL SERVICE
NIPPON CIVIC CONSULTING ENGINEERS CO., LTD
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Volume 1 : Feasibility Study Report 1
Data Collection, Diagnosis of the Existing Public Transport System and Urban Development Hypothesis

Volume 2 : Feasibility Study Report 2
New Transportation Study, Data Analysis and Alternative Corridors for Greater Cairo Metro Line No. 4

Volume 3 : Feasibility Study Report 3/4
Preliminary design on Greater Cairo Metro Phase 1 and Economic Financial Analysis

Volume 4 : Drawings

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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
### PREFACE

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GROSSARY OF ABBREVIATIONS AND MEASURING UNITS
## GLOSSARY OF ABBREVIATIONS AND MEASURING UNITS

### ABBREVIATIONS

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<th>Description</th>
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<tbody>
<tr>
<td>AASHTO</td>
<td>American Association of State Highways and Transportation Officials</td>
</tr>
<tr>
<td>AB</td>
<td>Absolute Block</td>
</tr>
<tr>
<td>ABS</td>
<td>Automatic Block Signals</td>
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<td>A/C</td>
<td>Air Conditioning</td>
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<tr>
<td>AC</td>
<td>Alternating Current</td>
</tr>
<tr>
<td>ACE</td>
<td>Arab Consulting Engineers</td>
</tr>
<tr>
<td>ACij</td>
<td>Access Length</td>
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<td>Average Daily Traffic</td>
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<tr>
<td>AF</td>
<td>Audio Frequency</td>
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<td>AFC</td>
<td>Automatic Fare Collection (system)</td>
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<td>AIDB</td>
<td>African Development Bank</td>
</tr>
<tr>
<td>AG</td>
<td>Automatic Gate</td>
</tr>
<tr>
<td>AGT</td>
<td>Automated Guide-way Transit</td>
</tr>
<tr>
<td>AHU</td>
<td>Air Handling Unit</td>
</tr>
<tr>
<td>AM</td>
<td>Amplitude Modulation</td>
</tr>
<tr>
<td>am</td>
<td>Ante meridian</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>AREMA</td>
<td>American Railway Engineering and Maintenance Association</td>
</tr>
<tr>
<td>ARS</td>
<td>Automatic Route Setting</td>
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<tr>
<td>ASCII</td>
<td>American Standard Code for Information Interchange</td>
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<tr>
<td>asl</td>
<td>Above Sea Level</td>
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<td>ASTM</td>
<td>American Society for Testing and Materials</td>
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<td>Auto Transformer</td>
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<td>Automatic Train Control</td>
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<td>ATO</td>
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<tr>
<td>ATP</td>
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<td>Automatic Train Stop</td>
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<td>Ave.</td>
<td>Average</td>
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**Final Report - Volume 3**

**Abbreviations and Units**
Abbreviations and Units

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

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
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<td>Cairo Metro Organization</td>
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<tr>
<td>CMOS</td>
<td>Complementary Metal Oxide Semiconductor</td>
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<tr>
<td>CNG</td>
<td>Compressed Natural Gas</td>
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<tr>
<td>COP</td>
<td>Crew Operation Panel</td>
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<td>CPEE</td>
<td>City Unit Cable</td>
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<td>CPM</td>
<td>Critical Path Method</td>
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<td>CREATS</td>
<td>Cairo Regional Area Transportation Study</td>
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<td>CRT</td>
<td>Cathode Ray Tube</td>
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<tr>
<td>CS</td>
<td>Cab Signal</td>
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<td>CSC</td>
<td>Contactless Smart Card</td>
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<tr>
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<td>Cairo Transport Authority</td>
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<td>CULTNAT</td>
<td>Cultural and National Heritage</td>
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<td>CV</td>
<td>Curriculum Vitae</td>
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<td>Continuously Welded Rail</td>
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<td>Dry Bulb (Ventilation)</td>
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<td>DO</td>
<td>Dissolved Oxygen</td>
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<td>DOS</td>
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<tr>
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<td>Design Standards for Railway Structures and Commentary</td>
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<td>EGSA</td>
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<td>EHF</td>
<td>Extremely High Frequency (mill-meter wave)</td>
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<td>EIA</td>
<td>Environmental Impact Assessment</td>
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<td>EIRENE</td>
<td>European Integrated Railway Radio Enhanced NEtwork</td>
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<td>EIRR</td>
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<td>ELCB</td>
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<td>EMC</td>
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<td>EPBM</td>
<td>Earth Pressure Balanced Machine</td>
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<td>FY</td>
<td>Fiscal Year, Financial Year</td>
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<td>Acronym</td>
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<td>GARBLT</td>
<td>General Authority for Roads, Bridges and Land Transport</td>
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<td>General Consultant</td>
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<td>Greater Cairo Area</td>
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<td>Greater Cairo Region</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>Grand Egyptian Museum</td>
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<td>GHG</td>
<td>Greenhouse Gas</td>
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<td>GIS</td>
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<td>Government of Japan</td>
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<td>GOPP</td>
<td>General Organization for Physical Planning</td>
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<td>GPS</td>
<td>Global Positioning by Satellite System</td>
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<tr>
<td>GRDP</td>
<td>Gross Regional Domestic Product</td>
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<td>GSM</td>
<td>Global System for Mobile communications</td>
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<td>GSM-R</td>
<td>Global System for Mobile communications for Railways</td>
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<td>GUI</td>
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<td>hr</td>
<td>hour</td>
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<td>Insulated Cable Engineers Association</td>
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<td>IDC</td>
<td>In-Direct Cost</td>
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<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
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<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
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<td>IGBT</td>
<td>Insulated Gate Bipolar Transistor</td>
</tr>
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<td>IMF</td>
<td>International Monetary Fund</td>
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<tr>
<td>IP</td>
<td>Implementation Program</td>
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<td>Insulated Rail Joint</td>
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<td>Internal Rate of Return</td>
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<td>Industrial Television</td>
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<td>International Union for Conservation of Nature and Natural Resources</td>
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<td>JARTS</td>
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<td>JBIC</td>
<td>Japan Bank for International Cooperation (former name of JICA)</td>
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<td>kV</td>
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<td>kilo Volt Ampere</td>
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<td>Liquid Crystal Display</td>
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<td>Light Emitting Diode</td>
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<td>MCPC</td>
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<td>MCS</td>
<td>Manual Control Switch</td>
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<tr>
<td>MDB</td>
<td>Manual Door Opening Button</td>
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<td>M&amp;E</td>
<td>Mechanical and Electrical</td>
</tr>
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<td>MDBF</td>
<td>Mean Distance Between Failure</td>
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<td>min.</td>
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<td>Metro Line 4 North section (Phase 2)</td>
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<td>M4W</td>
<td>Metro Line 4 West Section (Phase 1)</td>
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<td>MW</td>
<td>Mega Watt</td>
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<tr>
<td>NAT</td>
<td>National Authority for Tunnel, Ministry of Transport</td>
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<td>NATM</td>
<td>New Austrian Tunneling Method</td>
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<td>NFPA</td>
<td>National Fire Prevention Association</td>
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<td>NGO</td>
<td>Non-Governmental Organization</td>
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<td>NHB</td>
<td>Non-Home Based</td>
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<td>NOUH</td>
<td>National Organization for Urban Harmony</td>
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<td>NOx</td>
<td>Nitrogen Oxides</td>
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<td>Net Present Value</td>
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<td>Overhead Contact System</td>
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<td>OD / O/D</td>
<td>Origin and Destination</td>
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<td>ODA</td>
<td>Official Development Assistance</td>
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<td>Over Head Catenary</td>
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<tr>
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<td>Operation and Maintenance</td>
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<td>OP</td>
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<td>ORC</td>
<td>Overhead Rigid Conductor</td>
</tr>
<tr>
<td>p.a.</td>
<td>per annum</td>
</tr>
<tr>
<td>P&amp;L</td>
<td>Profit and Loss</td>
</tr>
<tr>
<td>PA</td>
<td>Public Announcement/ Public Address</td>
</tr>
<tr>
<td>PAP</td>
<td>Project Affected Person</td>
</tr>
<tr>
<td>Pax</td>
<td>Passenger</td>
</tr>
<tr>
<td>PBX</td>
<td>Private Automatic Branch Exchange</td>
</tr>
<tr>
<td>PC</td>
<td>Pre-stressed Concrete</td>
</tr>
<tr>
<td>PC</td>
<td>Personal Computer</td>
</tr>
<tr>
<td>PCP</td>
<td>Power Control Point</td>
</tr>
<tr>
<td>PCU</td>
<td>Passenger Car Unit</td>
</tr>
<tr>
<td>p/h</td>
<td>person per hour</td>
</tr>
<tr>
<td>PHPDT</td>
<td>Peak Hour Peak Direction Trips</td>
</tr>
<tr>
<td>PID</td>
<td>Passenger Information Display</td>
</tr>
<tr>
<td>PKI-SAM</td>
<td>Public Key Infrastructure - Security Access Key</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>pm</td>
<td>post meridian</td>
</tr>
<tr>
<td>PM</td>
<td>Particulate Matter</td>
</tr>
<tr>
<td>PMSM</td>
<td>Permanent Magnet Synchronous Motor</td>
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<tr>
<td>PPHPD</td>
<td>Passengers Per Hour Per Direction</td>
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<td>PPM</td>
<td>Planned Preventive Maintenance</td>
</tr>
<tr>
<td>PRC</td>
<td>Programmed Route Control</td>
</tr>
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<td>PRJ</td>
<td>Projector</td>
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<td>PSD</td>
<td>Platform Screen Door</td>
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<td>P.T.</td>
<td>Piaster</td>
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<td>PT</td>
<td>Person Trip</td>
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<tr>
<td>PTC</td>
<td>Programmed Traffic Control</td>
</tr>
<tr>
<td>PPM</td>
<td>Parts Per Million</td>
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<td>PSO</td>
<td>Public Service Obligation</td>
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<tr>
<td>PVC</td>
<td>Poly Vinyl Chloride</td>
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<td>PVU</td>
<td>Portable Verification Unit</td>
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<tr>
<td>PW</td>
<td>Permanent Way</td>
</tr>
<tr>
<td>QA</td>
<td>Quality Assurance</td>
</tr>
<tr>
<td>RA</td>
<td>Returned Air</td>
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<tr>
<td>RAMS</td>
<td>Reliability, Availability, Maintainability and Safety</td>
</tr>
<tr>
<td>RAP</td>
<td>Resettlement Action Plan</td>
</tr>
<tr>
<td>RBO</td>
<td>Regional Branch Offices</td>
</tr>
<tr>
<td>RC</td>
<td>Reinforced Concrete</td>
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<td>RCS</td>
<td>Radio Central Control System</td>
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<td>Rd.</td>
<td>Road</td>
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<tr>
<td>RF</td>
<td>Radio Frequency</td>
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<td>Rf</td>
<td>Rectifier equipment</td>
</tr>
<tr>
<td>RH</td>
<td>Relative Humidity</td>
</tr>
<tr>
<td>RI</td>
<td>Relay Interlocking</td>
</tr>
<tr>
<td>Rij</td>
<td>Railway Length</td>
</tr>
<tr>
<td>RL</td>
<td>Rail Level</td>
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<tr>
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<td>Return On Equity</td>
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<tr>
<td>ROI</td>
<td>Return On Investment</td>
</tr>
<tr>
<td>ROW</td>
<td>Right Of Way</td>
</tr>
<tr>
<td>RP</td>
<td>Revealed Preference</td>
</tr>
<tr>
<td>RPS</td>
<td>Revealed Preference Survey</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
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<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>RPF</td>
<td>Resettlement Policy Framework</td>
</tr>
<tr>
<td>RS</td>
<td>Rectifier Station</td>
</tr>
<tr>
<td>RS</td>
<td>Rolling Stock</td>
</tr>
<tr>
<td>RT</td>
<td>Refrigeration Tons</td>
</tr>
<tr>
<td>RTU</td>
<td>Remote Terminal Unit</td>
</tr>
<tr>
<td>RTRI</td>
<td>Railway Technical Research Institute, Japan</td>
</tr>
<tr>
<td>R/W</td>
<td>Read and Write</td>
</tr>
<tr>
<td>SA</td>
<td>Supply Air</td>
</tr>
<tr>
<td>SAM</td>
<td>Security Access Module</td>
</tr>
<tr>
<td>SCA</td>
<td>Supreme Council of Antiquities</td>
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<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition</td>
</tr>
<tr>
<td>SCU</td>
<td>Station Control Unit</td>
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<tr>
<td>SDH</td>
<td>Synchronous Digital Hierarchy</td>
</tr>
<tr>
<td>SDMP</td>
<td>The Strategic Urban Development Master Plan Study for a sustainable Development of the Greater Cairo Region in the Arab Republic of Egypt</td>
</tr>
<tr>
<td>Sec.</td>
<td>Section</td>
</tr>
<tr>
<td>sec.</td>
<td>second</td>
</tr>
<tr>
<td>SEVP</td>
<td>Signal Polyethylene Vinyl Cable</td>
</tr>
<tr>
<td>SF</td>
<td>Stored Fare (Ticket)</td>
</tr>
<tr>
<td>SHF</td>
<td>Super High Frequency (centimeter wave)</td>
</tr>
<tr>
<td>SI</td>
<td>Systeme Internationale d’Unites (SI Unit)</td>
</tr>
<tr>
<td>SI</td>
<td>Sensitive Indicator</td>
</tr>
<tr>
<td>SIFE</td>
<td>Students in Free Enterprise</td>
</tr>
<tr>
<td>SL</td>
<td>Screen Line</td>
</tr>
<tr>
<td>SM</td>
<td>Single Mode</td>
</tr>
<tr>
<td>SO₂</td>
<td>Sulfur Dioxide</td>
</tr>
<tr>
<td>SOFRETU</td>
<td>Société Française d’études et de réalisations de transports urbains</td>
</tr>
<tr>
<td>SP</td>
<td>Stated Preference</td>
</tr>
<tr>
<td>SPAD</td>
<td>Signal Passing At Danger</td>
</tr>
<tr>
<td>SPF</td>
<td>Shadow Pricing Factor</td>
</tr>
<tr>
<td>SPS</td>
<td>Stated Preference Survey</td>
</tr>
<tr>
<td>SPT</td>
<td>Standard Penetration Test</td>
</tr>
<tr>
<td>SQEE</td>
<td>Signal Quad Polyethylene Cable</td>
</tr>
<tr>
<td>sq.m.</td>
<td>square meter</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>SSOP</td>
<td>Station Staff operation Panel</td>
</tr>
<tr>
<td>STA / Sta.</td>
<td>Station</td>
</tr>
<tr>
<td>STRASYA</td>
<td>Standard Urban Railway System for Asia</td>
</tr>
<tr>
<td>STEP</td>
<td>Special Terms for Economic Partnership</td>
</tr>
<tr>
<td>SV</td>
<td>Switching Value</td>
</tr>
<tr>
<td>S/W</td>
<td>Scope of Work</td>
</tr>
<tr>
<td>SWWT</td>
<td>Spine Waste Water Tunnel</td>
</tr>
<tr>
<td>TAC</td>
<td>Track Access Charge</td>
</tr>
<tr>
<td>TAZ</td>
<td>Traffic Analysis Zone</td>
</tr>
<tr>
<td>TBM</td>
<td>Tunnel Boring Machine</td>
</tr>
<tr>
<td>TD</td>
<td>Train Detection</td>
</tr>
<tr>
<td>TD</td>
<td>Tender Document</td>
</tr>
<tr>
<td>TDM</td>
<td>Time Division Multiplex</td>
</tr>
<tr>
<td>TDMA</td>
<td>Time Division Multiple Access</td>
</tr>
<tr>
<td>TEF</td>
<td>Tunnel Exhaust Fans</td>
</tr>
<tr>
<td>TETRA</td>
<td>Terrestrial Trunked Radio</td>
</tr>
<tr>
<td>TIS</td>
<td>Ticket Initialization Unit</td>
</tr>
<tr>
<td>TOM</td>
<td>Ticket Office Machine</td>
</tr>
<tr>
<td>TOR</td>
<td>Terms Of Reference</td>
</tr>
<tr>
<td>TR</td>
<td>Ticket Reader</td>
</tr>
<tr>
<td>TV</td>
<td>Television</td>
</tr>
<tr>
<td>TVF</td>
<td>Tunnel Ventilation Fans</td>
</tr>
<tr>
<td>TVM</td>
<td>Ticket Vending Machine</td>
</tr>
<tr>
<td>UNDP</td>
<td>United Nations Development Programme</td>
</tr>
<tr>
<td>UIC</td>
<td>Union International des Chemins de fer (International Union of Railways)</td>
</tr>
<tr>
<td>UPS</td>
<td>Uninterruptible Power Supply</td>
</tr>
<tr>
<td>USRT</td>
<td>United States Refrigeration Tons</td>
</tr>
<tr>
<td>V</td>
<td>Volt</td>
</tr>
<tr>
<td>VAT</td>
<td>Value Added Tax</td>
</tr>
<tr>
<td>VHF</td>
<td>Very High Frequency</td>
</tr>
<tr>
<td>VOC</td>
<td>Vehicle Operating Cost</td>
</tr>
<tr>
<td>VOT</td>
<td>Value Of Travel Time</td>
</tr>
<tr>
<td>VVVF</td>
<td>Valuable Voltage Valuable Frequency</td>
</tr>
<tr>
<td>W</td>
<td>Watt</td>
</tr>
<tr>
<td>---</td>
<td>------</td>
</tr>
<tr>
<td>WB</td>
<td>World Bank</td>
</tr>
<tr>
<td>WB</td>
<td>Wet Bulb</td>
</tr>
<tr>
<td>W/D</td>
<td>Workshop/Depot</td>
</tr>
<tr>
<td>W/S</td>
<td>Work Station</td>
</tr>
<tr>
<td>WS</td>
<td>Wayside Signal</td>
</tr>
<tr>
<td>WAN</td>
<td>Wide Area Network</td>
</tr>
<tr>
<td>WWW</td>
<td>World Wide Web</td>
</tr>
<tr>
<td>WYSIWYG</td>
<td>What You See Is What You Get</td>
</tr>
</tbody>
</table>
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
km²  Square Kilometer
km/h  Kilometer per hour
kWh  Kilowatt hour
kV  Kilovolt
l  Liter
L.E.  Egyptian Pound
m  Meter
m²  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
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>sec</td>
<td>Second</td>
</tr>
<tr>
<td>ug/m³</td>
<td>Microgram per cubic meter</td>
</tr>
<tr>
<td>USRT</td>
<td>United States Refrigeration Tons</td>
</tr>
<tr>
<td>V</td>
<td>Volt</td>
</tr>
<tr>
<td>Vac</td>
<td>Volt alternating current</td>
</tr>
<tr>
<td>Vdc</td>
<td>Volt direct current</td>
</tr>
<tr>
<td>wt</td>
<td>weight</td>
</tr>
<tr>
<td>°C</td>
<td>Degree Celsius</td>
</tr>
<tr>
<td>°F</td>
<td>Degree Fahrenheit</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY OF VOLUME 3

