Report No. 63551-JO

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CONSOLIDATED CONSULTANTS
Engineering & Environment

Developing an Energy Efficient Urban Transport Plan for Zarqa City Downtown Area

Final Report – Volumes 1 and 2

World Bank / ESMAP

November 2011

ESMAP
Energy Sector Management Assistance Program

Document of the World Bank

ESMAP Mission
The Energy Sector Management Assistance Program (ESMAP) is a global knowledge and technical assistance trust fund program administered by the World Bank and assists low- and middle-income countries to increase know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth.

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- Ministry of Transport: Eng Mohannad S Qudah (Secretary General), Eng.Nagham Al-Soub
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LIST OF ABBREVIATIONS

ARR	-	Amman Ring Road
BRT	-	Bus Rapid Transit
CVDB	-	Cities and Villages Development Bank
CDS	-	City Development Strategy
CDSs	-	City Development Strategies
CG	-	Consultative Group
CNG	-	Compressed Natural Gas
CPZ	-	Controlled Parking Zone
EECI	-	Energy Efficient Cities Initiative
ESMAP	-	Energy Sector Management Assistance Program
ESRI	-	Geographic Information System Software Provider
ETMs	-	Electronic Ticket Machines
EU	-	European Union
GHG	-	Greenhouse Gas
GIS	-	Geographical Information System
ESMAP	-	Energy Sector Management Assistance Program
ETM	-	Electronic Ticketing Machine
GOJ	-	Government of Jordan
GAM	-	Greater Amman Municipality
IVE	-	International Vehicle Emissions
ITS	-	Intelligent Transport System
KABAAC	-	King Abdullah Bin Abdul Aziz City
KPIs	-	Key Performance Indicators
LTRC	-	Land Transport Regulatory Commission
LRS	-	Light Rail System
MOMA	-	Ministry of Municipal Affairs
MoT	-	Ministry of Transport
MoPIC	-	Ministry of Planning and International Co-operation
MPWH	-	Ministry of Public Works and Housing
PT	-	Public Transport
PTRC	-	Public Transport Regulatory Commission
PVR	-	Peak Vehicle Requirement
RJGC	-	Royal Jordanian Geographic Centre
RLDP	-	Regional and Local Development Project
RPCDS	-	Regional Programmatic City Development Strategy
RTPI	-	Real Time Passenger Transport Information
SCATS	-	Sydney Coordinated Area Traffic System
SVD	-	Selective Vehicle Detection
SWOT	-	Strengths, Weaknesses, Opportunities and Threats
TIS	-	Traffic Impact Studies
TDM	-	Travel Demand Management
UTC	-	Urban Traffic Control
VOC	-	Vehicle Operating Costs
VOT	-	Value of Time
ZC	-	Zarqa City
ZM	-	Zarqa Municipality

EXECUTIVE SUMMARY

Background

The World Bank / ESMAP received a proposal from the Zarqa Municipality in 2010 seeking technical and financial support for developing an energy efficient urban transport planning strategy for the city's Downtown area. This is in accordance with the Government of Jordan's regional development agenda and is linked with the Cities Alliance grant to prepare inputs for a broader City Development Strategy (CDS) in preparation for a new Zarqa Master Plan to be developed by the Ministry of Municipal Affairs (MOMA). This project's primary purpose is to develop an energy efficient transport plan for the downtown area of Zarqa.

Zarqa is located some 20km north east of Amman. Due to its position within the country, Zarqa has developed into a road hub and transit centre linking Iraq, Syria and Turkey with Jordan and the port of Aqaba. Furthermore, a high proportion of the population of Zarqa work and study in Amman, and Zarqa itself hosts three universities which attract trips to the city from other areas. Consequently, there are both heavy traffic movements between Zarqa and Amman, but also through Zarqa to neighbouring countries. Lack of alternative sustainable transport options, a poor internal road network structure, and rapidly increasing car ownership amongst other factors have led to a growing problem of congestion in the city.

The population of Zarqa City is 513,060, which is not far short of two thirds of the total population of the Zarqa Governorate. Zarqa's natural population growth of 2-3% per annum is in line with that of the country as a whole (2.8%). The average family size is 5.5 people, and the unemployment level (13%) is the highest in the country. As a consequence of Zarqa hosting some 50% of Jordan's industry, it is, along with neighbouring Russeifa, considered to be the most polluted area in the country. Congestion and pollution have undermined the quality of life of the residential communities in Zarqa City and have also negatively impacted upon the competitiveness of the business environment. Consequently, developing a strategic approach to addressing excessive use of the car, particularly in the city downtown area, is becoming increasingly critical.

Study Objectives

The study objectives are as follows:

- Develop a detailed energy efficient mobility plan, identifying specific projects for the Zarqa downtown area,
- Develop a plan for easy access to the proposed LRS terminal and stations using an efficient public bus transportation system in the city.

The first objective is regarded as primary, in that Zarqa Municipality aspires to deliver a series of projects, which will tackle congestion, reduce emission rates, improve public transport, stimulate economic activity and optimise energy consumption. The second objective relates to the plans for a Light Rail System to connect Zarqa to Amman. This is a heavily used corridor with a two way demand, but the success of any mass transit system will be dependent on a high level of inter-connectivity and accessibility from the whole of the urban area of Zarqa to stations on the line of route. During the course of the Study, it became apparent that the proposals for the Light Rail System were under reconsideration, with the possibility that a Bus Rapid Transit system might be substituted. Thus any proposals relating to public transport connectivity and integration must be equally relevant and effective, regardless of which mass transit system is ultimately chosen.

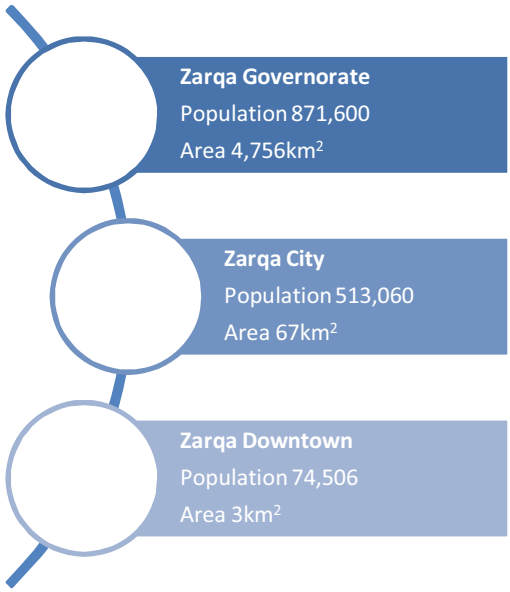
Study Vision

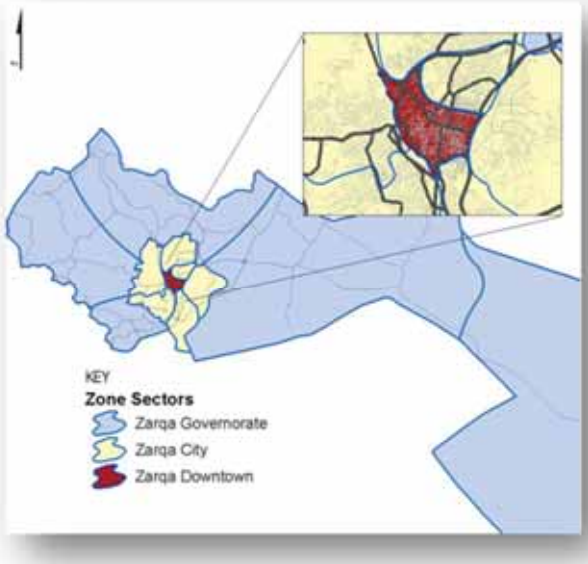
In developing a cohesive strategy, a vision statement has been adopted, which incorporates the above objectives, and which provides an overarching focus for determining the context and content of the selected measures. It is:

"Our vision is to promote an ambitious but realistic series of interlocking projects intended to enhance public transport accessibility, reduce congestion, stimulate economic activity and improve air quality and energy efficiency in the Downtown area of the City of Zarqa."

Study Area

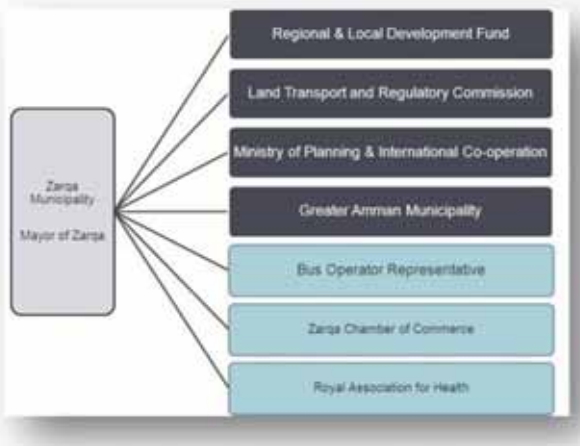
The project proposals for this study are targeted at the downtown area; however, the benefits will be felt throughout the city area. Therefore, for this project, our study boundary in terms of emissions impacts is Zarqa City, but the projects are focused on the downtown area, as shown in the figure below, which sets out the downtown area and Zarqa City in the context of the wider Zarqa Governorate.





Consultative Group

A fundamental objective of this project was to ensure continuous and constructive interaction between the study team and the key stakeholders. At the onset of the study, a Consultative Group (CG) was set up to provide a focal point for discussion and continuous feedback on all aspects of the study. The CG was made up of seven organisations that represent a broad range of interests with regards to transport in Zarqa. The organisations involved are shown in the figure to the side. The Chairman of the Consultative Group is the Mayor of Zarqa Municipality.



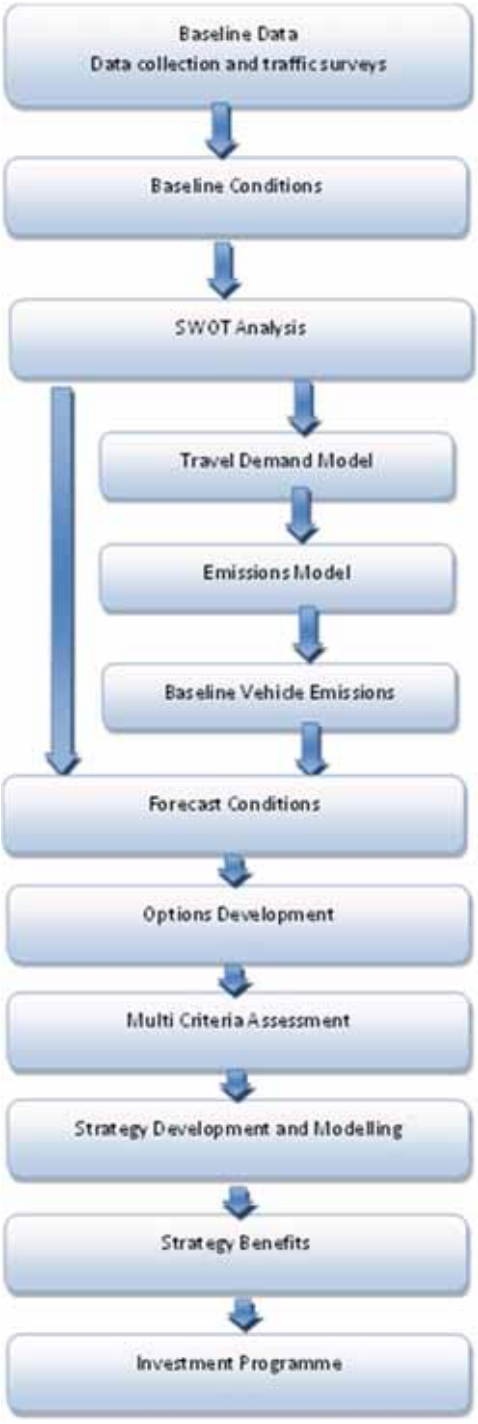
Approach

Our approach to this study and the development of an energy efficient transport strategy for the Zarqa Downtown area is based upon:

- Our understanding of the traffic characteristics within the downtown area, derived from a fundamental understanding of traffic circulation, car parking issues, road hierarchy and public transport coverage and effectiveness;
- The continuous interaction between the CG and the World Bank on all matters related to the project; and
- The continuous interaction between the study team and Zarqa Municipality.

The study approach is shown below:

- **Data Collection:** existing studies, reports and traffic surveys were undertaken. Discussions were held with all stakeholders.
- Baseline conditions and transport characteristics were assessed.
- Once we assessed the current data available we carried out a **SWOT** (strengths, weaknesses, opportunities and threats) analysis in order to provide guidance into the strategy development options.
- An **Excel and GIS model** was developed to assess demand, travel patterns, vehicle emissions.
- **Base line** emissions factors were developed, calibrated and validated against existing emissions and fuel sales.
- **Forecasts** were made of travel demand and greenhouse gas emissions.
- Using the SWOT analysis, discussions with the CG and our understanding of the transport issues downtown, over 60 projects were considered as **options** to take forward.
- In order to ensure that projects selected were realistic, politically acceptable, affordable and suitable, a multi criteria assessment was undertaken to reduce the number of projects into a strategy package.
- In parallel to the strategy development, a number of Core projects have been recommended in support of the strategy.
- Modelling was undertaken to assess the strategy benefits.
- Finally, based upon the strategy, a 10 year investment programme has been developed.



Data Collection

In developing a transport strategy for the downtown area, it is essential to have an understanding of the transport conditions. An extensive data collation exercise was organised and existing information on transport and emissions based data was collected from the following organisations:

- Zarqa Municipality and Greater Amman Municipality;
- Royal Jordanian Geographic Centre;
- Ministries of Interior, Environment, Transport and Public Works and Housing;
- Public Security Directorate;
- Land Transport Regulatory Commission; and
- MAWARED

In order to gauge the level of traffic demand in the downtown area, a traffic count survey was undertaken, primarily in the morning peak period between 0730 and 0930 hours, but also with some off-peak counts, using 15 minute time 'slices', by the Municipality, with assistance from the consultants. These were undertaken to gain a better appreciation of the volume of traffic using the highway network, and to establish the vehicle composition by type to obtain a snapshot of the traffic situation within the downtown area. The resulting key findings are as follows:

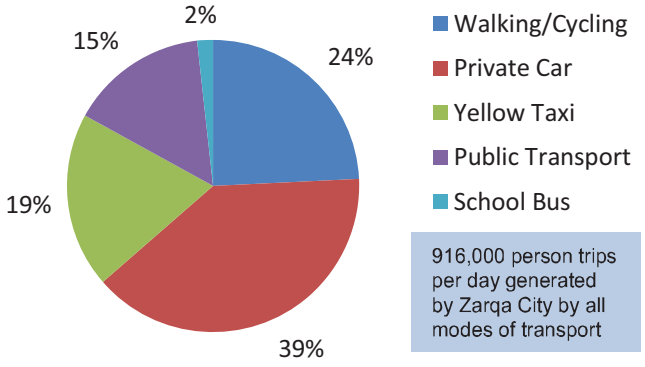
- Narrow streets – exacerbated by parked cars and lack of pedestrian segregation;
- High volumes of traffic – a demand of over 8,000 vehicles per hour on the main roads;
- Low traffic speeds - observed to be between 12-15km/h within downtown Zarqa;
- Pedestrian conflict – lack of crossings on routes with high traffic flows creating severance;
- High private vehicle demand - approximately 60% of all vehicles are cars or yellow taxis;
- Poor connectivity to public transport – lack of bus stops, and poor walking routes to terminals;
- Indiscriminate parking – no enforcement of existing parking restrictions;
- Lack of demand management – congestion is the only deterrent to travel by private vehicle;
- Poor air quality – slow vehicle speeds lead to more engine idling and higher emissions; and
- Poor public transport services – lack of formal infrastructure and a poor quality service offered.

Baseline Conditions

A private vehicle demand model was built using Zarqa City specific data inputs to provide an origin-destination matrix of private vehicle trip generation. The distribution of vehicles in the baseline year was validated using traffic counts on major highway corridors linking the city to neighbouring zones. The baseline public transport model was developed using first principles analysis of existing bus routes and vehicle provision in the city.

The baseline modelling process has evolved throughout the study to account for changes recommended by the CG members such as amendments to school bus estimates and taxi occupation levels.

The baseline mode share demonstrates a dependence on private vehicles. Public transport services are currently poor and consequently just 15% of people typically travel by this mode in the baseline year of 2010.



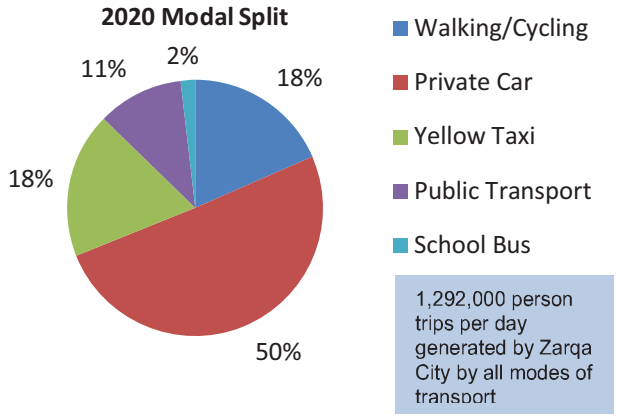
The predicted vehicular demand has been used in combination with emission factors derived from the International Vehicle Emissions model to calculate baseline GHG emissions. The emission factors compare well with similar studies.

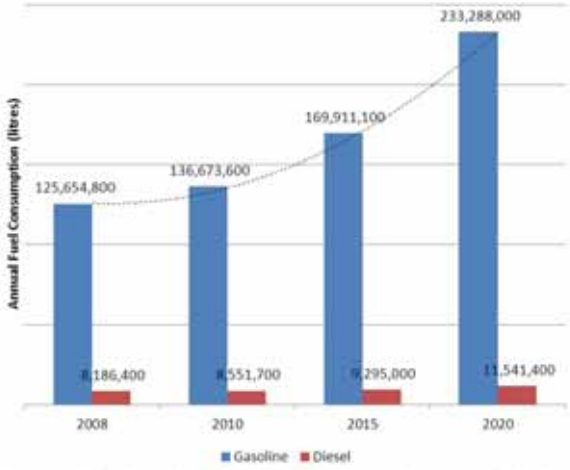
The study finds that in the baseline year of 2010 Zarqa City releases approximately 591kg CO2 per person per annum from passenger transport. This figure is a similar level to the passenger transport CO2 emissions from cities in the Middle East such as Tunis and Tehran.

Forecast Conditions

The baseline conditions have been forecast for future years 2015 and 2020 in a Do Minimum scenario. The private vehicle distance travelled by residents of Zarqa City is predicted to increase by 70% by 2020. This substantial increase is due to a growing population, the new KABAAC development to the east of the city, and increasing levels of car ownership resulting in a modal shift toward travel by private vehicles.

Consequently fuel consumption, particularly gasoline, is predicted to increase in line with vehicle demand. The result of the rapidly increasing fuel consumption and vehicle trips is significant growth in GHG emissions. CO2 emissions per capita are predicted to reach 741kg/capita/annum in 2020.





Annual emissions of Carbon Monoxide (CO), one of the main contributors to air pollution, are also predicted to increase substantially from 154kg/capita in 2010 to 196kg/capita in 2020. Given the increasing population of the city this will have a significant detrimental impact on the air quality in Zarqa.

Emission Type	Annual Emission per Capita (kg)		
	2010	2015	2020
CO2	591	673	741
NOX	7	8	8
PM	0.2	0.2	0.2
CO	154	177	196

Strategy Development

The strategy for the downtown area has been developed in conjunction with Zarqa Municipality and the CG. All stakeholders have thus attended officially held meetings, and discussed a number of issues, including the type, size and cost of the proposed strategy. World Bank comment and views have also been taken into account.

In developing a strategy for consideration, the approach taken was to:

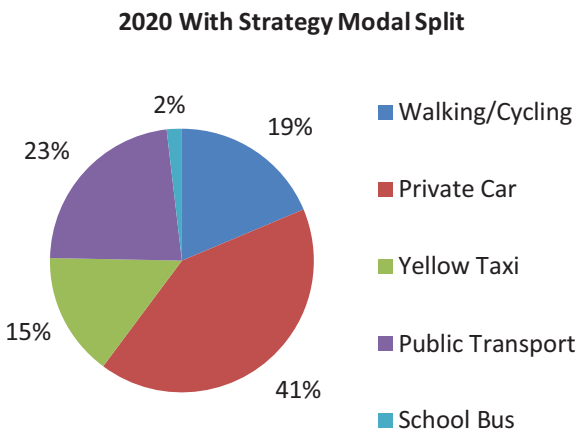
- Adhere to the project objectives;
- Assess the existing conditions: reconnaissance surveys and traffic counts;
- Assess, calibrate and validate the demand and emissions model;
- Have a continuous exchange of views, ideas and recommendations from the CG Group;
- Filter the potential projects through the use of a multi criteria assessment;
- Identify CORE projects to support the recommended strategy;
- Focus on public transport and demand management; and
- Develop an integrated strategy of public transport supported by demand management.

Through a process of selection using multi criteria assessment, 8 core studies and a strategy involving 12 projects have been identified for implementation over the short and medium term time horizon, This approach meets the key objectives and at the same time establish a foundations for transport planning in the Zarqa downtown area as well as Zarqa Municipality.

Strategy Benefits and Energy Savings

The strategy recommends in total, 8 core projects and 12 strategy projects. These projects are to be planned for and implemented over a 10 year time horizon, starting in 2011 and finishing in 2020. The recommended strategy has been tested and found to:

- Reduce total vehicle emissions of CO2 by 25% compared with 2020 Do Minimum scenario
- Reduce vehicle travel time by 10%
- Reduce private vehicle demand by 19% compared with 2020 Do Minimum scenario
- Reduce fuel consumption by at least 13% compared with 2020 Do Minimum scenario



	Annual Emission per Capita (kg)					
	2015			2020		
	Do Minimum	With Strategy	% Change	Do Minimum	With Strategy	% Change
CO2	673	553	-18%	741	559	-25%
NOX	8	6	-16%	8	6	-25%
PM	0.19	0.12	-37%	0.19	0.03	-84%
CO	177	146	-17%	196	152	-22%

The strategy will also:

- Provide a solid foundation for Zarqa to take forward the proposed strategy;
- Provide dedicated transport links to the Zarqa LRS/BRT terminal;
- Integrate the KABAAC development in terms of transport and land use; and
- Provide Zarqa Municipality with the necessary equipment, knowledge and skills to understand better the existing conditions, and to implement and monitor the strategy going forward.

Strategy Investment Programme

Core Projects

In total, we recommend that 8 core projects need to be completed over the next 3 years in order to ensure that a sound basis is provided for Zarqa Municipality to be able to assess transport projects and their future impacts. We feel that these projects must be commissioned within the next 18 months.

Project	CORE Project Descriptions	Implementation Time Frame	Indicative Costs(JD)
1	Co-operation with the Greater Amman Municipality	2012 - 2015	-
2	Purchase and installation of Permanent Traffic Counters;	2011	15,000
3	Installation of Air Quality Monitoring Stations	2012	62,000
4	Detailed Assessment of KABAAC Housing Development;	2013	See Project 5
5	Development of Zarqa Traffic Model;	2012 - 2013	600,000
6	Completion of Zarqa Urban Masterplan;	2012	1,000,000
7	Institutional Strengthening of Zarqa Municipality;	2012 – 2014	135,000
8	Introduction of Transport Policy: Traffic Impact Studies.	2012 – 2014	250,000
		Total	2,062,000

Strategic Projects

We have recommended 12 strategic projects spanning the 10 year period. Some of the projects can be implemented within the short term time horizon; however, others involve continuous action throughout the 10 year period. The total investment cost over the 10 year period is JD 49.1 million, equivalent to JD 4.9 million per year investment. In addition, for both core and strategic projects, a further allowance should be made of 10% for management time and 10% for contingencies.

Project No:	STRATEGY Project Descriptions	Implementation Time Frame	Indicative Costs (JD)
1	Integrate Land Use and Transport Planning Through New Bus Routes and Policy	2013 – 2014	2, 375,000
2	Public Transport Services Improvements: Purchase of 43 new buses with lease payments of between 10-15 years	2011 - 2020	11,122,800
3	Improve Accessibility to the Proposed LRS Terminal	2013 – 2016	5,974,000
4	Public Transport Terminal Improvements	2013 – 2018	14.277,500
5	Public Transport Ticketing Changes	2013 - 2014	400,000
6	Public Transport Infrastructure Improvements	2013 - 2015	123,000
7	New Low-Emission Vehicles	2012 - 2020	4,878,000
8	Walking Infrastructure improvements	2013 - 2014	250,000
9	Install ITS Measures	2014 – 2017	2,100,000
10	Junction and Highway Improvements	2014 – 2018	2,000,000
11	Parking	2013 – 2020	5,300,000
12	Public Awareness Scheme	2013 - 2019	300,000
		Total	49,100,300

1 Introduction

1.1 PROJECT BACKGROUND

To promote energy efficiency in the delivery of city services, the Energy Sector Management Assistance Program (ESMAP) in the World Bank launched a multi-year initiative - the Energy Efficient Cities Initiative (EECI) - in December 2008 to help scale-up energy efficiency improvements in developing country cities around the world. One of the tools to help scale up energy efficiency improvements under the EECI program is the provision of pre-investment policy support wherein ESMAP applies its expertise in advising cities on appropriate analytical tools, policy and regulatory framework, lifecycle costing principles, energy efficient codes, and financing schemes. ESMAP is also working with Cities Alliance City Development Strategies (CDS) in this regard.

Within this context and in keeping with the Government of Jordan's (GOJ) regional development agenda, ESMAP received a proposal from the Zarqa Municipality seeking technical and financial support for developing an energy efficient urban transport planning strategy for the city Downtown area. This is linked with the Cities Alliance grant to prepare inputs to the broader CDS for preparation of the new Zarqa Master Plan to be developed by the Ministry of Municipal Affairs (MOMA).

1.2 PROJECT OBJECTIVES

The project objectives, as stated in the Terms of Reference, are:

- Develop a detailed energy efficient mobility plan, identifying specific projects, for the Zarqa downtown area, and
- Develop a plan for easy access to the proposed LRS terminal and stations using an efficient public bus transportation system in the city.

During the course of the Study, it became apparent that the proposals for the Light Rail System were under reconsideration, with the possibility that a Bus Rapid Transit system might be substituted. Consequently, this Study has concentrated on ensuring that the proposals relating to public transport connectivity and integration are equally relevant and effective, regardless of whichever mass transit system is ultimately chosen.

1.3 ZARQA BACKGROUND

Zarqa is located some 20km north east of Amman. Due to its position within the country, Zarqa has become a road hub and transit centre linking Iraq, Syria and Turkey with Jordan and the port of Aqaba. Furthermore, a high proportion of the population of Zarqa work and study in Amman, and Zarqa itself hosts three universities which attract trips to the city. Consequently, there are both heavy traffic movements between Zarqa and Amman, but also through Zarqa to neighbouring countries. Lack of alternative sustainable transport options, a poor road network structure, and rapidly increasing car ownership amongst other factors have led to a growing problem of congestion in the city.

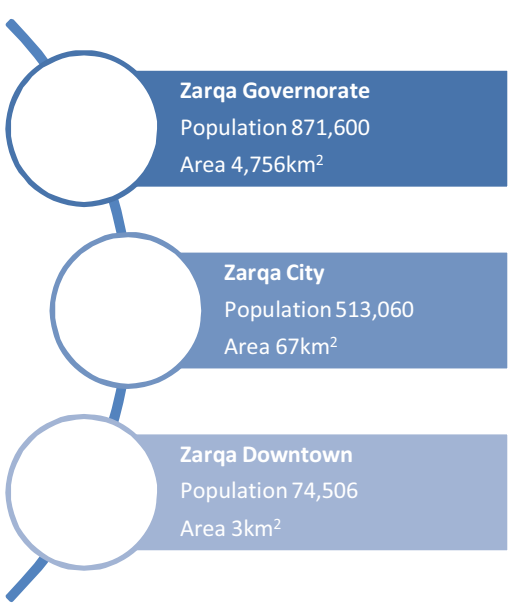
The population of Zarqa Governorate is 871,600 [(1)], with the majority living in Zarqa City which has a population of 513,060. Zarqa's natural population growth of 2-3% per annum is in line with that of the country as a whole (2.8%). The average family size is 5.5 people [(2)], and the unemployment level (13%) is the highest in the country. As a consequence of Zarqa hosting some 50% of Jordan's industry, it is, along with neighbouring Russeifa, considered to be the most polluted area in the country. The situation in Zarqa has undermined the quality of life of the residential communities and has also negatively impacted upon the competitiveness of the business environment. Some of the most pressing problems associated with transportation activity are congestion, traffic accidents, air pollution, Greenhouse Gas (GHG) emissions, and petroleum dependence. Thus, developing a strategic approach to motorization particularly in city downtown area is becoming increasingly critical.

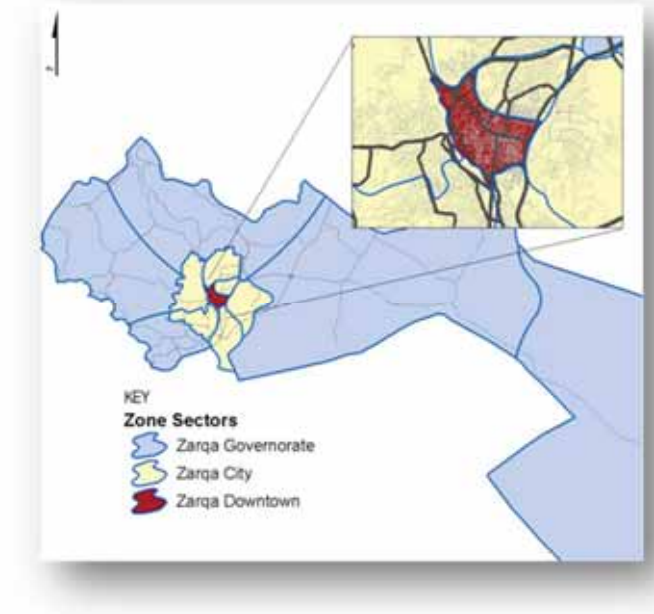
1.4 STUDY AREA

As stated above, one of the objectives of the study is to identify specific projects for the downtown area of Zarqa. The second objective however relates to wider accessibility of Zarqa City through implementation of an efficient bus transportation system linking to the proposed LRS network. The proposals for this project are predominantly targeted at the downtown area to meet the objectives; however the impacts of the Mobility Plan will be felt throughout the city. The study boundary in terms of transport emissions therefore covers the wider city boundary in order to capture the full impact of the proposals. Where it is possible to measure the impact of projects directly on the downtown district of Zarqa, the change in emissions and vehicle trips at this level is also provided.

Therefore, for this project, our boundary in terms of emissions circulation is Zarqa City but projects will be focussed on the downtown area, as shown in Figure 1.1 below which sets out the study area in the context of the wider Zarqa Governorate.

Figure 1.1: Zarqa Governorate, City and Downtown Area Boundaries





Source: Consultants

1.5 VISION STATEMENT

In order to develop a cohesive strategy, we have devised a vision statement, which incorporates the objectives, and which provides an overarching focus for determining the context and content of the selected measures. It is:

"Our vision is to promote an ambitious but realistic series of interlocking projects intended to enhance public transport accessibility, reduce congestion, stimulate economic activity and improve air quality and energy efficiency in the Downtown area of the City of Zarqa."

1.6 REPORT STRUCTURE

The Final Report is submitted in 2 Volumes.

- **Volume 1**: Technical Report (this report)
- **Volume 2 (Appendices)**: Project Details (under a separate volume)

This report, the Technical Report is set out in the following structure:

- **Section 2** summarises the Methodology and Approach of the Study

- **Section 3** provides a detailed description of the traffic conditions in downtown Zarqa;
- **Section 4** summarises the transport emissions and energy consumption for baseline and future years if nothing is done to curb the growing trend of motorisation;
- **Section 5** sets out details of the Strategy Development process;
- **Section 6** details the Core Projects
- **Section 7** details the shortlisted projects proposed along with best practice case studies – project details are provided under separate cover within the Appendices in Volume 2;
- **Section 8** details the likely impact of the proposed projects on emissions and energy consumption;
- **Section 9** presents the proposed Programme for Implementation; and
- **Section 10** provides a Summary and Conclusion to the Study.

2 Methodology and Approach

2.1 STUDY APPROACH

This work programme and report submission programme are shown graphically below in Figure 2.1.

This Final Report has been developed through continuous interaction between the project team, the World Bank, Zarqa Municipality and the Consultative Group (CG). Comments received at each stage of the study have been taken into account and these comments and advice have had a significant influence on the project and its outcomes.

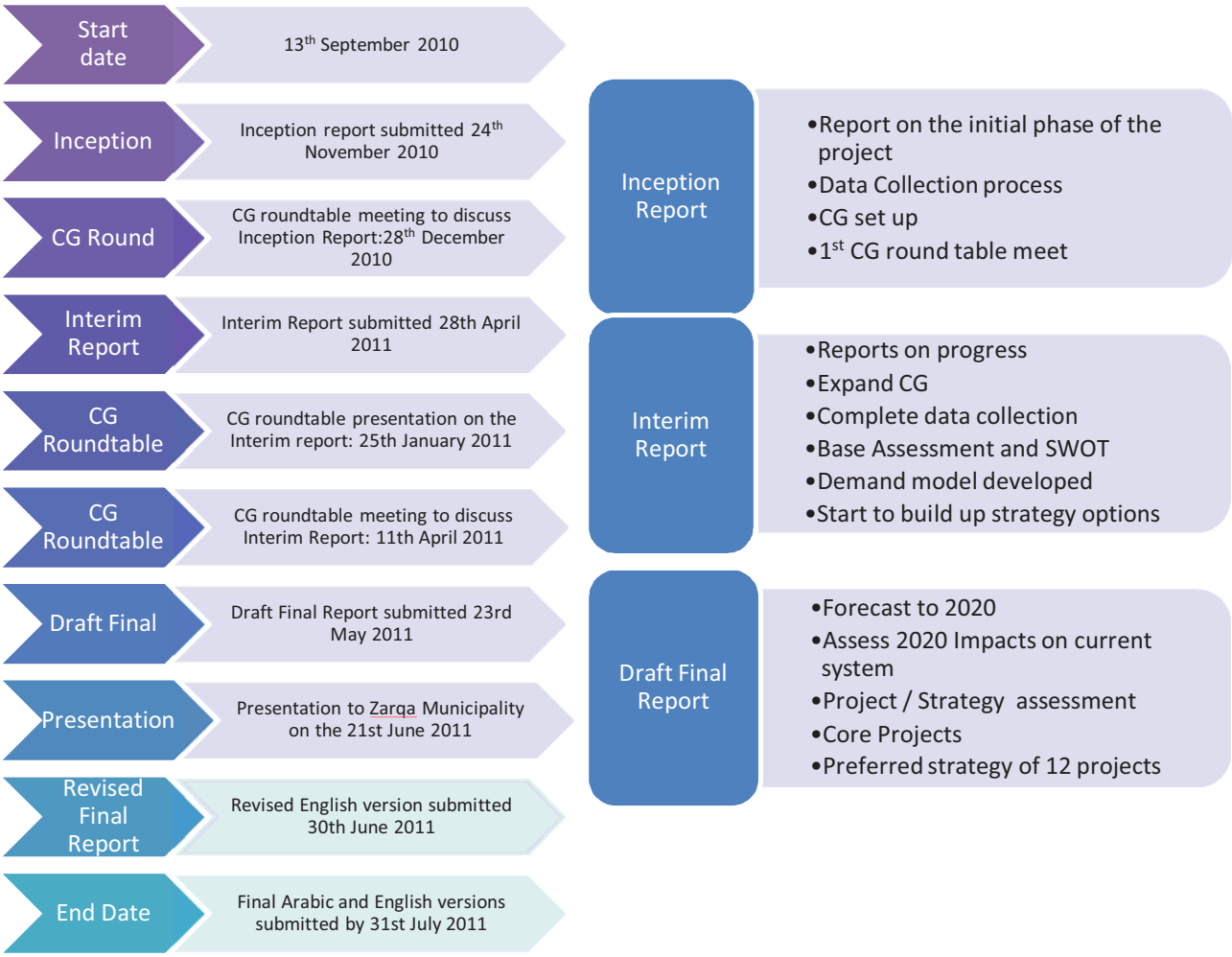
In developing this Final Report, comments received during the Interim phase of the study have been taken into account, along with comments received following submission of a Draft Final Report.

The focus of the final stage of the study has been to develop a mobility strategy, with an overarching vision, for Zarqa Downtown Area, comprising measures to achieve the following:

- Integration of land use and transport planning;
- Reduction of transport emissions and energy consumption;
- Encourage the use of public transport;
- Reduction of traffic congestion;
- Encourage walking and cycling;
- Improve road safety;
- Discourage the use of personal vehicles; and
- Improve institutional operation and regulations.

The work undertaken in this stage has built upon the work undertaken during the Inception and Interim stages. This has led to the development of realistic, effective, practical and implementable measures to meet these objectives. A package of measures has been proposed accordingly, combining the most suitable and cost effective projects in to an overall mobility strategy for Zarqa downtown area.

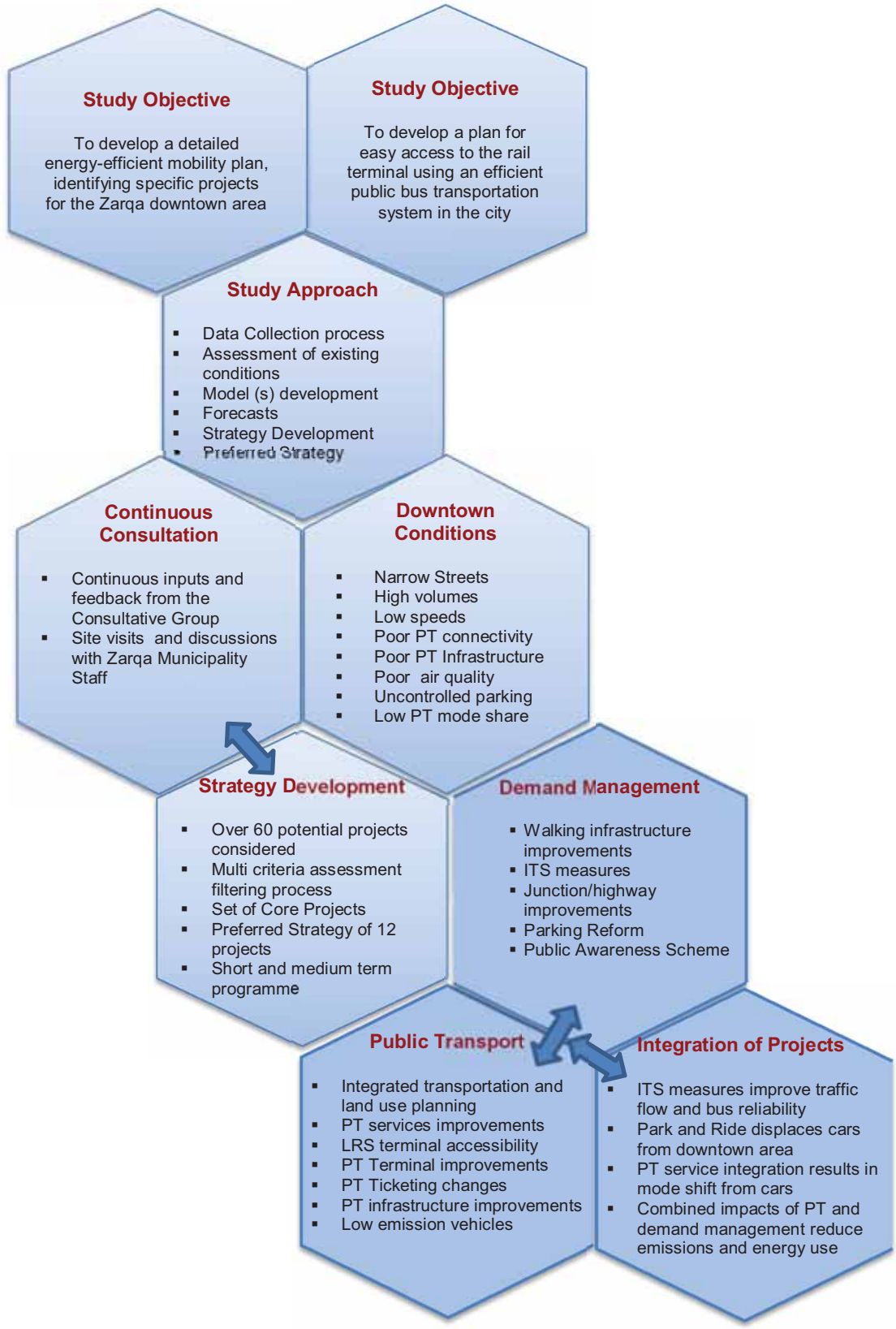
Figure 2.1: Work Programme



The study approach and process has hinged around a number of key integrated study components as shown in the Figure 2.2 below. The project development has been supported by a continuous process of dialogue between the Consultants, the World Bank, the CG and Zarqa Municipality. The approach has:

- Adhered to the project objectives;
- Assessed the existing conditions through a set of reconnaissance and traffic surveys;
- Calibrated and validated Excel based demand and emissions models;
- Forecast conditions to 2015 and 2020;
- Had a continuous exchange of views, ideas and recommendations with the CG, Zarqa Municipality and the World Bank;
- Considered over 60 project options;
- Used multi criteria to filter the projects;
- Focused on public transport and demand management to meet the study objectives; and
- Recommended an Integrated strategy of public transport supported by demand management measures.

Figure 2.2: Study Approach



2.2 DATA COLLECTION AND DATA SHORTFALLS

Given the nature of the project, a large scale data collection/survey programme has not been possible, and the work is reliant totally upon existing data sets, site reconnaissance visits, the consultant's knowledge of the area, together with some 'snapshot' surveys of traffic volumes, around the periphery, and in the Downtown area.

Throughout this Study, the source of all data used is referenced. However, there have been a number of instances where it has not been possible to obtain the data required. Table 2.1 below sets out the data shortfalls encountered in this Study.

Table 2.1: Data Shortfalls

Data Required	Reason	Status	Action
Master Plan socio economic data (number of households by zone, population by zone, etc	This information will form the basis for the development of the number of trips generated per zone.	Very little socio-economic data has been received. Most of the data provided has been from general statistics books. Breakdown of housing units by zone has not been provided.	General information on household size will be made using comparable data from Greater Amman and from the Annual Jordan Statistics.
Vehicle Registrations	The number of vehicles registered in Zarqa required to assess vehicle age profile which in turn will be used to estimate vehicle emissions	Age distributed vehicle registration figures have been received from GAM for Amman. We were unable to obtain equivalent data for Zarqa	Amman data has been used as a close representation for Zarqa
Vehicle Emissions Measurements	Required to support the calibration of the vehicle emissions model	Air quality data from a number of locations around Zarqa has been acquired however these are not suitable for emission validations	Emission factors have been validated against documented results for comparison purposes instead
School Buses / Private Schools	Required to predict the energy consumption and CO2 emissions generated by school buses	It has not been possible to ascertain the number of private schools or school buses in Zarqa, although it has been established that the numbers are considerably lower than in Amman	An estimate of the number of private schools has been made using Jordan statistics for guidance along with assistance from the CG members
Traffic Flow Data	Required to assist in the validation of trip generation	There is a lack of traffic flow data in Zarqa. However, several traffic surveys were obtained on highway links out of Zarqa.	Snapshot surveys in downtown Zarqa were undertaken to provide an indication of existing vehicular demand in Zarqa downtown
Vehicle Classification	Required to assist in the validation of trip generation	There is a lack of traffic flow data in Zarqa.	Snapshot surveys were undertaken in downtown Zarqa to provide an indication of typical split in vehicle numbers
Baseline mode split	This would help validate the predicted mode split for trip generation	There are no existing travel surveys to inform current modal split for validation purposes	The vehicle classification data from downtown snapshot surveys has been used to compare with predicted mode share and adjust accordingly
Vehicle speeds	Required to assist in calculating emission factors and public transport trip generation	There are no know surveys with speed data for Zarqa downtown or surrounding highways	Traffic speeds for varying vehicle types have been estimated based on observations

2.3 GEOGRAPHICAL INFORMATION SYSTEM

The GIS model for Zarqa was acquired from the Royal Geographical Society to incorporate into the emissions calculation process.

All data was provided in ESRI shapefile format. No pre-set cartographic style was supplied.

In addition to the data received from the Royal Geographical Society, WSP has developed a bus route dataset with support from the Land Transport Regulatory Commission (formerly the PTRC).

WSP also has an agreement with Microsoft Bing Maps and Google Maps enabling use of their aerial imagery within WSP reports. Whilst Google Maps has limited functionality within GIS, Bing Maps imagery can be used as a background layer for any map if it is available at that scale.

Additional GIS files are also available from the Amman Transport and Mobility Master Plan (TMMP). This includes accident locations used in the project sourced from the Jordanian Police.

The GIS model was used to calculate the following aspects of the demand model for private vehicles:

- Journey Time Costs
- Journey Distance Costs
- Zone Attractions

The costs in terms of time and distance between each model zone were calculated in GIS using ESRI Network Analyst software. The Origin and Destination (OD) cost matrices represent the quickest time and shortest distance between the centroid of each model zone. For trips to external zones with large rural areas the centroid was adjusted to represent the centre of an urban area instead of the actual geographic centre thus improving representation of trip origins and destinations.

GIS has also been used in the study to illustrate the internal CO_2 emissions in the Zarqa city zones and inter-zonal emissions along the main highway corridors on the network.

3 Downtown Zarqa Traffic

3.1 INTRODUCTION

This Section provides background information on the traffic conditions of the Zarqa downtown area to help inform the development of suitable projects to implement. Traffic count surveys and further site reconnaissance surveys were undertaken jointly by Zarqa Municipality and the Consultants. The results of the surveys are provided below.

3.2 DOWNTOWN HIGHWAY NETWORK

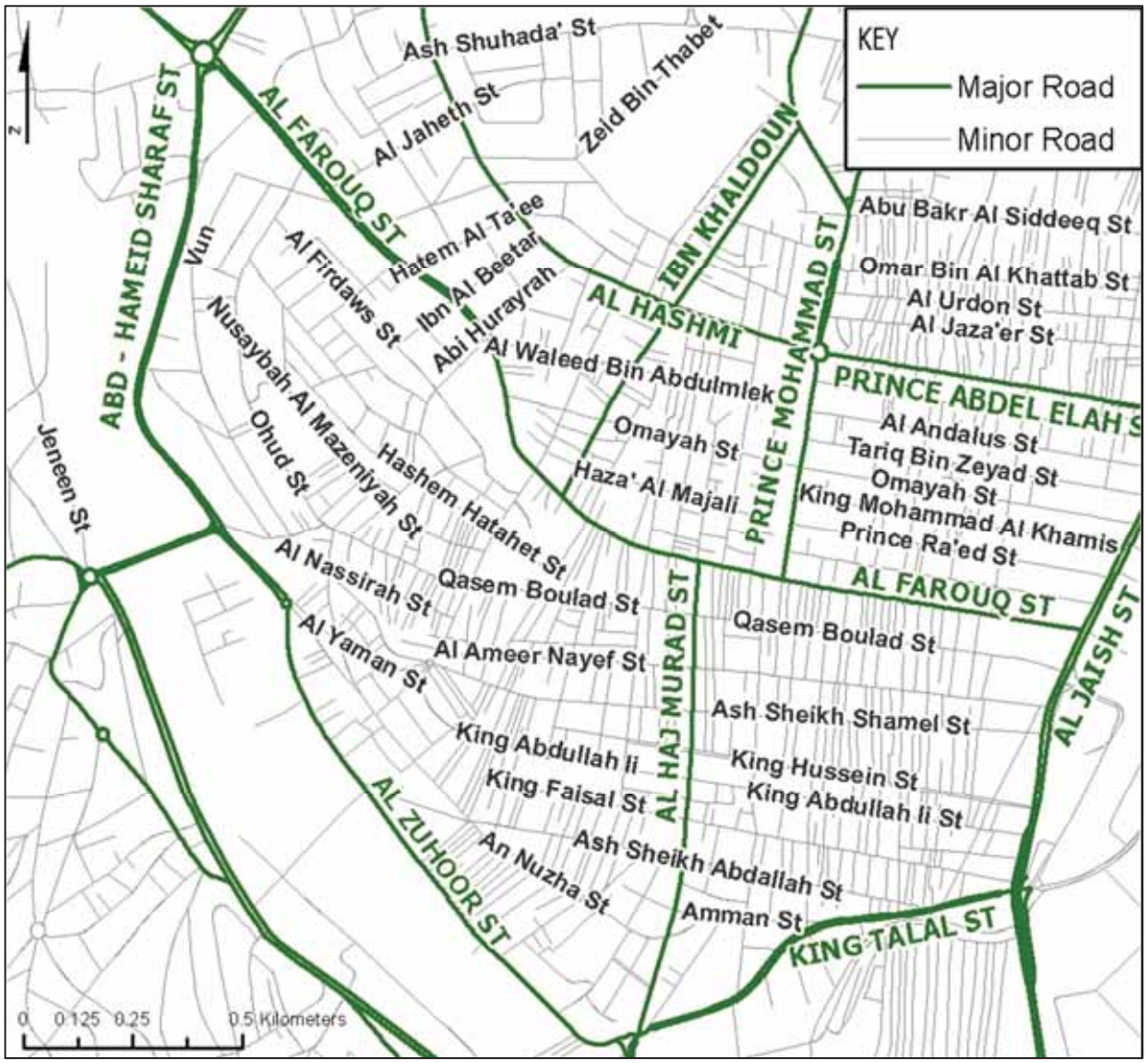
A road network plan with street names is provided below in Figure 3.1. Two of the main roads that border the downtown area, King Talal Street and Al Jaish Street, form part of the main highway corridor between Zarqa and Amman. The other main roads surrounding the downtown area serve less strategic purposes however they carry significant volumes of traffic through the western part of Zarqa city. The perimeter routes of the downtown area therefore play a key role in maintaining movement of traffic and reducing congestion.

Within the downtown Zarqa there is one main east – west link bisecting the district, known as Al Farouq Street. Al Farouq Street originates at a large roundabout to the west of the downtown area where it joins the main road to Jarash, and continues through downtown Zarqa where it meets the main Amman – Zarqa highway at the eastern extent of the district. At its western end Al Farouq Street is a wide corridor with a central reservation, however the road narrows to a single carriageway through the centre and eastern section of the downtown area.

The junctions on the peripheral roads that lead in to downtown Zarqa also have a strong influence on traffic flows, channelling vehicles into the narrow streets of the downtown area and controlling the flow of traffic on the main highway corridors passing through this zone.

There is a one-way system in place on streets located within the eastern side of the downtown area. The majority of streets forming an east-west alignment alternate between one-way eastbound and one-way westbound restrictions.

Figure 3.1: Street Names in Downtown Zarqa



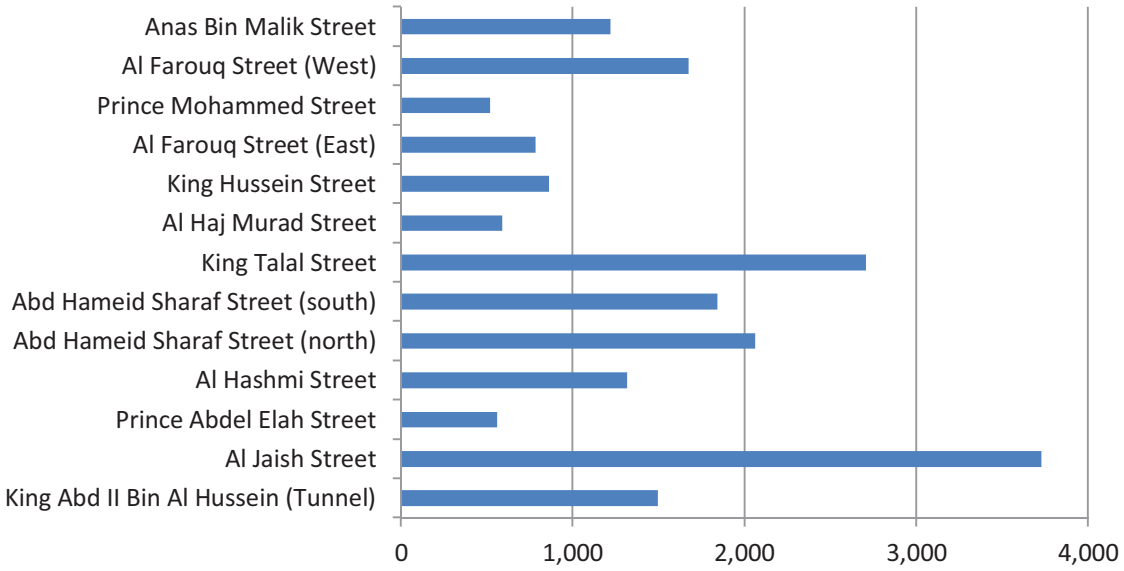
Source: Consultants

3.3 DOWNTOWN TRAFFIC CONDITIONS

A series of traffic counts were undertaken in downtown Zarqa to gain a better appreciation of the volume of traffic using the highway network, and to establish the vehicle composition. The traffic counts consisted of 15 minute snap-shot surveys at links on approaches to 14 junctions, undertaken by Zarqa Municipality with assistance from the Consultants during the week commencing 12th March 2011.

Although it was not possible to carry out all surveys at the same time to ensure consistency, the surveys provide an indication of the typical traffic levels using the roads during the day. The 15 minute traffic counts have been multiplied by four to establish approximate hourly flows on the roads at each junction approach to the junction. A summary of Traffic Survey details, including the survey results along with a location plan of the count points is provided in Appendix A (Volume 2), with a summary of the main highway link flows shown in Figure 3.2 below. Further analysis of the surveys follows.

Figure 3.2: Average Hourly Traffic Flows on Major Links (two-way)



3.3.1 Downtown Ring Road Traffic Flows

The downtown ring road carries a combination of through traffic destined for locations outside of Zarqa City, and also traffic destined for downtown Zarqa and locations within the city. Traffic levels on these links are therefore high. The downtown ring road can be split into four sections (north, east, south and west) to appreciate where demand is highest. The average two way traffic flows on these links is set out in Table 3.1 below.

Table 3.1: Downtown Ring Road Traffic Flows

Ring Road Section	Road Name	Average Hourly Two-way Traffic Flow	Busiest Direction Maximum Hourly Traffic Flow
Northern	Al Hashmi / Prince Abden Elah St	950	500
Eastern	Al Jaish St	3,700	2,100
Southern	King Talal Street	2,700	1,500
Western	Abd-Hameid Sharaf St	2,100	1,100

It is evident from Table 3.1 above that the eastern stretch of the downtown ring road carries the highest volume of traffic. The southern section of the ring road, formed of King Talal Street also accommodates a significant volume of traffic with approximately 2,700 vehicles per hour travelling along this stretch of road.

The high volumes of traffic on these routes is in part due to the fact that both Al Jaish Street and King Talal Street form part of the main Amman – Zarqa highway corridor. Consequently, they not only carry most vehicles travelling from Amman to downtown Zarqa, but also carry the majority of any heavy goods vehicles passing through Zarqa City. These routes carry the highest proportion of heavy vehicles of all the roads surveyed, with HGVs comprising up to 12% of all vehicles on King Talal Street.

Furthermore, these routes lie adjacent to the main bus terminals in Zarqa City. Evidence from the traffic surveys suggests that they carry high volumes of large buses and minibuses. On Al Jaish Street these public transport vehicles comprise over 20% of all vehicles surveyed, and on King Talal Street they form over 30% of vehicles on the route.

Urban road capacities are typically affected by their road width and characteristics, and defined by the busiest direction flow in a one hour period. The downtown ring road has a width in excess of 10m, and in many places accommodates two lanes in either direction with a central reservation, effectively creating a dual carriageway.

The capacity of a road of this type may be up to 2,600 vehicles per hour in the busiest direction according to UK standards. However, this assumes there to be limited and controlled pedestrian movements and a higher quality standard of road. In reality, the conditions on the Zarqa downtown ring road are busier with frequent pedestrian activity in the road which will significantly reduce the potential capacity of the route to somewhere in the region of 1,500-2,000 vehicles per hour. Therefore, a recorded flow of 2,100 vehicles one-way on Al Jaish Street, and 1,500 vehicles on King Talal Street suggests that these roads are already operating at full capacity and low levels of service. An indication of the volume / capacity ratio is provided in Table 3.2 below for the Downtown Ring Road to demonstrate which sections of the ring road have no spare capacity. The capacities have been derived using UK standards from Design Manual for Roads and Bridges [(3)], however they have been reduced to account for the poor quality of roads in Zarqa compared with the UK.

Table 3.2: Downtown Ring Road Capacity

Ring Road Section	Road Name	Busiest Direction Maximum Hourly Traffic Flow	Indicative Capacity*	Volume / Capacity Ratio
Northern	Al Hashmi / Prince Abden Elah St	500	900	0.55 – Under Capacity
Eastern	Al Jaish St	2,100	2,000	1.05 – At Capacity
Southern	King Talal Street	1,500	1,500	1.00 – At Capacity
Western	Abd-Hameid Sharaf St	1,100	1,500	0.73 – Under Capacity

*Capacities are indicative, based on approximate road widths, road conditions, and lane number estimations. DMRB standards apply to trunk roads in UK therefore the capacities have been reduced slightly in line with local conditions in Zarqa.

3.3.2 Internal Downtown Traffic Flows

Five of the main roads within downtown Zarqa were included in the traffic surveys. The results of the traffic surveys are presented in Table 3.3 below.

Table 3.3: Downtown Internal Traffic Flows

Road Name	Average Hourly Two-way Traffic Flow	Busiest Direction Maximum Hourly Traffic Flow
Al Farouq Street	1,200	650
Al Haj Murad Street (one-way count)	600	600
Anas Bin Malik Street (one-way count)	1,200	1,200
King Hussein Street	900	450
Prince Mohammed Street (one-way count)	500	500

Table 3.3 shows that the average traffic flow along Al Farouq Street is 1,200 vehicles per hour. This street serves as the main east-west link through downtown Zarqa and takes the form of a dual carriageway over the western section of its route.

Similarly, Anas Bin Malik Street, which bisects the downtown area, accommodates approximately 1,200 vehicles in one hour (in one direction). This is a significant volume of traffic for a narrow street, illustrating the high demand for vehicular access from the south of Zarqa into the downtown area.

The road capacity for urban all-purpose roads of similar characteristics to the internal downtown roads, i.e. unrestricted parking, unlimited access to shops and properties, and frequent pedestrian crossing activity, can range from approximately 750 vehicles per hour for roads of 6.1 metres width, up to 1,410 vehicles per hour in the busiest direction for roads up to 10 metres in width. Given that conditions in Zarqa differ from the UK, with poor pedestrian facilities and road conditions, the maximum capacity of the internal roads is likely to be below 1,410 vehicles per hour in the peak direction. Therefore with a flow of approximately 1,200 vehicles per hour, Anas Bin Malik Street is most likely operating at full capacity.

The more minor streets within downtown Zarqa are typically carrying 500 – 650 vehicles per hour in the busiest direction. For narrow routes such as these, the capacity is a maximum of 750 vehicles (Higher for one-way roads). The poor condition of the roads in the area, along with the high level of pedestrian activity and uncontrolled parking will reduce this in reality. This indicates that the inner roads of the downtown area are also suffering from congestion and are close to capacity.

An indication of the volume / capacity ratio is provided in Table 3.4 below for the inner Downtown streets to demonstrate typical levels of spare capacity. The capacities have been derived using UK standards from Design Manual for Roads and Bridges [3], however they have been reduced to account for the poor quality of roads in Zarqa compared with the UK.

Table 3.4: Downtown Internal Road Capacity

Road Name	Busiest Direction Maximum Hourly Traffic Flow	Indicative Capacity*	Volume / Capacity Ratio
Al Farouq Street	650	650	1.00 (At capacity)
Al Haj Murad Street (one-way count)	600	650	0.92 (Near capacity)
Anas Bin Malik Street (one-way count)	1,200	1,200	1.00 (At capacity)
King Hussein Street	450	650	0.70 (Under capacity)
Prince Mohammed Street (one-way count)	500	650	0.77 (Under capacity)

*Capacities are indicative, based on approximate road widths, road conditions, and lane number estimations. DMRB standards apply to trunk roads in UK therefore the capacities have been reduced slightly in line with local conditions in Zarqa.

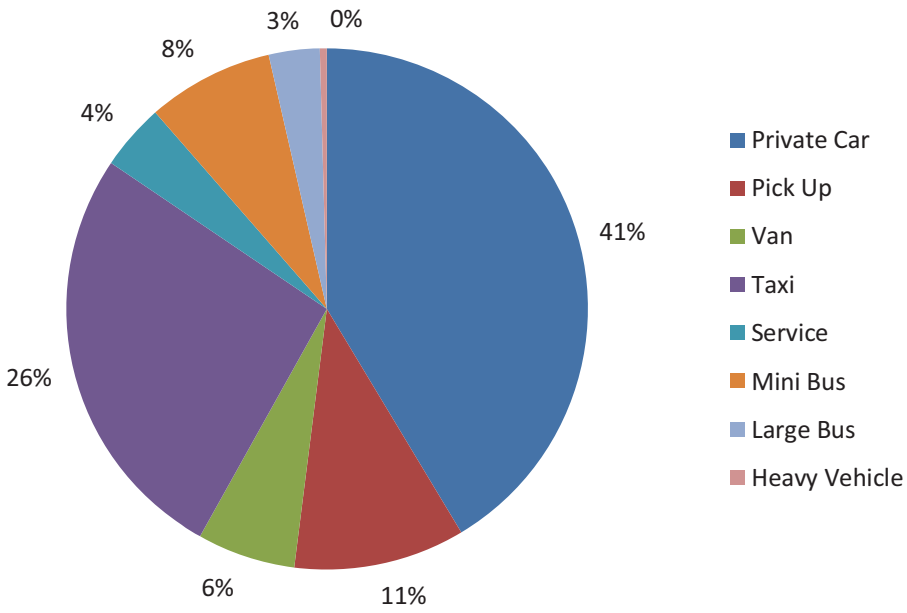
3.3.3 Downtown Traffic Demand

In total, demand on the downtown ring road is approximately 9,500 vehicles per hour (two-way). Within downtown, it is harder to estimate the total circulating traffic due to the dense grid network. However, approximately 4,000 vehicles are present on the main roads through downtown in a typical hour. Therefore across the full internal road network it is likely that this figure will increase to in the region of 6,000 to 8,000 vehicles per hour.

3.3.4 Vehicle Classification

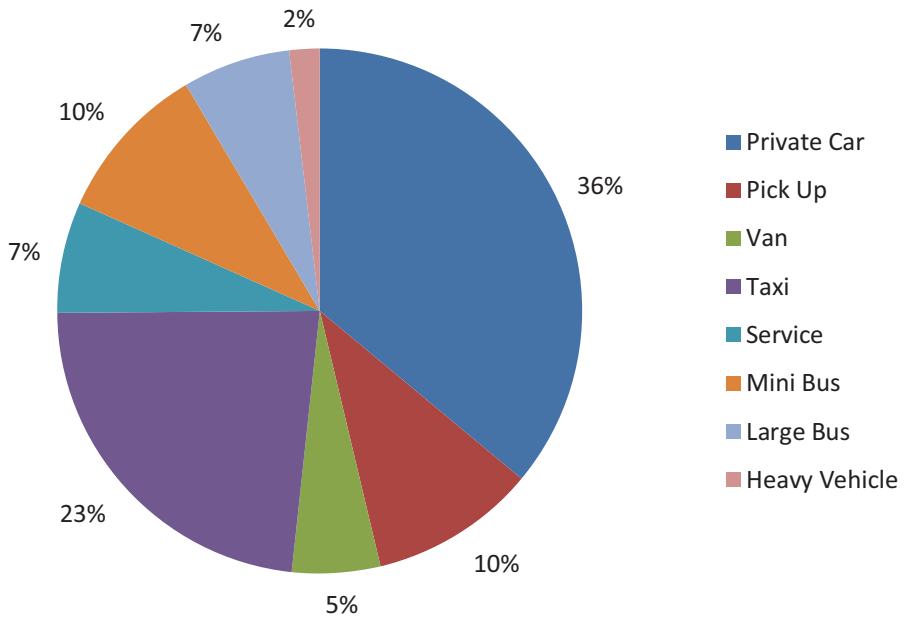
The traffic surveys also identified the type of vehicles present both within downtown Zarqa and on the peripheral roads surrounding the district. The average vehicle classification is set out below in Figure 3.3 for internal downtown Zarqa, and Figure 3.4 for the ring road surrounding downtown Zarqa.