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 14 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. Main Study Components of Volume 3

The main components to be covered in Volume 3 are as follows;

1) Review and Updating Demand Forecast for Metro Line 4
2) General Features and Main Characteristics
3) Preliminary Design for Phase 1
4) Outline Design for Phase 2
5) Operation and Maintenance Management Plan
6) Project Cost and Packaging
7) Planning of Project Implementation Program
8) Environmental and Social Considerations
9) Resettlement Action Plan (RAP) Framework Study
10) Archaeological Assessment Study
11) Economic and Financial Analysis

3. Review and Updating Demand Forecast for Metro Line 4

The forecasting reference years for demand estimation are set up on the basis of the construction schedule, i.e., as of 2020, 2023, 2027 and 2050. The year 2020 is the starting year of the Metro Line 4, Phase 1 section operation, while 2023 is the starting year of that of the Phase 2 section. The year 2027 is the base year of the projection and the year 2050 is the target year for facility planning. The results of the demand forecast and daily/peak hour passengers for Metro Line 4 are summarized in the tables below.

Table 1 Projected Passenger by Transportation Mode

<table>
<thead>
<tr>
<th>Year</th>
<th>Private Mode (Passenger Car, Taxi)</th>
<th>Public Bus Mode (Bus, Shared Taxi)</th>
<th>Public Rail Mode (Metro, LRT)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 2020</td>
<td>7,317,081</td>
<td>12,815,802</td>
<td>3,946,918</td>
<td>24,079,801</td>
</tr>
<tr>
<td></td>
<td>30.4%</td>
<td>53.2%</td>
<td>16.4%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Year 2023</td>
<td>8,292,396</td>
<td>12,607,342</td>
<td>4,388,364</td>
<td>25,288,102</td>
</tr>
<tr>
<td></td>
<td>32.8%</td>
<td>49.9%</td>
<td>17.4%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Year 2027</td>
<td>9,561,250</td>
<td>12,364,875</td>
<td>4,776,201</td>
<td>26,702,326</td>
</tr>
<tr>
<td></td>
<td>35.8%</td>
<td>46.3%</td>
<td>17.9%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Year 2050</td>
<td>19,222,178</td>
<td>16,017,445</td>
<td>7,961,171</td>
<td>43,200,794</td>
</tr>
<tr>
<td></td>
<td>44.5%</td>
<td>37.1%</td>
<td>18.4%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Unit: person-trip per day
Source: JICA Study Team

Table 2 Number of Passengers Per Day for Metro Line 4

<table>
<thead>
<tr>
<th>Year</th>
<th>Summary of Number of Passenger Per Day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Year 2020</td>
</tr>
<tr>
<td>Phase 1 Section</td>
<td>1,011,900</td>
</tr>
<tr>
<td>Phase 2 Section</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>1,011,900</td>
</tr>
</tbody>
</table>

Note: The passengers who ride on both Phase 1 and 2 sections on Metro Line 4 are counted as the passengers of Phases 1 and 2, respectively. Therefore, the number of passengers for Line 4 in total is smaller than the simple summation of Phase 1 and Phase 2 sections.

Source: JICA Study Team
Table 3  Summary of Metro Line 4 Section Maximum Passengers

<table>
<thead>
<tr>
<th>Year</th>
<th>Phase 1 Section</th>
<th>Phase 2 Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>Sec Pax (section passenger both direction per day) 427,700</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>PPHPD (passenger per hour per direction) 29,940</td>
<td>-</td>
</tr>
<tr>
<td>2023</td>
<td>Sec Pax (section passenger both direction per day) 447,700</td>
<td>725,100</td>
</tr>
<tr>
<td></td>
<td>PPHPD (passenger per hour per direction) 31,340</td>
<td>50,760</td>
</tr>
<tr>
<td>2027</td>
<td>Sec Pax (section passenger both direction per day) 584,700</td>
<td>763,800</td>
</tr>
<tr>
<td></td>
<td>PPHPD (passenger per hour per direction) 40,930</td>
<td>53,470</td>
</tr>
<tr>
<td>2050</td>
<td>Sec Pax (section passenger both direction per day) 784,700</td>
<td>796,400</td>
</tr>
<tr>
<td></td>
<td>PPHPD (passenger per hour per direction) 54,930</td>
<td>55,750</td>
</tr>
</tbody>
</table>

Source: JICA Study Team

4. General Features and Main Characteristics

The main technical characteristics for the railway system proposed for Metro Line 4 are shown in Table 4 below

Table 4  Main Technical Characteristics

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Phase 1</td>
</tr>
</tbody>
</table>

Alignment

| 1 | El Malek El Saleh Sta. (Line 1) – El Giza Sta. (Line 2) - El Remayah Square - Workshop/Depot | El Malek El Saleh Sta. (Line 1) - Ghamrah - El Sawaha Square - Ring Road Exit #18 |

Route length

| 2 | Total route length 16.1km | 17.9km |
|   | - Underground section length 16.1km | 12.5km |
|   | - Elevated section length 0km | 5.4km |

Stations

| 3 | Total number of stations 15 stations | 16 stations |
|   | - Number of underground stations 15 stations | 12 stations |
|   | - Number of elevated stations 0 stations | 4 stations |

Operation status

| 4 | Estimated number of passengers/day |
|   | - In year 2020 (Opening) 0.69 million (Phase 1 only) | 2.04 million (Phase 1 + Phase 2) |
|   | - In year 2050 | |
| Headways in peak hour | 4 minutes 00 seconds in 2020 2 minutes 09 seconds in 2050 |
| Maximum operation speed |
| - Underground section 80 km/hr |
| - Elevated section 100 km/hr |
| - Inside depot 25 km/hr |
| Average speed 32.2 km/hr |
### Executive Summary

#### No. Description

<table>
<thead>
<tr>
<th>Details</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwell time at intermediate stations</td>
<td>30 seconds</td>
<td></td>
</tr>
<tr>
<td>Round trip time</td>
<td>70 minutes</td>
<td>137 minutes (Phase 1 + Phase 2)</td>
</tr>
<tr>
<td>Daily operation hour</td>
<td>05:00h – 01:00h</td>
<td></td>
</tr>
<tr>
<td>Train size</td>
<td>8 cars in a train-set</td>
<td></td>
</tr>
<tr>
<td>Driver system</td>
<td>Single driver operation</td>
<td></td>
</tr>
<tr>
<td>Location of CCP</td>
<td>El Malek El Saleh</td>
<td></td>
</tr>
</tbody>
</table>

#### Standards of construction

<table>
<thead>
<tr>
<th>Details</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gauge</td>
<td>1,435 mm</td>
<td></td>
</tr>
<tr>
<td>Track center distance</td>
<td>3.5 m at elevated section</td>
<td></td>
</tr>
<tr>
<td>Tracks</td>
<td>Vibration-reducing track</td>
<td></td>
</tr>
<tr>
<td>Design Axle load</td>
<td>16 tonnes max.</td>
<td></td>
</tr>
<tr>
<td>Rail</td>
<td>UIC 54 kg/m</td>
<td></td>
</tr>
<tr>
<td>Max. gradient</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Min. horizontal curve radius</td>
<td>Main line: 250 m</td>
<td>Main line turnout curve: 160 m</td>
</tr>
<tr>
<td></td>
<td>Workshop / depot line: 160 m</td>
<td>Workshop / depot line turnout curve: 120 m</td>
</tr>
<tr>
<td></td>
<td>Platform section: 1,000 m</td>
<td></td>
</tr>
</tbody>
</table>

#### Tunnel structure

<table>
<thead>
<tr>
<th>Details</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of tunnel</td>
<td>Single track</td>
<td>Double tube</td>
</tr>
<tr>
<td>Diameter</td>
<td>6.2 m (inner diameter)</td>
<td></td>
</tr>
</tbody>
</table>