Figure 3.3: Zarqa Downtown (internal roads) Vehicle Classification



Source: Consultants

Figure 3.4: Zarqa Downtown (Ring Road) Vehicle Classification



Source: Consultants

It is evident from Figures 3.3 and 3.4 that the majority of vehicles in and around the downtown area are either private cars or taxis. On the roads surveyed within the downtown area this totals 67% of all vehicles, whereas 59% of traffic on the ring road consists of private cars and taxis. The ring road traffic comprises a greater proportion of service vehicles, minibuses, large buses, and heavy vehicles than the inner downtown area.

3.5 HIGHWAY CHARACTERISTICS OF DOWNTOWN ZARQA

A site visit to the downtown area was undertaken on Wednesday 9th March 2011 to further review the highway network in the downtown area. A selection of examples of typical characteristics and key problems with the highway network in the downtown area is provided below with images from the site visits carried out.

Highway Severance and Lack of Urban Planning

This image, taken at the junction between King Talal Street and Al Jaish Street illustrates the severance created by the highway which separates downtown Zarqa from King Abdullah Bus Terminal. The highway corridor along the eastern border of the downtown area is a wide carriageway accommodating significant volumes of traffic without any pedestrian crossing facilities to facilitate accessibility to the bus terminal. This is evidence of the lack of urban planning in Zarqa.

No Lane Markings

There is an almost complete absence of road markings indicating priorities. Even when priority is clear, for example at approaches to roundabouts, there is little lane discipline. Thus many junctions become blocked by crossing traffic. As illustrated in this image, Al Jaish Street to the east of downtown is wide without lane markings to aid drivers in following clear channels of traffic. This lack of order can contribute to vehicle collisions and traffic congestion.

Unmarked and Poorly Controlled Junctions

This photograph was taken at a junction with a main corridor into the downtown area, Al Haj Murad Street. The image illustrates how unclear the wide expanse of unmarked junction is for vehicles to navigate, without any indication of priority or lane directions. This lack of visible order can create confusion and conflicting movements amongst drivers, affecting the safety of traffic and making the junction difficult to cross for pedestrians.

Traffic Congestion and Obstructed Footways

Streets within the downtown area are narrow and lined with parked cars such as this example of Al Haj Murad Street, a north-south corridor through the centre of the downtown area. This arrangement reduces effective road capacity by over 50%.

Furthermore, this image illustrates the presence of clutter on footways which discourage pedestrians from using them.

Poor Maintenance of Roads and Footways

This image is taken on Prince Mohammed Street, a main road in the northeast of downtown Zarqa. There is evidence of neglect where footways are damaged and the road surface is littered and poorly maintained.

Main Downtown Corridor Severance

Al Farouq Street is the main corridor through downtown Zarqa in an east-west alignment. In the western half of downtown Zarqa the road is wide with a central reservation. This facilitates more vehicles however it also creates a barrier to pedestrian movements between the north and south of the downtown area.

Informal and Dangerous Bus Stops

In downtown Zarqa there are no formal bus stops, with vehicles pulling up in the middle of the street to allow passengers to board. This practice creates congestion, and leads pedestrians to walk within the highway in conflict with vehicles. Furthermore, the bus services are slowed down by this informal method of collecting passengers at irregular intervals, and vehicles are obstructed by buses stopping within the stream of traffic.

Poorly Maintained Parking Restrictions

A Pay and Display ticketing system is in use in part of the downtown area with a number of meters in place. However, car parking bay road markings are not provided on any of the streets. Enforcement of the Pay and Display scheme is the responsibility of the traffic police, however, enforcement is not strict and it is understood that the reason for this is to allow time for the population to become familiar with the scheme.

Narrow Congested Streets

As shown within this image, many of the streets in downtown Zarqa are narrow with vehicles parked on both sides of the carriageway creating congested lanes with a low capacity for providing access through the area.

Consequently, traffic speeds are observed to be slow, at 12-15kmph. This congestion is a significant contributor to high GHG emissions.

Indiscriminate and Illegal Parking

This image illustrates how haphazard parking around the corner of a junction restricts the capacity for vehicles turning into the minor road. This uncontrolled parking is typical across the downtown area and significantly adds to the creation of congestion. The problem is exacerbated by lack of parking restriction enforcement.

3.6 KEY ISSUES

Based on the above observations of the highway network and analysis of traffic conditions in downtown Zarqa, the key issues to be addressed are summarised as follows:

- **Narrow streets** – exacerbated by parked cars and lack of pedestrian segregation, resulting in a low level of service and extensive road side friction
- **High volumes of traffic** – a demand of over 8,000 vehicles per hour on the main roads
- **Low traffic speeds** - observed to be between 12-15km/h within downtown Zarqa
- **Pedestrian conflict** – lack of crossings on routes with high traffic flows creating severance
- **High private vehicle demand** - approximately 60% of all vehicles are cars or yellow taxis
- **Poor connectivity to public transport** – lack of bus stops, and poor walking routes to terminals
- **Indiscriminate parking** – no enforcement of existing parking restrictions
- **Lack of demand management** – congestion is the only deterrent to travel by private vehicle
- **Poor air quality** – slow vehicle speeds lead to more engine idling and higher emissions
- **Poor public transport services** – lack of formal infrastructure and a poor quality service offered

The above highlights issues that have been taken into account when developing a transport strategy for Zarqa. For example, new or enlarged highways based improvements in such a confined urban environment with set land uses is not desirable. In a busy commercial environment, applying aggressive demand management is also undesirable. The above clearly points to reducing the use of private vehicles and increasing the public transport modal share in a balanced and practical manner. The strategy, therefore, has been based upon a balanced mix of public transport, demand management and some highway based infrastructure improvements and this is further described in the latter stages of this report.

4 Base and Forecast: Traffic, Fuel and Emissions

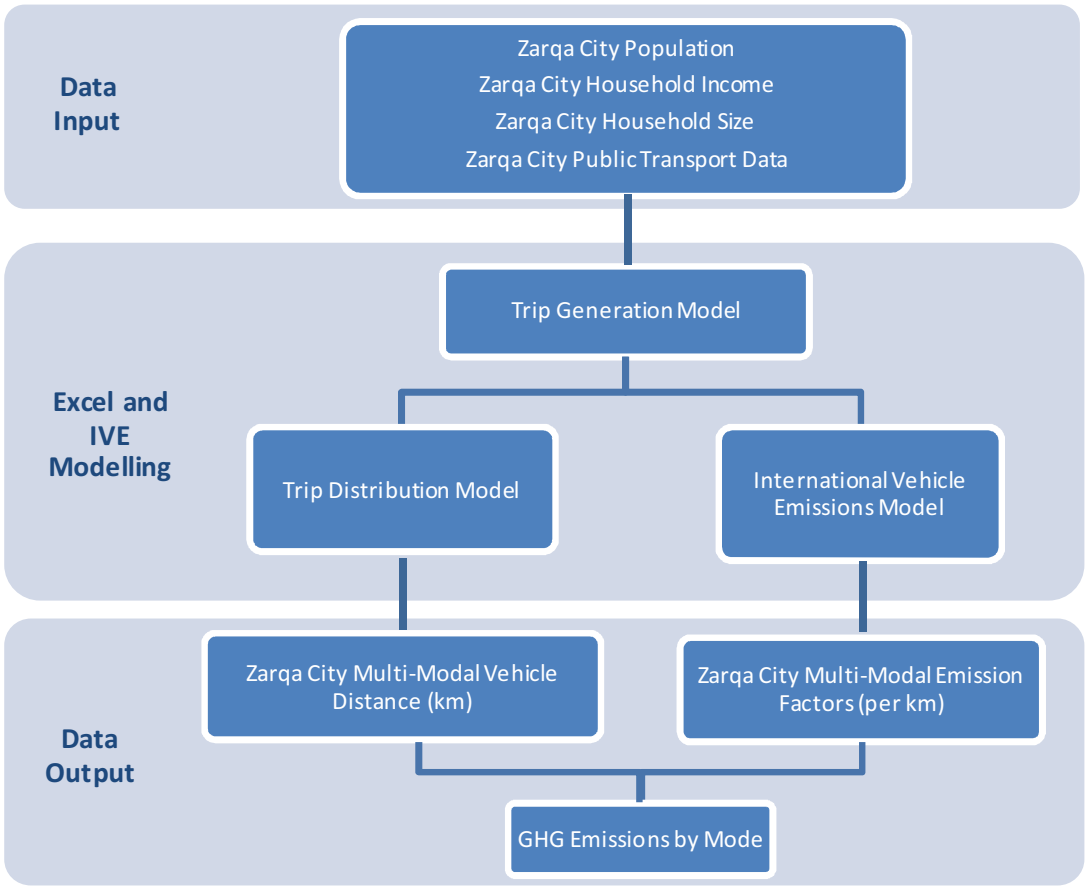
4.1 METHODOLOGY

4.1.1 Modelling Methodology

There is currently no existing data available for vehicle emissions in Zarqa. However it has been recognised that levels of transport in the region are increasing and will therefore lead to higher air pollution and rising GHG emissions. In order to calculate those emissions, the ideal approach would be to use both a bottom-up and a top-down method. In this way traffic counts and vehicle data would be used to calculate the emissions and then the results would be verified using fuel consumption data. However, neither traffic counts nor fuel consumption data are available, and therefore a baseline estimate of Zarqa's GHG emissions from transport cannot be calculated in this way. Furthermore, there is no data available on the purpose of journeys made in Zarqa, or the composition of public transport users and private vehicle drivers in terms of age, sex etc.

In the absence of Zarqa specific data on vehicles and traffic counts, a first principles method has been used to calculate the vehicle demand data, and the International Vehicle Emissions model has been used to calculate the emissions factors. The process followed is illustrated in Figure 4.1 below.

Figure 4.1: Zarqa City GHG Emissions Calculation Process



Source: Consultant

Due to the availability of 2008 data on fuel consumption in Zarqa, the model has been built based on this year for validation purposes. The 2008 model has then been forecast to 2010 to provide the baseline year assessment. Full details regarding the methodology and assumptions used are presented in Appendix B in Volume 2.

4.2 MODEL VALIDATION

The results from the 2008 model have been validated using two methods, firstly using a comparison of emission factors, and secondly using fuel consumption.

The 2008 emission factors are set out in Table 4.1 below.

Table 4.1: 2008 Emission Factors (grams per veh-km)

Vehicle Type	Emissions Factor (grams/ veh km)						
	CO_2	CH_4	N_2O	CO	NO_x	SO_x	PM
Private Car	186.8	1.1	0.0	52.8	2.2	0.0	0.0
Yellow Taxi	165.0	1.0	0.0	47.0	1.8	0.0	0.0
White Taxi	164.3	0.9	0.0	38.4	1.5	0.0	0.0
Minibus	245.9	0.0	0.0	1.5	1.8	0.2	0.9
Bus	1185.1	0.0	0.0	3.1	15.8	1.2	3.5

Source: Consultant

The emission factors for the Private Car can be compared with those provided in the paper 'Emission Rate of Gaseous Pollutants from Motor Vehicles' [4]. A comparison of the values is set out in Table 4.2 below.

Table 4.2: 2008 Emission Factor Comparison (grams per veh-km)

Source	Private Car Emissions Factor (grams/ veh km)			
	CO_2	CO	HC (such as CH_4)	NO_x
Zarqa Study (WSP-CC)	186.7	52.8	1.1	2.2
'Emission Rate of Gaseous Pollutants from Motor Vehicles' Mahmoud Abu Allaban et al	198.4	33.9	1.0	0.1

It is noted that the Zarqa study presents combined emission factors for private vehicles, allowing for a combination of gasoline, hybrid, and diesel vehicles whereas the paper by Mahmoud Abu Allaban is based solely on gasoline fuelled vehicles. It is stated within the paper that vehicle emission rates are dependent on several factors including age, engine size, and type of gasoline used. Therefore the emission factors in the paper will differ from the combined emission factor approach used in this study.

The 2008 baseline validation of fuel consumption has been carried out using a 'top down' approach.

Table 4.3 below sets out the 2008 model calculations along with the comparable data derived from the presentation 'Transportation and Environment in Jordan' presentation prepared by the Ministry of Environment, Jordan [5]

Table 4.3: 2008 Model Fuel Consumption Validation

	Fuel Consumption (litres)		CO2 Emissions (tons)	
	IVE Model	Top Down Validation	IVE Model	Top Down Validation
Gasoline	125,654,800	93,882,100	266,800	211,300
Diesel (Excluding Trucks)	8,186,400	10,996,500	25,100	29,400
Total	**133,841,300**	**104,878,500**	**291,900**	**240,700**

The data in Table 4.3 above indicates that the IVE model compares well with data factored down from a national level. It is noted that the Top-Down validation uses 2006 data which is expected to be lower than 2008 results.

A further validation exercise has also been undertaken, comparing the fuel consumption with fuel sales for Zarqa Governorate taken from the Jordan Statistical Yearbook [1] as follows in Table 4.4.

Table 4.4: 2008 Fuel Sales Validation

Fuel Type	Fuel Consumption (litres) IVE Model (Zarqa City)	Fuel Sales (litres) Jordan Statistical Yearbook (Zarqa Governorate)
Gasoline	125,654,800	104,477,000
Diesel	186,740,900*	218,799,000
Total	312,395,700	323,276,000

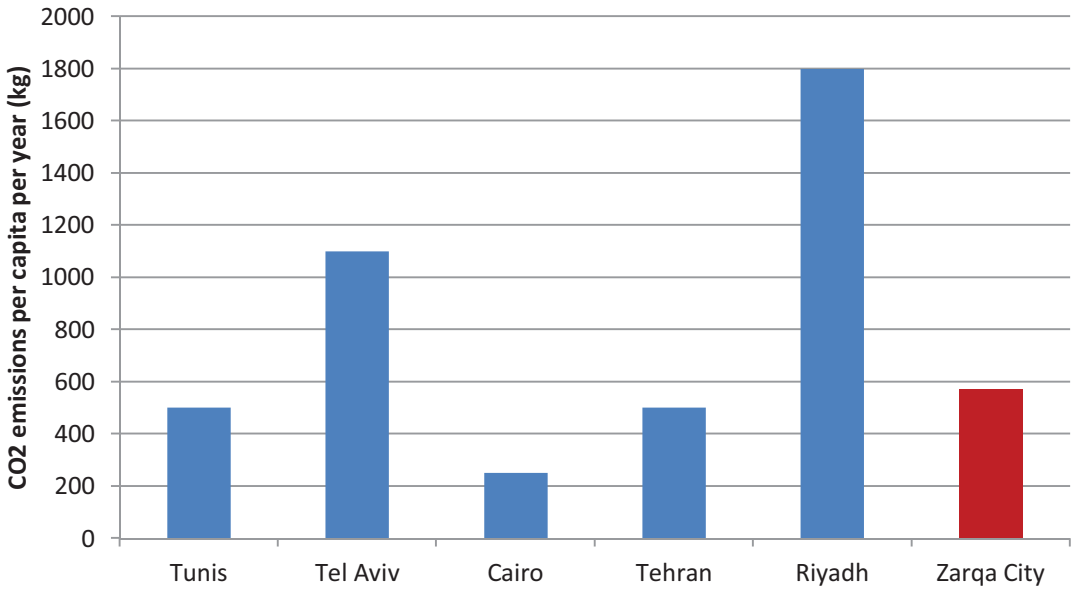
*Trucks estimate of 178,554,418litres added from Jordan presentation (5)

The data in Table 4.4 above indicates that the fuel consumption is of the right order for comparison with fuel sales. Not all fuel consumed by residents of Zarqa City will have been purchased within Zarqa Governorate, and likewise not all fuel purchased in Zarqa Governorate will be by residents of the area, therefore it is not expected that these figures would match exactly. Based on the validation exercises undertaken, it is deemed that the model is validated for the purpose of baseline assessments.

On a per capita basis, the IVE model results suggest that CO_2 emissions from passenger transport are approximately 569kg/year in 2008. This figure has been calculated by multiplying the CO_2 emission factor (per km) to the annual vehicle distance for each mode of transport to obtain a multi-modal annual CO_2 emission for Zarqa City. The total for all modes is divided by the population of Zarqa city to provide the annual emission per capita.

The paper 'Transport Energy Use and Greenhouse Gases in Urban Passenger Transport Systems: A Study of 84 Global Cities' [6] has been examined to provide a comparison of the Zarqa City results with similar cities. Five cities within the Middle East region were included in the study, these are: Tunis, Tel Aviv, Cairo, Tehran, and Riyadh. The per capita emissions of CO_2 from passenger transport (private and public transport) can be estimated from Figure 1 of the report. The results are set out in Figure 4.2 below.

Figure 4.2: Private and Public Transport CO_2 Emissions from other Cities



With a CO_2 emission result of 569 kg/capita/year in 2008, Zarqa city lies in the middle of the range of Middle Eastern cities from the study, however it appears most similar in CO_2 emission rates to Tehran and Tunis.

The average CO2 emitted by countries worldwide is 4,000 kg per person per year [7], although the average for industrialised nations is 11,000 kg per person per year. According to the World Development Report 2009 [8], road transport accounts for approximately 9.9% of emissions, about 70% of which is road transport. Converting the above figure of 569kg for road transport means that in 2008 Zarqa City's total CO_2 emissions from all sectors would likely be in the region of 8,000 kg per person per year – twice the global average for countries, although lower than more industrialised nations. It is now widely reported that for a sustainable future, a maximum of 2,000 kg per person per year of CO_2 must be targeted [7]. It is therefore concluded that Zarqa City currently exceeds the target 'acceptable' level of CO_2 emissions.

With regard to other greenhouse gases, nitrogen oxide (NOx) is one of the key emissions from transport that affects air quality and human health. In 2008 it is estimated that the city of Zarqa emits 6.4 kg/capita per year of NOx. This can be compared with the country of Tunisia, which emits approximately 4.9 kg/capita per year [9] of NOx from all transport. Although this figure for Tunisia was recorded in 2003, it encompasses all transport and the value for passenger road transport would be less than 4.9kg. Whilst low sulphur and ultra-low sulphur diesel fuel are not available in Jordan, particulate matter (PM) is also likely to remain a concern in Zarqa.

4.3 FORECAST BASELINE: TRAFFIC, FUEL AND EMISSIONS

The 2008 data presented above has been factored to calculate a forecast year result through adjustments to the following parameters:

- Population of Zarqa City;
- Income / Car Ownership;
- Vehicle Operating Costs;
- Value of Time;
- Vehicle Fuel Efficiency; and
- Public Transport Services.

Furthermore, the impact of new development at King Abdullah Bin Abdul Aziz City has been accounted for in the years 2015 and 2020.

Further details on the assumptions made to forecast the future Do Minimum scenario modelling are provided in Appendix B.

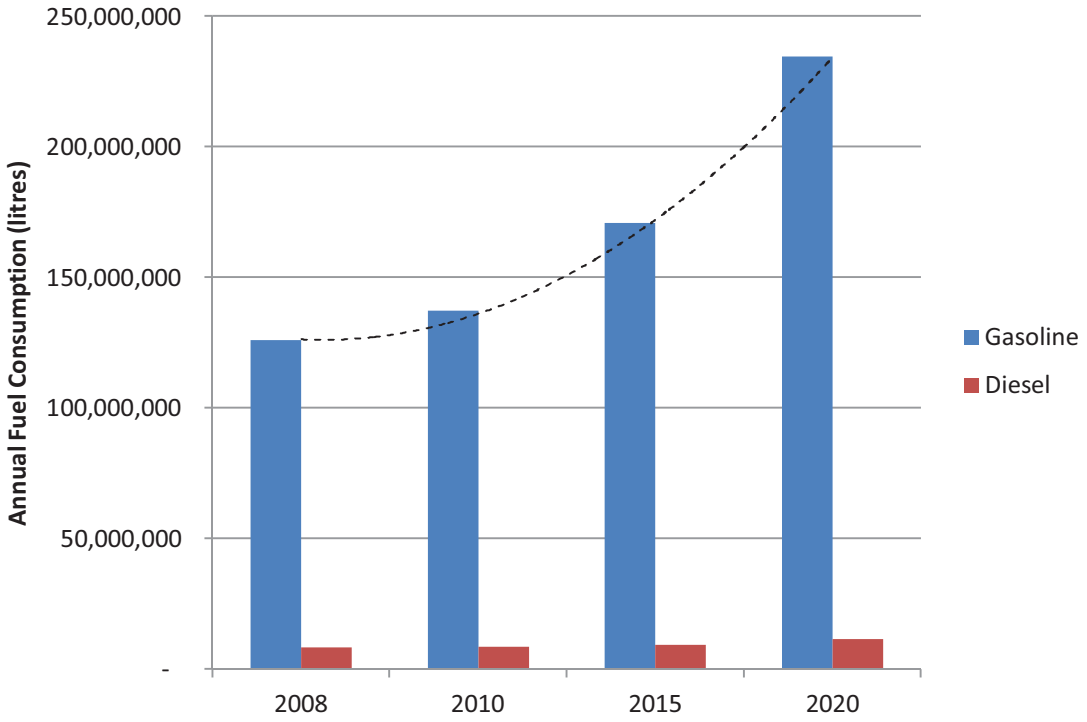
Using the assumptions and methodology set out in Appendix B, the baseline conditions have been forecast to gain an appreciation of emissions and energy consumption in Zarqa City in future years. Table 4.5 below sets out the vehicle travel demand for 2010, 2015 and 2020 which is shown to increase rapidly due to a growing population and a shift towards travel by private vehicles, spurred on by higher car ownership levels.

Table 4.5: Future Do Minimum Vehicle Travel Demand

Transport Mode	Daily Vehicle Distance Travelled (km)		
	2010 (Base)	2015	2020
Private Vehicle	3,001,500	3,954,800	5,607,600
Yellow Taxi	1,408,800	1,536,700	1,926,400
White Taxi	19,900	21,700	26,900
Minibus	132,800	144,300	179,100
Bus	32,000	34,700	43,100
School Bus	4,700	5,100	6,300

One impact from the growing demand for private vehicle travel is a significant increase in gasoline consumption, due to private vehicles predominantly using this form of fuel. Figure 4.3 below illustrates the predicted increase in fuel consumption in the next ten years without intervention.

Figure 4.3: Future Do Minimum Fuel Consumption



Source: Consultants

The resultant future Do Minimum emissions per capita are set out in Table 4.6 below.

Table 4.6: Zarqa City Future Do Minimum Emissions

Emission Type	Annual Emission per Capita (kg)		
	2010 (Base)	2015	2020
CO2	591	673	741
NOX	7	8	8
PM	0.2	0.2	0.2
CO	154	177	196

Source: Consultants

In conclusion, the modelling results indicate that due to increasing levels of car ownership, population growth and expansion of the city, along with limited provision of public transport facilities and pedestrian/cycling infrastructure, the GHG emissions from private transport in particular will continue to increase and result in worsening air quality in Zarqa City and the Downtown area.

5 Strategy Development

5.1 STUDY VISION

5.1.1 In order to develop a cohesive strategy, we have devised a vision statement, which incorporates the objectives, and which provides an overarching focus for determining the context and content of the selected measures. It is:

"Our vision is to promote an ambitious but realistic series of interlocking projects intended to enhance public transport accessibility, reduce congestion, stimulate economic activity and improve air quality and energy efficiency in the Downtown area of the City of Zarqa."

5.2 APPROACH

In the early stages of this study, a broad range of potential measures were identified to address transportation and environmental issues in Zarqa City. As the study progressed further, suggestions were made by the World Bank and the Consultative Group on wider transportation issues that need to be addressed in Zarqa.

A number of strategies were initially considered. With vehicle ownership growing at around 2% per annum, there is a limit to how far **new roads, road expansion and grade separation** could be provided within the downtown area without the removal of existing buildings and disruption to the historical land use pattern. The social and environmental implications would also need to be carefully considered.

At the other extreme, a strategy could be devised which would benefit **public transport** regardless of its effect on other traffic. The effect on general traffic would be felt most in the downtown area if, for example, the entire area was made a "no vehicle entry" zone and only accommodated public transport. Furthermore, the shop owners and trade in general would be significantly impacted and this would have serious commercial implications.

Formal **traffic restraint** could be put in place but would need adequate and acceptable levels of public transport for those that would be forced to shift. The easiest and most obvious scheme would involve restricting parking and expanding the existing controlled parking zone. Another measure would be to reinstate and expand the urban traffic control system within the downtown area.

A **balanced public/private** option strikes a realistic compromise between improving conditions for general traffic circulation and flow, whilst enhancing public transport public transport through the provision of busways, improved infrastructure and other priority measures.

Accordingly, it is preferable to adopt a strategy which gives incentives to public transport operations and use and, in parallel, some restraint to private traffic, while improving the road network to make a more efficient overall use of the road space.

The strategy for the downtown area, therefore, has been developed through consultation with Zarqa Municipality and the CG. All stakeholders have officially held meetings and discussed a number of issues, including the type, size and cost of the proposed strategy. World Bank comment and views have also been taken into account.

In developing a strategy for consideration, the approach taken has been to:

- Adhere to the project objectives;
- Assess the existing conditions and undertake reconnaissance surveys and traffic counts;
- Assess, calibrate and validate the demand and emissions model;
- Seek a continuous exchange of views, ideas and recommendations from the CG Group;
- Filter the potential projects through the use of a multi criteria assessment;
- Identify CORE projects to support the recommended strategy;
- Focus on public transport and demand management; and

- Apply an Integrated strategy of public transport supported by demand management.

Through a process of selection using multi criteria assessment, 8 core studies and a strategy involving 12 projects have been identified for implementation over the short and medium term time horizon, This approach meets the key objectives, and at the same time establishes a foundation for transport planning in the Zarqa downtown area as well as Zarqa Municipality. These studies and projects are described in Section 6 and 7 respectively. The multi-criteria assessment is described in more detail below.

5.3 MULTI-CRITERIA PROJECT ASSESSMENT

Many cities worldwide have faced the problems of traffic congestion / poor air quality and worked to improve these conditions, providing a wide range of examples of successful measures that could help to address the issues faced by Zarqa. Initial discussions led to over 60 possible projects that could be employed, however many of these could be dismissed quickly due to obvious impracticalities.

It was then necessary to reduce the remaining projects down to a shortlist of measures which are realistic, deliverable, and specific to the downtown area of Zarqa City. A multi-criteria assessment process was used to undertake this process of refining the potential projects. The criteria used to ascertain the suitability of a project were as follows:

- Political / social acceptability;
- Suitability for Zarqa;
- Technical Deliverability;
- Institutional Deliverability;
- Financial Deliverability;

This process was not definitive, and the remaining projects were streamlined further following feedback from Zarqa Municipality and the need to ensure projects remain focussed specifically on the downtown area of Zarqa, and furthermore that the projects are within the jurisdiction of Zarqa Municipality. The process was used to provide a steer towards the most suitable projects, with the final Core Projects and Strategy Projects selected from the resultant shortlist. Table 5.1 below shows the multi-criteria assessment that was undertaken to reduce the list of potential projects.

Table 5.1: Multi Criteria Assessment

Project	MULTI-CRITERIA ASSESSMENT					
	Political /Social Acceptability	Suitability for Zarqa	Technical Deliverability	Institutional Deliverability	Financial Deliverability	Is it viable for implementation
Public Transport Measures						
P&R facilities + services in key locations serving PT interchanges	✓	✓	✓	✓	✓	Yes
Integration of bus route with land use proposals, (inc. KABAAC)	✓	✓	✓	✓	✓	Yes
Internal Infrastructure Improvements to Bus Terminals	✓	✓	✓	✓	✓	Yes
Access Improvements to the Bus Terminals in Zarqa	✓	✓	✓	✓	✓	Yes
Adequate frequency / capacity of PT between Zarqa and Amman	✓	✓	✓	✓	×	Yes
Free Shuttle Bus between Downtown and PT Interchanges	✓	×	✓	✓	×	Possible
New/improved bus routes to LRS terminal	✓	✓	✓	✓	×	Yes
Competitive fares for public transport	✓	✓	✓	✓	×	Yes
Review of ticketing systems	✓	✓	✓	✓	×	Yes
Public Transport staff training	✓	✓	✓	✓	×	Yes
Provision of bus stops (shelters, lighting, seating, timetables)	✓	✓	✓	✓	×	Yes
Provision of electronic ticketing machines at major interchanges	✓	✓	✓	✓	×	Yes
Real-time timetable information provided at terminals / bus stops	✓	✓	✓	✓	×	Yes
Bus lanes/bus priority on key corridors within Zarqa	×	✓	✓	✓	✓	Yes
Differentiated approach to PT markets by quality/ type of provisior	✓	✓	✓	✓	×	Yes
Improvements to pedestrian links to public transport interchanges	✓	✓	✓	✓	×	Yes
Transport Demand Management Measures						
High Occupancy Vehicle lanes on route between Zarqa / Amman	×	✓	✓	✓	×	Possible*
Vehicle Restrictions on access within downtown area	×	✓	✓	×	✓	Yes*
Pedestrianised zones in and around the major PT interchanges	×	✓	✓	✓	×	Yes*
Low-emission zones	×	✓	×	✓	×	No
Parking Restrictions and Pricing Policy	✓	✓	✓	✓	✓	Yes
Personal Travel Planning Services	×	×	✓	✓	×	No
Restricted Registration (e.g. capping of new vehicles)	×	×	✓	×	✓	No
Integrated Land Use Planning (KABAAC)	✓	✓	✓	✓	✓	Yes
Public Awareness (i.e. marketing of car share schemes)	?	?	✓	✓	✓	Yes
Travel websites with real-time travel information	✓	✓	×	×	×	Possible
Congestion Charging and/or Distance-based Charging	×	✓	×	×	✓	No
Toll and Road Pricing	×	✓	×	×	✓	No
Driver Behaviour Training	✓	✓	✓	✓	×	Yes
New traffic signals, optimisation of the old, linking of all signals	✓	✓	✓	✓	×	Yes
Variable Speed Limits	✓	✓	✓	✓	×	Yes*
Junction improvements	✓	✓	✓	✓	✓	Yes
Provision of new road-markings indicating lane demarcations	✓	✓	✓	✓	✓	Yes
Vehicle Technology, Operation and Fiscal Measures						
Fuel tax increases	×	✓	×	×	×	No
Mileage based emission charges	×	✓	×	×	×	No
Changes to sales tax / import duty	×	×	×	×	×	No
Car Quota System	×	×	×	×	×	No
Vehicle registration tax/charge	×	✓	✓	×	×	No
Competitive bidding for new vehicle licenses	×	×	×	×	×	No
Subsidies / tax rebates for low emission vehicles	✓	✓	✓	✓	×	Yes*
Provision of new low emission buses	✓	✓	✓	✓	×	Yes
Minimum Engine Emission Standards	✓	✓	✓	✓	?	Yes*
Electric Vehicles	×	✓	✓	×	?	No
Car Scrappage Scheme	✓	✓	✓	✓	?	Yes*
Rationalisation of School Buses	✓	✓	✓	✓	✓	Yes
Institutional Strengthening of Zarqa Municipality	✓	✓	✓	✓	×	Yes
Institutional linkages between GAM and Zarqa Governorate	✓	✓	✓	✓	×	Yes

*Later removed due to either being not specific to downtown Zarqa, not within the jurisdiction of Zarqa Municipality, or unpopular with Zarqa Municipality

6 Core Projects

6.1 CORE PROJECT REQUIREMENTS

In addition to the 12 strategy projects, a number of core projects were developed. These projects are deemed necessary in order to provide a sound basis for Zarqa Municipality to be able to assess transport projects and their impacts going forward. We feel that these projects must be implemented within the next 18 months or so.

The core requirements are as follows:

- 'Co-operating' with the Greater Amman Municipality on technical matters;
- Purchase and Installation of Permanent Traffic Counters;
- Installation of Air Quality Monitoring Stations;
- Detailed Assessment of KABAAC Housing Development;
- Development of Zarqa Traffic Model;
- Completion of Zarqa Urban Masterplan;
- Institutional Strengthening of Zarqa Municipality; and
- Introduction of Transport Policy: Traffic Impact Studies.

Further details on each project are set out below.