#### Station structure

<table>
<thead>
<tr>
<th>Details</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Platform</td>
<td>11 stations</td>
<td>16 stations</td>
</tr>
<tr>
<td>- Island type</td>
<td>4 stations</td>
<td>0 stations</td>
</tr>
<tr>
<td>Platform width</td>
<td>12.0 m (island type)</td>
<td></td>
</tr>
<tr>
<td>Platform height</td>
<td>1100 mm</td>
<td></td>
</tr>
<tr>
<td>Platform length</td>
<td>170 m</td>
<td></td>
</tr>
</tbody>
</table>

#### Depot

<table>
<thead>
<tr>
<th>Details</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stabling capacity</td>
<td>35 train sets</td>
<td>35 train sets</td>
</tr>
<tr>
<td>Facilities</td>
<td>Stabling and maintenance facilities</td>
<td></td>
</tr>
</tbody>
</table>

#### Rolling stock

<table>
<thead>
<tr>
<th>Details</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of rolling stock</td>
<td>EMU (Electric Multiple Unit)</td>
<td></td>
</tr>
<tr>
<td>Train formation</td>
<td>M-N1-T-N2-N2-T-N1-M</td>
<td>or Tc-N3-N1-N3-N1-N3-N1-Tc</td>
</tr>
<tr>
<td>Passenger capacity (AW2: 7 person/m²)</td>
<td>2,000 passenger/train</td>
<td></td>
</tr>
<tr>
<td>Train dimensions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Car length (over coupler faces)</td>
<td>20.0 m</td>
<td></td>
</tr>
<tr>
<td>- Car width</td>
<td>2.88 m</td>
<td></td>
</tr>
<tr>
<td>- Car height</td>
<td>4.1 m</td>
<td></td>
</tr>
<tr>
<td>- Train length (8-car unit)</td>
<td>160 m</td>
<td></td>
</tr>
</tbody>
</table>

#### Propulsion System

<table>
<thead>
<tr>
<th>Details</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit control system</td>
<td>Inverter with IGBT</td>
<td></td>
</tr>
<tr>
<td>Traction motor</td>
<td>PMSM*1 or Induction motor</td>
<td></td>
</tr>
<tr>
<td>Motor output power</td>
<td>140 kW/motor</td>
<td></td>
</tr>
<tr>
<td>Car body material</td>
<td>Lightweight stainless steel</td>
<td></td>
</tr>
<tr>
<td>Doors</td>
<td>8 doors per car (4 on each side)</td>
<td></td>
</tr>
<tr>
<td>Kinetic performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Initial acceleration ratio</td>
<td>0.9 m/s²</td>
<td></td>
</tr>
<tr>
<td>- Max service deceleration</td>
<td>1.1 m/s² (ability 1.3 m²/s²)</td>
<td></td>
</tr>
<tr>
<td>Air conditioning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Type of air conditioning</td>
<td>Roof-mounted with line-flow fan</td>
<td></td>
</tr>
<tr>
<td>- Capacity</td>
<td>40,000 kcal/h/car</td>
<td></td>
</tr>
</tbody>
</table>
### Power supply and traction system

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Electrification system</td>
<td>1500VDC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type of centenary system</td>
<td>OHC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Tunnel: Overhead rigid conductor)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Nominal voltage</td>
<td>1500VDC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Max. voltage</td>
<td>1800VDC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Min. voltage</td>
<td>1000VDC</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>HVS (High Voltage Station)</td>
<td>1 HVS 80MVA</td>
<td>1 HVS 80MVA</td>
</tr>
<tr>
<td></td>
<td>- Number of stations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Transformer capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>RS (Rectifier Station)</td>
<td>5 RS 6MW</td>
<td>6 RS 6MW</td>
</tr>
<tr>
<td></td>
<td>- Number of stations</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>LPS (Lighting Power Station)</td>
<td>1 LPS/station and Depot</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Number of stations</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Signalling and Telecommunications system

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Signals</td>
<td>On-board signal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Main line including between main line and stabling in Depot</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Inside of Depot</td>
<td>Wayside signal</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Train detection system</td>
<td>Track circuit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Interlocking</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Point machine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Train Interval control system</td>
<td>ATP (Automatic Train Protection, Continuous control)</td>
<td>PTC (Programmed Traffic Control)</td>
</tr>
<tr>
<td></td>
<td>- System</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Accuracy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Backbone transmission network system</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- System</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Transmissionmedia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Train radio system</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- System</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Antenna</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>CCTV (Closed Circuit Television) system including on-board monitoring system</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Passenger Information system</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Monitoring of platform, concourse, ticket gate, elevator, escalator, others</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>AFC (Automatic Fare Collection) system</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Type of ticket media</td>
<td>Magnetic Ticket (MT), Contactless IC ticket</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- IC chip standard</td>
<td>ISO/IEC 14443 (Type-A)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Card size</td>
<td>ISO 7810</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>PSD (Platform Screen Door) system</td>
<td>For underground stations, except El Remayah station</td>
<td>For elevated stations, including El Remayah station</td>
</tr>
<tr>
<td></td>
<td>- Full height PSD</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Half height PSD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Other major facilities</td>
<td>Elevator, Escalator, Air conditioner, Air intake &amp; Exhaust system, Fire protection system, etc.</td>
<td></td>
</tr>
</tbody>
</table>

*1: PMSM: Permanent Magnet Synchronous Motor
*2: VHF: Very High Frequency
*3: TDM/TDMA: Time Division Multiplex/Time Division Multiple Access
Source: JICA Study Team
5. Preliminary Design for Phase 1

The feasibility study route on Metro Line 4 Phase 1 consists of the Phase 1A section (El Malek El Saleh – El Remayah Square), Phase 1B section (El Remayah Sq. – Hadeek Al Aharam – Workshop/Depot). The Phase 1A study was undertaken at a full-scale level. The Phase 1B study was carried out on a preliminary level, with limited material and data because of the delay in finalizing the location of the workshop/depot and the alignment route. Preliminary design was consist of following plans.

- Train operating plan
- Disaster prevention & security plan
- Rolling stock plan
- Civil works plan
- Architectural works plan
- System and facilities & equipment plan
- Workshop/Depot plan

Outline of Metro Line 4 is shown in following figure.

![Outline of Metro Line 4](image_url)

Source: JICA Study Team

**Figure 1** Outline of Metro Line 4
5.1 Train Operating Plan

Estimated daily number of trains (working day, one-way) and train-kilometres are shown in Table below. The required number of train-sets is 20 in 2020, 66 in 2023 (starting year of Phase 2 operation), 68 sets in 2027, and 70 sets in 2050.

Table 5 Estimated Daily Number of Trains (Working day, One-way) and Train-kilometres

<table>
<thead>
<tr>
<th>Items</th>
<th>Year</th>
<th>2020</th>
<th>2023</th>
<th>2027</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of trains per hour per direction</td>
<td>A</td>
<td>15</td>
<td>26</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>Number of trains per direction per day (Working day)</td>
<td>B</td>
<td>198</td>
<td>343</td>
<td>353</td>
<td>367</td>
</tr>
<tr>
<td>Number of trains per day (Holidays)</td>
<td>C</td>
<td>127</td>
<td>223</td>
<td>233</td>
<td>240</td>
</tr>
<tr>
<td>Train-km (Working day)</td>
<td>D</td>
<td>6,376</td>
<td>23,118</td>
<td>23,792</td>
<td>24,736</td>
</tr>
<tr>
<td>Train-km (Holidays)</td>
<td>E</td>
<td>4,089</td>
<td>15,030</td>
<td>15,704</td>
<td>16,176</td>
</tr>
<tr>
<td>Train-km per year (000)</td>
<td>F</td>
<td>2,202</td>
<td>7,994</td>
<td>8,240</td>
<td>8,559</td>
</tr>
</tbody>
</table>

Route km: = 16.1 km (2020), = 16.1 + 17.6 = 33.7 km (2023, 2027, 2050)
Source: JICA Study Team

5.2 Disaster Prevention & Security Plan

In order to operate the metro properly and safely, the management and countermeasure for the emergency/disaster incident are very important issues. Fire, flooding, strong wind (at grade or elevated section), etc. are considered as the emergency/disaster incidents for the metro. Especially, fire and its management/countermeasure is most crucial matter for the underground section of metro operation. Therefore, JICA Study Team has studied and compared the fire management and countermeasure to be applied for Metro Line 4. Basically, JICA Study Team proposed Japanese standard and regulations with consideration of NFPA and local regulations.

5.3 Rolling stock plan

JICA Study Team proposes the rolling stock for Metro Line 4 on the basis of the customer satisfaction, efficiency, reliability, maintenance reduction, environmental friendliness and application of up-to-date technology. Main specification of rolling stock is described in the above technical characteristics table.

5.4 Civil Works Plan

5.4.1 Tunnel Section

JICA Study Team has proposed Single Track Double Tunnel (STDT) type with the shield TBM for the Metro Line 4 tunnel section. The STDT has many advantages in construction,
environment, cost and operation. The application of the STDT is increasing all over the world, including Europe.

In addition, STDT can change the location of two tunnels flexibly from horizontal to vertical. It is possible for STDT to avoid existing structures and pass narrow spaces. In some areas, the foundation/piles of existing structures are closely situated and the space between them is very narrow. STDT can provide less impact to the surrounding environment.

5.4.2 Station Section

JICA Study Team has studied and proposed three types of standard station structure with consideration of the surrounding condition, neighbouring structures, convenience and economical advantages. On the other hand, five stations are located in the densely populated and congested area and there are constrains of the land use of the ground level. In order to avoid some structures or minimize the land acquisition the station structures in the said area are different from that of the standard stations. The major features of Metro Line 4 station structure are as follow.

- All stations of the Metro Line 4 (phase 1) are underground.
- Tunnel structure type of the Metro Line 4 is single track double tunnels.
- The platform of Metro Line 4 is mainly island type except for the two-storey platform stations, namely, El Nile station and El Giza station.
- PSD is installed at all stations of Metro Line 4.

JICA Study Team has also studied and described construction method with typical traffic management plan for special stations.

5.5 Architectural Works Plan

As for the station design concept, JICA Study Team has classified into three types as “Signature Station”, “Modal Interchange Station” and “Typical Station”.

5.5.1 Signature Station

Metro Line 4 will be a gateway line to the world heritage Pyramids and the Grand Egyptian Museum (GEM). El Remayah Station, a terminal station for Phase 1, is important for foreign visitors and to those who travel to 6th October City from the station using public buses, taxis and private cars. This station will be the signature station for Line 4, and will be designed to emphasize a great expectation for the world heritage concept. Not only the annexed structures are above ground, but also the interior design of the station’s public areas will be in harmony with the image of this great heritage.

5.5.2 Typical Station

Because of the similarity of geographic, topographic and social environment conditions, the stations located in Pyramids Road will be designed as typical stations.

A typical station has three underground floors with a minimum length of 190 m required for
both technical and station operation facilities. This figure of 190 m is derived from the sum of 170 m platform length (160 m train length plus 5 m of clearance for both ends of the train) and an 10 m from both ends of the platform, which is added for the provision of rooms required for station operation.

5.5.3 Modal Interchange Station

Four stations are proposed as modal interchange stations, which need to provide short and medium distance bus terminals and facilities for taxis and private cars. JICA Study Team has developed conceptual master plans for these four stations: First of these is for an underground temporary terminal and transfer to Metro Line 1 at El Malek El Saleh Station with a proposal for redevelopment for commercial and other facilities. Second is M4W Sta. No.4 (El Giza Station) for a underground transfer to Metro Line 2 and the ENR with a proposal for underground development and a transportation plaza. Third is M4W Sta. No.12 (El Remayah Station) for a large and shallow underground station including a bus terminal to 6th October City, multi level car parking and underground commercial development. The fourth plan is M4W Sta. No.15 as a terminal station, with a large open car park and bus terminals to and beyond 6th October City, in view of further development and growing populations.

5.6 System and Facilities & Equipment Plan

5.6.1 Signalling

The signal system comprises the “Route control function”, “Remote route control function”, “Train interval control function”, “Train operation support device”, “Signal cables” and “Power supply equipment”. JICA Study Team has proposed to install computerized interlocking devices (CI) and electric point machines for traffic control function. Controls of the entire routes of entire stations are performed by remote control from a single CCP.

5.6.2 Telecommunication

The communication system comprises the “Communication line equipment”, “Optical carrier equipment”, “Train radio equipment”, “Platform monitoring system”, “Video monitoring system”, “Station communication equipment”, “Depot communication equipment” and “CCP communication equipment”. JICA Study Team has proposed Optical Fibre Cable (OFC) and CCP are laid as the backbone transmission system throughout all lines. Digital radio system is used for the train radio, and leaky coaxial cable (LCX) will be used inside the tunnel.

5.6.3 Power Supply

The power supply system includes all electrical systems for receiving electricity from a power company’s substation, and feeding rolling stocks and station facilities. An overall view of the power supply system is as shown in Figure 2 Main features of the power supply system for Metro Line 4 are shown in Table 6.
Table 6  Key Features of the Power Supply System for Metro Line 4

<table>
<thead>
<tr>
<th>Item</th>
<th>Metro Line 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phase 1</td>
</tr>
<tr>
<td>Nominal voltage of contact line</td>
<td>1,500 V DC</td>
</tr>
<tr>
<td>Type of contact line</td>
<td>Overhead Rigid Conductor</td>
</tr>
<tr>
<td>High Voltage Station (HVS)</td>
<td>Number and receiving voltage</td>
</tr>
<tr>
<td></td>
<td>Transformer capacity</td>
</tr>
<tr>
<td>Rectifier Station (RS)</td>
<td>Receiving voltage</td>
</tr>
<tr>
<td></td>
<td>Number of RS</td>
</tr>
<tr>
<td></td>
<td>Rectifier capacity</td>
</tr>
<tr>
<td></td>
<td>Back-up power supply for RS</td>
</tr>
<tr>
<td>Lighting and Power Station (LPS)</td>
<td>Receiving voltage</td>
</tr>
<tr>
<td></td>
<td>Number of LPS</td>
</tr>
<tr>
<td></td>
<td>Back-up power supply for station facility</td>
</tr>
</tbody>
</table>

Source: JICA Study Team
5.7 Workshop/Depot Plan

The Metro Line 4, Phase 1 depot yard is divided into two distinct parts. One part is associated with stabling and cleaning and another part is dedicated to maintenance and repair. In addition to these two complexes, there are buildings for administration, signalling and control as well as for traction power supplies.