Core Project 1: CO-OPERATION WITH THE GREATER AMMAN MUNICIPALITY	
Project Description	Zarqa Municipality needs to develop internal transport planning skills in order to participate in and/or lead urban master planning, transport impacts assessment and public transport matters. The most effective means of achieving this is through learning from other organisations within Jordan which have already developed such skills.
Rationale	▪ Close interaction between Amman and Zarqa in terms of transport ▪ GAM has gone through a similar urban master plan / transport masterplan – strategy over the last 4 years ▪ GAM has developed its institutional capacity over the last 5 years
Project Need	▪ Zarqa Municipality will need continuous technical support as they develop a capability in transport to implement the strategy and move to embed transport assessment within its structure
Implementation Options	We are unaware of these technical skills being available in the public sector in Jordan, other than with GAM. GAM has expressed concerns over their capacity to be able to undertake such additional work, in which case alternative skills sources would need to be pursued from the private sector, either within Jordan or from international experts. Another possible option, in view of the close proximity and connectivity between the two cities, would be the establishment of a joint unit with shared funding.
Scope	▪ ZM – GAM to develop an initial 3 year technical assistance agreement to cover the following key scopes by providing advice and information regarding: - Automatic traffic counting station purchase and installation - Sharing of traffic, transport and socio-economic data - Manual Classified Count data sharing - SCATS: Information and guidance on the planning, installation and maintenance of SCATS system - Communication strategy - Sharing copies of its TIS guidelines
Equipment	▪ None
Cost	▪ Agreement between parties needed to address costs, commitments, training and additional skills required.
Monitoring Mechanisms	Three year plan to be drawn up with appropriate milestones – at the end of the period, ZM should be able to undertake all necessary technical work through its own resources.

Core Project 2: PURCHASE AND INSTALLATION OF TRAFFIC COUNTERS	
Project Description	Effective transport planning cannot be achieved without adequate and accurate data. This projects is intended to provide the Municipality with temporary and permanent traffic counters in order to produce data for traffic modelling.
Rationale	Essential to measure volume and changes in traffic flows and vehicle mix
Project Need	There is currently very little, if any traffic count information available for Zarqa City. Therefore, Zarqa Municipality do not have information related to vehicle growth, peak hour and/or daily demand, vehicle classification and traffic entering/exiting or crossing specific screen lines or cordons. ZM is therefore unable to make any informed decision on traffic related issues across the network.
Implementation Options	It is possible to obtain data through manual surveys, but traffic counters are a more cost effective method, which also enables almost an infinite amout of data to be collected.
Scope	This information can be used as a standalone database to support ZM in assessing traffic growth, vehicle classification or simply traffic demand in specific areas of the city or single highway corridors. ATC surveys will provide the following important information. ▪ 24 hour flows ▪ 14 hour flows (0600-2000) ▪ Peak hour flows (AM, inter-peak, PM, afternoon, and evening) ▪ Daily traffic variation ▪ Traffic totality The information would be most useful in the following locations: ▪ Major corridors capturing inter-urban and intra-urban traffic movements ▪ Locations where count data can be used in the future to update the demand figures ▪ Close to areas which potentially are going to be developed in the near future
Equipment	Traffic count equipment can be purchased from a variety of sources. These include: ▪ PEEK Traffic ▪ Golden River Two types of equipment can be bought: ▪ Temporary Traffic counters using tube detectors: these are temporary counters that involve installing tubes across a road in various types of configurations depending upon the road cross section. The tubes are left on the road for around a week. Data that can be collected includes traffic volumes and vehicle classification. ▪ Permanent Traffic count equipment using loop detectors: this involves installing loop detectors in the road way, i.e. this involves cutting the surface and embedding the loop below the surface. The detector works using a magnetic field. These are permanent counters and are capable of providing weekly, monthly, seasonal, annual traffic count data. The loops are also capable of classifying vehicle types. Some counters can also measure air pollution at the road surface level. Whilst information may not be very accurate, it does provide some indication of air pollutant levels on an hourly, daily, weekly monthly annual basis.
Cost	Traffic count equipment varies depending upon the specific needs. Our recommendation for ZC is as follows: ▪ Temporary Traffic Count Equipment: 3 no traffic counts with vehicle classification and monitor measuring capabilities. Cost per machine: 3No. @ 350JD each = 1050jD Tube requirements: 300m of tube @ 125JD/100m = 375JD Plus Nails, Clamps, Tape ▪ Permanent Traffic counter equipment: 6 No traffic counters with vehicle classification and air monitoring capabilities. Cost per machine: 5No. @ 1000JD each = 5,000JD
Monitoring Mechanisms	Output orientated in terms of numbers and types of counters purchased and amount of data recorded. ZM needs to show demonstrable use of data in the study of trends and traffic growth, and its use as a KPI for the reduction of traffic growth and increased public transport use.

Core Project 3: INSTALLATION OF AIR QUALITY MONITORING STATIONS	
Project Description	Real time air quality monitoring is the most effective methodology for checking the actual levels of pollutants and other emissions. This project is concerned with the purchase of suitable monitoring stations.
Rationale	Essential to provide real time results, rather than relying on modelling techniques
Project Need	There are currently no air quality monitoring stations in Zarqa City and therefore it is not possible to establish current air quality in the study area or verify any modelling predictions. This project is also required to provide a Key Performance Indicator in the measurement of improvements made to the network and/or operations.
Implementation Options	No alternative option available other than reliance on synthetic modelling techniques.
Scope	Monitoring using passive and automatic monitoring techniques should be undertaken for three pollutants, including particulate matter, carbon monoxide and oxides of nitrogen at a number of locations relevant to public exposure and background levels. Monitoring should be undertaken at roadside locations, where there is relevant public exposure, and at one background location. It is recommended that monitoring is undertaken for at least three months.
Equipment	It is recommended that one continuous air quality monitoring station is hired for the monitoring period. This station will continuously sample the air and record concentrations of particulate matter, carbon monoxide and oxides of nitrogen. Electricity (3 x 240V supplies required) to power the monitoring station and a secure location will be required. It would be possible to provide a generator to power the monitoring station if an electricity supply cannot be provided. The monitoring equipment and data-logging equipment will be checked and calibrated on a scheduled basis and in accordance with the standard reference methods. At the continuous air quality monitoring station, passive diffusion tubes to measure concentrations of oxides of nitrogen would be deployed in triplicate with monthly deployments for a period of 3 months. At 5 other locations around the downtown area of Zarqa, tubes would be deployed in duplicate with monthly deployments for a period of 3 months. Upon retrieval, tubes would be despatched for analysis to an ISO 17025 accredited laboratory with a blank tube also being analysed.
Cost	The cost of the monitoring will depend on the length of the monitoring equipment, the chosen supplier, shipping costs, the proposed power source and exchange rate at the time. An estimate of costs for a three month monitoring program is shown below. 3 months of passive diffusion tube monitoring for oxides of nitrogen at 5 locations = JD 12,000 3 months of continuous monitoring for particulate matter, carbon monoxide and oxides of nitrogen at 1 location = JD 50,000 Alternatively, An indicative cost for purchasing one continuous air quality monitoring station only, running it for a year (excluding power costs) is approximately JD100,000, assuming that the monitoring station is not powered by a generator. This fee excludes diffusion tube monitoring, which would cost approximately JD39,000 for a year. These indicative fees are exclusive of any local taxes or fees.
Monitoring Mechanisms	Output orientated in terms of purchase of effective monitoring stations and suitable quantity of recorded data. ZM needs to show use of data in the study of trends and relationships between traffic growth and air quality. Used as a KPI on a reduction of traffic growth and increased public transport use.

Core Project 4: DETAILED ASSESSMENT OF KABAAC HOUSING DEVELOPMENT	
Project Description	A full assessment of the transport implications of this very large development on the Zarqa area has not been undertaken. This project is intended to ensure that a full understanding of these impacts is achieved and that necessary measures are adopted to ameliorate the adverse impacts.
Rationale	The size of this new development will have a major impact on Zarqa and its surrounding transport system.
Project Need	Given the magnitude of the KABAAC development and the impact upon ZC and its environs, a detailed traffic impact assessment and internal traffic assessment must be undertaken. The key reasons for the need of such as study are: 1. To measure the impacts of the development on ZC 2. To better understand the development phasing and phased impacts upon ZC 3. To provide a solid platform for the development of an integrated public transport strategy covering the KABAAC and ZC 4. To provide a platform for the measurement of impacts upon the surrounding network and to ensure mitigation measures are planned to enable land use and transport integration between KABAAC and ZC
Implementation Options	There are no effective alternative options to undertaking such a study, although there may well be alternative measures to consider in terms of addressing the transport implications of the development. Problems associated with a manual approach to collecting data for such an assessment are described in 'Cost' below.
Scope	It is recommended that this assessment be undertaken after the full development of the ZC traffic model. The traffic model will provide the tools necessary to test impacts and phasing and a series of alternative strategies. The types of issues that need to be assessed include: ▪ Proposed road network ▪ Proposed planning data ▪ Trip generation ▪ Trip attraction ▪ Model split and assumptions made ▪ Interface proposals with ZC and its network ▪ Propose public transport routes, stops and interchanges ▪ Phased development and its step change impacts
Cost	Whilst a specific cost of the traffic impact of the KABAAC can be estimated, our strong recommendation is that this assessment be undertaken as part of the traffic model development recommendation (Project 5). Any attempt to assess the impacts of such a large development using manual methods will not prove effective and will limit the testing of planning scenarios, options and wider impacts. Therefore, the cost of this component is included within the traffic model costs.
Monitoring Mechanisms	A suitable report with impacts identified and quantified and remedial measures. Need to show use as a basis for the development of integrated land use-transport integration ensuring that recommended measures are implemented over time.

Core Project 5: DEVELOPMENT OF ZARQA TRAFFIC MODEL	
Project Description	In order to assess the impacts of traffic and transport changes caused by demand, new development and transport improvements, a city the size of Zarqa requires a multi-modal traffic model. This project proposes the outline scope for a suitable model.
Rationale	The provision of a traffic model will enable the Municipality and others to consider a wide variety of 'what if' scenarios
Project Need	To some extent this study has highlighted the need for the development of a traffic model for Zarqa. There are a variety of reasons why a traffic model is required: ▪ Zarqa has a large population ▪ Zarqa has complex transport, employment and educational interaction with the adjacent capital, Amman ▪ It is an industrial centre ▪ The KABAAC development and its associated impacts need to be better understood ▪ The model will allow for road network improvements to be tested ▪ The model will allow for public transport improvements to be tested ▪ Then model will allow for demand management measures to be tested ▪ The model will allow for the assessment of air quality ▪ The model will allow for traffic forecasts and subsequent impacts upon the transport system. ▪ The model be a tool to be used to develop transport strategy and 5 year planned investment
Implementation Options	A variety of different modelling solutions are available, but it is recommended that compatibility with the VISUM model operated by GAM is ensured. One alternative would be to extend the GAM model to include the Zarqa Municipality area, but it is considered that a free standing, but compatible, model would be preferable for the sake of ease of use.
Scope	It is recommended that the traffic model should be of the 4 stage gravity model type, i.e. it needs to include: ▪ Trip generation ▪ Trip distribution ▪ Modal split ▪ Trip assignment The model also needs to account for public transport - it is recommended that PT demand is modelled separately. The fundamental stages of the model development include:

	Traffic Surveys: ▪ Household Surveys ▪ Origin-destination surveys ▪ Manual and automatic traffic counts ▪ Journey time surveys ▪ Public transport surveys ▪ Car parking surveys Model development: ▪ Development of base year private and goods vehicle matrices ▪ Development of public transport matrices ▪ Development of demand for say base year 2012 ▪ Development of matrices for forecast year 2017, 2022 ▪ Development of daily and peak hour matrices (AM, and PM) As part of this development, the overall model needs to be able to test projects and overall strategies. The appraisal approach needs to take into account economic, environmental and social issues. These must include as a minimum: ▪ Economics: project appraisal, EIRR, B/C ratio and net present value, modal shift, etc ▪ Environmental: air quality impacts, carbon emissions, etc, land take, ▪ Social benefits: employment opportunities,
Cost	A budget should be made available for the development of a traffic model for approximately 600,000JD
Monitoring Mechanisms	The traffic model must be maintained and updated as transport schemes are implemented. The model must be updated with new OD surveys and socio-economic forecasts every 5 years. All major urban developments or schemes must first be tested using the traffic model in order to be able to assess impacts and economic viability.

Core Project 6: COMPLETION OF ZARQA URBAN MASTERPLAN	
Project Description	This project consists of the completion of the Zarqa Urban Masterplan. This urban planning blueprint would also include a transport plan, designed to achieve overall objectives and address the impacts of future development.
Rationale	The Zarqa Masterplan study must be reactivated as detailed urban planning is urgently required.
Project Need	The Zarqa Urban Masterplan project was started in 2010 but after only 3 months was stopped. This plan is fundamental to the development of Zarqa and the effective integration of the KABAAC development, and thus should be regarded as a priority.
Implementation Options	Implementation of this project requires resources from within ZM, but also requires external expert assistance, either from a national organisation with suitable skills, or from international consultants.
Scope	The study duration is envisaged to be at least 18 months. The project should be undertaken by a joint local and international team. Phase 1: Vision / Existing conditions / Land use / constraints / options / concept plan development Phase 2: Feasibility / Concept plan refinement / Phasing Phase 3: Detailed design Phase 4: Implementation planning and costing
Equipment	-
Cost	JD 1 million
Monitoring Mechanisms	The urban masterplan must act as a framework for growth within Zarqa Municipality. The urban growth plan will provide a number of area action plans and these must be implemented over time. Ad hoc development must be made illegal with the urban plan acting as the legal framework for development. Monitoring of the plan must be made by Zarqa Municipality along with MOMA

Core Project 7: INSTITUTIONAL STRENGTHENING OF ZARQA MUNICIPALITY	
Project Description	This project addresses the need for the recruitment of additional skilled staff in order for ZM to undertake the full functions of a transport planning authority.
Rationale	It is clear that, in order to integrate land use and transport planning effectively, and for the Municipality to play an effective role in working in partnership with other organisations and project managing transport improvement schemes, there is a need to expand the skills base and personnel able to tackle this type of work.
Project Need	The requirements may be summarised as follows: • Transport planning - to be undertaken at both the strategic and detailed levels; • Public transport planning and organisation – to work closely with the LTRC in delivering major changes; • Technical support – to oversee and organise transport modelling, transport ITS etc.; • Project management – to have expertise in the delivery of major projects and the ability to negotiate, liaise and persuade individuals and other organisation to agree to joint action proposals.
Implementation Options	ZM will need to give consideration to the various options for organisational structure for transport planning functions. Transport planning is closely aligned with both land use planning and highway engineering, and there is an opportunity within the organisational structure to ensure that these various skills are well integrated.
Scope	To undertake transport planning needs for the Municipality area, the following tasks would need to be included: • Collation of all economic, social and transport data and detailed analysis; • Liaison with relevant Government Departments (e.g. MPHW, MoT, MoMA) regarding planning matters; • Negotiation with developers regarding transport requirements and implications of proposals; • Design and produce local transport plan. It is recommended that 1 x qualified transport planner plus a graduate trainee should be recruited. To undertake public transport planning and organisation, the following tasks would need to be included: • Assessment of public transport needs for new developments; • Liaison with LTRC regarding development of current bus network; • Assist LTRC in collecting data on current bus usage through surveys. It is recommended that either 1 x transport planner be recruited, or the tasks of the graduate trainee above be extended. To undertake technical support for transport modelling, appraisal and ITS matters, the following tasks should be included: • Take 'ownership' of the chosen modelling software and model; • Input data changes and run model when required; • Implementation and on-going development of ITS solutions, such as RTPI and SVD equipped traffic lights. It is recommended that 1 x transport planner with modelling and ITS expertise be recruited, plus 1 x graduate trainee. To undertake project management and team leadership, the following tasks would need to be included: • Organise and project manage the various programme elements of the recommended projects; • Highly skilled negotiating and man management attributes. It is recommended that 1 x Project Manager be appointed. In view of the skills base needed, it is recommended that the Municipality should work in close co-operation with the Ministry of Municipal Affairs (MoMA), the Greater Amman Municipality and the Amman Institute to share current transport planning skills and to jointly seek some time-constrained external assistance in training and organisation.
Equipment	Office accommodation and IT equipment (software and hardware) are the main additional costs, other than staff salaries.
Cost	Estimated cost of JD 100k per annum
Monitoring Measures	Engineers/planners qualified to degree standard must be recruited to strengthen ZM's capacity and capability. Each staff member's career progress must be monitored with 6 month reviews undertaken. Short term exchange programs with GAM are an option with regards to work experience.

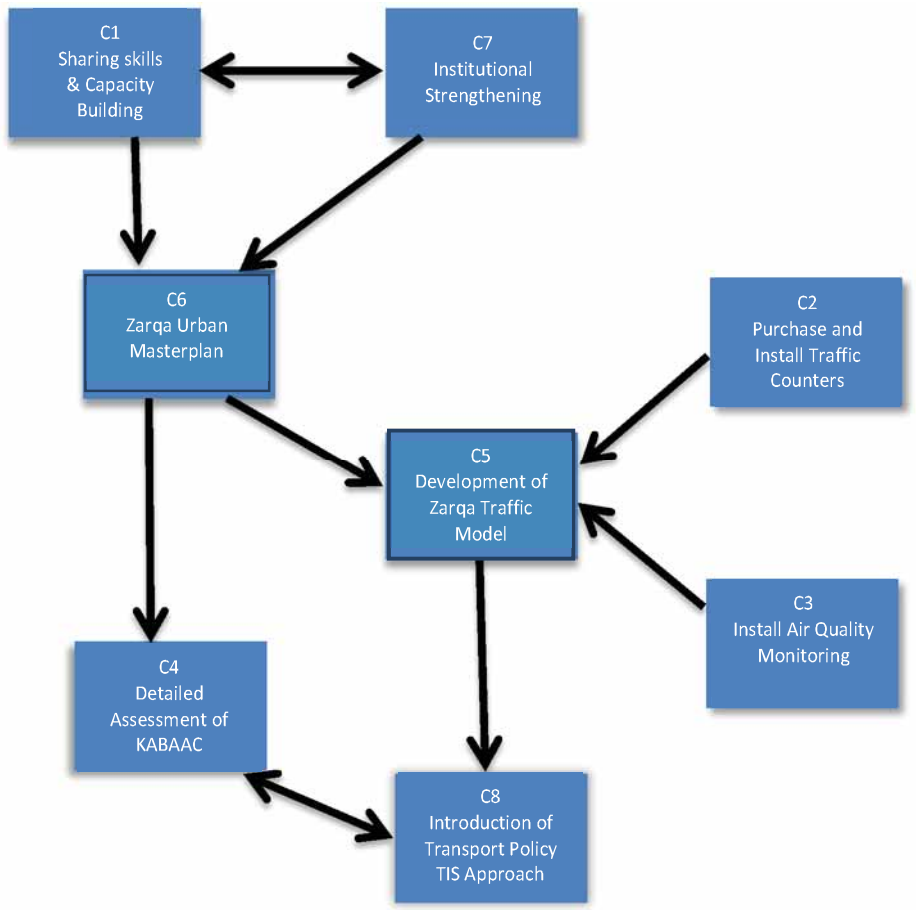
Core Project 8: INTRODUCTION OF TRANSPORT POLICY: TRAFFIC IMPACT STUDIES	
Project Description	This project consists of establishing the methodology and process for addressing the transport and traffic impacts of proposed development.
Rationale	To develop Traffic Impact Study procedures and ensure consideration of transport impacts of new development whether road or building, are well catered for.
Project Need	Traffic Impact Studies (TIS) are not normally required as part of a planning application. Whilst some developments have had TISs, even these have not been undertaken to any acceptable standards. It's fundamental that TISs are undertaken for a variety of reasons. ▪ Assess the site area existing condition ▪ Understand the background traffic ▪ Develop development trip generation demand ▪ Estimate traffic impacts ▪ Develop mitigation measures ▪ Test mitigation measures (technical and economic) ▪ Select preferred option ▪ Seek Municipal approval TIS standards must be developed and controlled by each municipality. Approval processes must be put in place and municipal staff must be trained in the assessment of TISs.
Implementation Options	An alternative approach would be to contract private sector suppliers to undertake the necessary work, either on a case by case basis or through an on-going contract to cover all such work. On balance, it is considered that the advantages of developing in-house skills outweigh any advantages of contracting out this process, in particular when considering the political implications required in decision making.
Scope	**Production of the TIS** Under normal TIS procedures, a traffic impact assessment will need to be undertaken for most "developments" regardless of size and type. The following tasks would normally be undertaken as part of the TIS process. **Consultation** ▪ Submit required introductory paperwork to the municipality for approval to gain a liaison engineer; ▪ Submit and agree a scoping report to set out the methodology to be used. This will avoid delays at later stages and ensure that all aspects required are dealt with in the required detail; ▪ Undertake regular consultation with the municipality throughout the development of the TIS; ▪ Liaise with the design architects and other interested parties during progress meetings. **Data Collection** To review the existing conditions and surrounding highway infrastructure and access to the "development", the following information and data will be sought in relation to junctions near to the site and will be collected either through a survey or from the Municipality: ▪ Existing road network ▪ Existing traffic flows on the existing highway network; ▪ Information on existing and future traffic generated by other neighbouring proposed developments in the vicinity of the site; ▪ Future plans for roadway network improvements in the vicinity of the site; and ▪ Future plans for public transport systems in the vicinity of the site. **Site Survey/Traffic Counts** If required through discussion and liaison with the municipality, traffic counts would be undertaken for the analysis of the site conditions. If existing traffic counts are not available or unreliable due to dramatic changes in the environment, then a site survey will be conducted to observe traffic flows and turning movements affecting the site and surrounding area. Subsequently, traffic counts will be planned and executed to augment any existing data. **Study Area** The study area will be agreed as part of the scoping report developed at the initial stage of the project in consultation with Zarqa Municipality. **Trip Generation** Generated trips from the development will be estimated for morning, midday and evening peaks using trip rates for specific land-use categories. Trip rates from Jordanian or similar manuals can be used. **Trip Distribution, Assignment and Modal Split** Existing traffic flow data is used to assign traffic to the surrounding network supplemented by an assessment of the surrounding area and likely trip generators and attractors. **Analysis Year** The horizon / analysis year is a function of the type of the traffic impact study. The analysis will be conducted for the existing, future baseline and future with development conditions to show the extent of the level of service at junctions within the study area. The output will include the level of service results, delay and volume to capacity ratios. **Junction Analysis** Capacity analysis in the critical peak hours must be conducted for all junctions and links in the study area, including the access points using standard junction modelling analysis tools. **Parking and Traffic Circulation** Parking demand may need to be estimated as part of the study exercise. The parking requirements for the proposed development will be calculated using parking rates from Jordanian or similar Trip Generation and Parking

	Rates Manuals. An assessment of parking circulation will be undertaken to determine possible areas of congestion and concern. The different needs of staff, pupils and visitors would be considered at this stage. This will include detailed track run analysis if required. **Connectivity to the External Road and Highway Network** Adequate accesses to/from the development to the road network will be proposed and examined to accommodate trips from the development. If improvements to the external network are required, these would be developed as part of the production of the TIS and concept layouts provided. In addition, any amendments to the internal network would also be provided in concept layout as part of the production of the TIS. **Service Vehicle Assessment** Track runs for service vehicles will be undertaken to ensure that service areas can be reached and are large enough to afford the required manoeuvrability for vehicles. Interaction between their routes and pupil/school activities is preferred to be avoided and the masterplan would be developed to achieve this where possible. **Sustainability and Accessibility Assessment** An assessment of the surrounding sustainable mode opportunities will be undertaken to determine the likely mode split that can be achieved by the development. A strategy for linkages to these transport nodes will be developed including an assessment of any pedestrian and cycle routes and possible improvements. **Report** The findings of the TIS should be summarised in a report to be approved before submission to Zarqa Municipality. **Deliverable** TIS report
Equipment	VISUM software (JD 25,000)/ Dbase software (JD 1000) / GIS (JD 4,000)
Cost	Staff and training costs JD 30,000
Monitoring Measures	Timescales should be set for processing TISs, and a reporting system established to measure both the quantity of TISs undertaken and the percentage achieved within the relevant timescale.

6.2 INTER-CONNECTIVITY BETWEEN CORE PROJECTS

There is a strong inter-connectivity between the Core Projects, which assists in dictating the order in which they are undertaken. Figure 6.1 shows this relationship graphically

Figure 6.1: Inter-connectivity of Core Projects



7 Proposed Strategy Projects

7.1 DEVELOPMENT OF STRATEGY SCENARIOS

At an earlier stage in the Study, project measures were set within three categories. Firstly, by providing an incentive to travel sustainably such as Public Transport improvements, secondly by creating a deterrent to the use of private vehicles in the form of Travel Demand Management measures, and thirdly by measures aimed at directly improving emissions and energy efficiency, which in themselves may not result in modal shift.

However, having passed the potential projects through the multi-criteria framework, twelve were identified as having a good potential for further development. Of the twelve, six were primarily associated with public transport improvements, five were TDM measures and one was aimed at directly improving emissions and fuel efficiency, but only applicable to public transport. Consequently, when considering the strategy, we realised that our initial intention to test three separate scenarios and select the best components from each was impracticable.

In addition, some measures are capable of being modelled, whilst others do not lend themselves to this approach. Consequently, as all twelve proposed measures appeared to be realistic, viable and well proven in many other similar strategies used elsewhere in the world, we determined that the most practical course was to develop a multi-faceted mobility strategy that included all twelve identified measures and which addressed the need to include 'pull' type measures commonly in the form of public transport improvements, and 'push' style measures in the form of Travel Demand Management to reflect the different approaches to changing travel behaviour. We also included the measure intended to directly improve fuel efficiency and pollution.

The sifting process, through which all potential projects were passed, resulted in the list of measures shown in Table 7.1 below.

Table 7.1: Scenario Measures

Scenario	Measures
Public Transport Improvements and Vehicle Technology, Operation and Fiscal	- Integrated Transportation and Land Use Planning - Park and Ride facilities and services - Integration of bus route strategy with land use proposals - Internal Infrastructure Improvements to the King Abdullah and Prince Rashid Bus Terminals in Zarqa - Access Improvements to the King Abdullah and Prince Rashid Bus Terminals in Zarqa - New/improved bus routes linking urban areas of Zarqa to the LRS terminal - Competitive pricing for public transport - Review of ticketing systems - Public Transport staff training - Provision of bus stops (shelters, lighting, seating, timetables) - Provision of electronic ticketing machines - Bus lanes / bus priority on key corridors within Zarqa - Improvements to pedestrian links to public transport interchanges. - Provision of new low emission buses - Rationalisation of School Buses
Travel Demand Management	- Pedestrianised zones - Parking Restrictions and Pricing Policy - Parking Restriction Enforcement - Link and Optimisation of Traffic Signals - Junction improvements to include provision of high-quality road markings indicating priority and lane restrictions - Provision of new road markings indicating lane demarcations on main roads

Final consideration of these proposed measures led to the withdrawal of two of them. Firstly, a clearer indication of the less significant role played by school buses in Zarqa compared with Amman, for example, due to the comparatively low number of private schools in the area, meant that a rationalisation of school buses would not result in any worthwhile improvements in congestion, air quality or energy efficiency. Secondly, discussions with stakeholders and others have led us to believe that the creation of pedestrianised zones would be very difficult to achieve politically at the moment. That particular measure was therefore not

considered in the final combination of 12 projects to be taken forward, but should be retained for future consideration when the effects of parking and improved public transport strategies take effect and the attractiveness of such a measure becomes more apparent and acceptable to the general public.

Figure 7.1 below sets out the 12 final projects along with the issues that each project will address.

Figure 7.1: Zarqa Downtown Projects

7.2 PUBLIC TRANSPORT PROJECTS

7.2.1 Introduction

Of the 12 improvements proposed in this report, 6 directly involve the planning and/or operation of bus services, whilst a further 1 involves new vehicle technology for the vehicles used to provide such services.

However, before considering these in detail, it is essential to understand the necessity of fundamental change to the organisational structure of bus service provision in order for the proposals to stand any chance of success, which, in turn, also impacts on the objectives of this study.

7.2.2 Current problems with Public Transport Planning, Organisational Structure and Operations in Zarqa

The problems associated with public transport in Zarqa have been identified and refined following further analysis of current route patterns. The problems may be summarised as follows:

- The industry is fragmented into a large number of very small operators (often owning only a single bus);
- Contracts serving common destinations are allocated to a multiplicity of separate operators with no co-ordination between them;
- In theory, buses cannot be switched between different contracts, even where the contracts are allocated to the same operator – this results in inflexibility;
- There is a serious imbalance between peak vehicle requirement (PVR) and off-peak requirements, such that many vehicles are idle for much of the day – this is particularly apparent with regard to university services;
- Analysis of urban bus operations in Zarqa has indicated that many routes are ‘over-bussed’ in terms of the numbers licensed – this means that either there are too many buses being operated on the services or, more likely, an excessive number of buses are underutilised;
- Both these previous factors are not conducive to profitability, as the vehicle fleet is under-utilised, and this does not permit investment in new vehicles;
- The only subsidy provided for public transport services currently is for the benefit of students – bus operators are, in fact, worse off financially, as the consequence is a significantly poorer cash flow due to the time gap before subsidy is paid to them;
- Operators cannot control fares, which are set by the LTRC – increases due under the official formula for inflation are not always enacted, due to concerns over the impact on low income families;
- Where service extensions for new development are identified by the LTRC, it is often difficult to persuade operators to extend existing contracts due to concerns over profitability in the absence of subsidy;
- Over 90% of bus contracts are issued under ‘grandfather rights’, whereby there are no termination dates and the contracts are, in reality, in perpetuity, regardless of their relevance to changing needs and passenger demands;
- As the vast majority of services operate without formal timetables, it is difficult to monitor performance quality and reliability;
- Lack of profitability leads to relatively low pay scales for bus drivers, which in turn leads to difficulties in recruitment, despite generally high unemployment levels;
- Overall, the operating industry may be considered to be in a poor condition in terms of profitability, flexibility, ability to invest and with little near future possibility of improvement.

Under these circumstances, proposals for improving the quality, reliability and perception of local bus routes serving the Downtown Zarqa area have to be considered within a wider context.

7.2.3 Study Objectives Context

It will be recalled that the Study Objectives are to:

- Develop a detailed energy efficient mobility plan, identifying specific projects for the Zarqa downtown area, and

- Develop a plan for easy access to the proposed LRS terminal and stations using an efficient public bus transportation system in the city.

Whilst these are the main objectives, in recommending various public transport related proposals to achieve these, it is necessary to ensure that the following sub-objectives are also met in order that the proposals are feasible and implementable:

- That a steering group be formed between the LTRC, the Zarqa Municipality and representatives from the bus operators in order to consider the proposals and negotiate how they should be successfully implemented;
- That a commitment be agreed between these parties that bus operators should be no worse off financially as a result of changes implemented, and that a stated objective of the implementation proposals would be to enhance profitability, investment and employment opportunities within the bus operating industry;
- That, in order to achieve the required changes, the LTRC and the Zarqa Municipality would proactively explore additional funding opportunities from both internal and external sources, primarily to 'bridge the gap' during the transition from the current situation to the post-implementation phase;
- The need for such funding is based on the premise that the costs of upgrading vehicle fleets, expanding services, possible compensation for removing excess capacity and restructuring the industry into larger operating units are unlikely to be generated from current bus company profitability and private investment potential.

Given the density of the urban population areas in and around Zarqa, and the extent of the retail and commercial activities, it is considered that there is good potential for the operation of profitable local bus services, but only if a more integrated and co-ordinated bus network can be created through bus operation restructuring, the collation of full usage data and the application of bus network planning techniques.

In previous work undertaken by WSP/CC for the LTRC [(10)], the concept of a hierarchical approach to the provision of bus services was recommended. This is intended to replace the current method of categorising bus services into 'internal' for services wholly within a single Governorate, and 'external' for services that cross Governorate boundaries. The levels recommended were:

- Level 0 - International services between Jordan and neighbouring countries;
- Level 1 – Premium Inter City: a series of high quality premium price express services linking the cities of Jordan. Currently, services of this quality standard operate between Amman and Aqaba, and the recommendation is to expand this network to cover other major cities in Jordan (including Zarqa) once a commercial case can be made for them;
- Level 2 – Core National Network; a more extensive network of limited stop services that connect the main cities and towns in Jordan. This is a development of existing services, but with a quality upgrade, reordered using network planning best practice and co-ordinated to form a national network;
- Level 3 - Other Inter Governorate Services: the remaining standard regional services operating between the Governorates. Effectively these are services not considered to be core, and are often designed to serve specific universities at limited times of the day;
- Level 4 – Intra Governorate: those regional services which operate within a single Governorate. These form the network of services linking villages and small towns with major urban areas in each Governorate;
- Level 5 – Local services: urban services operating entirely within an individual municipality boundaries.

In formulating public transport proposals to meet the main objectives of this study, we have primarily concentrated on level 5 services as offering the most significant benefits to the Zarqa Downtown area, and, as a second priority, level 2 and 3 services, in as much as these services are important because:

- They form the current public transport corridor between Zarqa and Amman, which will need to be the subject of serious restructuring in the event of the introduction of an LRS scheme; and
- They include a large number of services operating to universities, and the large scale movement of university students through Zarqa has been identified as a possible problem in generating excessive bus movements around the Downtown area.

For existing bus contracts, LTRC has three categories of size: white taxis, minibuses and large buses. In the work previously undertaken by WSP/CC for LTRC (formerly the PTRC) referenced above, we recommended that a more hierarchical approach was adopted, whereby there would be six categories by size. These are: white taxis, minibuses (12 passenger seats or less), Midibuses (up to 22 passenger seats), Medium buses (up to 40 passenger seats), large buses and coaches.

The current local services in Zarqa (Level 5) are primarily operated by Toyota Coaster buses, which are categorised as minibuses in the current LTRC listings. Consequently, when future replacement buses for this type of vehicle are discussed in this report, the terms ‘midibus’ or ‘medium bus’ are used, rather than ‘minibus’, which refers to a smaller category of vehicle.

7.4 PROJECT 1: INTEGRATE LAND USE AND TRANSPORT PLANNING THROUGH NEW BUS ROUTES AND POLICY CHANGES

7.4.1 Proposed Measures

- Introduce changes to planning procedures to ensure traffic and land use assessments of all new developments are fully taken into account during the masterplan stages of a project.
- Initially to consider how the KABAAC development, could benefit from bus interchange and bus routes to feed the development, and at the same time integrate this with connections to the rest of Zarqa and Greater Amman

Further details regarding the project proposals are provided in Appendix C, and a map of proposed bus services for the KABAAC development at Figure D6 of Appendix D, both of which are in Volume 2.

7.4.2 Project Need

At present, the land use planning process does not properly assess all transport needs of development. Not only are traffic assessments required, but also public transport services need to be planned as an integral part of the development design. Recent good practice in other parts of Jordan, noticeably in Amman, has demonstrated the benefits of this integrated approach. It is essential if trip generation by private car is to be minimised from future development, and can be built on the restructuring of the bus network in Zarqa, which is an integral part of these proposals.

7.4.3 How does the Project Meet the Study Objectives?

The key foundation for a successful combination of land use and transport planning is to complete a masterplan for the area. In Section 6 of this report, 8 core requirements are identified that are deemed necessary to ensure base conditions are better understood in Zarqa city and to provide support for the implementation of the proposed Energy Efficient Mobility Plan. One of these is the completion of the masterplan commenced in 2010, but on which work has been suspended.

Completion of the masterplan is also directly connected with another of the core requirements, that of institutional strengthening of Zarqa Municipality in order to provide the skills necessary to undertake transport planning functions. Such skills are being fostered within the Kingdom, and it is recommended that the Zarqa Municipality works closely with GAM to encourage and develop the requisite resources, tapping into the undoubted enthusiasm already existing within the organisation.

An excellent example of a country which has a long history of espousing the concept of integrating land use planning and transport planning is Singapore, whose approach is described in Case Study Box 1 below. The importance of public transport, or transit, in the development of sustainable urban areas has been widely recognised in recent years, for example the Center for Transit-Oriented Development in the USA is a national non-profit organisation dedicated to providing best practices, research and tools to support market-based transit-oriented development [(11)].

7.4.4 Supporting Measures

The success of this project is highly dependent on the implementation of core projects 4, 6 and 7. Core projects 4 and 6 involve analysing the transport needs of the King Abdullah Bin Abdul Aziz City and setting this into context of a completed Zarqa Master Plan. Core project 7 addresses the institutional strengthening required in order to ensure that transport planning staff and skills are in place to design and assist the LTRC in implementing new public transport services.

Significant relationship with other projects can be summarised as follows:

2	Public Transport Services Improvements	The proposed services for KABAAC form part of a larger group of improved services
4	Public Transport Terminal Improvements	All bus services would benefit from this project
5	Public Transport Ticketing Changes	All bus services would benefit from this project
6	Public Transport Infrastructure Improvements	Regular bus stops and bus priority would enhance the KABAAC services
7	New Low-Emission Vehicles	Low emission buses are recommended for these new services
9	Install ITS Measures	Signal priority and real time information would enhance usage
12	Public Awareness Scheme	This would encourage modal shift to public transport

Case Study Box 1: Integrated Land Use and Transport Planning, Singapore [12]

Singapore has been integrating transportation planning with land use planning since the 1970s. This was undertaken with consideration to the growing environmental impact of transportation.

The land transport policies of Singapore aimed to deliver an effective land transport network that is integrated, efficient, cost-effective and has a sustainable plan to optimize the use of transport resources and safeguard the well-being of the travelling public. Elements of the project include:

- investment and maintenance of the road infrastructure;
- investment in public transport;
- improvement of public transport;
- traffic management schemes;
- implementing road user charges;
- fiscal measures directed at car ownership; and
- comprehensive land use planning

Along with the above, Singapore used the following strategies to create an environmentally sustainable transportation system:

- Vehicle emission standards imposed since 1984 by adopting UN/ECE R15.03 and EURO IV standards were adopted for petrol and diesel vehicles respectively;
- Cleaner fuels, with leaded petrol phased out in 1998 and the use of ultra-low sulphur diesel imposed in 2005;
- Enforcement of mandatory smoke inspection;
- Educate fleet owners for regular vehicle maintenance as well as drivers to influence driving habits; and
- Other policies such as such as vehicle quota system and electronic road pricing

The project has led to a reduced emission of sulphur, SO_2 and PM 2.5 which in turn improved air quality.

The effectiveness of Singapore's land transport policies was based on two foundations: effective implementation and the workability of the policies.

7.4.5 Project Details

Integrate Land Use and Transport Planning Through New Bus Routes and Policy Changes		
Project Description	• Create an integrated land use and transport planning section at the Municipality • Design all transport needs and requirements for development at the planning stage • Work in partnership with public and private sector organisations to deliver the required infrastructure and services • Consider the transport requirements for the King Abdullah Bin Abdul Aziz City development, particularly the need for bus services • Design and implement suitable new services, which are integrated into the public transport network, provide a wide range of travel opportunities for residents and meet the objectives of the study	
Area	No infrastructure involved.	
Phase	Short term	
Estimated Cost (JDs)	The cost of institutional strengthening and implementing integrated land use and transport planning is covered within Core project 7. Cost of providing a new fleet of buses to operate the services would be JD 2,375,000	
Strategic Relevance	Important strategic benefit of providing connectivity between a major new development and both Zarqa downtown and the New Zarqa areas. It would represent an early example of the benefits of adopting a more sustainable approach to integrating transport with land use planning.	
Environmental Impacts	Any impacts resulting from an additional number of buses would be more than compensated for through the benefits of mode share in areas which currently have no or limited public transport availability.	
Potential User Revenues	Potential leasing income from operators might be JD210,900 per annum, for the first ten years, reducing to 53,500 for the next 5 years (10 year lease for midibuses and a 15 year lease for medium size buses).	
Project Readiness	Readiness of Authority	Able to contribute to a partnership with LTRC and the operators, but may need skills enhancement in the short term.
	Project Readiness	Requires strategic approval by LTRC to undertake structural change to bus operations and successful negotiations with service providers, together with research into most cost effective vehicle specifications and availability. Otherwise should be deliverable within 1-2 years maximum.
	Financing in Place	No
Social	Employment Generation / Equal Opportunities	Will create new jobs and enhance long term viability of the bus operating industry.
	Social Impacts	Through providing improved mobility, should benefit the local economy in Zarqa and provide better links to job opportunities.
	Geographical Coverage	King Abdullah Bin Abdul Aziz City and urban areas to the south and south east of Zarqa downtown area
Monitoring Measures (KPIs)	• Increased use of public transport evidenced by greater number of trips made • Increased number of full time jobs in bus operating industry • Reduced emissions per vehicle	
Impact Assessment within Emissions Model	It is not possible to directly model all aspects of the measures in this project, i.e. the impact of policy changes on private vehicle use. However, it is possible to model a proposed new bus network in the public transport trip generation. Furthermore, an estimate can be made of the corresponding modal shift from private transport to public transport as a result of the enhanced public transport provision.	

7.5 PROJECT 2: PUBLIC TRANSPORT SERVICES IMPROVEMENTS

7.5.1 Proposed Measures

- Introduction of fixed timetables for bus services, the restructuring of the bus operating industry to foster integration and the reorganisation of bus contracts into service groups.
- Bus lanes / bus priority on key corridors within Zarqa to facilitate the movement of buses, including bus lanes within Zarqa that have direct and speedy access to the main bus terminals.
- Public Transport staff training - Courses to be run through the LTRC and/or agencies to train staff in a) customer care, b) safe driving, and c) fuel economy techniques.

Further details regarding the project proposals are provided in Appendix D, including maps of proposed bus services in Figures D1 to D13, in Volume 2.

7.5.2 Project Need

Our analysis of current bus services in the area has demonstrated that although the geographic coverage is adequate (except in the case of new developments), the system itself is disjointed and uncoordinated, with little in the way of set timetables and a general tendency for resources to fail to respond to demand patterns. Examination of contract details indicates that there appears to be an excessive number of buses allocated licenses, in comparison with the vehicle requirements necessary for a relatively high frequency network. The main reasons for this appear to be:

- An excessive differential between the peak vehicle and off-peak vehicle requirements, primarily because of the way in which the demand for transport for university students distorts the system;
- Too many contracts for different operators to serve the same general areas, which results in concerns over the profitability of services for individual operators, despite good latent demand;
- Excessive allowance for ‘spare vehicle’ capacity, due to the low average fleet size of individual operators;
- Inflexibility in the ability to move capacity from one service to another, which results in the need for a large number of requests for temporary permits/licenses;
- As demand has increased over the years, the tendency has been to increase the number of allocated buses, but retaining a similar size configuration, whereas a conversion to larger buses would have enabled the numbers of vehicles required to be reduced.

7.5.3 How does the Project Meet the Study Objectives?

The purpose of the staged components of this proposal set out in Appendix D is to address the problems by:

- Creating a reliable, predictable and attractive public transport network, which will generate additional usage by both current public transport users and by those currently using private cars;
- Establishing a more robust and profitable operating industry, which will encourage additional employment and enhance economic activity in Zarqa;
- Providing an energy efficient public transport system, that will also assist in reducing overall pollution from road transport sources in Zarqa: and
- Ensuring good connectivity from all urban areas of Zarqa Municipality and other contiguous areas to the Downtown area and the main terminal locations which are likely to interface with a rail or bus based rapid transit system.

An example of a city which has tackled the problems of providing more sustainable transport options, through revitalising bus networks, implementing bus priority measures and engaging with its stakeholders is Burgos, in Northern Spain, as described in Case Study Box 2 below.

Radical restructuring of a bus operating industry is not a common occurrence, however the island of Malta experienced this very recently, and several factors there were similar to the circumstances in Zarqa. Although EU regulations ultimately shaped the solution applied in Malta, the process of analysing the problems and the recommendations proposed are of interest, and these are described in Case Study Box 3 below.

7.5.4 Supporting Measures

The success of this project is not particularly dependent on the implementation of any of the core projects, with the exception of core project 7, the institutional strengthening of Zarqa Municipality. Significant relationships with other projects can be summarised as follows:

1	Integrate Land Use and Transport Planning Through New Bus Routes and Policy Changes	Effective bus network redesign and on-going adjustments and alterations are dependent on an informed integrated transport planning system being in place
3	Improve Accessibility to the Proposed LRS Terminal	Integration between local urban services covering the downtown area and majo longer distance corridors such as Zarqa to Amman is extremely important
4	Public Transport Terminal Improvements	All bus services would benefit from this project
5	Public Transport Ticketing Changes	All bus services would benefit from this project
6	Public Transport Infrastructure Improvements	Regular bus stops and bus priority would enhance the reliability and energy efficiency of bus services
7	New Low-Emission Vehicles	A phased introduction of low emission buses would improve the quality of public transport services
8	Walking Infrastructure improvements	Easy and safe access to the downtown area from the main bus terminals would encourage greater use of public transport
9	Install ITS Measures	Signal priority and real time information would enhance usage
10	Junction and Highway Improvements	These would enhance the reliability and safety of bus services
12	Public Awareness Scheme	This would encourage modal shift to public transport

Case Study Box 2: Clean High Mobility Bus Services, Burgos, Spain [13]

Burgos is a city in northern Spain. The city is the leader among Spanish cities in terms of sustainable mobility with big efforts for a city centre free of cars, a free bicycle loan system and clean public transport.

Burgos aimed to increase the number of passengers using collective public transport by encouraging sustained use of the transport system, ensuring the accessibility, safety and comfort of users travelling on cleaner urban transport.

Public transport service improvements included:

- Introducing priority bus lanes;
- Increase the frequency of buses;
- Modernization of urban bus service by determining demand and modeling, bus route and length can then be planned according to passenger demand;
- Install 20 electronic information panels at bus stops; and
- Provide Training workshops for local police officers and others including system operators.

Public satisfaction has been assessed by means of surveys and indicators such as occupancy rates and frequency of usage.

The implementation of the scheme has led to more than 7% increase in passengers using public transport at the end of the project.

Sources: http://www.civitas-initiative.org/measure_sheet.phtml?language=en&id=297

Case Study Box 3: Restructuring the Bus Service Network in Malta [14]

Restructuring the bus operating industry in Malta has been a priority for the Maltese Government for many years, as the then current system did not meet the requirements of European Union regulations, which require an element of 'controlled competition'. Bus services in Malta had a number of similarities to Jordan, for example:

- 600 land passenger enterprises employing 930 people in a small country with a population of 0.4 million
- 508 buses owned by 440 individuals
- Poor interworking of services, and lack of co=ordination
- Irregular timetables, little publicity and mixed vehicle quality
- Overbussing – each bus was only required to operate on alternate days

Significant differences from the Jordan situation were that the operators had a relatively strong trade association and that an operational subsidy was paid by the Malta Transport Authority (ADT).

Consultants employed by the Maltese Government recommended that the best way forward to restructure the industry would be for the services on the island to be split up into a number of route groups and operated on a net cost contract basis. Steps recommended were:

- to divide the network at an early stage into the route groups that would form the basis of the new arrangements;
- to give general details to all operators of the timetable for changes, both in terms of the new service provision and the proposed timing of the release of service groups into the contracting process;
- to give details to all operators of the proposals to reduce the size of the industry.

The concept promoted was for single entity operators to agree to share one bus between two of them, thus reducing the total fleet strength to a level more consistent with demand. These entities would then be encouraged to either form co-operatives, companies or 'sell out' to larger companies. The new organisations would then bid for one or more of the 9 route groupings proposed.

These proposals are clearly of relevance to the situation in Zarqa, however the proposals have not been delivered in this form, as they were deemed not to be in accord with EU requirements on promoting competition. Instead, an overseas bus conglomerate, Arriva, owned by German state rail operator DB, won a contract to operate all bus services in Malta. The new fleet of just 264 buses is due to commence operation of the restructured services in the summer of 2011, although the number of seats available will increase by 6,600 to 20,500 through the use of larger buses.

Sources: https://mitc.gov.mt/page.aspx?pageid=51

7.5.5 Project Details

Public Transport Services Improvements		
Project Description	■ Undertaking detailed surveys to understand thoroughly the current demand patterns and volume of passengers and to validate this information against the proposed revised route network, which features restructured high frequency urban routes feeding into longer distance services at key terminals ■ Restructuring of the bus industry into larger units, operating discrete groups of contracts ■ Improve vehicle standards by introducing more modern buses ■ Improving bus service reliability by introducing bus lanes and bus priority corridors within the downtown area ■ Upgrading the quality and skills of bus driving staff through effective training	
Area	Affects streets identified in the Zarqa downtown area for bus priority measures.	
Phase	Short to medium term.	
Estimated Cost (JDs)	Cost of comprehensive passenger surveys would be JD150,000 Cost of scheduling and route software plus IT equipment would be JD10,000 Purchase of 22 midibuses per year over a ten year period (total 220 buses) would be JD990,000 per annum, cost of 4 medium buses in first year would be JD400,000 6 kms of bus lanes at JD43,800 per km would cost JD262,800 UTC system to provide priority for buses at traffic lights is costed within Project 9 Public transport staff training (to be established and run by LTRC) would cost JD50,000 per annum	
Strategic Relevance	Primary project designed to achieve modal shift from private car to public transport – intended to form the local component of a national plan to provide enhanced connectivity between the main centres in the Kingdom.	
Environmental Impacts	Intended to reduce emissions in the downtown area and increase energy efficiency of public transport.	
Potential User Revenues	Assuming a ten year life, the leasing of midibuses would produce revenue of JD108,000 in the first year, rising by a further JD108,000 in each consecutive year to reach an annual total of JD1,080,000 in the tenth and subsequent years, assuming leases are renewed for new buses once the original buses are 10 years old..	
Project Readiness	Readiness of Authority	Able to contribute to a partnership with LTRC and the operators, but will need skills enhancement in the short term.
	Project Readiness	Essential to achieve partnership working with LTRC and bus operators to undertake structural change to bus operations and successful negotiations with service providers, together with research into most cost effective vehicle specifications and availability. Implementation of bus lanes and priorities will require consultation with affected parties. LTRC will need to agree training proposal, identify funding and arrange delivery.
	Financing in Place	No
Social	Employment Generation / Equal Opportunities	Overall, will retain and enhance long term viability of the bus operating industry, although short term repositioning of staff will be necessary – intended to enhance status of bus driving.
	Social Impacts	Through providing improved mobility, should benefit the local economy in Zarqa and provide better links to job opportunities.
	Geographical Coverage	Downtown area of Zarqa, together with the whole urban area of the City and public transport corridors to adjacent cities and towns.
Monitoring Measures (KPIs)	• Increased number of bus passengers and trips being made • Measurable reduction in private car trips in the downtown area • Reduction in vehicle emissions from buses • Increased stability of public transport network	
Impact Assessment within Emissions Model	The proposed new bus network can be modelled in the public transport trip generation model. Furthermore, an estimate can be made of the corresponding modal shift from private transport to public transport as a result of the enhanced public transport provision.	

7.7 PROJECT 3: IMPROVE ACCESSIBILITY TO THE PROPOSED LRS TERMINAL

7.7.1 Proposed Measures

- Introduce new bus routes within urban areas of Zarqa linking to the LRS terminal.
- Provision of Park and Ride facilities and services - identify and make available land near the public transport interchanges, including the new LRS terminal.
- Free Shuttle Bus between Downtown zone and Public Transport Interchanges.

Further details regarding the project proposals are provided in Appendix E, together with a map of proposed longer distance bus services in the Zarqa area and a map of the proposed Park and Ride/Shuttle Bus service (Figures E1 and E2) in Volume 2.

7.7.2 Project Need

Early in 2011, the Government indicated that the proposed Light Rail scheme between Amman and Zarqa would not be proceeding, and that an alternative strategy, such as Bus Rapid Transit, were under consideration. If a fixed rail scheme, following the track of the Hejaz Railway, is not now a possibility, this would result in significant changes to the inter-connectivity with the bus-based transportation system. The fixed rail scheme positioned proposed stations along the route length, and included a terminal station at New Zarqa, adjacent to the proposed new bus terminal, and the retention and development of the current main station in Zarqa, which is immediately adjacent to the King Abdullah Bus Terminal.

Consequently, the development of improved access to the LRS would have been concentrated on further improved interconnectivity at the existing King Abdullah Terminal to the adjoining LRS station, and to create a new 'hub and spoke' operation based on the New Zarqa Terminal, proposed for construction adjacent to the LRS Terminal.

However, if a decision is made in the future to pursue a road based solution, such as Bus Rapid Transit, this results in a degree of uncertainty as to how interconnectivity could be achieved. It is very unlikely that a BRT scheme would utilise the track bed of the old Hejaz Railway, as the route is very narrow and winding and thus not particularly suitable for rubber wheeled based technology. Nevertheless, it is our view that the primary requirements for interconnectivity with the bus terminals in Zarqa, including a new facility at New Zarqa, will remain a priority, regardless of the detailed routing between Zarqa and Amman.

7.7.3 How does the Project Meet the Study Objectives?

One of the original objectives for the Study was to develop a plan for easy access to the proposed LRS terminal and stations using an efficient public bus transportation system in the city. This objective has had to be revised to some extent because of subsequent changes to the LRS proposals. Further details are provided in Appendix E. The main features, and how the project addresses the study objectives, are:

- Improvements in the local urban bus network, as set out in projects 1 and 2, which are designed to provide better integration with any proposed rapid transit system, and the introduction of a BRT service to operate between King Abdullah Terminal in Zarqa and the Hashemite University. The latter facility could be implemented in conjunction with a BRT based service between Zarqa and Amman, or as a standalone 'light' BRT system. There is also the potential for this BRT service to provide a greatly improved interconnectivity between Zarqa downtown and the Free Zone, located in close proximity to the University.
- A Park and Ride scheme, as a means of reducing emissions in the Downtown area, has much to commend it. Although sometimes regarded as an interim solution, in that one leg of the trip remains by use of the private car, Park and Ride often enables the leg of the trip likely to create the most emissions to be completed by a public transport mode.
- An effective and reliable shuttle bus service is an essential element for a successful Park and Ride scheme. In the majority of cases, this would take the form of a direct link between the chosen Park and Ride site and a city centre, however, in the case of Zarqa, we believe that a single service linking all three proposed Park and Ride sites with each other and with key Downtown attractors would be the most attractive and cost efficient approach.

Another justification for selecting this proposal is that such a combined Park and Ride/shuttle service would provide an attractive and effective means of distributing passengers arriving at both King Abdullah and

Prince Rashid Terminals to other locations within the Downtown area and would also provide additional interconnectivity with an LRS system.

One of the most well-known BRT schemes is the Transmilenio system in Bogota, Columbia, which is described in Box 4 below. The section of BRT operation that is recommended from Zarqa to the Hashemite University is not to this degree of complexity, but would consist of modern high-capacity buses operating to a frequent timetable and with a degree of bus priority measures applicable in the built-up urban area.

Park and Ride facilities are well established in many parts of the world, and Box 5 below describes the Beyhaghi facility in Iran. In the UK, one of the most well-known systems is at Oxford, which has been in operation for over 25 years, and which includes a number of parking sites around the periphery of the city [15].

Free or low cost shuttle bus services have been introduced in many cities as a means of improving accessibility and restraining car trips to the downtown areas. Box 6 below describes a well-established system in Chattanooga, Tennessee USA, which also utilises electric buses.

7.7.4 Supporting Measures

The success of this project is not particularly dependent on the implementation of any of the core projects, with the exception of core project 7, the institutional strengthening of Zarqa Municipality.

Significant relationships with other projects can be summarised as follows:

1	Integrate Land Use and Transport Planning Through New Bus Routes and Policy Changes	Effective specialised services, such as Park & Ride and a downtown shuttle service are dependent on an informed integrated transport planning system being in place
2	Public Transport Services Improvements	The proposed revised bus network has been designed to integrate with a Park an Ride/shuttle bus service.
4	Public Transport Terminal Improvements	The proposed new service would form an essential link between these terminals.
5	Public Transport Ticketing Changes	All bus services would benefit from this project
6	Public Transport Infrastructure Improvements	Regular bus stops and bus priority would enhance the connectivity of the propose service
7	New Low-Emission Vehicles	The use of low emission buses on the new service would improve the quality of public transport services and encourage non-public transport users.
8	Walking Infrastructure improvements	Easy and safe access to the downtown area from the main bus terminals would encourage greater use of the new service.
9	Install ITS Measures	Signal priority and real time information would enhance usage
10	Junction and Highway Improvements	These would enhance the reliability and safety of the service.
11	Parking	A holistic on-street and off-street parking policy and strategy are essential for the Park and Ride bus service to be successful.
12	Public Awareness Scheme	This would encourage modal shift to Park and Ride.

Case Study Box 4: Bus Rapid Transit System, Bogota, Colombia [16]

Bogota is the capital city of Colombia. Prior to the construction of the TransMilenio, Bogota's bus rapid transit (BRT) system, the city consists of thousands of independently operated and uncoordinated mini buses.

A bus system was chosen due to its cost effectiveness in comparison with a railway system. The initial system took three years to complete from its conception to opening in December 2000. There are subsequent phases planned until 2016.

TransMilenio consists of several interconnecting BRT lines, each composed of numerous elevated stations in the center of a main avenue. Passengers typically reach the stations via a bridge over the street. There are dedicated lanes in the center of the street for bus traffic (express and local buses).

Contactless smart card ticketing system (MIFARE) is implemented. Furthermore, Bogotá has many bicycle paths built throughout the city in conjunction with TransMilenio and cycling parking facilities are provided at the TransMilenio stations at each end of a line.

The construction cost for the first phase of 41 km was US$240 million, or US$5.9 million/km. Most of the money required to build TransMilenio was provided by the Colombian central government, while the city of Bogotá provided the remaining 30%.

Daily ridership reached to 800,000 after the TransMilenio opened. TransMilenio has since been expanded and ridership in early 2006 was 1,050,000 daily, and in 2009, it was 1,400,000 daily.

With the TransMilenio in place, a reduction of 93% in fatalities from traffic accidents has been reported. Furthermore, a 40% reduction of some air pollutants; and a 32% drop in travel time for users.

Seventy-five percent of Bogotaans rate the system as good or very good.

Other cities are building systems modeled on Transmilenio, for example Mexico City.

To cover operating costs, the system is charging a flat fare (less than $0.85 USD per trip). The operation is funded entirely by fare collection with no subsidies provided. It incorporates a sustainable private participation scheme and, although the system is bus-based, its operation is similar to that of a rail-based system.

Case Study Box 5: Beyhaghi Park-Ride Terminal, Tehran, Iran [17]

Beyhagi Park-Ride Terminal is located in Argentine Square, Tehran and was developed in 1991 by Tehran Municipality following traffic problems resulting from population growth and the expansion of urban regions in the city.

In order to encourage people to use the public transport system, Beyhagi Terminal was developed with a park and ride facility, accommodating 5,000 cars. The provision of a park and ride allows more than 10,000 passengers per day to travel using Tehran Bus Company services.

Increased bus ridership results are reported. In combination with other bus related measures, the document "Air Pollution Counter Measures in Tehran" prepared for the mayor of Tehran reports that for every one million dollars spent on public transport there will be as much as 186 tons reduction in pollutants.

Case Study Box 6: Downtown Chattanooga Electric Shuttle Bus, Tennessee USA [18]

Poor air quality, traffic congestion, urban decay, and loss of revenue once plagued Chattanooga. As the downtown area was revitalised, it became apparent that a new mode of transport was needed to reduce pollution, relieve traffic congestion, and free up land for development projects rather than parking lots.

The Downtown Electric Shuttle Bus is a free service seven days a week with a frequency of 5 minutes. The service provides convenient access to attractions, retail areas, leisure facilities and employment in the Downtown area. Convenient car parking is provided at the terminals. The bus fleet consists of 81 vehicles, of which 16 are alternative fuel.

The project cost in the region of $160,000-180,000 for electric buses, however the fuel and maintenance costs are cheaper than diesel vehicles. Operating costs for the electric buses are covered by parking revenues and lease of commercial space in the parking facilities.

The downtown service has recorded over 11.3million passengers since 1992, with the electric buses covering more than 1.9million miles. It is estimated that 65 tons of pollutants have been saved so far. A key lesson learnt was that finding an efficient way to charge the vehicle batteries is essential.

7.7.5 Project Details

Improve Accessibility to the Proposed LRS Terminal		
Project Description	▪ Designing the urban bus network to provide excellent interconnectivity with the most likely routings of a rapid transit system. ▪ Providing a BRT service between King Abdullah Terminal, Zarqa and the Hashemite University, either as an extension of a Zarqa to Amman system or as a standalone 'light' BRT. ▪ Designing a Park and Ride system based on three separate sites to connect with the downtown area and major attractors, in conjunction with an integrated parking strategy. ▪ Providing a shuttle bus around the downtown area, using the proposed Park and Ride service.	
Area	New at grade Park and Ride car parks to be constructed at locations on the periphery of the downtown area.	
Phase	Short term (BRT might be in the medium term, dependent on decisions on the rapid transit system between Zarqa and Amman).	
Estimated Cost (JDs)	Cost of BRT buses assuming 15 new articulated buses would replace 25 conventional full size = JD2,700,000 Cost of 4 kms of bus lane at JD43,800 per km would be JD175,200. Cost of providing the Park and Ride car parks would be JD673,000 per site, totalling JD2,019,000 for three. Cost of purchasing midibuses to operate the Park and Ride service and also the shuttle bus service (24 midibuses) would be JD1,080,000.	
Strategic Relevance	Park and Ride project designed to achieve partial modal shift from private car to public transport. Local bus network and the shuttle bus concept are intended to strengthen accessibility provided by the longer distance strategic link to Amman..	
Environmental Impacts	Intended to reduce emissions in the downtown area and increase energy efficiency of public transport.	
Potential User Revenues	Potential leasing income for the BRT proposal would be JD180,000 per annum, but all or part of this may be needed as subsidy in view of the high capital costs involved. Potential leasing income from the lease of the midibuses would be JD84,000 per annum, but this would probably need to be subsidy due to the low fares income from a Park and Ride/shuttle bus type of service.	
Project Readiness	Readiness of Authority	Able to contribute to a partnership with LTRC and the operators, but will need skills enhancement in the short term.
	Project Readiness	Essential to achieve partnership working with LTRC and bus operators to design suitable schemes.
	Financing in Place	No
Social	Employment Generation / Equal Opportunities	Will create new jobs and enhance long term viability of the bus operating industry.
	Social Impacts	Through providing improved mobility, should benefit the local economy in Zarqa and provide better links to job opportunities.
	Geographical Coverage	Downtown area of Zarqa and immediately adjacent area..
Monitoring Measures (KPIs)	• Increased mode share for public transport between Zarqa and the Hashemite University • Targets to be set for number of cars using the Park and Ride facilities • Targets to be set for load factor for the Park and Ride/shuttle bus services	
Impact Assessment within Emissions Model	It is not possible to measure the impact of this project in isolation	

7.8 PROJECT 4: PUBLIC TRANSPORT TERMINAL IMPROVEMENTS

7.8.1 Proposed Measures

- Internal Infrastructure Improvements to the King Abdullah and Prince Rashid Bus Terminals in Zarqa - Redesign the internal layout of the terminals with a view to reducing pedestrian – vehicle conflicts and facilitating smooth internal circulation.
- Access Improvements to the King Abdullah and Prince Rashid Bus Terminals in Zarqa - Redesign entry and exit access entry with a view to minimising conflict with external traffic and reducing pedestrian-vehicle conflicts.

Further details regarding the project proposals are provided in Appendix F in Volume 2.

7.8.2 Project Need

The existing bus terminals in Zarqa City require improvements to provide efficient, well designed layouts and attractive facilities for passengers.

The Municipality of Zarqa has undertaken improvements, with plans for further work, mainly affecting the King Abdullah Terminal. Work has been undertaken to rehabilitate the Terminal by removing many of the kiosks, shops and the old roof, and there are plans to create a commercial building to replace these kiosks and shops. There is also a project to create another commercial building in the Terminal to accommodate the remaining kiosks and market stands and to provide much needed toilet facilities. This is to be funded through the Regional and Local Development Project scheme, financed by the World Bank and the Agence France de Développement (AFD).

A new bus terminal facility located close to New Zarqa would provide excellent interchange for local services originating in the downtown area of Zarqa and would be closely integrated into the proposed terminal of the Zarqa to Amman rapid transit system, together with the proposed Park and Ride at grade car park facility.

7.8.3 How does the Project Meet the Study Objectives?

Improving the facilities, layouts and operational design of the main bus Terminals in Zarqa come under this category. Experience from other countries such as Brazil (Case Study Box 7 below) demonstrates that these types of improvement can be effective, but are usually combined with other measures, such as the provision of real time information, better buses or improved ticketing and timetabling thus making it difficult to isolate the impacts of individual measures.

Improvements to the terminals in Zarqa would certainly address the objective of promoting an efficient public bus transportation system in the city.

In the case of improved access to minimise conflict with other traffic and pedestrians, the main benefit would clearly be one of safety, although there would also be a benefit to ease of access between the possible LRS stations, the bus interchange terminals and destinations in the Downtown area.