In addition to the train washing, stabling, light maintenance and heavy maintenance facilities, there are yard facilities provided for the re-profiling of wheels by a ground wheel lathe; stabling, maintenance and repair of two diesel shunting locomotives; stabling, maintenance and repair of on-track plant for track maintenance and other works.

The ultimate capacity of the workshops is intended to permit the throughput of 20 full trainsets, annually, for 3-yearly and 6-yearly planned maintenance and overhaul during full 24-hour shift operation. This capacity should be adequate to cater to the needs of the Phase 1 initial fleet and for its later expansion to 30 trains as well as for the future needs of the Phase 2 fleet, projected to be additional 30 trains.

6. Outline Design for Phase 2

The study of the Phase 2 Northern Route section between El Malek El Saleh and Ring Road Exit #18 via El Sawaha Square along Port Said Street was carried out at the level of an outline design. The solutions and countermeasures for the risks and consideration of tunnel construction, especially the section of the route which runs in parallel with the Spine Waste Water Tunnel (SWWT) are also studied.

7. Operation and Maintenance Management Plan

Following plans are studied and described.

- System operations plan especially for CCP as well as train drivers and station staff, including fire fighting and evacuation plan
- Maintenance plan
- Organization plan (managed by ECM)
- Estimation of staff numbers for Metro Line 4
- Training plan (Japanese training system for drivers is introduced)

Estimations of staff numbers for Metro Line 4 is shown in Table 7.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Y2020</th>
<th>Y2023</th>
<th>Y2027</th>
<th>Y2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route km</td>
<td>16.1</td>
<td>33.7</td>
<td>33.7</td>
<td>33.7</td>
</tr>
<tr>
<td>Number of Stations</td>
<td>15</td>
<td>31</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>Number of Rolling Stock</td>
<td>160</td>
<td>528</td>
<td>544</td>
<td>560</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Number of Staff Required</td>
</tr>
<tr>
<td>Operation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drivers</td>
<td>79</td>
<td>286</td>
<td>295</td>
<td>306</td>
</tr>
<tr>
<td>Drivers in the depot</td>
<td>23</td>
<td>46</td>
<td>46</td>
<td>46</td>
</tr>
</tbody>
</table>
### Executive Summary

#### Categories

<table>
<thead>
<tr>
<th>Categories</th>
<th>Y2020</th>
<th>Y2023</th>
<th>Y2027</th>
<th>Y2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCP controllers</td>
<td>24</td>
<td>38</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>Station Staff</td>
<td>290</td>
<td>595</td>
<td>595</td>
<td>595</td>
</tr>
<tr>
<td>Sub total</td>
<td>416</td>
<td>965</td>
<td>974</td>
<td>985</td>
</tr>
<tr>
<td>Civil and Track</td>
<td>50</td>
<td>104</td>
<td>104</td>
<td>104</td>
</tr>
<tr>
<td>Rolling Stock</td>
<td>95</td>
<td>312</td>
<td>321</td>
<td>331</td>
</tr>
<tr>
<td>Electrical Equipment</td>
<td>75</td>
<td>157</td>
<td>157</td>
<td>157</td>
</tr>
<tr>
<td>Sub total</td>
<td>220</td>
<td>573</td>
<td>582</td>
<td>591</td>
</tr>
<tr>
<td>Administrative staff</td>
<td>131</td>
<td>131</td>
<td>131</td>
<td>131</td>
</tr>
<tr>
<td>Total</td>
<td>767</td>
<td>1,669</td>
<td>1,687</td>
<td>1,708</td>
</tr>
</tbody>
</table>

#### Total number of staff without the staff dispatched to the maintenance outsourcing companies

- 647 in Y2020
- 1,305 in Y2023
- 1,687 in Y2027
- 1,708 in Y2050

Source: JICA Study Team

### 8. Project Cost and Packaging

#### 8.1 Project Cost

The project cost consists of the initial capital cost and the O&M cost. It should be noted that initial capital costs include only the costs of infrastructure (civil works, track work and electrical and mechanical installations) and rolling stock provision, incurred during the construction period. Table 8 shows the summary of estimated initial cost for STEP Loan and Table 9 shows the total O&M cost for Metro Line 4.

**Table 8  Summary of Estimated Initial Cost (STEP Loan)**

<table>
<thead>
<tr>
<th>Description</th>
<th>Phase-1</th>
<th>Phase-2</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F/P</td>
<td>L/P</td>
<td>Total</td>
</tr>
<tr>
<td>Construction Cost</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil Works (Tunnel)</td>
<td>124.1 M</td>
<td>157.9 M</td>
<td>281.9 M</td>
</tr>
<tr>
<td>Civil Works (Elevated)</td>
<td>0.0 M</td>
<td>0.0 M</td>
<td>0.0 M</td>
</tr>
<tr>
<td>Station (Civil)</td>
<td>209.9 M</td>
<td>524.0 M</td>
<td>733.9 M</td>
</tr>
<tr>
<td>Track</td>
<td>109.4 M</td>
<td>48.7 M</td>
<td>60.4 M</td>
</tr>
<tr>
<td>Depot / Workshop</td>
<td>48.2 M</td>
<td>85.7 M</td>
<td>133.9 M</td>
</tr>
<tr>
<td>Station Facilities</td>
<td>210.4 M</td>
<td>123.6 M</td>
<td>334.0 M</td>
</tr>
<tr>
<td>Power Supply &amp; Electrification</td>
<td>73.6 M</td>
<td>60.4 M</td>
<td>134.0 M</td>
</tr>
<tr>
<td>Signal &amp; Telecom.</td>
<td>115.9 M</td>
<td>45.4 M</td>
<td>160.4 M</td>
</tr>
<tr>
<td>Total Construction Cost (①)</td>
<td>853.0 M</td>
<td>1,046.2 M</td>
<td>1,899.2 M</td>
</tr>
<tr>
<td>Rolling Stock</td>
<td>428.7 M</td>
<td>0.0 M</td>
<td>428.7 M</td>
</tr>
<tr>
<td>Total Procurement Cost (②)</td>
<td>428.7 M</td>
<td>0.0 M</td>
<td>428.7 M</td>
</tr>
<tr>
<td>Total of ①+②</td>
<td>1,281.8 M</td>
<td>1,046.2 M</td>
<td>2,328.0 M</td>
</tr>
<tr>
<td>Consultancy Service (① of 7%)</td>
<td>59.7 M</td>
<td>73.2 M</td>
<td>132.9 M</td>
</tr>
<tr>
<td>Physical Contingency (①+② of 5%)</td>
<td>61.4 M</td>
<td>56.3 M</td>
<td>117.7 M</td>
</tr>
<tr>
<td>Land acquisition &amp; Resettlement</td>
<td>79.1 M</td>
<td>129.2 M</td>
<td>208.3 M</td>
</tr>
<tr>
<td>Diversion of Public Utility</td>
<td>0.3 M</td>
<td>30.8 M</td>
<td>31.1 M</td>
</tr>
<tr>
<td>General Administration (① of 3%)</td>
<td>0.0 M</td>
<td>57.0 M</td>
<td>57.0 M</td>
</tr>
<tr>
<td>Price Escalation</td>
<td>526.9 M</td>
<td>371.7 M</td>
<td>900.6 M</td>
</tr>
<tr>
<td>Total-1</td>
<td>527.4 M</td>
<td>1,030.3 M</td>
<td>1,557.7 M</td>
</tr>
<tr>
<td>Grand Total</td>
<td>1,835.9 M</td>
<td>1,676.3 M</td>
<td>3,512.2 M</td>
</tr>
</tbody>
</table>

Source: JICA Study Team
Table 9  Total O&M Cost for Metro Line 4

<table>
<thead>
<tr>
<th>Items</th>
<th>Unit</th>
<th>Y2020</th>
<th>Y2023</th>
<th>Y2027</th>
<th>Y2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel costs</td>
<td>LE’000</td>
<td>12,293</td>
<td>24,795</td>
<td>32,053</td>
<td>32,452</td>
</tr>
<tr>
<td>Power cost</td>
<td>LE’000</td>
<td>12,500</td>
<td>30,040</td>
<td>30,500</td>
<td>30,960</td>
</tr>
<tr>
<td>Maintenance cost</td>
<td></td>
<td>21,971</td>
<td>27,578</td>
<td>1,659</td>
<td>1,687</td>
</tr>
<tr>
<td>Parts cost</td>
<td>LE’000</td>
<td>44,035</td>
<td>130,397</td>
<td>133,771</td>
<td>137,150</td>
</tr>
<tr>
<td>Cleaning cost</td>
<td>LE’000</td>
<td>1,266</td>
<td>3,622</td>
<td>3,703</td>
<td>3,785</td>
</tr>
<tr>
<td>Other costs</td>
<td></td>
<td>7,587</td>
<td>15,679</td>
<td>15,679</td>
<td>15,679</td>
</tr>
<tr>
<td>Security cost</td>
<td>LE’000</td>
<td>1,981</td>
<td>3,555</td>
<td>3,587</td>
<td>3,619</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>LE’000</td>
<td>101,633</td>
<td>235,666</td>
<td>220,952</td>
<td>225,332</td>
</tr>
</tbody>
</table>

Source: JICA Study Team

8.2 Packaging
JICA Study Team has proposed three packages for civil works, one package for railway system which includes electric and mechanical works, including station facilities and depot/workshop facilities, and one package for rolling stock.

9. Planning of Project Implementation Program
The implementation schedule is shown in Figure 3.

Figure 3  Project Implementation Schedule

10. Environmental and Social Considerations
Environmental Impact Assessment (EIA) was conducted with consideration of the Egyptian environmental regulations as well as the JICA Guideline for Environmental and Social Considerations, and ex-JBIC Guidelines for Confirmation of Environment and Social Considerations (hereinafter the Guidelines, or Guidelines of JICA and ex-JBIC) as donor policies.
11. Resettlement Action Plan (RAP) Framework Study

Resettlement Action Plan (RAP) Framework was prepared by reflecting regional conditions, which are studied through site reconnaissance and a socio-economic interview survey, and by considering donor policies such as JICA and ex-JBIC Guidelines as well as World Bank Operational Polices 4.12 on Involuntary Resettlement and Egyptian regulations.

12. Archaeological Assessment Study

Preservation of the archaeological and cultural properties as well as their landscapes was prioritized in this study. In line with this policy, with all available information, JICA Study Team was examined the archaeological assets of the area along the proposed routes for the Metro Line 4. This study was aims to eventually propose the risk assessment and countermeasures for the buried cultural properties.

13. Economic and Financial Analysis

The economic and financial appraisals of the Metro Line 4 construction project were undertaken both for the case of Phase 1 route only (i.e. without the addition of the second phase route) and for the case of an entire metro route comprising both the Phase 1 and Phase 2 route components.

13.1 Economic Appraisal

The result of the economic appraisal, such as Economic Internal Rate of Return (EIRR), Economic Net Present Value (ENPV), and Benefit Cost (BCR) are shown in table below.

<table>
<thead>
<tr>
<th>Item</th>
<th>Phase 1</th>
<th>Phase 1 + Phase 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>EIRR</td>
<td>17.10%</td>
<td>15.04%</td>
</tr>
<tr>
<td>ENPV</td>
<td>6,751.4 L.E. million</td>
<td>5,165.5 L.E. million</td>
</tr>
<tr>
<td>BCR</td>
<td>1.96</td>
<td>1.45</td>
</tr>
</tbody>
</table>

Source: JICA Study Team

13.2 Financial Appraisal

The result of the financial appraisal was measured by the following six indicators, which were estimated both for the Phase 1 only and the combined Phases 1 and 2 projects.

- Project FIRR, before financing
- Project FIRR, after financing
- Return on Equity (ROE)
- NPV at 12% rate of discount, before financing
- NPV at 12% rate of discount, after financing
- NPV to Equity at 12% rate of discount

The financial results of the comparison of the two project financing alternatives are given in Table 10.
## Table 10  Comparison of Financial Results for STEP Loan vs. Normal Loan with Standard Conditions - Financing of Phase 1 project

<table>
<thead>
<tr>
<th>Loan Type</th>
<th>Project FIRR</th>
<th>Project NPV (LE million)</th>
<th>ROE</th>
<th>NPV to Equity (mille million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEP Loan</td>
<td>2.85</td>
<td>-7,400</td>
<td>13.89%</td>
<td>163</td>
</tr>
<tr>
<td>Normal Loan</td>
<td>1.96</td>
<td>-8,502</td>
<td>Negative</td>
<td>9</td>
</tr>
</tbody>
</table>

Source: DCF Model of JICA Study Team
CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The Greater Cairo Region is the premier city in Egypt. It is steeped in history and containing large numbers 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. The Cairo Metro, the only specialized metro system in operation in the African Continent, commenced construction in 1981. Its design was based on the “Plans for Construction of Cairo Metro 3 Lines”, developed by SOFRETU in 1973 to improve road traffic congestion.

The current status of the Cairo Metro is as follows.

<table>
<thead>
<tr>
<th>Metro Line</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line 1</td>
<td>Phase 1 (28 km) started operation in 1987. The whole line (44 km) in full service by 1989.</td>
</tr>
<tr>
<td>Line 2</td>
<td>Phase 1 (8 km) started operation in 1996. The whole line (21.6 km) in full service by 2005.</td>
</tr>
<tr>
<td>Line 3</td>
<td>Phase 1 (4.3 km) under construction, scheduled to start operation in 2011. The whole line is 34.2 km.</td>
</tr>
</tbody>
</table>

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 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.

As a long-term strategic development plan, the General Office of Physical Planning (GOPP) has prepared “the Cairo Vision 2050”. This vision document proposes 14 metro routes as the main public transport system in the Greater Cairo Region.

As a consequence, the Government of Egypt has decided to construct, as early as practicable, the Metro Line 4 as initially proposed by CREATS, and in October 2008, requested the Government of Japan (GOJ) to implement the “Development Study Fiscal Year 2008 on Greater Cairo Metro Line 4 Project made 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 Objective of the Study

The primary objective is to conduct a feasibility study for Metro Line 4 (line length approximately 35 km), from a depot adjacent to the interchange of Alexandria Desert Road and Ring Road to El Sawaha square or Nasr City via the 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. 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 plan the project appropriately, from the perspectives of 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, namely the “JICA Preparatory Survey on Greater Cairo Metro Line No.4”, consists of three reports. The main tasks and activities to be covered in these reports are as follows;

1) Feasibility Study Report 1 (Volume 1)
   - Data collection, diagnosis of the existing public transport system and urban development hypothesis;
   - Collection of relevant data about the existing and foreseen public utilities;
   - Collection of relevant socio-economic data; and
   - Collection of relevant data for preliminary design.

2) Feasibility Study Report 2 (Volume 2)
   - Analysis of all collected data for the generation of O/D Matrices and development of a transportation study of Metro Line 4.
   - Recording of all the data concerning vehicles and all transport modes and performing a field traffic survey in the study area and a review of the demand forecast.
   - Comparison and evaluation of two alternative corridors regarding Metro Line 4 alignment

3) Feasibility Study Report 3/4 (Volume 3)
   - Preparation of design guidelines & criteria and general features of the Metro Line 4 Phase 1.
Preparation of the general design specifications of Metro Line 4.
Submission of the final results and pertinent analysis showing the feasibility of the implementation of the whole project from both economic and financial perspectives.

The present document is the combined Feasibility Study Reports 3/4 (Volume 3), and is based on the results of Feasibility Study Reports 1 and 2 (Volume 1 and 2).

1.3 Study Area and Concept of Feasibility Study Report 3/4

1.3.1 Study Area

The Study Area is defined as follows: Phase 1 of the proposed Metro Line 4, running from a depot/workshop via the Grand Egyptian Museum (GEM) to El Malek El Saleh Station, with a length of about 16 km; and Phase 2 route is between El Malek El Saleh via El Sawaha Square and directly to Ring Road Exit #18, with a length of about 18 km, referred to as the “northern route”. In addition, an alternative Phase 2 route, starting from El Malek El Saleh to Nasr City, with a length of about 23.5 km, referred to as the “eastern route”, was evaluated and compared with the originally proposed northern route. Figure 1-1 shows the Phase 1 route and the two alternative routes considered for Phase 2.

![Figure 1-1 Study Area](image-url)
1.3.2 Concept for the Feasibility Study Report 3/4

(1) Route Selection for Phase 2 Section
The results of the comparison of the two alternative routes for Phase 2 are presented in Volume 2. These results show that both routes are feasible in terms of the future transportation demand. However, the transportation demand of Northern Route is larger than that of the Eastern Route in the year 2022, and a study of the rehabilitation of tramway line and its transformation into a Super-Tram from Abbasiya to Nasr City to connect with Metro Line 3 has been started. In this context, the JICA Study Team recommended giving priority to the northern route as the route for construction in the second phase of Metro Line 4 project. Accordingly, JICA Study Team has carried out the feasibility study on the basis of a northern route for Phase 2.

(2) Workshop/Depot Location
The final location of the workshop/depot as well as of the route of Metro Line 4 between the workshop/depot and El Remayah Square was informed officially through NAT on 20th October 2009. JICA Study Team has carried out the feasibility study on this location and route.

(3) Concept for the Feasibility Study on Metro Line 4
The feasibility study route on Metro Line 4 consists of the Phase 1A section (El Malek El Saleh – El Remayah Square), Phase 1B section (El Remayah Square – Hadayek Al Aharam – Workshop/Depot), and Phase 2 northern route, as shown in Figure 1-1. The feasibility study has been carried out in accordance with following concept:

- The Phase 1A study was undertaken at a full-scale level. The Phase 1A route is as defined in NAT Letter No. PL/402/700, dated 11th May 2009.
- The Phase 1B study was carried out on a preliminary study with limited material and data because of the delay in finalizing the location of the workshop/depot and the alignment route. The location of the workshop/depot is as defined in NAT Letter No. PL/1428/700, dated 19th October 2009. The Phase 1B route is as defined in NAT Letter No. PL/1439/700, dated 20th October 2009.
- The Phase 2 study was carried out as a preliminary level study on the northern route, which was recommended in Feasibility Study Report 2. This route is planned to run under/above Port Said Street, where the existing Spine Wastewater Tunnel is located.

Based on the above concept, the following component studies were carried out as part of the Metro Line 4 Feasibility Study. In this respect, Feasibility Study Reports 3 and 4 were combined into one report.

- Review & updated demand forecast
- Alignment plan
In addition to the above, the following studies have been carried out and are included in appendices to this report.

Appendix 1 : Preliminary work and remarks on Basic Design Stage
Appendix 2 : Preliminary study for extension line connecting to 6th October City
Appendix 3 : NAT comments with JST response on draft Report 3/4

---

1.4 Remarks toward the Basic Design Stage

After the submission of the draft Report 3/4 in the end of December 2009, NAT made some major decisions on certain components, as enumerated below:

1) **Final workshop/depot location and Phase 1B route was finalized.**
   - Phase 1B route was changed from the route defined in NAT Letter No. PL/1428/700 dated on 20th October 2009, by verbal instruction from NAT in early January 2010. Subsequently, the final decision has been made through NAT Letter No. PL/203/700 dated on 10th March 2010.
   - Station No.13 (Grand Egyptian Museum) was shifted from behind to the front of the museum entrance.
   - A new station was requested between Station No.13 and Station No.14.

2) **Power supply system of Metro Line 4 will be 3rd rail system, instead of the overhead rigid conductor system.**
   - The decision has been made through NAT’s comments on draft Report 3/4 in NAT Letter No. EMD/3 dated 18th January 2010.
3) **HVS and administration buildings are shifted from inside the workshop/depot to a new location between the military officers housing area and the Hadayek Al Ahram housing area.**

   - The decision has been made through NAT Letter No. PL/203/700 dated 10th March 2010.

4) **Location of Stations No.10 and No.11 are shifted.**

   - The decision has been made in the meeting with the NAT Chairman held on 28th January 2010 in Japan.
   - Station No.10 (El-Maryoteya Station) is shifted next to the Ring Road viaduct on El Maryoteya Canal.
   - Station No.11 (El-Ahramat Station) is shifted as close to the Pyramid side as possible.

5) **Connection with ENR Line is cancelled.**

   - The decision has been made in a meeting held on 7th February 2010.
   - The rolling stock transportation plan and access to the depot with the handling facilities study will be carried out in the basic design stage.

Basically, the above decisions have not been reflected in this Report 3/4 in terms of study period. These modifications will be studied in the basic design stage.

In addition to the above decisions, JICA Study Team has received NAT comments on the draft Report 3/4 in the beginning of February 2010. JICA Study Team and NAT had several technical meetings on NAT’s comments in February 2010 to clarify all the items. As a result, modification of the report and additional information or data have been added in the final edition of Report 3/4 or provided separately. However, some of the comments require further study to meet NAT’s requirements. Therefore, JICA Study Team and NAT have agreed to conduct the remaining and additional items of study in the basic design stage.

The above results, based on the discussion with each NAT department, are attached in Appendix 3 of this Report (Volume 3).

Moreover, general information and remarks related to the change from the 1,500V DC overhead rigid conductor system to the 750V DC 3rd rail system are presented in Appendix 1 of this Report (Volume 3).
CHAPTER 2  UPDATING FUTURE DEMAND FOR METRO LINE NO.4

2.1 Methodology of Updating Future Metro Demand

Based on the final alignment and location of the stations, the future passenger demand for the Metro Line 4 has been projected and is presented in this chapter. The methodology of the demand forecast is the same as that described in Feasibility Study Report 2 (Volume 2). This methodology involves application of the conventional “four-step” approach and transportation models described in Feasibility Study Report 2 (Volume 2).

2.2 Summary of Person-Trips by Travel Mode

The forecasting reference years for demand estimation are set up on the basis of the construction schedule, i.e., as of 2020, 2023, 2027 and 2050. The year 2020 is the starting year of the Metro Line 4, Phase 1 section operation, while 2023 is the starting year of that of the Phase 2 section. The year 2027 is the base year of the projection and the year 2050 is the target year for facility planning. The results of the demand forecast are summarized in the table below. Based on Cairo Vision 2050, the number of metro and LRT passengers includes the passenger volume forecast for the existing, on-going, planned and under-planning lines up to 2050.

Table 2-1  Projected Passenger by Transportation Mode

<table>
<thead>
<tr>
<th>Year</th>
<th>Private Mode (Passenger Car, Taxi)</th>
<th>Public Bus Mode (Bus, Shared Taxi)</th>
<th>Public Rail Mode (Metro, LRT)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>7,317,081</td>
<td>12,815,802</td>
<td>3,946,918</td>
<td>24,079,801</td>
</tr>
<tr>
<td></td>
<td>30.4%</td>
<td>53.2%</td>
<td>16.4%</td>
<td>100.0%</td>
</tr>
<tr>
<td>2023</td>
<td>8,292,396</td>
<td>12,607,342</td>
<td>4,388,364</td>
<td>25,288,102</td>
</tr>
<tr>
<td></td>
<td>32.8%</td>
<td>49.9%</td>
<td>17.4%</td>
<td>100.0%</td>
</tr>
<tr>
<td>2027</td>
<td>9,561,250</td>
<td>12,364,875</td>
<td>4,776,201</td>
<td>26,702,326</td>
</tr>
<tr>
<td></td>
<td>35.8%</td>
<td>46.3%</td>
<td>17.9%</td>
<td>100.0%</td>
</tr>
<tr>
<td>2050</td>
<td>19,222,178</td>
<td>16,017,445</td>
<td>7,961,171</td>
<td>43,200,794</td>
</tr>
<tr>
<td></td>
<td>44.5%</td>
<td>37.1%</td>
<td>18.4%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Unit: person-trip per day
Source: JICA Study Team

2.3 Daily Station and Section Passenger Volumes for Metro Line 4

Future numbers of station and section passengers per day for Metro Line 4 were projected by assigning metro and LRT trips based on the updated O/D matrixes to the future Metro & LRT network. The forecasted daily passengers are summarized in Table 2-2. “Sta. Pax” represents the number of passengers both boarding and alighting at each station and “Sec. Pax” means the volume of passengers passing through line section between stations. The station passenger in Table 2-2 is the summation of boarding and alighting passengers by each station respectively. The demand forecast basically targets daily passengers. Therefore, the boarding and alighting passengers in each station are logically equal.
Boarding passengers, and also alighting passengers, are 50% of the total station passengers in Table 2-2.