7.8.4 Supporting Measures

The success of this project is not particularly dependent on the implementation of any of the core projects, with the exception of core project 7, the institutional strengthening of Zarqa Municipality.

Significant relationships with other projects can be summarised as follows:

1	Integrate Land Use and Transport Planning Through New Bus Routes and Policy Changes	Well-designed bus terminals in the most appropriate locations are important in the success of land use and transport planning integrated policies.
2	Public Transport Services Improvements	Safe and efficient terminals supplement PT service improvements.
3	Improve Accessibility to the Proposed LRS Terminal	Integration between local urban services covering the downtown area and the major longer distance corridors, such as Zarqa to Amman, is extremely important in relation to the location of efficient and effective terminals.
6	Public Transport Infrastructure Improvements	Bus terminals are one level of hierarchy in the provision of facilities for passengers, and complement the other levels, such as on-street bus stops.
8	Walking Infrastructure improvements	Easy and safe access to terminals and minimising conflict between pedestrians and buses within the footprint of terminals are key factors in .providing a safe and pleasant environment.
9	Install ITS Measures	Real time information would enhance usage of bus services and provide a key information link within bus terminals.
12	Public Awareness Scheme	This would encourage modal shift and increase the use of terminals.

Case Study Box 7: Bus Station Design, Curitiba, Brazil (19)

Curitiba is internationally recognized as an environmentally sustainable city mainly due to its efficient and innovative BRT transportation system implemented since the 1970s. Curitiba's public transportation consists entirely of buses with unified fare. There are several different types of bus, each with a different function.

Besides its BRT system, Curitiba has designed unique boarding tube stations with the intention of avoiding fare evaders. These stations are enclosed, easily accessed and are placed along direct routes and express lanes.

To increase convenience, boarding efficiency and reduce fare evaders, passengers pay an entrance fare at the turnstile and wait for their respective direct or express bus to pass. The tubes elevate passengers to the bus platform level where automatic doors operated by the tube conductor open parallel to the bus doors. Buses are designed with three doors, two doors for exiting and a front door for boarding. Furthermore, each tube station is equipped with lifts as well as station and route maps.

The design of the bus station has contributed to the success of Curitiba's BRT.

Results of the 1991 traveller survey estimated that the introduction of the BRT has led a reduction of about 27 million vehicle trips per year; this is an equivalent of about 27million liters of fuel per annum. With comparison to eight other Brazilian cities of its size, Curitiba uses about 30 % less fuel per capita. Furthermore, approximately 28% of the BRT users previously travelled by car.

7.8.5 Project Details

Public Transport Terminal Improvements		
Project Description	▪ Design and implement improved facilities at both King Abdullah and Prince Rashid terminals, concentrating on minimising conflict between pedestrians and buses. ▪ Design and construct a new terminal adjacent to New Zarqa and integrated with the LRS proposals and the Park and Ride facility.	
Area	Existing terminals in the downtown area and a location in New Zarqa.	
Phase	Short term – new terminal at New Zarqa may be medium term, depending on the progress of the LRS scheme.	
Estimated Cost (JDs)	Cost of improvements to the internal layouts at King Abdullah and Prince Rashid Terminals to minimise conflict with pedestrians and costs of access design improvements, including entry and exit designs, would be JD6,520,000 for King Abdullah Terminal and JD4,832,500 for Prince Rashid Terminal. Cost of construction of new bus terminal at New Zarqa would be around JD2,925,000. Costs for pedestrian road crossing improvements are included in Project 8.	
Strategic Relevance	The three terminals considered will be a critical element in the strategic LRS scheme.	
Environmental Impacts	No specific impacts.	
Potential User Revenues	None anticipated.	
Project Readiness	Readiness of Authority	Able to implement improvements and construction of new terminal.
	Project Readiness	Essential to achieve partnership working with LTRC and bus operators to design suitable layouts.
	Financing in Place	No
Social	Employment Generation / Equal Opportunities	No specific employment opportunities other than construction, and some staffing at the proposed new terminal.
	Social Impacts	Through providing improved accessibility, should benefit the local economy in Zarqa.
	Geographical Coverage	Improved facilities for all bus services coming into Zarqa.
Monitoring Measures (KPIs)	• Restricted to keeping to cost estimates, sustainability and passenger throughput.	
Impact Assessment within Emissions Model	It is not possible to measure the impact of this project in isolation	

7.9 PROJECT 5: PUBLIC TRANSPORT TICKETING CHANGES

7.9.1 Proposed Measures

- The introduction of a high quality premium fare scale for Level 1 services across Jordan serving Zarqa, and a standard class fare scale for an integrated Level 2 national network.
- Competitive pricing for public transport through the introduction of through ticketing for multi-part trips on Levels 3, 4 and 5 services.
- The introduction of Electronic Ticketing Machines (ETMs) to eliminate, or at least reduce, on board cash payments.

Further details regarding the project proposals are provided in Appendix G in Volume 2.

7.9.2 Project Need

The current system takes into account both fixed costs and variable costs, with the latter being applied to the relevant line length in kilometres. However this system is clearly not currently functioning in achieving its objectives. A desire not to inflate fares excessively has resulted in the full impacts of fuel cost rises (the single highest cost element for transport operation in Jordan) not being reflected in fares readjustments, with the result that bus operators' margins have been severely squeezed to the point where profitability is difficult to achieve and transport staff wages are, in many cases, reducing in real terms, causing industrial relations problems.

7.9.3 How does the Project Meet the Study Objectives?

Provision of a highly affordable and more extensive network of bus service would enhance longer distance accessibility to work, education and leisure facilities. Consequently the demand for private vehicle trips to and from downtown Zarqa will be reduced.

The benefits of introducing integrated public transport fares, such as an increase in usage, are demonstrated by the example of Freiburg in Germany, as shown in Case Study Box 8 below.

7.9.4 Supporting Measures

The success of this project is not particularly dependent on the implementation of any of the core projects.

Significant relationships with other projects can be summarised as follows:

1	Integrate Land Use and Transport Planning through New Bus Routes and Policy Changes	New bus services are made more attractive through the provision of differentiated and through fares which do not require passengers to pay separately for each link in the journey.
2	Public Transport Services Improvements	New bus services are made more attractive through the provision of differentiated and through fares which do not require passengers to pay separately for each link in the journey.
3	Improve Accessibility to the Proposed LRS Terminal	Multi-modal ticketing opportunities would enhance usage on both buses and the LRS system.
6	Public Transport Infrastructure Improvements	Regular bus stops help to optimise the benefits of sophisticated ticket systems.
12	Public Awareness Scheme	This would publicise the opportunities provided by more sophisticated fare scales and journey opportunities.

Case Study Box 8: Simplified / Integrated Public Transport Fares, Freiburg, Germany [20]

Between 1950 and 1970 motorisation grew rapidly in Freiburg. Freiburg's transport system has however become more sustainable over time, with a trend away from car use despite strong population growth, rising incomes, and a booming economy.

Introduction in 1984 of Germany's first transferable flat rate monthly transport ticket -a low cost 'environmental' travel card. The system was later extended in 1991. Key features include:

- Unlimited use at no financial cost once trips above a certain threshold are conducted
- Interpersonal transferability and
- Wide regional validity

The monthly tickets offer bargain fares for regular public transport users.

In combination with other public transport improvements, patronage doubled between 1983 and 1995.

The percentage of public transport riders using monthly tickets rose from 39% in 1974 to 92% in 2006.

- Implement controversial policies in stages
- Plans should be flexible and adaptable over time to changing conditions
- Policies must be multi-modal and include both incentives and disincentives
- Fully integrate transport and land-use planning
- Citizen involvement must be an integral part of policy development and implementation
- Support from higher levels of Government is crucial to making local policies work
- Sustainable transport policies must be long term with policies sustained over time for lasting impact

7.9.5 Project Details

Public Transport Ticketing Changes		
Project Description	▪ Implementation of a nationwide fares scale for long distance travel by bus. ▪ Introduction of through ticketing with the provision of a clearing house system. ▪ All local buses to be equipped with Electronic Ticket Machines (ETMs).	
Area	No physical infrastructure will result.	
Phase	Short term.	
Estimated Cost (JDs)	Costs for integrated ticketing systems are dependent on wider scale introduction by the LTRC, in particular the establishment of a clearing house. Introduction of lower cost journeys is dependent on a business case or the payment of some form of subsidy by LTRC. LTRC intend to introduce ETMs throughout Jordan, and a tender is currently under consideration. To fit the level 5 bus fleet in Zarqa with ETMs as a standalone exercise would cost about JD400,000 assuming a total of 332 buses. This cost would include software and back office equipment.	
Strategic Relevance	Intention to provide the Kingdom with an integrated national public transport system.	
Environmental Impacts	Encourages the use of public transport and thus reduces the number of trips undertaken by private car.	
Potential User Revenues	None anticipated.	
Project Readiness	Readiness of Authority	Wholly dependent on LTRC, although the Municipality can provide support..
	Project Readiness	Dependent on successful contract to equip buses throughout the Kingdom.
	Financing in Place	Yes – LTRC intend to let a contract.
Social	Employment Generation / Equal Opportunities	No specific employment opportunities other than increasing employment in the public transport industry.
	Social Impacts	Through providing improved accessibility, should benefit the local economy in Zarqa.
	Geographical Coverage	Improved accessibility and fare costs available for certain journeys on all bus services coming into Zarqa.
Monitoring Measures (KPIs)	• Additional trip generation must at least generate sufficient additional revenue to counteract any reduction in individual trip revenue • Achieve targets for fitting all buses with ETMs.	
Impact Assessment within Emissions Model	It is not possible to measure the impact of this project in isolation	

7.10 PROJECT 6: PUBLIC TRANSPORT INFRASTRUCTURE IMPROVEMENTS

7.10.1 Proposed Measures

- Provision of bus stops (shelters, lighting, seating, timetables) to eliminate the “hail and ride” culture that currently exists
- Provision of real-time timetable information at terminals and bus stops to improve trust and reliability of bus services

Further details regarding the project proposals are provided in Appendix H in Volume 2.

7.10.2 Project Need

The concept of a normal bus journey does need to be changed significantly, and this appears to be well understood by key players in the transport sector in Jordan. At present, the perception held by public transport users is that the only place to commence a bus journey is a recognised Bus Terminal. Bus Terminals are where buses wait to pick up passengers, and their departure times are often determined by the number of people presenting themselves at Bus Terminals to make a specific journey. The introduction of fixed timetables with intermediate timing points would enable formalised bus stops to be located throughout urban areas.

In turn, this will enable passengers to access bus stops far closer to where they live in order to board the bus service they require, with much of the uncertainty about the time when the bus will arrive removed.

7.10.3 How does the Project Meet the Study Objectives?

The purpose of many of our proposals concerning public transport is to create a step change in the public perception of the reliability and predictability of using bus services. Currently, there is a great emphasis on the importance of Bus Terminals, which are regarded as the locations where buses wait to pick up passengers, and their precise departure times are often determined by the number of people presenting themselves at Bus Terminals to make a specific journey. The introduction of fixed timetables would enable formalised bus stops to be located throughout the urban area of Zarqa.

Of course, local bus services do stop within the Downtown area of Zarqa at the moment, but such locations are entirely ‘ad hoc’, although usually known to regular bus users. However these locations have no signs or indications that they are bus stops, there are no timetables or other indications and they are often located at highway intersections, which can be dangerous for passengers. In addition, buses often cause obstruction to other traffic whilst setting down and picking up passengers, which exacerbates congestion in the Downtown area.

A combination of published timetables and physical bus stop location will enable passengers to access bus stops far closer to where they live in order to board the bus service they require, with much of the uncertainty about the time when the bus will arrive removed.

The introduction of a Real Time Passenger Transport Information (RTPI) system has a multitude of benefits in meeting the study objectives. These can be summarised as:

- The system identifies the location of all buses and enables operators to take remedial action in the event of unreliable running as a result of, for example, congestion;
- The anticipated arrival time of a bus at each bus stop can be predicted and displayed at the stop, which encourages usage through greater certainty;
- Information on bus times in real time can be provided via the internet or mobile phones,

It should be noted that LTRC hope to introduce this technology in the near future, and is in the process of assessing detailed proposals and costs at the time this report is being produced.

RTPI systems are well established throughout the world, and Case Study Box 9 below shows a typical, but technically very advanced, system installed in Helsinki, Finland, which utilises mobile telephony.

7.10.4 Supporting Measures

The success of this project is not particularly dependent on the implementation of any of the core projects, with the exception of core project 7, the institutional strengthening of Zarqa Municipality.

Significant relationships with other projects can be summarised as follows:

1	Integrate Land Use and Transport Planning Through New Bus Routes and Policy Changes	The provision of formal bus stops and the availability of timetable information are a significant factor in ensuring that bus services can serve new developments effectively.
2	Public Transport Services Improvements	The provision of formal bus stops and the availability of timetable information assist in optimising the benefits of improved bus services.
3	Improve Accessibility to the Proposed LRS Terminal	Bus stops and timetable information improve the ease of use and propensity to use public transport thus assisting inter-connectivity at major interchanges.
4	Public Transport Terminal Improvements	Bus stops and terminals form part of the hierarchy of movements between transport modes and are thus inter-dependent.
5	Public Transport Ticketing Changes	There is a direct relationship between through ticketing benefits and the provision of formal bus stops and timetable publicity.
8	Walking Infrastructure improvements	Pedestrian improvements assist in creating better accessibility to formal bus stops.
9	Install ITS Measures	Real time information enhances significantly the provision of public transport information to bus users.
12	Public Awareness Scheme	There is a direct relationship between public awareness schemes and the provision of public transport information.

Case Study Box 9: Helsinki Real Time Passenger Transport Information [21]

Helsinki's comprehensive approach to passenger information includes a door to door journey planner, a real time timetable service using mobile phone browsers, passenger information displays, the HELMI telematic system, wireless broadband on vehicles, a regional e-travel card and single ticket purchase via mobile phone.

During 2006/07 WSP Finland implemented *WSP Live!(*now renamed *Mattersoft Live!)* - an innovative public transport real-time pilot project for Helsinki City Transport (HKL) as part of HKL's HELMI 2 project. It provides:-

- Traffic light priorities for buses and trams
- Real-time display system for use both on vehicles, at terminals and at individual bus/tram stops
- Real time web and mobile services
- Wi-Fi availability for passengers in the vehicle

HKL's objective is to provide reliable and consistent information to both the operator and to the travelling public. The new system differs from the previous one in both the architecture and in the way it provides information to users. It tracks the position of each vehicle with high-accuracy GPS and high frequency mobile Internet connection. All the major logics and computing equipment are on the server side, which reduces the cost of on-board equipment.

By the end of 2008, 200 trams and buses had been upgraded with the new system. Passengers with a Wi-Fi capable laptop or mobile device can connect to the internet. In addition, the Helsinki implementation offers specific travel information for whichever vehicle the passenger is travelling on. Several methods are used to provide real-time information for passengers and all communications are based on open internet technologies, resulting in very cost-effective services. Retained data for individual journeys is available for browsing on a secure web interface and is also used by the stop time prediction algorithms to update the stop time forecasts.

7.10.5 Project Details

Public Transport Infrastructure Improvements		
Project Description	■ Identify suitable locations and construct bus stops/shelters throughout bus routes in the downtown area, using the criteria developed by the LTRC. ■ This process should be expanded into the urban areas of the Municipality as funding becomes available. ■ Ensure that up to date timetable information is displayed at all bus stops, following restructuring of bus services and the introduction of fixed timetables. ■ Equip buses with suitable tracking system in order to introduce Real Time Passenger Transport Information at terminals and bus stops.	
Area	Streets where bus routes operate in the downtown area.	
Phase	Short term	
Estimated Cost (JDs)	In the downtown area, there would be a requirement for 22 paired bus stops (that is, 44 stops in total) cost for this at JD2,800 per stop would be JD123,200. This includes shelter, stop and timetable. The provision of bus stops should also be extended to cover the whole area of the Municipality in due course. The cost of installing a Real Time Passenger Transport Information system is included in Project 9 below.	
Strategic Relevance	RTPI forms part of a nationwide initiative to make public transport services more reliable and predictable.	
Environmental Impacts	Encourages the use of public transport and thus reduces the number of trips undertaken by private car.	
Potential User Revenues	None anticipated, although the Municipality should explore the potential for advertising at bus stops and shelters to defray the costs.	
Project Readiness	Readiness of Authority	Able to implement bus stop and shelters programme, but wholly dependent on LTRC to introduce RTPI.
	Project Readiness	Essential to achieve partnership working with LTRC, bus operators and police to identify suitable bus stop locations. May also require local consultation.
	Financing in Place	No (LTRC hope to have finance for RTPI)
Social	Employment Generation / Equal Opportunities	No specific employment opportunities other than construction, and some specialist staffing to operate the RTPI system..
	Social Impacts	Through providing improved accessibility, should benefit the local economy in Zarqa.
	Geographical Coverage	Downtown area of Zarqa, including all bus terminals.
Monitoring Measures (KPIs)	• Number of bus stops required and adherence to a timetable for their construction. • Roll out of RTPI programme in accordance with agreed timetable.	
Impact Assessment within Emissions Model	It is not possible to measure the impact of this project in isolation	

7.11 PROJECT 7: NEW LOW-EMISSION VEHICLES

7.11.1 Proposed Measures

- Changes to the bus vehicle fleet to provide new low emission buses
- Benchmark and set appropriate fuel consumption goals by bus type

It was originally intended to investigate the potential to rationalise the operation of School Buses by analysing school bus routes and their utilisation to maximise the efficiency of the services and minimise the number of school bus vehicles in operation at any one time. However, it became apparent that, due to the relatively low number of private schools located in Zarqa, the school bus movement in the peak periods was not sufficiently large to warrant further investigation.

In terms of considering specifications for new buses, we consider that existing white taxis should be replaced over three years by hybrid cars, new services such as the bus routes designed for King Abdullah bin Abdul Aziz City and the Park and Ride/Shuttle bus system should be provided by new buses, preferably CNG powered if this is practicable, and that replacement buses purchased in future should either be CNG powered or to at least Euro 3 standard. We are, however, aware of the dichotomy that, whilst Euro 3 specified buses should reduce emissions, they are not necessarily more fuel efficient.

Further details regarding the project proposals are provided in Appendix I in Volume 2.

7.11.2 Project Need

The public transport vehicle fleet is ageing, with a majority of buses between 10 and 17 years old. In addition, such vehicles suffer from poor emission levels and contribute towards the overall poor air quality in the area. Investment needs to be made in order to ensure that the average age of the bus fleet is reduced over a period of time, and such investment needs to ensure that the vehicles selected for purchase are as energy efficient and have as low emissions as is practicable.

7.11.3 How does the Project Meet the Study Objectives?

A fundamental element of this report is to encourage the greater use of public transport. The main reasons for this may be summarised as:

- Public transport is a more energy efficient means of transporting people (provided that it is well used) – this is even more true if the emissions from individual buses can be reduced through changes to technical specification;
- Improved public transport provides better accessibility to education, health and work for those without access to a private car;
- Public transport has the potential to reduce overall emissions, if it can replace trips that would otherwise be made by private car.

We have described a number of proposals designed to make public transport services more attractive in the Zarqa Downtown area. Paradoxically, our proposals might well result in a smaller number of buses operating a higher overall mileage, as they are used in a much more efficient way. Consequently, this proposal considers how the use of low-emission buses might ensure that overall improvements to air quality in the Downtown area are achieved, as well as resulting in improved energy efficiency.

We have assumed that new buses purchased as part of these projects will be to Euro III specification, although it is appreciated that low or ultra-low sulphur diesel fuel is not yet available in Jordan. In broad terms, new buses to this specification should have a significant impact on emissions, but may not have much impact on fuel efficiency. This project is intended to enhance significantly fuel efficiency, and, in the absence of the ability to move to Euro V specification buses, CNG powered vehicles look like potentially the most practicable alternative. Case Study Box 10 below shows how CNG powered buses in Delhi, India have been deployed to achieve these objectives.

7.11.4 Supporting Measures

The success of this project is not particularly dependent on the implementation of any of the core projects.

Significant relationships with other projects can be summarised as follows:

2	Public Transport Services Improvements	The introduction of new buses with reduced emissions is dependent on a successful restructuring of bus operations.
8	Walking Infrastructure improvements	Walking is more attractive where successful efforts have been made to reduce the effects of emissions on air quality.
12	Public Awareness Scheme	Improvements to the quality of buses used on local services would be a useful component in public awareness schemes.

Case Study Box 10: CNG Buses, Delhi, India [22]

With rapid increase in vehicle kilometers driven and poor vehicles technology, there was growing concerns about the rising levels of air pollution in the national capital region (NCR) of India, which includes Delhi.

The Supreme Court of India involvement began in the 1980s when it is apparent that the responsible government had taken no appropriate action to combat air pollution. A time frame for measures to tackle air pollution to be taken was issued by the court in 1998.

By 2000, all pre-1990 cars and taxis to be replaced by clean fuelled vehicles. No buses to be more than eight years old except those using CNG or other clean fuels. A new interstate bus terminal will be built at the entry points to the north and southwest.

By 2001, all post-1990 cars and taxis will receive financial incentives for replacement to clean fuelled vehicles by 2001. City bus to be converted to single fuel mode on CNG.

In terms of fuel supply, Gas Authority of India Ltd. to expand its CNG dispensing capacity from 9 to 80 stations by 2001.

In terms of testing and maintenance, two independent fuel testing labs were established in 1999 and inspection and maintenance (I&M) facilities to be set up by transport department and private sector by 2001.

The conversion to CNG vehicles has results in a decrease of CO2, SO2 and CO. Between 2000 and 2008, CO2 emissions have reduced by 72% and SO2 levels have reduced by 57 %. PM and nitrogen dioxide levels have also shown a slight decrease.

While the CNG adaption has helped Delhi reduce pollutant concentrations, the following problems were encountered during the process:

- Delay in management decisions on infrastructure due to limited CNG allocation
- Uncertainty on demand for CNG
- Lack of indigenous technology
- Capital intensive to implement
- Infrastructural constraints

A proper plan is necessary for the implementation of such large scale conversion to ensure there is sufficient availability of alternative means of transport for all users and to minimise chaos on roads.

Alongside this, the government and associated organisation will need to fully support and promote the public transportation system with stringent standards enforced for non-CNG or fuelled clean vehicles.

7.11.5 Project Details

New Low-Emission Vehicles		
Project Description	■ To improve emission levels of buses by introducing new, improved specification vehicles ■ To replace the white taxi fleet over a three year period by hybrid vehicles ■ To introduce new buses for the proposed additional services in the KABAAC area and for the Park and Ride/shuttle bus system, either by utilising CNG powered buses or buses to Euro 3 specification ■ To instigate a fleet replacement programme for local urban bus services, associated with the restructuring of the local bus operating industry	
Area	No infrastructure implications.	
Phase	Short and medium term	
Estimated Cost (JDs)	Purchase of 60 hybrid white taxis over a three year period would be JD500,000 per annum. Whilst it is recommended that detailed investigation is made into the practicalities of purchasing new CNG powered buses, it is difficult to price this option without understanding the likely costs of importing buses, establishing CNG infrastructure and the cost of CNG to the operator compared to diesel fuel. As a very general rule, new CNG buses tend to cost around 20% more to purchase than equivalent diesel powered vehicles.	
Strategic Relevance	Closely linked to the availability and quality of fuels capable of use by buses.	
Environmental Impacts	Intended to improve emissions across the bus operating fleet, partially counteracting the improved utilisation of buses.	
Potential User Revenues	Assuming a seven year life, the leasing of white taxis would produce revenue at JD72,000 in the first year, rising to JD144,000 in the second year and JD216,000 per annum thereafter.	
Project Readiness	Readiness of Authority	Able to contribute to a partnership with LTRC and the operators, but will project must be led by LTRC..
	Project Readiness	Essential to achieve partnership working with LTRC and bus operators to undertake structural change to bus operations and successful negotiations with service providers, together with research into most cost effective vehicle specifications and availability.
	Financing in Place	No
Social	Employment Generation / Equal Opportunities	No significant, immediate impact likely.
	Social Impacts	Improved air quality likely to have significant health benefits
	Geographical Coverage	Downtown area of Zarqa, together with the whole urban area of the City.
Monitoring Measures (KPIs)	• Use of spreadsheet model to demonstrate impacts of planned changes, using targets and timescales • Calculation of targets for fuel consumption improvements for different sizes and types of bus	
Impact Assessment within Emissions Model	The impact of this project can be modelled by calculating the emission factors for new low-emission vehicles in the IVE model	

7.12 TRAVEL DEMAND MANAGEMENT PROJECTS

7.12.1 Introduction

Five of the proposed projects comprise Travel Demand Management (TDM) measures which are designed to manage the demand for travel, predominantly acting to discourage travel by private vehicles and thus enhancing the appeal of sustainable travel.

7.12.2 Current Problems with Travel Demand Management in Zarqa

Travel demand management measures to discourage use of the private car and promote sustainable travel are limited in Zarqa, with existing congestion being the main deterrent to road based travel. Many opportunities exist to enhance the appeal of public transport and walking/cycling for residents of the city, however funding and lack of support from the public threaten the success of changing travel behaviour.

7.12.3 Study Objectives Context

The implementation of TDM measures are intended to assist the main study objectives through:

- Encouraging the use of public transport;
- Increasing accessibility for pedestrians and cyclists;
- Deterring private vehicles from travelling to downtown Zarqa;
- Improving the flow of traffic through downtown Zarqa; and
- Making the highway network safer for pedestrians and motorists.

7.13 PROJECT 8: WALKING INFRASTRUCTURE IMPROVEMENTS

7.13.1 Proposed Measures

- Footway Audit to identify areas of missing footway and damaged or obstructed footway in need of maintenance;
- Provision of continuous footways where there are currently missing sections within downtown Zarqa and along routes to bus stations;
- Provision of pedestrian footbridges across Al Jaish Street to link downtown Zarqa with King Abdullah bus station and KABAAC to the east of Zarqa;
- Provision of pedestrian footbridges across King Talal Street to link downtown Zarqa with Prince Rashid bus station;
- Provision of signalised at-grade pedestrian crossings in downtown Zarqa; and
- Installation of directional and information signage for pedestrians to aid navigability with emphasis on links to Public Transport.

Further details regarding the project proposals are provided in Appendix J in Volume 2.

7.13.2 Project Need

Pedestrian safety is a significant issue in Zarqa. The regular occurrence of pedestrians walking within the carriageway and crossing amidst moving traffic both inhibits the flow of vehicles adding to congestion, and also results in accidents which deter people from choosing to walk to their destinations through fear of their safety. Accident records indicate that 82% of pedestrian fatalities occur due to pedestrians walking within the road.

7.13.3 How does the Project Meet the Study Objectives?

The proposal to encourage more people to walk needs to focus on improving pedestrian facilities such as clear, well maintained footways, and pedestrian crossings to facilitate safer movement across the downtown district. Furthermore, through the creation of a safe walking environment, with particular focus on improving pedestrian desire lines to the bus stations, the accessibility of public transport terminals would also be improved. Successful implementation of this measure will result in an increase in walking trips, subsequently reducing many of the shorter distance vehicle trips, thereby also assisting a reduction in downtown GHG emissions. The example of Makati City in the Philippines in Box 11 below demonstrates that through a large-scale program of pedestrian improvements in a commercial district, it is possible to dramatically increase the number of pedestrians and the average walking distance.

Further evidence exists of the success of walking schemes, such as in Wanstead, London, where renewal of street facilities including repaving and new crossing facilities enhanced accessibility and resulted in pedestrian numbers using the area during the day increase by 75%, and increasing during the night by 122% [(23)].

7.13.4 Supporting Measures

Significant relationships with other projects can be summarised as follows:

3	Improve Accessibility to the Proposed LRS Terminal	Accessibility to the proposed LRS system should also be improved for pedestrians and cyclists
4	Public Transport Terminal Improvements	Public Transport Terminals need to provide good access for pedestrians
6	Public Transport Infrastructure Improvements	The new public transport infrastructure such as bus stops will need good quality footways linking them to surrounding areas
9	Install ITS Measures	The installation of traffic signals at junctions provides the opportunity to accommodate safe pedestrian crossing facilities integrated with the signals
11	Parking	Expansion of parking restrictions along with stricter enforcement will improve visibility for pedestrians crossing roads
12	Public Awareness Scheme	The travel awareness scheme will assist promotion of walking as a safe, healthy and free mode of transport

Case Study Box 11: CBD Pedestrian Friendly Streets, Makati City, Manila, Philippines [24]

Ayala Avenue serves as the main artery of the Makati Central Business District. Following the economic boom in the 70's and 80's the commercial district became congested with traffic, and the air became more polluted, in part due to construction growth and unfriendly streets.

Underpasses and elevated walkways were constructed, including at-grade covered walks. Street-planting was enhanced, and sidewalk pavings were repaired and restored. The idea was to provide connected covered walks along areas where pedestrians often passed.

Surveys indicated that the walkway improvements increased pedestrian movements by 200,000 on a typical weekday, and reduced pedestrian travel time by 7-10 minutes. Furthermore, the travel distance on foot covered by pedestrians increased from 400 metres to 700 metres.

Lessons learned include:

- Provide midway pedestrian alleys if the block is more than 250 meters
- Build more accessible passageways like under and overpasses (with escalators and covers)
- Build more covered walks or plant more shade trees, if possible, to provide pedestrian comfort and relief from harsh tropical climate
- Implement strong measures to force the utility providers to use a common pole to reduce sidewalk clutter.
- Instigate the policy regarding uniformity in sidewalk level
- Widen sidewalk with a minimum clearance of 1.20 m. In some cases, sidewalk widening can be done through apportioning part of the road allotted to parking.
- Parking can be concentrated in a designated parking building. In extreme instances, road closure can be imposed and totally pedestrianized.
- Apply shared street principle in very narrow sidewalk and street. Bollards can be used to protect pedestrian from vehicular flow.
- Impose rule on design coherence and uniformity. Enforce unified theme for street furniture like lighting, paving, benches, street signage, bollards, kiosks, trees, etc.
- Apply environment-friendly resources, like porous materials for paving to revive the aquifers and shade trees to help purify the air.
- Enforce traffic rules strictly not only for erring drivers but also for the straying pedestrians
- Have a good program of maintenance

The project requires minimal on-going costs required for maintenance

7.13.5 Project Details

Walking Infrastructure Improvements		
Project Description	▪ Footway Audit to identify areas of missing footway and damaged or obstructed footway in need of maintenance; ▪ Provision of continuous footways where there are currently missing sections within downtown Zarqa and along routes to bus stations; ▪ Provision of pedestrian footbridges across Al Jaish Street (the Amman – Zarqa corridor) to link downtown Zarqa with King Abdullah bus station and KABAAC to the east of Zarqa; ▪ Provision of pedestrian footbridges across King Talal Street to link downtown Zarqa with Prince Rashid bus station; ▪ Provision of signalised at-grade pedestrian crossings in downtown Zarqa; and ▪ Installation of directional signage for pedestrians to aid navigability.	
Area	Downtown Zarqa, and connections through to Public Transport terminals	
Phase	Short Term Implementation	
Estimated Cost (JDs)	52JD per metre of new footway. Length of footway required is unknown – estimate 2km = JD112,000 30,000 JD per footbridge = JD60,000 + assume JD15,000 to complete existing footbridge = JD75,000 13,000 JD cost per at-grade crossing. Approximately 50 crossings = JD65,000 200 JD Signage (per sign) = JD3,500 TOTAL estimated to be = JD250,000	
Strategic Relevance	Improved pedestrian infrastructure and pedestrian facilities will enhance accessibility to local bus terminals, thus facilitating wider uptake of public transport. Therefore this measure not only improves conditions in the immediate vicinity of downtown Zarqa, but also will assist with the update of sustainable travel between Zarqa and external destinations.	
Environmental Impacts	Modal shift towards walking will predominantly reduce short distance vehicle trips, in particular those that are internal to downtown Zarqa. The project will therefore have a positive impact on the environment through modal shift.	
Potential User Revenues	This project will not generate any revenue directly. However, increasing the accessibility of public transport by walking will encourage travel by bus, and therefore may lead to increases in ticket sales for other modes of transport.	
Project Readiness	Readiness of Authority	Zarqa Municipality recognise that pedestrians are a problem and are in support of measures to improve facilities. However, ZM are not in favour of cycling improvements due to impracticality.
	Project Readiness	The project can be implemented without significant difficulty
	Financing in Place	No
Social	Employment Generation / Equal Opportunities	This project will not directly facilitate generation of employment in the region. However, through making the streets safer for pedestrians it may encourage more women to walk in the city.
	Social Impacts	Improved pedestrian facilities helps to create a sense of public realm, with a more pleasant walking environment. This can lead to increased levels of street activity.
	Geographical Coverage	The extent of improvements will be limited to downtown Zarqa, including the ring road and links to bus terminals
Monitoring Measures (KPIs)	Accident Records: Road Accidents are already recorded in Zarqa. The incidence of accidents involving pedestrians, in particular the number of pedestrian fatalities occurring as a result of crossing carriageways or walking along highways will need to be monitored. A reduction in pedestrian related accidents would suggest that the improved walking infrastructure is working effectively at improving pedestrian safety. Pedestrian Trips: A pedestrian survey should be undertaken prior to implementation of the improvements to establish the existing level of pedestrian activity in downtown Zarqa. The survey could comprise 12 hour pedestrian counts on key corridors through the district. Repeated surveys further to the improvements would indicate if the number of pedestrian trips has increased as a result of safer crossings and improved facilities.	
Impact Assessment within Emissions Model	An estimate can be made for the likely increase in walking, and the subsequent reduction in private vehicle travel demand, that would result from improvements to walking infrastructure. The impact of the estimated increase in walking trips can be modelled	

7.14 PROJECT 9: INSTALLATION OF ITS MEASURES

7.14.1 Proposed Measures

- Replacement of existing traffic signals with modern LED signals;
- Conversion of key priority junctions on the ring road surrounding downtown Zarqa and within the district to traffic signals; and
- Coordination of signals by a traffic adaptive central Urban Traffic Control (UTC) system.

Further details regarding the project proposals are provided in Appendix K in Volume 2.

7.14.2 Project Need

The Downtown Area of Zarqa effectively comprises a grid network of roads and streets with many cross-roads and junctions including several roundabouts. There are currently some major traffic intersections where the Zarqa-Amman corridor meets the Zarqa Downtown district, and furthermore there are many junctions within the downtown area serving a high demand of traffic.

However, traffic signals in Zarqa are widely spaced and it appears that there is no method of coordination between signalised intersections in operation to optimise traffic movements on the main corridor and the Downtown area. The Area coordination of signals requires distance between signalised junctions or signalised pedestrian crossings to be ideally no greater than 500m to move traffic in discrete platoons of vehicles. Where links between signalised intersections increase beyond 500m then platoons are dispersed and area coordination becomes less efficient. Also there appears to be significant uncontrolled intersections between those which are currently signal controlled. These act as sinks and sources for traffic on links between controlled intersections and would have to be taken into consideration when designing any area signal coordination solution for the Downtown area.

7.14.3 How does the Project Meet the Study Objectives?

Ultimately this project will assist with smoothing traffic flows on the peripheral roads surrounding downtown Zarqa, helping to ease congestion and reduce journey times for vehicles and at the same time support public transport. The example of Portland USA in Box 12 below where optimisation of traffic signals was carried out demonstrates that significant savings in gasoline consumption and CO_2 emissions can be made. Co-ordination of the traffic signal network in downtown Zarqa will help achieve similar savings.

Furthermore, the installation of traffic signals at junctions will increase safety at the main intersections for both vehicles and pedestrians crossing the road.

7.14.4 Supporting Measures

Significant relationships with other projects can be summarised as follows:

2	Public Transport Services Improvements	ITS offers the potential to introduce SVD for bus priority
9	Junction and Highway Improvements	The provision of clearer lanes on the main highway corridors will work in conjunction with optimised traffic signal operations to encourage smoother traffic flows

Case Study Box 12: Optimising Traffic Signal Timing, Portland, USA [25]

The Portland metropolitan region has made a firm commitment to implement traffic management to increase efficiency on local streets and freeways. Between 1988 and 1997, the Traffic Bureau has optimized street signal systems on approximately 22 arterials, for 225 intersections in Portland.

The City plans to continue to optimize signals in the future to meet changing traffic demands. Since 2004, the City of Portland has improved signal timings at 135 intersections on 16 streets.

A computer software program called Trafficware Syncro Studio was used to carry out traffic signal optimization. The process of traffic signal optimization involve changing of timing parameters relative to the length of the green light for each traffic movement and the timed relationship between signalized intersections.

With traffic patterns changing throughout the day and week, the signal timing parameters were modified to reflect the needs of these unique traffic patterns. Collection of traffic volumes throughout the day is required.

Optimizing traffic signal timing allows idling and the acceleration of vehicles to be reduced and therefore leads to less fuel being burned and less carbon dioxide emissions.

The cost of the project was $533,000 USD, funded by the Climate Trust of Oregon.

This project has resulted in a saving of over 1,750,000 gallons of gas each year. This equates to a reduction in gasoline consumption of 15,460 tons of CO_2 based on a conversion factor of 8.8 metric tons of CO_2 saved per 1,000 gallon of gasoline not consumed. In terms of financial saving, this equates to $4.13 million dollars per year to consumers.

7.14.5 Project Details

Install ITS Measures		
Project Description	▪ Replacement of existing traffic signals with modern LED signals; ▪ Conversion of key junctions on the ring road surrounding downtown Zarqa and within the district to traffic signals; and ▪ Coordination of signals by a traffic adaptive central Urban Traffic Control (UTC) system.	
Area	Downtown Zarqa	
Phase	Short Term	
Estimated Cost (JDs)	Approximately JD60,000 per junction (JD45,000 for Electrical + JD15,000 Civils). For 15 new traffic signal junctions this equates to JD900k Set up of an Urban Traffic Control Centre JD1.0M UTC system (not including the actual building of a Control Centre) SVD facilities for bus services JD500 per local SVD installation. But could be part of a centralised bus tracking system linked to UTC item above. Initial budget assume JD200k Total cost approximately JD2.1m	
Strategic Relevance	The implementation of traffic signals around the downtown Zarqa ring road will assist with developing a wider linked signal operation across the city, in particular on the Zarqa – Amman highway corridor. Furthermore, the scheme can be expanded to include bus priority measures to assist public transport accessibility from Zarqa to external destinations.	
Environmental Impacts	The smoothing of traffic flows will have a positive impact on air quality.	
Potential User Revenues	This project will not generate any revenue.	
Project Readiness	Readiness of Authority	Traffic Study Analysis Required first
	Project Readiness	The project will require pre-planning work in the form of traffic signal design and modelling prior to implementation
	Financing in Place	No
Social	Employment Generation / Equal Opportunities	The project will generate employment for operators of the Urban Traffic Control Centre, as well as maintenance staff and construction workers
	Social Impacts	Pedestrians will benefit from new crossings incorporated in the junctions, and highway safety will be improved for all users
	Geographical Coverage	Predominantly downtown Zarqa, however it is recommended that wider signal installation is considered.
Monitoring Measures (KPIs)	Travel Times: The results of journey time surveys will indicate if congestion is easing on key corridors around Zarqa downtown as a result of the traffic signal implementation and optimisation. Furthermore, public transport journey times will also indicate any improvements in journey time as a result of the project Accident Rates: Highway accidents are already recorded in Zarqa. The number of accidents recorded in future can be compared with current records to assess change in junction safety resulting from the project. Air Quality: Air quality monitoring results can be used to ascertain if ITS measures in combination with other projects are improving air quality across the city.	
Impact Assessment within Emissions Model	ITS measures have been demonstrated to facilitate an increase in vehicle speeds (10-15%). The emission factors can therefore be amended to account for this effect.	

7.15 PROJECT 10: JUNCTION AND HIGHWAY IMPROVEMENTS

7.15.1 Proposed Measures

- Provision of high quality road markings on all junctions on the downtown ring road and major intersections within downtown Zarqa;
- Provision of lane markings on downtown ring road and on major roads through the downtown district;
- Clearance of any unnecessary street clutter obstructing visibility at junctions;
- Introduction of parking restrictions around junction bellmouths to ensure clear manoeuvres into and out of side roads can be made, and to ensure that good visibility is achieved.

Further details regarding the project proposals are provided in Appendix L.

7.15.2 Project Need

All junctions in downtown Zarqa, including those which are signal controlled, are lacking in road markings to provide clarity over which arms have priority. The lack of structure at highway junctions leads to conflict, and slows down the flow of traffic through the junctions. Furthermore, there is evidence of parking at junctions, which not only restricts visibility for vehicles, but also constrains the carriageway width and inhibits turning manoeuvres.

Street markings are no clearer away from junctions, where wide carriageways on the peripheral roads of downtown Zarqa have no markings to distinguish between lanes, thereby creating mixed formations of vehicles as opposed to clear lanes of traffic. Smaller streets would benefit from centre-line road markings to segregate conflicting traffic movements on two-way routes.

7.15.3 How does the Project Meet the Study Objectives?

The proposals aim to smooth the flow of vehicles on links by providing high-quality lane markings, and facilitate safer, more organised movements at junctions by clearly directing vehicles with priority markings and stop lines. Clearance of street clutter in visibility splays will also make junctions safer, with vehicles having an enhanced view of any oncoming vehicles or crossing pedestrians before pulling out on to main roads or turning into side roads.

In order for this project to be successful it is essential that road markings are created with a high-quality paint to withstand the wear and tear and climate conditions. Junction improvements have been shown to provide benefits in road safety elsewhere, such as in the Denmark case study presented in Box 13 below where junction improvements were made as part of a wider safety initiative.

7.15.4 Supporting Measures

Significant relationships with other projects can be summarised as follows:

1	Integration of land use / transport planning	Improved highways and junctions will facilitate links with the KABAAC development and assist with enabling new bus services
2	Public Transport Services Improvements	The bus services will benefit from improved road conditions and junctions
8	Walking Infrastructure Improvements	Consideration of pedestrians at improved junctions to provide layouts that accommodate all users will be essential
9	Install ITS Measures	ITS measures will be supported by the improved junction and highway quality
11	Parking	Improvements to junctions will be enhanced by stricter parking restrictions around bellmouths to increase visibility for drivers and pedestrians

Case Study Box 13: Every Accident is one too many, Denmark [26]

The vision of the Denmark's road safety strategy (2001-2012) is "Every Accident is One too Many". The vision sets a course towards a future road system without any road crashes and retains a focus on preventive measures. Approximately 85% of all road accidents in Denmark involve one or more of the four elements: speeding, alcohol, cyclists, and/or junctions.
The accident risk in urban areas is three times higher in urban areas than on main roads (motorways) and primary rural roads. To address speed in urban area, the following measures were undertaken:

- local speed plans
- categorization of urban roads by function i.e. urban thoroughfares, local roads, residential areas, industrial roads, school roads, etc.
- speed differentiation where motorized and non-motorized traffic have to share their space
- speed restrictions and traffic calming by infrastructural means for example, speed bumps, roundabouts and bottlenecks

Specific measures for implementation at junctions include:

- roundabouts instead of junctions
- speed reductions at junctions
- stop signs
- better traffic lights and traffic light control (longer pauses, better timing)
- black-spot treatment
- Improved road lighting

The number of people injured and killed in road traffic accident in 2009 is approximately 300 persons, in comparison to 430 in 2001.
The success of the project is due the overall approach to road safety and how the authorities manage it.

7.15.5 Project Details

Junction and Highway Improvements		
Project Description	▪ Provision of high quality road markings on all junctions on the downtown ring road and major intersections within downtown Zarqa; ▪ Provision of lane markings on downtown ring road and on major roads through the downtown district; ▪ Clearance of any unnecessary street clutter obstructing visibility at junctions; ▪ Introduction of parking restrictions around junction bellmouths to ensure clear manoeuvres into and out of side roads can be made, and to ensure that good visibility is achieved.	
Area	Downtown Zarqa	
Phase	Short Term	
Estimated Cost (JDs)	Treatment of main roads to get lane markings/centre lines = approx. JD100k Approx. 30 Junctions identified to be improved – JD60k per junction = JD1,800k Total cost = approx. JD2,000,000	
Strategic Relevance	If the scheme proves successful it could be expanded to wider area and along main highway corridors	
Environmental Impacts	The project will not have any direct environmental impacts.	
Potential User Revenues	The project will not generate any revenue	
Project Readiness	Readiness of Authority	No – preparation in planning design and junction counts required
	Project Readiness	The project will require the sourcing of high quality paint for road markings and preliminary design work before implementation
	Financing in Place	No
Social	Employment Generation / Equal Opportunities	The project will not directly generate employment, however it is recommended that maintenance teams are employed to keep the higher standards of carriageways and junctions
	Social Impacts	Adherence to proposed road markings is questionable – achieving social acceptance of the proposals may be a challenge
	Geographical Coverage	Downtown Zarqa
Monitoring Measures (KPIs)	Travel Times: The results of journey time surveys will indicate if travel through Zarqa downtown is improved due to clearer lanes and improved visibility at junctions. Accident Rates: Highway accidents are already recorded in Zarqa. The number of accidents recorded in future can be compared with baseline records to assess any improvements in junction safety resulting from the project.	
Impact Assessment within Emissions Model	The proposed improvements support other projects and it is therefore not modelled in isolation	

7.16 PROJECT 11: PARKING

7.16.1 Proposed Measures

- Expansion of existing Autopark car parking restriction scheme;
- Improvements to existing Autopark restrictions including high quality road markings, new parking meter machines, and clear signage informing drivers of the restrictions;
- Enforcement patrol team to ensure compliance with parking restrictions;
- Creation of a multi-storey car park to re-provide parking lost through on-street restrictions; and
- Park and Ride facilities.

Further details regarding the project proposals are provided in Appendix M of Volume 2. It should be noted that the precise geographic area for expanding the Autopark system would need to be the subject of detailed technical analysis, including consideration of the suitability of applying a Controlled Parking Zone (CPZ) to the area, in order to safeguard parking for local residents.

Further details regarding the project proposals are provided in Appendix M in Volume 2.

7.16.2 Project Need

In summary, the main areas of concern regarding parking conditions in Zarqa are as follows:

- Indiscriminate and careless parking across downtown Zarqa;
- Poor visibility of existing parking restrictions, i.e. road markings and payment machines / signage;
- Lack of enforcement of existing parking restrictions; and
- Behavioural acceptance of parking restrictions.

Currently there are limited formal parking facilities in Zarqa. Within the downtown area there are no dedicated public car parks therefore almost all parking takes place on-street. A parking scheme known as AutoPark was introduced in part of the district, operating a pay and display scheme. However, enforcement is not strict, and there is a lack of road markings to inform drivers of the restrictions. Elsewhere parking takes place indiscriminately, around junctions and blocking narrow streets. This uncontrolled parking behaviour adds significantly to congestion in the area.

7.16.3 How does the Project Meet the Study Objectives?

Reform of the car parking arrangements in downtown Zarqa will assist with the study objectives in two ways. Firstly, the expansion of Autopark along with stricter enforcement of the scheme will act to discourage drivers from entering the downtown area in the knowledge that they will have to pay to park in the main part of the district. In particular, this deters short-distance trips internal to downtown Zarqa where the alternative of walking is viable. Displaced parking can be accommodated in a new multi-storey car park designed to re-provide lost parking spaces and remove the clutter of parked vehicles from the narrow carriageways, together with the proposed Park and Ride sites described in Project 3.

A case study of Bucharest in Box 14 below shows that public transport use increased, vehicle use in the central area was successfully restricted, and there were small reductions in the congestion experienced as a result of parking reform.

In addition to discouraging vehicle trips from terminating in the heart of downtown Zarqa, formalising the parking restrictions will help to create clearer streets by minimising the careless parking that takes place and restricts carriageway width and junction visibility. This will therefore facilitate smoother traffic flows through the narrow streets in downtown Zarqa.

7.16.4 Supporting Measures

Significant relationships with other projects can be summarised as follows:

1	Integration of land use / transport planning	Parking policy will form part of key changes to transport planning procedures
3	Improve accessibility to proposed LRS terminal	A holistic on-street and off-street parking policy and strategy are essential for the Park and Ride bus service to be successful. Furthermore, the introduction of parking costs will act as a deterrent to private vehicle travel. It is therefore essential to provide high quality sustainable alternatives to private vehicle travel in the form of bus services
10	Junction and Highway Improvements	Improvements to junctions will be enhanced by stricter parking restrictions around bellmouths to increase visibility for drivers and pedestrians
12	Public Awareness Scheme	Engage with people to explain the benefits of a more structured parking policy and the advantages of Park and Ride and improved bus services.

Case Study Box 14: TELLUS Parking Scheme, Bucharest, Romania [27]

Since the 1990s, Bucharest has been confronted with an increasing number of private cars. This combine with the lack of off street parking facilities and the inadequate implementation of traffic policies, the city centre area faces congestion and subsequently increasing travel time and traffic related pollution.

The project aims to reduce congestion, especially in the historical area of the city, and promote the use of public transport (PT) by providing adequate parking provisions but at the same time restrict on-street parking.

The project has four demonstration measures:

- Parking restrictions in central area;
- PT Fleet management by GPS;
- Modernizing the ticketing and payment system of the PT; and
- Clean & silent PT fleet.

A parking house within a capacity of 1000 cars was constructed during the project. It integrates commercial spaces and links with public transport and points of interest in the area, like the historical area of the city centre. Furthermore parking information system was implemented to provide details about available parking spaces.

Air quality (CO emissions) measurements were carried out in the vicinity of the new parking facility between years 2000 and 2005. Despite the increasing number of cars, CO concentration reduces during the 5 years. This is a generally a result of reduced vehicle age and improved car efficiency. The results suggested that car parking facilities alone do not produce results.

The following table illustrates the project's achievements:

Timescale	Objective	Achievement
Immediate	Improving traffic fluency	Partially achieved
	Restricting the vehicle use in central area	Achieved
	Remodelling the PT network	Not achieved
intermediate	Designing other parking facilities	Achieved
	Reduce congestion by 5%	Partially achieved
	Increase PT use with 5%	Achieved

In order to assure the success of large scale parking restriction and construction project, the following should be considered:

- Obtain political support and ensure the projects will be sustained in case of political changes;
- Effective communication between all parties involved;
- Assign enough time for user awareness campaign before project implementation;
- Ensure integration with public transport service in order to maximize the benefits. Note that a rapid introduction of parking restriction without providing sufficient substitution may result in traffic disorder.
- New facilities for public transport may be required; in order to hinder the perception of reduced mobility by the general public.

Public - Private Partnership (PPP) was founded to be a viable alternative for financing and implementing urban development projects.

7.16.6 Project Details

Parking		
Project Description	■ Expansion of existing Autopark car parking restriction scheme; ■ Improvements to existing Autopark restrictions including high quality road markings, new parking meter machines, and clear signage informing drivers of the restrictions; ■ Enforcement patrol team to ensure compliance with parking restrictions; ■ Creation of a multi-storey car park to re-provide parking lost through on-street restrictions; and ■ Park and Ride facilities.	
Area	Downtown Zarqa	
Phase	Short Term	
Estimated Cost (JDs)	Modernise Existing AutoPark = JD100,000 Expand Existing AutoPark = JD200,000 Multi-Storey Car Park approximately JD4.2m Plus Staff Enforcement Costs JD90k per year = JD800k up to 2020 Total JD5.3m	
Strategic Relevance	The implementation of parking restrictions in downtown Zarqa will have wider influence in the city, potentially shifting parking to the outskirts of the district.	
Environmental Impacts	Parking restrictions will most likely reduce the vehicular demand for travel in to downtown Zarqa, thereby reducing the environmental impact of traffic in this zone.	
Potential User Revenues	This project represents a good opportunity to generate revenue for funding of other measures. Generation of revenue will however be dependent on effective enforcement of the parking restrictions to ensure that drivers purchase parking tickets, and those that don't are fined.	
Project Readiness	Readiness of Authority	Zarqa Municipality can expand existing system
	Project Readiness	AutoPark is already set up and ready to be expanded and improved
	Financing in Place	To be agreed between Zarqa Municipality and AutoPark
Social	Employment Generation / Equal Opportunities	This project will generate employment in the form of an enforcement team within the traffic police sector.
	Social Impacts	The introduction of additional and stricter parking restrictions is likely to be unpopular and therefore will encounter significant objections from local people. The social acceptability of this project will present a challenge due to the current culture of free parking at all times.
	Geographical Coverage	The parking restrictions are proposed in part of downtown Zarqa, however measures will be wider than this such as multi-storey car parks.
Monitoring Measures (KPIs)	Parking Revenue: The revenue generated from parking will indicate the success of enforcement Journey Times: the travel times from journey time surveys should improve due to less congested streets from formalised on-street parking and relocation of some parking to multi-storey car parks Traffic Surveys: Successful parking restrictions will deter vehicles from entering downtown Zarqa. The traffic surveys will therefore reveal if traffic volumes in downtown Zarqa are reducing accordingly.	
Impact Assessment within Emissions Model	The introduction of parking restrictions can be modelled by assuming a small reduction in private vehicle trip demand	

7.17 PROJECT 12: PUBLIC AWARENESS SCHEME

7.17.1 Proposed Measures

Further details regarding the project proposals are provided in Appendix N of Volume 2.

7.17.2 Project Need

Public awareness campaigns are the way in which transport improvements and opportunities are brought to the attention of the public. In order to maximise their benefit potential, it is important to ensure that people have an opportunity to appreciate the new alternatives available to them. However, in addition to that, a public awareness scheme seeks to 'educate' people about the wider implications of travel choices, and their impacts on health, family and society.

7.17.3 How does the Project Meet the Study Objectives?

Effective public awareness schemes optimise the effectiveness of the measures delivered within the various other projects. They also have the aim of engaging with citizens to achieve 'buy in' and support for what can be difficult decisions to make.

For example, there have been European campaigns, such as 'TravelWise' and 'In Town Without My Car', which use a wide range of media and professional marketing techniques to make the general public aware of their transport choices. A more specific example of this at a more local level is the MIDAS campaign described in Case Study Box 15 below, where 9 partners in six EU countries endeavoured to demonstrate the benefits of using less energy intensive forms of transport, and measured the impact of the campaign by undertaking before and after mode share surveys.

Supporting Measures

The success of this project is not particularly dependent on the implementation of any of the core projects, with the exception of core project 7, the institutional strengthening of Zarqa Municipality.

1	Integrate Land Use and Transport Planning Through New Bus Routes and Policy Changes	Explain to public how transport needs for new development will be determined in future and offer the opportunity to be involved in consultation. Ability to explain to residents of KABAAC about new travel opportunities
2	Public Transport Services Improvements	Ability to spread the message about the new services and the introduction of fixed timetables etc.
3	Improve Accessibility to the Proposed LRS Terminal	Major opportunity exists to use travel awareness to promote the BRT and shuttle bus concepts.
4	Public Transport Terminal Improvements	Use to publicise improvements.
5	Public Transport Ticketing Changes	Use to show new 'value for money' travel opportunities.
6	Public Transport Infrastructure Improvements	Explain to people about the location and benefits of bus stops and shelters.
7	New Low-Emission Vehicles	Ability to explain the problems associated with poor air quality and the improvements possible with low emission buses.
8	Walking Infrastructure improvements	Communicate the improved environment for walking
9	Install ITS Measures	Explain benefits of RTPI
11	Parking	Engage with people to explain the benefits of a more structured parking policy and the advantages of Park and Ride and improved bus services.

Case Study Box 15: Measures to Influence Transport Demand to Achieve Sustainability, 6 European Cities [28]

Measures to Influence transport Demand to Achieve Sustainability (MIDAS) is made up of a consortium of 9 partners within six EU countries with Liverpool (UK), Aalborg (DK), Cork (IRL), Clermont Ferrand (FR), Bologna (IT) and Suceava (RO) being case study cities

The objective was to encourage a transfer to less energy intense modes of transport by optimising the use of soft measures aimed at reducing demand for private motorised transport.

The approach taken was:

- Awareness and Education including school travel awareness workshop and cycle training
- Participation & Consultation and Information & Advice including direct marketing or individualised marketing, communication tools such as website, public information exhibitions, promotional activities and marketing and awareness campaigns for different mode or transport and urban travel plan.
- Planning and Coordination including travel plan and working with developer.

The project cost 2.2 Million Euro

Impact on modal share:

Bologna: 1% increase in people using public transport, 40% increase for bike hire service

Cork: 11% increase for trains and 8% for bus, 9% of people increased their walking

Liverpool: 32% said they were cycling more in Liverpool

Suceava: 3% decrease in respondents who said that they are using their car daily to go to work, furthermore those who use a car only when essential increased from 18% to 28%.

Impact on energy consumption and emissions

In Aalborg and Bologna, energy consumption decreased by 2,260 and 545 GJ/year respectively. In Clermont-Ferrand, a 10% reduction in energy consumption is estimated for 2025.

In terms of savings in emissions, a reduction of 323 Mg in CO_2 and -447kg of NOx in Bologna (Whole City). In Clermont-Ferrand by 2025, an 8% reduction in CO_2 and a 74% reduction in NOx and CH_4 (mainly due to clean vehicles).

- Soft measures alone are not enough; an excellent promotional campaign will only have limited effect if the transport service whose use is being encouraged is of poor quality.
- Barriers can be overcome by effective consultation allowing stakeholders to work together to identify solutions and to design information and marketing campaigns. To assist citizens in changing their travel habits it is important to involve them directly in the design and implementation of soft measures.
- Soft measures are effective in raising awareness of the benefits of energy efficient modes of travel, and in achieving a level of modal transfer. In order to maximise effectiveness, a sustained awareness campaign is required over the longer term and it is important to target young people, who have yet to become habitual car users.

7.17.4 Project Details

Public Awareness Scheme		
Project Description	▪ Design and implement a Public Travel Awareness Campaign. ▪ Ensure that the campaign is correctly timed in conjunction with the implementation of key elements of the various projects, e.g. bus service improvements, parking provision, Park and Ride and shuttle bus and BRT. ▪ Ensure that the campaign addresses the need to engage with stakeholders and residents and includes explanations regarding the impacts on air quality and congestion of continued increase in the use of the private car.	
Area	Does not involve any physical construction.	
Phase	Short to medium term – throughout project delivery at appropriate times.	
Estimated Cost (JDs)	Spend is estimated at 300,000 over a six year period to cover professional design, advertising, promotion and events.	
Strategic Relevance	May be considered as a pilot project which could be rolled out to other cities in Jordan.	
Environmental Impacts	No direct environmental impact, but could result in further mode shift to more sustainable transport and improvements in air quality.	
Potential User Revenues	None anticipated.	
Project Readiness	Readiness of Authority	Able to lead a partnership with LTRC and the operators, but will need skills enhancement in the short term.
	Project Readiness	Essential to time project to emphasise benefits of delivered projects.
	Financing in Place	No.
Social	Employment Generation / Equal Opportunities	Limited.
	Social Impacts	Intended to change travel behaviour, which would result in improved health.
	Geographical Coverage	Applicable to whole Zarqa Municipality area and surrounding districts.
Monitoring Measures (KPIs)	Impossible to differentiate between impacts of projects and the impacts of this campaign, but surveys to determine degree of awareness should be held during implementation period to ensure effectiveness of campaign.	
Impact Assessment within Emissions Model	This is a supporting measure to the full set of projects and will therefore contribute towards the success of the strategy. It is therefore not possible to measure the impact of this project in isolation.	

7.18 CATEGORISATION OF PROJECTS

Both the core and strategy projects require a mixture of skills. Some are primarily about capacity building, whilst others require engineering, environmental or planning skills in order to be implemented. Most strategy projects will need capacity building to be delivered, but some may be progressed from existing resources, provided that joint working arrangements are made with appropriate agencies.

Table 7.2 below describes the projects in terms of their type and the primary skills and resources needed to enable them to be implemented.

Table 7.2: Core and Strategy Projects by Type and Skills

Project Number	Project Descriptions	Project Type Main Skills	Comments
Core Project 1	Co-operation with the Greater Amman Municipality	Capacity Building	
Core Project 2	Purchase and installation of Permanent Traffic Counters;	Engineering	
Core Project 3	Installation of Air Quality Monitoring Stations	Environmental	
Core Project 4	Detailed Assessment of KABAAC Housing Development;	Transport Planning	
Core Project 5	Development of Zarqa Traffic Model;	Transport Planning	
Core Project 6	Completion of Zarqa Urban Masterplan;	Transport Planning	
Core Project 7	Institutional Strengthening of Zarqa Municipality;	Capacity Building	
Core Project 8	Introduction of Transport Policy: Traffic Impact Studies.	Transport Planning	
Strategy Project 1	Integrate Land Use and Transport Planning Through New Bus Routes and Policy	Public Transport + Transport Planning	Joint Working Partnership needed under leadership of LTRC
Strategy Project 2	Public Transport Services Improvements: Purchase of 43 new buses with lease payments of between 10-15 years	Public Transport + Transport Planning + Engineering	Joint Working Partnership needed under leadership of LTRC
Strategy Project 3	Improve Accessibility to the Proposed LRS Terminal	Public Transport + Transport Planning	Joint Working Partnership needed under leadership of LTRC
Strategy Project 4	Public Transport Terminal Improvements	Public Transport + Engineering	Joint Working Partnership needed under leadership of LTRC
Strategy Project 5	Public Transport Ticketing Changes	Public Transport	Joint Working Partnership needed under leadership of LTRC
Strategy Project 6	Public Transport Infrastructure Improvements	Public Transport + Engineering	Joint Working Partnership needed under leadership of LTRC
Strategy Project 7	New Low-Emission Vehicles	Public Transport + Environmental	Joint Working Partnership needed under leadership of LTRC
Strategy Project 8	Walking Infrastructure improvements	Transport Planning + Engineering	
Strategy Project 9	Install ITS Measures	Public Transport + Engineering + ITS	Joint Working Partnership needed under leadership of LTRC
Strategy Project 10	Junction and Highway Improvements	Engineering	
Strategy Project 11	Parking	Transport Planning + Engineering	
Strategy Project 12	Public Awareness Scheme	All skills + Communications	

8 Strategy Impact on Energy and GHG Emissions

8.1 PROJECT MODELLING

8.1.1 Introduction

Where possible the impact of each of the proposed projects has been modelled using the demand model and IVE emissions model.

For the majority of the projects that have been modelled, an estimate of the change in travel behaviour has been based on best practice examples and previous experience. The demand model and IVE model have then been used to ascertain the changes in energy consumption and GHG emissions that result from the revised multi-modal transport demand.

The results are therefore indicative of the reductions in private vehicle trips and GHG emissions that could be achieved, and should only be treated as a guide to the energy savings possible.

8.1.2 Projects 1 to 6:

- Integration of Land Use and Transport Planning Through New Bus Routes and Policy Changes
- Public Transport Services Improvements
- Improve Accessibility to the Proposed LRS Terminal
- Public Transport Terminal Improvements
- Public Transport Ticketing Changes
- Public Transport Ticketing Changes
- Public Transport Infrastructure Improvements

It is not possible to model the changes that would result from each of the proposed public transport improvements in isolation. The measures will work together in an integrated way to provide a higher quality service and improve accessibility across the region, consequently encouraging a modal shift towards travel by public transport.

The modal shift towards public transport resulting from the proposed improvements of Projects 1 to 6 cannot be predicted in the model, therefore estimates of modal shift have been based on our experience and evidence from public transport reform in Jordan and elsewhere. In order to achieve the estimated levels of modal shift it is essential that all of the supporting public transport measures are in place such as terminal design, ticketing changes, and infrastructure improvements, as well as the more substantial overhaul of the service network.

It is acknowledged that additional impacts from reduced journey times and faster vehicle speeds as a result of bus priority, and the impact of park and ride facilities will also have an effect on GHG emissions and public transport utilisation. However, the modelling for this project has been done simply using modal shift to provide an indication of the potential results that can be achieved.

The approach for modelling the combined public transport strategy is as follows:

- 2015 – Increase Public Transport mode share to 20%
- 2015 – Assume 50% of buses are new vehicles to Euro III standard
- 2020 – Increase Public Transport mode share to 22.5%
- 2020 – Assume 100% of buses are new vehicles to Euro III standard
- Private Car and Yellow Taxi vehicle trips reduced in accordance with uptake of public transport
- Incorporate revised PT vehicle numbers and route lengths into the PT trip generation model for 2015, with the number of vehicles operating forecast to increase in 2020 to provide capacity for the increasing demand

The modelling results are presented later within this Section.

8.1.3 Project 7: New Low-Emission Vehicles

This project has been modelled to provide an indication of the reduction in GHG emissions that would result from the introduction of low emission public transport vehicles. Two proposals have been modelled as follows:

- Replacement of white taxi fleet with hybrid cars
- Replacement of current minibuses with CNG buses

The new vehicles have been incorporated into the IVE model to provide revised emission factors for white taxis and midibuses. The modelling results are presented later within this Section.