Table 2-2 Number of Passengers Per Day for Metro Line 4

<table>
<thead>
<tr>
<th>Phase</th>
<th>Year 2020</th>
<th>Year 2023</th>
<th>Year 2027</th>
<th>Year 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section</td>
<td>1,011,900</td>
<td>1,100,700</td>
<td>1,594,900</td>
<td>2,041,500</td>
</tr>
<tr>
<td>Phase</td>
<td>0</td>
<td>1,475,800</td>
<td>1,681,600</td>
<td>1,874,400</td>
</tr>
<tr>
<td>Total</td>
<td>1,011,900</td>
<td>2,576,500</td>
<td>3,276,500</td>
<td>3,915,900</td>
</tr>
</tbody>
</table>

Note: The passengers who ride on both Phase 1 and 2 sections on Metro Line 4 are counted as the passengers of Phases 1 and 2, respectively. Therefore, the number of passengers for Metro Line 4 in total is smaller than the simple summation of Phase 1 and Phase 2 sections.
| Phase1 Sta. 01 | 66,900 | 72,500 | 81,300 | 97,900 |
| Phase1 Sta. 02 | 99,800 | 104,700 | 110,100 | 137,900 |
| Phase1 Sta. 03 | 89,800 | 95,200 | 103,100 | 129,500 |
| Phase1 Sta. 04 | 40,000 | 42,300 | 47,600 | 53,700 |
| Phase1 Sta. 05 | 61,100 | 63,500 | 66,700 | 80,600 |
| Phase1 Sta. 06 | 122,800 | 129,100 | 149,800 | 179,500 |
| Phase1 Sta. 07 | 81,200 | 86,000 | 103,700 | 119,600 |
| Phase1 Sta. 08 | 89,800 | 95,200 | 103,100 | 129,500 |
| Phase1 Sta. 09 | 40,000 | 42,300 | 47,600 | 53,700 |
| Phase1 Sta. 10 | 61,100 | 63,500 | 66,700 | 80,600 |
| Phase1 Sta. 11 | 122,800 | 129,100 | 149,800 | 179,500 |
| Phase1 Sta. 12 | 81,200 | 86,000 | 103,700 | 119,600 |
| Phase1 Sta. 13 | 89,800 | 95,200 | 103,100 | 129,500 |
| Phase1 Sta. 14 | 40,000 | 42,300 | 47,600 | 53,700 |
| Phase1 Sta. 15 | 61,100 | 63,500 | 66,700 | 80,600 |
| Phase1 Sta. 16 | 122,800 | 129,100 | 149,800 | 179,500 |
| Phase1 Sta. 17 | 81,200 | 86,000 | 103,700 | 119,600 |
| Phase1 Sta. 18 | 89,800 | 95,200 | 103,100 | 129,500 |
| Phase1 Sta. 19 | 40,000 | 42,300 | 47,600 | 53,700 |
| Phase1 Sta. 20 | 61,100 | 63,500 | 66,700 | 80,600 |
| Phase1 Sta. 21 | 122,800 | 129,100 | 149,800 | 179,500 |
| Phase1 Sta. 22 | 81,200 | 86,000 | 103,700 | 119,600 |
| Phase1 Sta. 23 | 89,800 | 95,200 | 103,100 | 129,500 |
| Phase1 Sta. 24 | 40,000 | 42,300 | 47,600 | 53,700 |
| Phase1 Sta. 25 | 61,100 | 63,500 | 66,700 | 80,600 |
| Phase1 Sta. 26 | 122,800 | 129,100 | 149,800 | 179,500 |
| Phase1 Sta. 27 | 81,200 | 86,000 | 103,700 | 119,600 |
| Phase1 Sta. 28 | 89,800 | 95,200 | 103,100 | 129,500 |
| Phase1 Sta. 29 | 40,000 | 42,300 | 47,600 | 53,700 |
| Phase1 Sta. 30 | 61,100 | 63,500 | 66,700 | 80,600 |

Remarks: Sta. Pax. = Station passenger (boarding and alighting), Sec Pax. = Section passenger both directions between stations
Source: JICA Study Team

2.4 Determination of Peak Hour Passenger Distribution and Ratio

The peak hour distribution and ratio assumed for the metro operation were established on the basis of the CREATS home interview survey data, as follows. Departure time distributions are listed in Table 2-3 and shown as hourly histograms in Figure 2-1. Arrival
time distributions are listed in Table 2-4 and shown as hourly histograms in Figure 2-2. Analysis of these tables and figures shows the following:

- **Morning peak:** On a boarding time basis, the highest traffic volume was seen between 6:00-8:00 and daily traffic volume ratio was 13.1% (the average rate from 6:00 to 8:00). On an alighting time basis, the highest traffic volume was seen between 7:00-9:00 and the daily traffic volume ratio was 13.7% (the average rate from 7:00 to 9:00).

- **Afternoon peak:** On a boarding time basis, the highest traffic volume was seen between 14:00-16:00 and the daily traffic volume ratio was 15.1% (the average rate from 14:00 to 16:00). On an alighting time basis, the highest traffic volume was also seen between 14:00-16:00 and the daily traffic volume ratio was 11.3% (the average rate from 14:00 to 16:00).

- **Considering that the morning peak is much more critical for passengers who are concerned not to miss their trains, the alighting base is much more stable because although the loading station is different, the alighting station is usually a common destination. Based on the data shown in Table 2-4 for the period between 8:00 and 9:00, **14% (the average of 17.1 and 11.0) is adopted as the peak hour ratio).**

Table 2-3  Hourly Peak Ratio of the Metro (Boarding Time-Based)

<table>
<thead>
<tr>
<th>Departure Time</th>
<th>Trip Purpose</th>
<th>Total</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Work</td>
<td>Education</td>
<td>Other HB</td>
</tr>
<tr>
<td>0</td>
<td>1,018</td>
<td>67</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>604</td>
<td>689</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>332</td>
<td>199</td>
<td>80</td>
</tr>
<tr>
<td>4</td>
<td>309</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>10,738</td>
<td>2,882</td>
<td>463</td>
</tr>
<tr>
<td>6</td>
<td>144,580</td>
<td>223,155</td>
<td>8,090</td>
</tr>
<tr>
<td>7</td>
<td>61,998</td>
<td>80,328</td>
<td>4,367</td>
</tr>
<tr>
<td>8</td>
<td>108,103</td>
<td>100,034</td>
<td>9,563</td>
</tr>
<tr>
<td>9</td>
<td>43,202</td>
<td>70,229</td>
<td>20,107</td>
</tr>
<tr>
<td>10</td>
<td>1,077</td>
<td>2,763</td>
<td>1,489</td>
</tr>
<tr>
<td>11</td>
<td>5,597</td>
<td>14,191</td>
<td>4,416</td>
</tr>
<tr>
<td>12</td>
<td>19,776</td>
<td>89,421</td>
<td>8,412</td>
</tr>
<tr>
<td>13</td>
<td>9,789</td>
<td>34,306</td>
<td>930</td>
</tr>
<tr>
<td>14</td>
<td>89,693</td>
<td>149,559</td>
<td>3,804</td>
</tr>
<tr>
<td>15</td>
<td>170,843</td>
<td>171,419</td>
<td>7,626</td>
</tr>
<tr>
<td>16</td>
<td>8,085</td>
<td>10,993</td>
<td>1,362</td>
</tr>
<tr>
<td>17</td>
<td>28,858</td>
<td>56,811</td>
<td>9,272</td>
</tr>
<tr>
<td>18</td>
<td>34,538</td>
<td>44,642</td>
<td>13,824</td>
</tr>
<tr>
<td>19</td>
<td>2,768</td>
<td>2,809</td>
<td>801</td>
</tr>
<tr>
<td>20</td>
<td>20,118</td>
<td>8,208</td>
<td>4,199</td>
</tr>
<tr>
<td>21</td>
<td>28,750</td>
<td>2,152</td>
<td>1,639</td>
</tr>
<tr>
<td>22</td>
<td>2,024</td>
<td>0</td>
<td>348</td>
</tr>
<tr>
<td>23</td>
<td>14,377</td>
<td>1,660</td>
<td>489</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>807,202</td>
<td>1,065,517</td>
<td>101,281</td>
</tr>
</tbody>
</table>

Source: CREATS HIS (2002) as analyzed by the JICA Study Team

Note: HB = Home Based, NHB = Non-home Based
Table 2-4 Hourly Peak Ratio of the Metro (Alighting Time-Based)

<table>
<thead>
<tr>
<th>Arrival Time</th>
<th>Trip Purpose</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Work</td>
<td>Education</td>
</tr>
<tr>
<td>0</td>
<td>6,255</td>
<td>67</td>
</tr>
<tr>
<td>1</td>
<td>1,641</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>666</td>
<td>638</td>
</tr>
<tr>
<td>3</td>
<td>553</td>
<td>213</td>
</tr>
<tr>
<td>4</td>
<td>134</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>2,725</td>
<td>190</td>
</tr>
<tr>
<td>6</td>
<td>23,058</td>
<td>28,645</td>
</tr>
<tr>
<td>7</td>
<td>69,864</td>
<td>130,340</td>
</tr>
<tr>
<td>8</td>
<td>160,651</td>
<td>170,260</td>
</tr>
<tr>
<td>9</td>
<td>95,963</td>
<td>111,477</td>
</tr>
<tr>
<td>10</td>
<td>11,202</td>
<td>22,768</td>
</tr>
<tr>
<td>11</td>
<td>8,135</td>
<td>18,831</td>
</tr>
<tr>
<td>12</td>
<td>9,174</td>
<td>39,815</td>
</tr>
<tr>
<td>13</td>
<td>7,973</td>
<td>44,958</td>
</tr>
<tr>
<td>14</td>
<td>50,465</td>
<td>108,637</td>
</tr>
<tr>
<td>15</td>
<td>137,926</td>
<td>148,382</td>
</tr>
<tr>
<td>16</td>
<td>48,172</td>
<td>57,213</td>
</tr>
<tr>
<td>17</td>
<td>53,663</td>
<td>70,255</td>
</tr>
<tr>
<td>18</td>
<td>34,893</td>
<td>76,366</td>
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<tr>
<td>19</td>
<td>10,265</td>
<td>13,116</td>
</tr>
<tr>
<td>20</td>
<td>21,641</td>
<td>14,674</td>
</tr>
<tr>
<td>21</td>
<td>25,946</td>
<td>6,810</td>
</tr>
<tr>
<td>22</td>
<td>8,991</td>
<td>776</td>
</tr>
<tr>
<td>23</td>
<td>17,445</td>
<td>2,087</td>
</tr>
<tr>
<td>Total</td>
<td>807,200</td>
<td>1,066,517</td>
</tr>
</tbody>
</table>

Source: CREATS HIS (2002) as analyzed by the JICA Study Team
Note: HB = Home Based, NHB = Non-home Based
Figure 2-2  Hourly Distribution of Metro Passengers (Alighting Time-Based)
2.5 Estimation of Station and Section Peak Hour Passenger Volumes

Based on the application of a peak hour ratio of 14%, the station and section peak hour passenger volumes for Metro Line 4 were estimated as shown in Table 2-5 below.

<table>
<thead>
<tr>
<th>Station No</th>
<th>Year 2020</th>
<th>Year 2023</th>
<th>Year 2027</th>
<th>Year 2050</th>
<th>Year 2022</th>
<th>Year 2023</th>
<th>Year 2027</th>
<th>Year 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase2 Sta. 17</td>
<td>0</td>
<td>26,740</td>
<td>32,070</td>
<td>35,700</td>
<td>0</td>
<td>13,370</td>
<td>16,040</td>
<td>17,850</td>
</tr>
<tr>
<td>Phase2 Sta. 16</td>
<td>0</td>
<td>14,390</td>
<td>18,330</td>
<td>19,220</td>
<td>0</td>
<td>18,740</td>
<td>20,590</td>
<td>25,170</td>
</tr>
<tr>
<td>Phase2 Sta. 15</td>
<td>0</td>
<td>10,460</td>
<td>11,650</td>
<td>13,090</td>
<td>0</td>
<td>26,960</td>
<td>28,980</td>
<td>35,600</td>
</tr>
<tr>
<td>Phase2 Sta. 14</td>
<td>0</td>
<td>8,550</td>
<td>9,700</td>
<td>10,710</td>
<td>0</td>
<td>29,320</td>
<td>31,890</td>
<td>38,540</td>
</tr>
<tr>
<td>Phase2 Sta. 13</td>
<td>0</td>
<td>15,540</td>
<td>17,000</td>
<td>17,220</td>
<td>0</td>
<td>37,420</td>
<td>39,400</td>
<td>36,740</td>
</tr>
<tr>
<td>Phase2 Sta. 12</td>
<td>0</td>
<td>12,710</td>
<td>14,170</td>
<td>16,310</td>
<td>0</td>
<td>40,810</td>
<td>43,650</td>
<td>44,490</td>
</tr>
<tr>
<td>Phase2 Sta. 11</td>
<td>0</td>
<td>6,920</td>
<td>8,300</td>
<td>9,140</td>
<td>0</td>
<td>45,280</td>
<td>47,180</td>
<td>49,570</td>
</tr>
<tr>
<td>Phase2 Sta. 10</td>
<td>0</td>
<td>8,650</td>
<td>9,970</td>
<td>11,170</td>
<td>0</td>
<td>47,020</td>
<td>49,670</td>
<td>52,090</td>
</tr>
<tr>
<td>Phase2 Sta. 09</td>
<td>0</td>
<td>9,620</td>
<td>10,610</td>
<td>11,540</td>
<td>0</td>
<td>50,760</td>
<td>53,470</td>
<td>55,750</td>
</tr>
<tr>
<td>Phase2 Sta. 08</td>
<td>0</td>
<td>18,270</td>
<td>19,810</td>
<td>20,820</td>
<td>0</td>
<td>38,720</td>
<td>40,010</td>
<td>42,770</td>
</tr>
<tr>
<td>Transfer Line 1/4</td>
<td>0</td>
<td>30,030</td>
<td>36,250</td>
<td>38,600</td>
<td>0</td>
<td>38,040</td>
<td>40,140</td>
<td>43,010</td>
</tr>
<tr>
<td>Phase2 Sta. 07</td>
<td>0</td>
<td>6,900</td>
<td>7,250</td>
<td>8,760</td>
<td>0</td>
<td>38,720</td>
<td>40,010</td>
<td>42,770</td>
</tr>
<tr>
<td>Phase2 Sta. 06</td>
<td>0</td>
<td>4,370</td>
<td>4,580</td>
<td>4,830</td>
<td>0</td>
<td>38,040</td>
<td>40,140</td>
<td>43,010</td>
</tr>
<tr>
<td>Transfer Line 3/4</td>
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<td>35,870</td>
<td>36,580</td>
<td>37,370</td>
<td>0</td>
<td>16,740</td>
<td>26,680</td>
<td>36,550</td>
</tr>
<tr>
<td>Phase2 Sta. 05</td>
<td>0</td>
<td>4,720</td>
<td>5,170</td>
<td>6,240</td>
<td>0</td>
<td>15,700</td>
<td>25,680</td>
<td>35,160</td>
</tr>
<tr>
<td>Phase2 Sta. 04</td>
<td>0</td>
<td>4,870</td>
<td>5,570</td>
<td>6,680</td>
<td>0</td>
<td>15,930</td>
<td>25,960</td>
<td>35,460</td>
</tr>
<tr>
<td>Phase2 Sta. 03</td>
<td>0</td>
<td>4,860</td>
<td>5,140</td>
<td>6,270</td>
<td>0</td>
<td>15,930</td>
<td>25,960</td>
<td>35,460</td>
</tr>
<tr>
<td>Phase2 Sta. 02</td>
<td>0</td>
<td>4,860</td>
<td>5,140</td>
<td>6,270</td>
<td>0</td>
<td>15,930</td>
<td>25,960</td>
<td>35,460</td>
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</table>
### Phase 1 Stations 01 to 15

<table>
<thead>
<tr>
<th>Station</th>
<th>9,370</th>
<th>10,150</th>
<th>11,380</th>
<th>13,710</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfer Line 1/4</td>
<td>21,840</td>
<td>23,690</td>
<td>26,570</td>
<td>31,980</td>
</tr>
<tr>
<td>Phase 1 Sta. 01</td>
<td>15,600</td>
<td>19,280</td>
<td>26,780</td>
<td>32,280</td>
</tr>
<tr>
<td>Phase 1 Sta. 02</td>
<td>3,770</td>
<td>3,990</td>
<td>4,200</td>
<td>4,280</td>
</tr>
<tr>
<td>Phase 1 Sta. 03</td>
<td>13,970</td>
<td>14,660</td>
<td>15,410</td>
<td>19,310</td>
</tr>
<tr>
<td>Phase 1 Sta. 04</td>
<td>18,750</td>
<td>22,600</td>
<td>30,390</td>
<td>36,900</td>
</tr>
<tr>
<td>Transfer Line 2/4</td>
<td>37,030</td>
<td>37,860</td>
<td>42,980</td>
<td>50,900</td>
</tr>
<tr>
<td>Phase 1 Sta. 05</td>
<td>5,600</td>
<td>5,920</td>
<td>6,660</td>
<td>7,520</td>
</tr>
<tr>
<td>Phase 1 Sta. 06</td>
<td>8,550</td>
<td>8,890</td>
<td>9,340</td>
<td>11,280</td>
</tr>
<tr>
<td>Phase 1 Sta. 07</td>
<td>17,190</td>
<td>18,070</td>
<td>20,970</td>
<td>25,130</td>
</tr>
<tr>
<td>Phase 1 Sta. 08</td>
<td>11,370</td>
<td>12,040</td>
<td>14,520</td>
<td>16,740</td>
</tr>
<tr>
<td>Phase 1 Sta. 09</td>
<td>10,470</td>
<td>10,540</td>
<td>11,840</td>
<td>12,100</td>
</tr>
<tr>
<td>Phase 1 Sta. 10</td>
<td>14,840</td>
<td>15,500</td>
<td>19,610</td>
<td>24,180</td>
</tr>
<tr>
<td>Phase 1 Sta. 11</td>
<td>6,640</td>
<td>6,710</td>
<td>7,430</td>
<td>11,730</td>
</tr>
<tr>
<td>Phase 1 Sta. 12</td>
<td>6,750</td>
<td>7,060</td>
<td>8,860</td>
<td>9,070</td>
</tr>
<tr>
<td>Phase 1 Sta. 13</td>
<td>5,420</td>
<td>5,730</td>
<td>6,800</td>
<td>13,310</td>
</tr>
<tr>
<td>Phase 1 Sta. 14</td>
<td>3,610</td>
<td>3,810</td>
<td>6,240</td>
<td>10,650</td>
</tr>
<tr>
<td>Phase 1 Sta. 15</td>
<td>3,880</td>
<td>4,550</td>
<td>5,670</td>
<td>11,980</td>
</tr>
</tbody>
</table>

**Source:** JICA Study Team

#### 2.6 Passenger- and PCU¹-km and -hours for “With” and “Without” Project Cases

Estimates of passenger-km, passenger-hours, PCU-km and PCU-hours for the “With” and “Without” project cases were required as inputs for the measurement of economic benefits in the economic appraisal of the project (see Chapter 13 for the application of these indicators). These estimates were achieved by means of simulation, and the results are shown in Table 2-6.

---

¹ “PCU” means “Passenger Car Unit”, a standard unit for measuring traffic volume, which results from expressing different vehicle types as in terms of an equivalent number of PCU, e.g. a large truck or a large bus is equivalent to 2.5 PCU, a motorcycle is equivalent to 0.3 PCU, and so on.
### Table 2-6 (1) Analysis of “With” and “Without” Project Cases of Metro Line 4 Phase 1 + Phase 2

<table>
<thead>
<tr>
<th>No of Trip</th>
<th>Unit</th>
<th>Year 2020</th>
<th>Year 2023</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>With</td>
<td>Without</td>
</tr>
<tr>
<td>Pax Car</td>
<td>Person trip</td>
<td>7,317,081</td>
<td>7,323,339</td>
</tr>
<tr>
<td>Bus</td>
<td>Person trip</td>
<td>12,815,802</td>
<td>13,116,175</td>
</tr>
<tr>
<td>Acc. Shared Taxi</td>
<td>Person trip</td>
<td>1,561,461</td>
<td>1,439,039</td>
</tr>
<tr>
<td>MRT+LRT</td>
<td>Person trip</td>
<td>3,946,918</td>
<td>3,640,287</td>
</tr>
<tr>
<td>Total</td>
<td>Person trip</td>
<td>25,641,262</td>
<td>25,518,840</td>
</tr>
<tr>
<td>Pax Car</td>
<td>Person * km</td>
<td>110,825,670</td>
<td>110,923,052</td>
</tr>
<tr>
<td>Bus</td>
<td>Person * km</td>
<td>152,824,967</td>
<td>157,130,172</td>
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<tr>
<td>Acc. Shared Taxi</td>
<td>Person * km</td>
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<td>8,446,811</td>
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<tr>
<td>MRT+LRT</td>
<td>Person * km</td>
<td>82,021,068</td>
<td>77,928,168</td>
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<tr>
<td>Total</td>
<td>Person * km</td>
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<td>354,428,203</td>
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</table>

<table>
<thead>
<tr>
<th>Person * hrs</th>
<th>Unit</th>
<th>Year 2020</th>
<th>Year 2023</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>With</td>
<td>Without</td>
</tr>
<tr>
<td>Pax Car</td>
<td>Person * hrs</td>
<td>4,826,426</td>
<td>4,835,980</td>
</tr>
<tr>
<td>Bus</td>
<td>Person * hrs</td>
<td>6,441,170</td>
<td>6,632,212</td>
</tr>
<tr>
<td>Acc. Shared Taxi</td>
<td>Person * hrs</td>
<td>342,875</td>
<td>349,317</td>
</tr>
<tr>
<td>MRT+LRT</td>
<td>Person * hrs</td>
<td>2,417,079</td>
<td>2,296,374</td>
</tr>
<tr>
<td>Total</td>
<td>Person * hrs</td>
<td>14,027,550</td>
<td>14,113,883</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Person * km</th>
<th>Unit</th>
<th>Year 2027</th>
<th>Year 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>With</td>
<td>Without</td>
</tr>
<tr>
<td>Pax Car</td>
<td>Person trip</td>
<td>9,561,250</td>
<td>9,586,006</td>
</tr>
<tr>
<td>Bus</td>
<td>Person trip</td>
<td>12,364,875</td>
<td>12,944,028</td>
</tr>
<tr>
<td>Acc. Shared Taxi</td>
<td>Person trip</td>
<td>1,838,061</td>
<td>1,596,994</td>
</tr>
<tr>
<td>MRT+LRT</td>
<td>Person trip</td>
<td>4,776,201</td>
<td>4,172,292</td>
</tr>
<tr>
<td>Total</td>
<td>Person trip</td>
<td>28,540,387</td>
<td>28,299,320</td>
</tr>
<tr>
<td>Pax Car</td>
<td>Person * km</td>
<td>153,070,132</td>
<td>153,343,242</td>
</tr>
<tr>
<td>Bus</td>
<td>Person * km</td>
<td>135,185,866</td>
<td>145,245,958</td>
</tr>
<tr>
<td>Acc. Shared Taxi</td>
<td>Person * km</td>
<td>8,281,379</td>
<td>8,880,433</td>
</tr>
<tr>
<td>MRT+LRT</td>
<td>Person * km</td>
<td>108,472,661</td>
<td>95,911,703</td>
</tr>
<tr>
<td>Total</td>
<td>Person * km</td>
<td>405,010,038</td>
<td>403,381,336</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Person * hrs</th>
<th>Unit</th>
<th>Year 2027</th>
<th>Year 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>With</td>
<td>Without</td>
</tr>
<tr>
<td>Pax Car</td>
<td>Person * hrs</td>
<td>7,103,095</td>
<td>7,124,956</td>
</tr>
<tr>
<td>Bus</td>
<td>Person * hrs</td>
<td>6,050,484</td>
<td>6,523,895</td>
</tr>
<tr>
<td>Acc. Shared Taxi</td>
<td>Person * hrs</td>
<td>363,230</td>
<td>392,621</td>
</tr>
<tr>
<td>MRT+LRT</td>
<td>Person * hrs</td>
<td>3,260,617</td>
<td>2,985,900</td>
</tr>
<tr>
<td>Total</td>
<td>Person * hrs</td>
<td>16,777,426</td>
<td>16,947,372</td>
</tr>
<tr>
<td>PCU</td>
<td>PCU Trip</td>
<td>7,856,480</td>
<td>7,909,136</td>
</tr>
<tr>
<td>PCU*km</td>
<td>PCU*km</td>
<td>130,692,469</td>
<td>131,680,555</td>
</tr>
<tr>
<td>PCU*Hours</td>
<td>PCU*hrs</td>
<td>6,046,580</td>
<td>6,100,306</td>
</tr>
<tr>
<td>Ave Travel km</td>
<td>km</td>
<td>16.63</td>
<td>16.65</td>
</tr>
<tr>
<td>Ave Travel time</td>
<td>min</td>
<td>46.18</td>
<td>46.28</td>
</tr>
<tr>
<td>Average Speed</td>
<td>km/hour</td>
<td>22.45</td>
<td>22.40</td>
</tr>
</tbody>
</table>

Source: JICA Study Team

### Table 2-6 (2) Analysis of “With” and “Without” Project Cases of Metro Line 4 Phase 1 + Phase 2

<table>
<thead>
<tr>
<th>PCU (Car, Bus, Acc)</th>
<th>Unit</th>
<th>Year 2027</th>
<th>Year 2050</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>With</td>
<td>Without</td>
</tr>
<tr>
<td>PCU Trip</td>
<td></td>
<td>9,561,250</td>
<td>9,586,006</td>
</tr>
<tr>
<td>PCU*km</td>
<td></td>
<td>98,731,961</td>
<td>99,121,495</td>
</tr>
<tr>
<td>PCU*hrs</td>
<td></td>
<td>4,282,355</td>
<td>4,303,933</td>
</tr>
</tbody>
</table>

Note: PCU = passenger car unit

Source: JICA Study Team
2.7 Station Context Planning (Multimodal Interchanges)

Stations of a metro line are integrated into the urban settings of a city. Therefore, their implementation needs to be studied at the metro station level itself. However, it is also crucial to study the surrounding environment in order to provide good access to the station, not only for other public transport modes and pedestrians, but also to improve urban space quality.

This issue is addressed in this part of the report through various objectives set to define the principles of the station context planning around each station of Metro Line 4. This part is divided into three sections:

- Definition of station classification
- Typology of spatial arrangement according to the station classification
- Station context planning and space organization for each station

Concerning the definition of the Metro station classification, three different criteria are identified to plan a station and its setting. Even though these are somehow interrelated, they appear at different stages of the station context planning process.

(1) Level of Traffic

This criterion integrates the number of forecast boarding and alighting for the station and is related to the population, employment and student densities around the station. It will have an impact not only on the dimensioning of the underground station but also on the ground level conditions around the station to design pedestrian accesses to the station.

- Category A: Total traffic of In and Out passengers during peak period is greater than 30,000 passenger per hour
- Category B: Total traffic of In and Out passengers during peak period is between 15,000 and 30,000 passenger per hour
- Category C: Total traffic of In and Out passengers during peak period is lower than 15,000 passenger per hour

This item is consistent with the demand forecast in this study. It allows classifying the stations for their underground sizing according to their maximum forecast frequentation. This maximum forecast frequentation is generally the horizon 2050. Some stations are also upgraded to the higher traffic category when they are major inter-modal nodes, or act as transfer points with the existing Metro stations.
(2) **Inter-modality**

Inter-modality integrates the role of the station in the public transport network. Stations are classified according to the level of inter-modality, assessed by the diversity of modes and number of lines stopping at the station. This criterion is essential to organize and size the inter-modal facilities. For this item, stations are classified into two categories.

- Inter-modal Station: connected with more than two modes or routes.
- Simple Station: connected with one mode or not connected to another public transport network.

The criterion will reflect the fact that some stations have a major role in the network, such as connection to a mass rapid transit system or a metropolitan arterial outward city.

(3) **Urban Context**

Greater Cairo is a very heterogeneous city. Therefore, the urban form varies significantly along the Metro corridors. These different urban environments thus impact the spatial organization proposed around each station. This criterion takes into account the local urban context by the type of buildings and road networks.

- Category 1: High-rise area served by a wide and organized street network
- Category 2: Densely built area with quite low-rise buildings (5-6 floor average) served by a narrow road network
- Category 3: Military area

All these categories will be associated with the typology for spatial organization. Table 2-7 presents the outcome of the analysis, as the classification according to the three abovementioned criteria.

<table>
<thead>
<tr>
<th>Stations</th>
<th>Level of Traffic</th>
<th>Inter-modality</th>
<th>Urban Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.1 (El Malek El Saleh)</td>
<td>A</td>
<td>Inter-modal station</td>
<td>2</td>
</tr>
<tr>
<td>No.2 (El Rauda)</td>
<td>C</td>
<td>Simple station</td>
<td>2</td>
</tr>
<tr>
<td>No.3 (El Nile)</td>
<td>B</td>
<td>Simple station</td>
<td>2</td>
</tr>
<tr>
<td>No.4 (El Giza)</td>
<td>A</td>
<td>Inter-modal station</td>
<td>1</td>
</tr>
<tr>
<td>No.5</td>
<td>C</td>
<td>Simple station</td>
<td>1</td>
</tr>
<tr>
<td>No.6</td>
<td>C</td>
<td>Simple station</td>
<td>1</td>
</tr>
<tr>
<td>No.7</td>
<td>B</td>
<td>Simple station</td>
<td>1</td>
</tr>
<tr>
<td>No.8</td>
<td>B</td>
<td>Simple station</td>
<td>1</td>
</tr>
<tr>
<td>No.9</td>
<td>C</td>
<td>Simple station</td>
<td>1</td>
</tr>
<tr>
<td>No.10</td>
<td>B</td>
<td>Simple station</td>
<td>1</td>
</tr>
<tr>
<td>No.11</td>
<td>C</td>
<td>Simple station</td>
<td>1</td>
</tr>
<tr>
<td>No.12 (El Remayah)</td>
<td>C</td>
<td>Simple station</td>
<td>1</td>
</tr>
<tr>
<td>No.13 (GEM)</td>
<td>C</td>
<td>Simple station</td>
<td>2</td>
</tr>
<tr>
<td>No.14</td>
<td>C</td>
<td>Simple station</td>
<td>3</td>
</tr>
<tr>
<td>No.15</td>
<td>C</td>
<td>Simple station</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: JICA Study Team
CHAPTER 3
GENERAL FEATURES AND MAIN CHARACTERISTICS
CHAPTER 3 GENERAL FEATURES AND MAIN CHARACTERISTICS

3.1 General Features of Metro Line 4

Metro Line 4 will be designed to provide a high-capacity, safe, reliable and cost-effective urban railway service in Greater Cairo. Its main function will be to connect presently under-served, but fast growing, new urban communities in western Cairo with the central city area. Commuters joining the railway at its extreme western end will be able to travel the 16 km to El Malek El Saleh Station (the interchange station with Metro Line 1) in 30 minutes, whereas the same trip by bus could take more than 1 hour in present traffic conditions.

Because the new railway will be required to offer high standards of safety, reliability and system performance and availability, it will be equipped with state-of-the-art technology, designed to automate route setting, provide fail-safe train operation and control, provide superior riding comfort, and cope effectively with emergencies.

3.2 Main Technical Characteristics of Metro Line 4

The railway system to be introduced must be capable of offering safety and reliability, as well as cost-effective operation throughout its entire service life cycle. Accordingly, it is extremely important to the ongoing operation of the existing railway system that these fundamental requirements be met, even if the initial capital cost is slightly more expensive.

The main technical characteristics for the railway system proposed for Metro Line 4 are shown in Table 3.1. Detailed explanations of these characteristics are given in Chapter 4 of this report (Volume 3).

<table>
<thead>
<tr>
<th>Table 3.1 Main Technical Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Alignment</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>Route length</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>Stations</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>Operation status</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>
### JICA PREPARATORY SURVEY ON GREATER CAIRO METRO LINE NO.4

**Final Report - Volume 3  3-2**

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Phase 1</strong></td>
</tr>
<tr>
<td>1</td>
<td>Headways in peak hour</td>
<td>4 minutes 00 seconds in 2020</td>
</tr>
<tr>
<td>2</td>
<td>Maximum operation speed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Underground section</td>
<td>80 km/hr</td>
</tr>
<tr>
<td></td>
<td>- Elevated section</td>
<td>100 km/hr</td>
</tr>
<tr>
<td></td>
<td>- Inside depot</td>
<td>25 km/hr</td>
</tr>
<tr>
<td>3</td>
<td>Average speed</td>
<td>32.2 km/hr</td>
</tr>
<tr>
<td>4</td>
<td>Dwell time at intermediate stations</td>
<td>30 seconds</td>
</tr>
<tr>
<td>5</td>
<td>Round trip time</td>
<td>70 minutes</td>
</tr>
<tr>
<td>6</td>
<td>Daily operation hour</td>
<td>05:00h – 01:00h</td>
</tr>
<tr>
<td>7</td>
<td>Train size</td>
<td>8 cars in a train-set</td>
</tr>
<tr>
<td>8</td>
<td>Driver system</td>
<td>Single driver operation</td>
</tr>
<tr>
<td>9</td>
<td>Location of CCP</td>
<td>El Malek El Saleh</td>
</tr>
<tr>
<td></td>
<td><strong>Standards of construction</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Gauge</strong></td>
<td>1,435 mm</td>
</tr>
<tr>
<td></td>
<td><strong>Track centre distance</strong></td>
<td>3.5 m at elevated section</td>
</tr>
<tr>
<td></td>
<td><strong>Tracks</strong></td>
<td>Vibration-reducing track</td>
</tr>
<tr>
<td></td>
<td><strong>Design axle load</strong></td>
<td>16 tonnes max.</td>
</tr>
<tr>
<td></td>
<td><strong>Rail</strong></td>
<td>UIC 54 kg/m</td>
</tr>
<tr>
<td></td>
<td><strong>Max. gradient</strong></td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td><strong>Min. horizontal curve radius</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Main line:</td>
<td>250 m</td>
</tr>
<tr>
<td></td>
<td>Main line turnout curve:</td>
<td>160 m</td>
</tr>
<tr>
<td></td>
<td>Workshop / depot line:</td>
<td>160 m</td>
</tr>
<tr>
<td></td>
<td>Workshop / depot line turnout curve:</td>
<td>120 m</td>
</tr>
<tr>
<td></td>
<td>Platform section:</td>
<td>1,000 m</td>
</tr>
<tr>
<td>10</td>
<td><strong>Tunnel structure</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type of tunnel</td>
<td>Single track Double tube</td>
</tr>
<tr>
<td></td>
<td><strong>Diameter</strong></td>
<td>6.2 m (inner diameter)</td>
</tr>
<tr>
<td></td>
<td><strong>Number of Platform</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Island type</td>
<td>11 stations</td>
</tr>
<tr>
<td></td>
<td>- Side type</td>
<td>4 stations</td>
</tr>
<tr>
<td>11</td>
<td><strong>Platform width</strong></td>
<td>12.0 m (island type)</td>
</tr>
<tr>
<td>12</td>
<td><strong>Platform height</strong></td>
<td>1,100 mm</td>
</tr>
<tr>
<td>13</td>
<td><strong>Platform length</strong></td>
<td>170 m</td>
</tr>
<tr>
<td>14</td>
<td><strong>Depot</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Stabling capacity</strong></td>
<td>35 train sets</td>
</tr>
<tr>
<td></td>
<td><strong>Facilities</strong></td>
<td>Stabling and maintenance facilities</td>
</tr>
<tr>
<td>15</td>
<td><strong>Rolling stock</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Type of rolling stock</strong></td>
<td>EMU (Electric Multiple Unit)</td>
</tr>
<tr>
<td></td>
<td><strong>Train formation</strong></td>
<td>M-N1-T-N2-N2-T-N1-M</td>
</tr>
<tr>
<td></td>
<td><strong>Passenger capacity (AW2: 7 person/m2)</strong></td>
<td>2,000 passenger/train</td>
</tr>
<tr>
<td></td>
<td><strong>Train dimensions</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Car length (over coupler faces)</td>
<td>20.0 m</td>
</tr>
<tr>
<td></td>
<td>- Car width</td>
<td>2.88 m</td>
</tr>
<tr>
<td></td>
<td>- Car height</td>
<td>4.1 m</td>
</tr>
<tr>
<td></td>
<td>- Train length (8-car unit)</td>
<td>160 m</td>
</tr>
<tr>
<td></td>
<td><strong>Propulsion System</strong></td>
<td>Inverter with IGBT</td>
</tr>
<tr>
<td></td>
<td>- Circuit control system</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Traction motor</td>
<td>PMSM 1 or Induction motor</td>
</tr>
<tr>
<td></td>
<td>- Motor output power</td>
<td>140 kW/motor</td>
</tr>
<tr>
<td>16</td>
<td><strong>Car body material</strong></td>
<td>Lightweight stainless steel</td>
</tr>
<tr>
<td>No.</td>
<td>Description</td>
<td>Details</td>
</tr>
<tr>
<td>-----</td>
<td>-------------</td>
<td>---------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Phase 1</td>
</tr>
<tr>
<td></td>
<td>Doors</td>
<td>8 doors per car (4 on each side)</td>
</tr>
<tr>
<td></td>
<td>Kinetic performance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Initial acceleration ratio</td>
<td>0.9 m/s²</td>
</tr>
<tr>
<td></td>
<td>- Max service deceleration</td>
<td>1.1 m/s² (ability 1.3 m/s²)</td>
</tr>
<tr>
<td></td>
<td>Air conditioning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Type of air conditioning</td>
<td>Roof-mounted with line-flow fan</td>
</tr>
<tr>
<td></td>
<td>- Capacity</td>
<td>40,000 kcal/h/car</td>
</tr>
<tr>
<td></td>
<td>Air conditioning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Power supply and traction system</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electrification system</td>
<td>1500VDC</td>
</tr>
<tr>
<td></td>
<td>Type of centenary system</td>
<td>OHC (Tunnel: Overhead rigid conductor)</td>
</tr>
<tr>
<td></td>
<td>Voltage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Nominal voltage</td>
<td>1500VDC</td>
</tr>
<tr>
<td></td>
<td>- Max. voltage</td>
<td>1800VDC</td>
</tr>
<tr>
<td></td>
<td>- Nin. voltage</td>
<td>1000VDC</td>
</tr>
<tr>
<td></td>
<td>HVS (High Voltage Station)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Number of stations</td>
<td>1 HVS</td>
</tr>
<tr>
<td></td>
<td>- Transformer capacity</td>
<td>80MVA</td>
</tr>
<tr>
<td></td>
<td>RS (Rectifier Station)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Number of stations</td>
<td>5 RS</td>
</tr>
<tr>
<td></td>
<td>- Capacity</td>
<td>6MW</td>
</tr>
<tr>
<td></td>
<td>LPS (Lighting Power Station)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Number of stations</td>
<td>1 LPS/station and Depot</td>
</tr>
<tr>
<td></td>
<td>Signalling and Telecommunications system</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Signals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Main line including between main line and stabiling in Depot</td>
<td>On-board signal</td>
</tr>
<tr>
<td></td>
<td>- Inside of Depot</td>
<td>Wayside signal</td>
</tr>
<tr>
<td></td>
<td>Train detection system</td>
<td>Track circuit</td>
</tr>
<tr>
<td></td>
<td>Route Control system</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Interlocking</td>
<td>Electrical interlocking</td>
</tr>
<tr>
<td></td>
<td>- Point machine</td>
<td>Electrical point machine</td>
</tr>
<tr>
<td></td>
<td>Train Interval control system</td>
<td>ATP (Automatic Train Protection, Continuous control)</td>
</tr>
<tr>
<td></td>
<td>Train operation support system</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- System</td>
<td>ATO (Automatic Train Operation)</td>
</tr>
<tr>
<td></td>
<td>- Accuracy</td>
<td>Stopping accuracy; Approx. plus minus 350mm</td>
</tr>
<tr>
<td></td>
<td>Backbone transmission network system</td>
<td>SDH (Synchronous Digital Hierarchy)</td>
</tr>
<tr>
<td></td>
<td>- System</td>
<td>Optical fibre transmission system</td>
</tr>
<tr>
<td></td>
<td>- Transmission media</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Train radio system</td>
<td>VHF² TDM/TDMA³</td>
</tr>
<tr>
<td></td>
<td>- System</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Antenna</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CCTV (Closed Circuit Television) system including on-board monitoring system</td>
<td>Monitoring of platform, concourse, ticket gate, elevator, escalator, others</td>
</tr>
<tr>
<td></td>
<td>Passenger Information system</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PIDS (Passenger Information Display System)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PA (Public Address System)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clock system</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Station Facilities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AFC (Automatic Fare Collection) system</td>
<td>Magnetic Ticket (MT), Contactless IC ticket</td>
</tr>
<tr>
<td></td>
<td>- Type of ticket media</td>
<td>ISO/IEC 14443 (Type-A)</td>
</tr>
<tr>
<td></td>
<td>- 1C chip standard</td>
<td>ISO 7810</td>
</tr>
<tr>
<td></td>
<td>- Card size</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PSD (Platform Screen Door) system</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Full height PSD</td>
<td>For underground stations, except El Remayah station</td>
</tr>
<tr>
<td></td>
<td>- Half height PSD</td>
<td>For elevated stations, including El Remayah station</td>
</tr>
<tr>
<td>No.</td>
<td>Description</td>
<td>Details</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------</td>
<td>--------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Other major facilities</td>
<td>Elevator, Escalator, Air conditioner, Air intake &amp; Exhaust system, Fire protection system, etc.</td>
</tr>
</tbody>
</table>

*1: PMSM: Permanent Magnet Synchronous Motor  
*2: VHF: Very High Frequency  
*3: TDM/TDMA: Time Division Multiplex/Time Division Multiple Access  
Source: JICA Study Team