8.1.4 Project 8: Walking Infrastructure Improvements

Section 7.10 refers to evidence where walking infrastructure improvements have resulted in significant increases in pedestrian movements. It is not possible to accurately predict the likely increase in walking trips resulting from the proposed improvements; however a modest estimate of modal shift will be built into the demand model to provide an indication of the potential energy savings that will occur as a result of this project.

The method for modelling this project is as follows:

- 2015 - Increase in walking trips in downtown Zarqa by 5%. This modal shift is only within downtown Zarqa, therefore the city wide modal split is only minimally affected. Trips have been reduced from private car and yellow taxi trips on a pro rata basis according to their internal downtown trip generation.
- By 2020 it is anticipated that pedestrian infrastructures will have more of an effect due to changes in driver discipline accepting the introduction of pedestrian crossings, thereby increasing the effectiveness of their presence. Therefore, walking trips internal to downtown Zarqa have been increased by 10%, through a reduction in private car and yellow taxi trips.

It is noted that walking infrastructure improvements within downtown Zarqa will only influence the propensity to walk within this district; therefore the shift to walking from private vehicles is restricted to this area only. Although the improved walking facilities may lead to an increase in public transport use due to enhanced accessibility, this impact has not been modelled within this Project. The modelling results are presented later within this Section.

8.1.5 Project 9: Install ITS Measures

Installation of ITS measures has been shown in worldwide examples to smooth traffic flows, thereby increasing the average traffic speed significantly [(29)].

For the purpose of modelling the impact on Zarqa City, an assumed increase in average of speed of vehicles of 10% has been applied. This will require the junction and highway improvements stated in Project 10 to support the ITS measures and facilitate smoother traffic flows. The average speed of vehicles has therefore been increased in the IVE model, resulting in revised emission factors. Greater increases in Public Transport speed will be achieved if SVD measures are implemented in the longer term.
It is noted that it is not possible to model the impact of smoother traffic flows on fuel consumption within the model, however evidence suggests that fuel savings would also be made as a result of this project. The modelling results are presented later within this Section.

8.1.6 Project 10: Junction and Highway Improvements

It is not possible to identify the direct impacts of the proposed junction and highway improvements on trip demand, fuel consumption or energy savings. However, this project will support other measures and therefore the impacts are built into the remaining projects.

8.1.7 Project 11: Parking

The proposed parking measures are likely to have two main impacts: a deterrence in vehicle trips destined for downtown Zarqa due to parking charges and restrictions – these trips are assumed to either be internal downtown trips, or trips from the remainder of the city that could be avoided (i.e. people may choose to travel together in one car rather than two to save parking costs, or may choose not to travel at all).

Secondly, in an effort to avoid the parking restrictions, people may park slightly further out than the very central downtown area where the parking restrictions are in place. This effect is a slight reduction in travel distance. The impact of proposed park and ride measures is modelled separately in the public transport projects.

The modelling approach has therefore been to:

- Reduce vehicles travelling to downtown Zarqa by 2%.
- Assume 5% of vehicles travelling to downtown Zarqa park further out, thereby reducing their vehicle trip distance by 1km.

The modelling results are presented later within this Section.

8.1.8 Project 12: Public Awareness Scheme

A public travel awareness scheme is widely recognised to have modal shift benefits, however the schemes are largely dependent on there being good public transport services in place to support the appeal of changing modes of travel.

Therefore, the public awareness scheme alone is unlikely to have any substantial impact on the travel demand in Zarqa City. This measure will simply support the public transport and walking infrastructure improvement projects in achieving their targets. Consequently this project has not been modelled in isolation.

8.2 PROJECT MODELLING RESULTS

The results for the individual projects are set out in Table 8.1 below in the form of net and percentage changes in private vehicle distance travelled, number of private vehicle trips, fuel consumption, and CO2 emissions for Zarqa City.

Table 8.1: Individual Project Results

		Private Vehicle Distance Savings (Vehicle Kilometres per Day)		Private Vehicle Trip Savings (No. Vehicle Trips per Day)		Energy and Emission Savings	
		Downtown Zarqa*	Zarqa City**	Downtown Zarqa*	Zarqa City**	Reduction in Fuel Consumption (litres per year)	Reduction in CO2 emissions (tons per year)
Projects 1 to 6	2015	160,150 (12%)	632,050 (12%)	27,750 (12%)	57,100 (12%)	13,984,500 (8%)	31,450 (8%)
	2020	309,300 (17%)	1,274,300 (17%)	53,200 (17%)	113,600 (17%)	30,507,950 (12%)	82,650 (15%)
Project 7	2015	-	-	-	-	-	9,100 (2%)
	2020	-	-	-	-	-	11,300 (2%)
Project 8	2015	11,400 (1%)	11,400 (0.2%)	4,200 (2%)	4,200 (1%)	351,500 (0.2%)	750 (0.2%)
	2020	22,200 (1%)	22,200 (0.3%)	8,150 (3%)	8,150 (1%)	685,700 (0.3%)	1,450 (0.3%)
Project 9	2015	-	-	-	-	-	36,000 (9.2%)
	2020	-	-	-	-	-	49,300 (9.2%)
Project 11	2015	24,150 (2%)	24,150 (0.4%)	4,150 (2%)	4,150 (1%)	744,550 (0.4%)	1,600 (0.4%)
	2020	31,500 (2%)	31,500 (0.4%)	5,400 (2%)	5,400 (1%)	972,550 (0.4%)	2,100 (0.4%)

*All trips generated by downtown, and all trips attracted to downtown from within Zarqa City

**All trips generated by Zarqa City

(Figures in brackets are percentage savings compared with the Do Minimum)

8.3 STRATEGY MODEL

A separate exercise has been undertaken to model the combined impact of the 12 projects. The results of the combined strategy are set out below.

8.3.1 Strategy Impact on Trip Generation

The Strategy is predicted to result in modal shift towards more sustainable modes of transport in the form of public transport. In the case of assessment year 2020 it is estimated that Private Car mode share will reduce from 50% to 41%, and Yellow Taxi from 18% to 15%. The mode shares for 'Do Minimum' and ''With Strategy' scenarios are set out in Table 8.2 below.

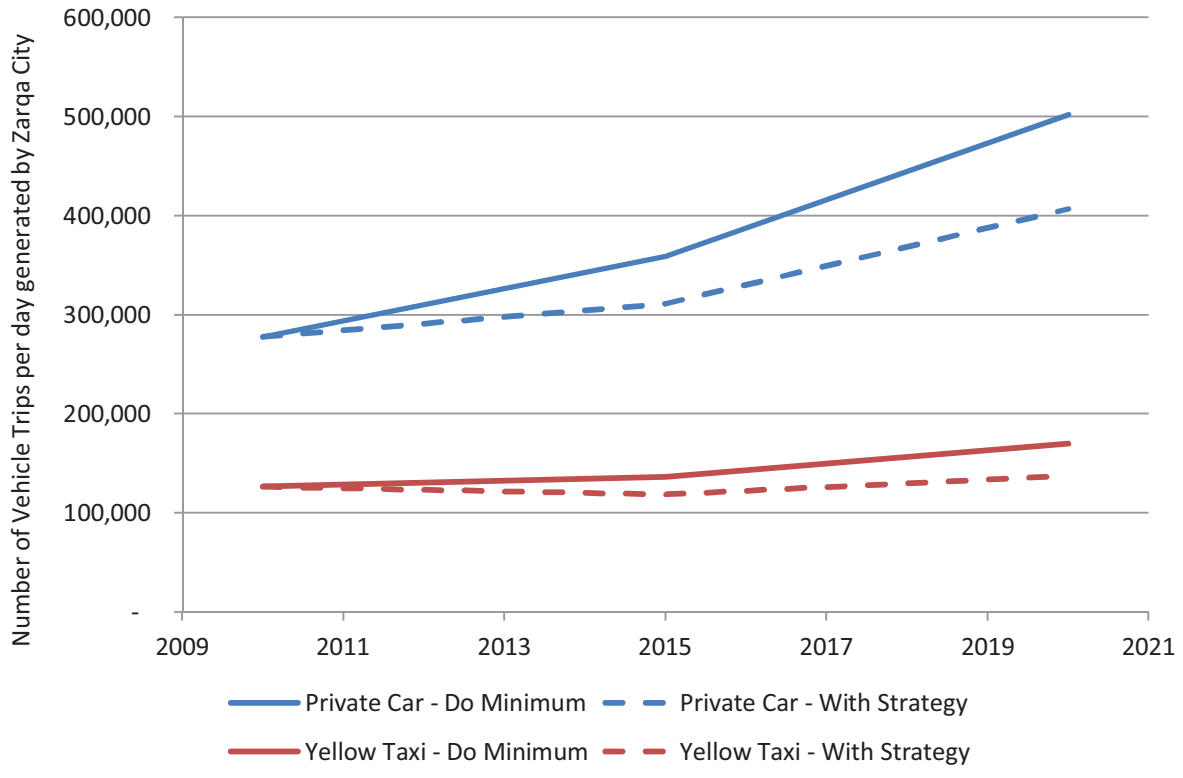
Table 8.2: Zarqa City Modal Split

Transport Mode	2015		2020	
	Do Minimum	With Strategy	Do Minimum	With Strategy
Walking/Cycling	21%	22%	18%	19%
Private Car	46%	40%	50%	41%
Yellow Taxi	19%	16%	18%	15%
Public Transport	13%	20%	11%	23%
School Bus	2%	2%	2%	2%

Analysis of the number of trips made in Zarqa City suggests that the strategy results in a reduction of approximately 900 private vehicle trips per hour made internally within the downtown district in the forecast year of 2015. In 2020, this reduction increases to 1,700 vehicles per hour taken off the internal downtown highway network. This impact will significantly ease congestion on the narrow downtown streets.

Figure 8.2 below illustrates the forecast trip generation for both private cars and taxis, with and without the strategy in place.

Figure 8.2: Forecast Private Vehicle Trip Generation



Source: Consultants

Public transport trip generation is predicted to increase as a result of the significant investment in public transport services and infrastructure. Therefore, as a result of modal shift towards bus transportation, and in line with increasing population levels the number of trips made by public transport per day is predicted to increase from 139,400 per day in 2010 to 290,800 per day in 2020. Without the strategy in place, public transport use is predicted to decline such that it is estimated the Do Minimum number of trips per day in 2020 would be 140,300. The strategy therefore doubles public transport trip generation in 2020.

A summary of the daily vehicle distances with the strategy in place for Zarqa City is set out below in Table 8.3. The results are compared with the Do Minimum vehicle distances set out within Table 4.7 of this report. Evidently the restructuring of public transport services has had an impact on white taxi, minibus, and bus vehicle trips. Where bus utilisation levels have been improved, and new bus services have been introduced to accommodate the increasing levels of demand, the total distance travelled by buses per day in Zarqa City has more than doubled.

Table 8.3: Zarqa City Vehicle Distance Results

Transport Mode	Zarqa City Daily Vehicle Distance Travelled (km)					
	2015			2020		
	Do Minimum	With Strategy	% Change	Do Minimum	With Strategy	% Change
Private Vehicle	3,954,800	3,473,650	-12%	5,607,650	4,619,850	-18%
Yellow Taxi	1,530,700	1,345,300	-12%	1,926,350	1,588,050	-18%
White Taxi	21,650	10,550	-51%	26,850	14,450	-46%
Minibus/Midibus	144,300	51,700	-64%	179,100	70,800	-60%
Bus	34,750	106,300	206%	43,100	145,650	238%
School Bus	5,050	5,050	0%	6,300	6,300	0%

There is a notable increase in the distance travelled by the bus 'fleet' operating in the Zarqa city area. This is due to the restructured public transport proposals, which provide for medium buses, large buses and coaches to cover more of the longer distance routes, thus replacing many of the existing minibuses. The increased bus mileage is therefore compensating for the reduction in minibus and white taxi routes.

8.3.2 Strategy Impact on Fuel Consumption

The predicted change in transport behaviour has an impact on fuel consumption, although it has not been possible to measure the full impact of the strategy on this parameter. The results are an over-prediction of fuel consumption in the 'With Strategy' scenarios.

Due to the reduced distance travelled by private vehicles in Zarqa City (and accounting for the increased distance travelled by public transport to accommodate additional demand), it is estimated that total fuel savings of 8% in 2015 and 13% in 2020 can be achieved. Table 8.4 below summarises the fuel consumption results.

Table 8.4: Zarqa City Annual Fuel Consumption

Fuel Type	Zarqa City Fuel Consumption (litres)*					
	2015			2020		
	Do Minimum	With Strategy	% Change	Do Minimum	With Strategy	% Change
Gasoline + Diesel	179,206,100	164,156,100	-8%	244,829,500	212,721,800	-13%

*Excludes Trucks

8.3.3 Strategy Impact on GHG Emissions

It was noted in Section 4 that Zarqa City currently emits approximately 591 kg per capita of CO_2 on an annual basis. Table 8.5 below presents the forecast 'Do Minimum' CO2 emissions per capita along with the predicted results of the strategy.

Table 8.5: CO_2 Emissions Forecasts (kg/capita/annum)

	Annual Emission per Capita (kg)					
	2015			2020		
	Do Minimum	With Strategy	% Change	Do Minimum	With Strategy	% Change
CO2	673	553	-18%	741	559	-25%
NOX	8	6	-16%	8	6	-25%
PM	0.19	0.12	-37%	0.19	0.03	-84%
CO	177	146	-17%	196	152	-22%

In terms of air quality, NOx, CO and PM are the most critical pollutants included in Table 8.5 above. It is not possible to calculate the concentration of these pollutants in the air, only to consider them in absolute terms. Therefore these emission results cannot be compared with Jordan air quality standards.

However, the results can be used to understand the improvements in comparison with the Do Minimum scenario. It is evident from Table 8.5 above that all pollutant levels will be reduced compared to the Do Minimum due to the reduced levels of private vehicle trips, and the improved standards of public transport vehicles. The most significant savings are for PM in the year 2020. This impact is predominantly due to the replacement of buses with Euro III standard vehicles, and the introduction of CNG midibuses due to the current minibuses and buses emitting the highest levels of PM.

8.3.4 Strategy Impact across Zarqa City

In summary, the potential energy and emission savings in Zarqa City in 2020 are as follows:

- **Fuel savings of at least 13%, equivalent to 32 million litres per year;**
- **Road Transport energy savings of 1,800 MJ per year per capita; and**
- **Reduction in total vehicle emissions of CO_2 of 25% equivalent to 130,000 tons per year**

The impact of the strategy on CO_2 emissions across Zarqa City has been illustrated using GIS to map the emissions within each zone and on the main highway corridors. The figures below represent the 'Do Minimum' dispersion of CO_2 emissions in Zarqa City for 2010, 2015 and 2020, along with the CO_2 emissions in 2015 and 2020 with the Strategy in place. Full scale versions of the figures are provided in Appendix O as Figures O1 to O5.

Due to the differing modelling approaches of public and private transport, it is only possible to derive the private vehicle emissions in this manner. The images do not therefore reflect the changes in emissions from public transport.

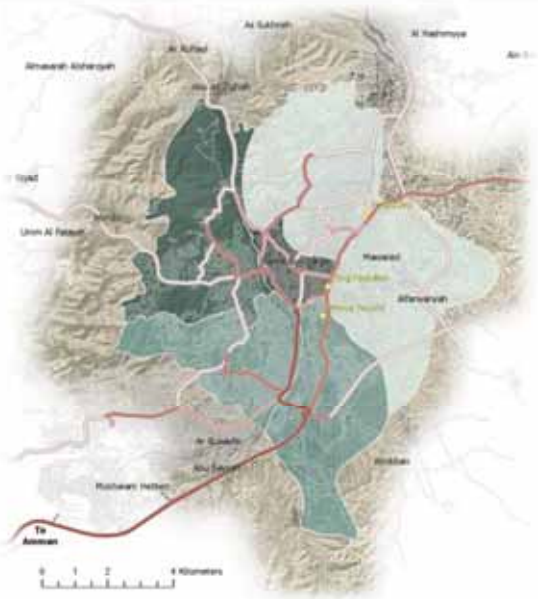
The images have been created by using an origin-destination matrix of CO_2 emissions (calculated from origin-destination trip generation and trip lengths in the demand model) for the Zarqa City zones. For each O-D relationship, the CO_2 emissions have been assigned to the most direct route, providing a total CO_2 emission for the main highway corridors across the city and to external zones such as Amman.

Where it is not possible to identify the vehicle route, i.e. where trips are made internally within a zone, the CO_2 emissions are represented through shading of the zone to illustrate the internal trip CO_2 emissions.

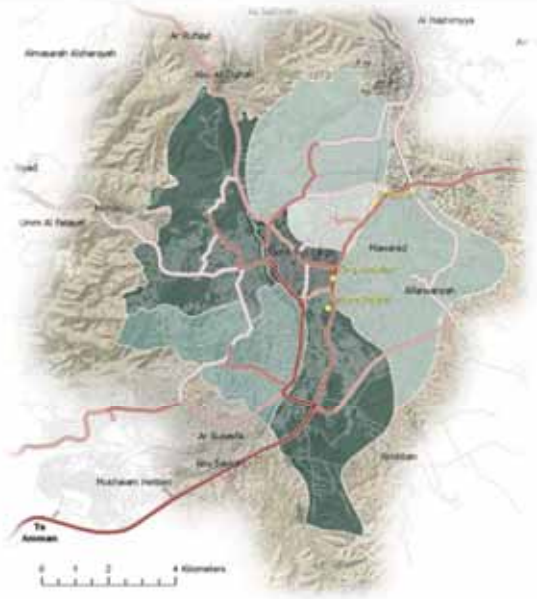
The images illustrate that in the Do Minimum scenario, the CO_2 emissions progressively increase over the assessment years. In terms of internal trips, the most notable change is the increase in emissions to the east of the city. This is due to the development of KABAAC. The Amman-Zarqa highway corridor is also shown to deteriorate over time with substantially higher CO_2 emissions from vehicles on this route.

The 2015 With Strategy and 2020 With Strategy scenarios show improvements upon the forecast Do Minimum scenarios, with the impact more noticeable in 2020 when the strategy has been fully implemented. In 2020, there is a clear reduction in CO_2 emissions across the city, demonstrating the wider benefits of the Strategy.

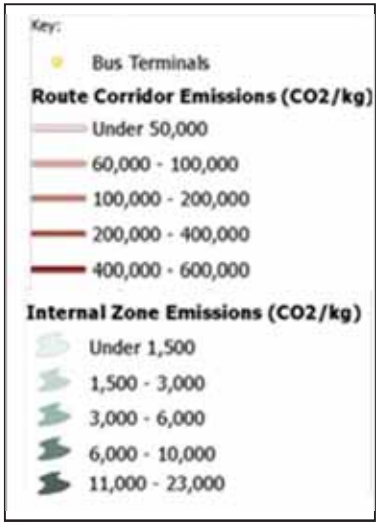
2010 Do Minimum (Without Strategy)



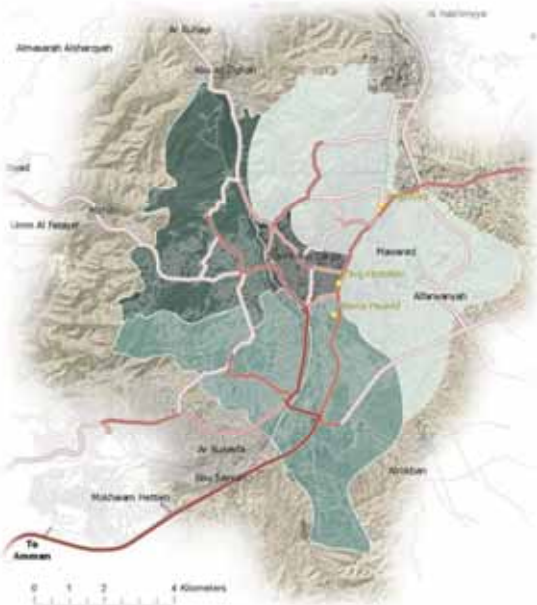
2015 Do Minimum (Without Strategy)



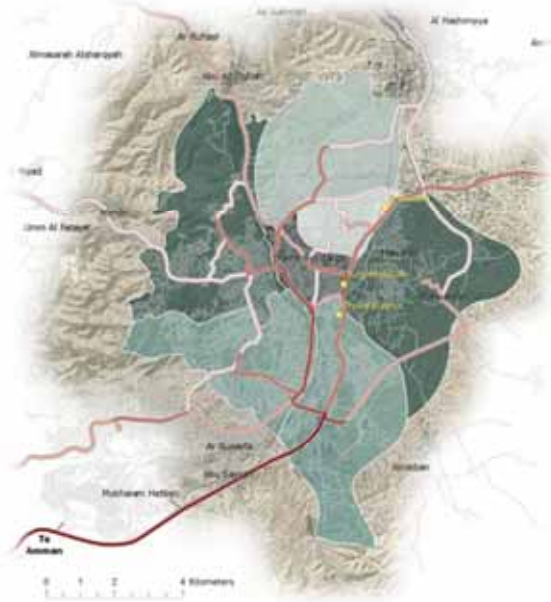
2020 Do Minimum (Without Strategy)



2015 With Strategy



2020 With Strategy



9 Programme

9.1 PROPOSED MOBILITY STRATEGY

9.1.1 Introduction

The strategy has been developed to incorporate a number of key factors. These have been to:

- Adhere to the project objectives;
- Assess the existing conditions, undertake reconnaissance surveys and traffic counts;
- Assess, calibrate, and validate the demand and emissions model;
- Have a continuous exchange of views, ideas and recommendations from the CG Group;
- Filter the potential projects through the use of a multi criteria assessment;
- Identify CORE projects to support the recommended strategy;
- Focus on public transport and demand management; and
- Develop an integrated strategy of public transport supported by demand management.

This section describes the components of the strategy programme and the project implementation timetable.

Through a process of selection using multi criteria assessment, twelve projects have been selected for implementation over the short and medium term time horizon that best meet the key objectives, and at the same time establish a foundation for transport planning in the Zarqa downtown area as well as throughout the Zarqa Municipality.

The proposed twelve projects are detailed below, including project description, start and end date and estimated costs.

9.1.2 The Core Projects

The strategy will be supported by the implementation of the core projects as detailed below. These core projects have a number of key roles to play in the strategy development and sustainability of the programme. They will:

- Provide tools and methods to establish the existing conditions in terms of traffic problems and emissions and air quality;
- Will provide tools that will enable Zarqa Municipality to monitor, plan and budget for on-going transport improvement in the Zarqa Downtown areas and Zarqa Municipality as a whole;
- Provide Zarqa Municipality guidance, advice and support in further development of the Zarqa Transport Strategy; and
- Embed with Zarqa Municipality the skill sets required to further develop the strategy in responding to short, medium and long term needs.

In support of the strategy, the above mentioned core projects must be implemented over the short term. The total cost of implementation is estimated to be around JD 2.062 million to be spread over a 3 year period resulting in an investment of JD 687,300 per annum. To these sums, it is necessary to add contingency and management costs, as described in paragraph 9.4 and as shown in Table 9.6 below.

Table 9.1: CORE Project Programme

Project	Description	Start Date	End Date	Cost JD	Implementation Trigger	Lead and Support Agencies
1	Co-operating with Greater Amman Municipality on issues related to advice and information on: • Automatic traffic counting station purchase and installation • Sharing of traffic, transport and socio-economic data • Manual Classified Count data sharing • SCATS: Information and guidance on the planning, installation and maintenance of SCATS system • Communication strategy • Sharing copies of its TIS guidelines	2012	Initial 3 year period to 2015	-	Terms of reference and scopes to be jointly developed and agreed upon	▪ Zarqa Municipality (Lead) ▪ Greater Amman Municipality (Support) ▪ LTRC (Support)
2	Purchase and Installation of temporary and permanent traffic count equipment	2011	On-going process	JD 15,000	Review of manufacturers and assessment of site locations	Zarqa Municipality with advice and support from GAM
3	Installation of air quality monitoring stations	2012	On-going process	JD 62,000	Review of manufacturers and assessment of site locations	Zarqa Municipality with support from Ministry of Environment
4	Detailed Assessment of the KABAAC Housing Development	2013		See project 6	Part of the Zarqa Traffic Model Development	Zarqa Municipality (Lead) with possible support from GAM and the Amman Institute
5	Development of a Zarqa Traffic Model	2012	2013	JD 600,000	Expression of Interest to be drafted and issued Terms of reference to be drafted Project to be budgeted for 2012	Zarqa Municipality (Lead) with advice and support from GAM
6	Completion of the Zarqa Urban Masterplan	2012	2012	JD 1 million	Expression of Interest to be drafted and issued Terms of reference to be drafted Project to be budgeted for 2012	Zarqa Municipality (Lead) with advice from GAM and possible support from the Amman Institute
7	Institutional Strengthening of Zarqa Municipality	2012	2014	3 year programme 3 people JD 45,000 per	Staff positions to be identified, terms of reference prepared and job specifications	Zarqa Municipality (Lead)

				annum	developed	
8	Introduction of the transport policy for Traffic Impact Studies	2012	2014	JD 250,000	Develop policy document to make TIAs a standard procedure Will involve national policy	MoT MPWH MoMA
		Sub Total	2012-2015	JD 2,062,000		

9.2 STRATEGY PROJECTS

The process by which the final strategy projects were determined is described in Chapter 7. They consist of those measures which were identified as being viable, practicable and with the best chance of meeting the overall objectives. As previously described, they provide an incentive to travel sustainably, such as Public Transport improvements, or they create a deterrent to the use of private vehicles in the form of Travel Demand Management (TDM) measures or they are aimed at directly improving emissions and energy efficiency, although not in themselves resulting in modal shift.

The final list of 12 projects are summarised in the table below.

Table 9.2: Strategy Project Programme

Project	Description	Start Date	End Date	Implementation Cost (JD)	Implementation Trigger and Comment	Lead and Support Agencies
1	Integrate Land Use and Transport Planning Through New Bus Routes and Policy Changes	2013	2014	2,375,000	Decision to operate buses in KABAAC 43 new buses, with lease payments for 10-15 years	Zarqa Municipality LTRC Bus operators
2	Public Transport Services Improvements	2011 2012 2012 2012 2012	2012 2012 2020 2014 2020	150,000 10,000 10,300,000 262,800 400,000	Surveys Software Vehicle purchase Bus lanes Driver training	Zarqa Municipality LTRC Bus operators
3	Improve Accessibility to the Proposed LRS Terminal	2014 2013 2015 2014	2015 2016 2015 2014	175,2000 2,019,000 2,700,000 1,080,000	Bus lanes Park & Ride sites BRT vehicles P & R buses	Zarqa Municipality LTRC Bus operators GAM
4	Public Transport Terminal Improvements	2113 2014 2016	2015 2016 2018	6,520,000 4,832,500 2,925,000	King Abdullah Prince Rashid New Zarqa	Zarqa Municipality LTRC Bus operators
5	Public Transport Ticketing Changes	2013	2014	400,000	ETMs	Zarqa Municipality LTRC Bus operators GAM
6	Public Transport Infrastructure Improvements	2013	2015	123,000	Bus stops/shelters	Zarqa Municipality LTRC Bus operators
7	New Low-Emission Vehicles	2012 2013	2015 2020	1,500,000 3,378,000	Hybrid White Taxi Add cost CNG	Bus operators LTRC
8	Walking Infrastructure improvements	2013	2014	250,000	Plan / design	Zarqa Municipality
9	Install ITS Measures	2014	2017	1,100,000 1,000,000	Additional Signals plus SVD Plan/Build UTC Centre	Zarqa Municipality
10	Junction and Highway Improvements	2014	2018	100,0000 1,900,000	Road markings Junction Traffic Management Improvements	Zarqa Municipality
11	Parking	2013	2020	5,300,000	Contractual agreement	Zarqa Municipality

					between ZM and Autopark	Parking operators
12	Public Awareness Scheme	2013	2019	300,000	Travel Awareness Campaign	LTRC Bus operators
		Total Cost	JD	49,100,300		

9.3 CONSTRUCTION COST ESTIMATES

The calculation of the core and strategy costs have been based upon recent studies and recent construction projects and the consultant's extensive experience of transport sector projects worldwide and in Jordan.

Table 9.3: Cost basis for each of the core projects

Project	Project Title	Cost Basis
Core Project 1	Co-operation with GAM	This project has not been costed, as it is dependent on negotiations between the parties involved.
Core Project 2	Permanent Traffic Counters	Sourced from suppliers.
Core project 3	Air Quality Monitoring	Sourced from suppliers.
Core project 4	KABAAC	Sourced from a number of recent traffic impact assessments.
Core Project 5	Zarqa Traffic Model	Estimated using bottom up techniques. Used recent transport model projects let in the region Used the Amman TMMP fee as a guide
Core Project 6	Zarqa Masterplan	Used the previous budget allocated for this project. Compared similar study costs in region.
Core Project 7	Institutional Strengthening	Used typical current professional salary bands in Jordan as a guide as well as existing salary bands in various Municipalities.
Core Project 8	Transport policy	Estimated the person man hours effort required to introduce such a policy.

Table 9.4: Cost basis for each of the strategy projects.

Project	Project Title	Cost Basis
Strategy Project 1	Integrate Land Use and Transport Planning through new Bus Routes and Policy Changes	• Institutional strengthening costs are covered in Project7. • Cost prices for new buses obtained from the market. No account has been taken of any potential leasing income.
Strategy Project 2	Public Transport Services Improvements	• Survey costs calculated from hourly rates for surveyors. • Scheduling and route software costs based on market prices. • Cost prices for new buses obtained from the market. No account has been taken of any potential leasing income. • Bus lane priority costs calculated by using local market prices
Strategy project 3	Improve Accessibility to the Proposed LRS Terminal	• Cost prices for new buses obtained from the market. No account has been taken of any potential leasing income. • Bus lane priority costs and Park and Ride sites calculated by using local market prices.
Strategy project 4	Public Transport Terminal Improvements	• Terminal improvement costs derived from similar work undertaken elsewhere in Jordan • Cost of new Bus Interchange points calculated using local material and labour prices.
Strategy Project 5	Public Transport Ticketing Changes	• Cost of ETMs based on international prices. • As LTRC already plan to consider integrated ticketing and a clearing house system, costs have not been assumed for these items to avoid double counting.
Strategy Project 6	Public Transport Infrastructure Improvements	• Obtained from recent improvements made in Amman and Consultants own estimates.
Strategy Project 7	New Low Emissions Vehicles	• Prices for hybrid white taxis obtained from the market. • No calculations made regarding the cost of operating CNG powered buses – a detailed business case needed to consider all costs and savings.
Strategy Project 8	Walking Infrastructure Improvements	• Estimates obtained from recent infrastructure projects of similar nature in Jordan.
Strategy Project 9	Installation of ITS Measures	• Estimates from various manufacturers and suppliers worldwide, together with experience of project managing the construction and operation of UTC centres. • As LTRC already plan to consider the introduction of real time information systems, costs have not been assumed for these items to avoid double counting.
Strategy project 10	Junction and Highway Improvements	• Estimates from similar recent contracts let in Jordan
Strategy project 11	Parking	• Parking equipment costs based on market prices • Staff enforcement costs based on current labour rates • No assessment has been made for income to offset costs. • Price of multi-story car park construction based on assessment of local building costs.
Strategy Project 12	Public Awareness Scheme	• Costs calculated on typical local charges for professional design, advertising, promotion and events

9.4 DESIGN & PROJECTS MANAGEMENT AND CONTINGENCY COSTS

For Core projects we have allowed a general contingency of 10% plus a further 10% cost to take into account general project management.

We have provided indicative strategy project costs only and it would not be appropriate at this stage to allocate contingencies to each particular project. As an indication, an overall allowance of 10% may be considered. We have also allocated a 10% design and management cost.

The design and project management cost is considered to include all preparatory work needed to reach the construction contract stage, as well as the detailed design.

9.5 STRATEGY PROGRAMME

This strategy involves developing an implementation programme for the Core (2011-2013), short (2012-2015) and medium term (2016-2020) time horizons. The core requirements call upon studies to be undertaken over the next 3 years to ensure Zarqa Municipality is in a position to support the short and medium term projects and at the same time build a foundation to support the launching of larger and longer term transport initiatives.

The short and medium term strategy development will call upon the various components developed from analysis undertaken throughout the study. The results of the reconnaissance and traffic surveys, coupled with the forecasts and emission factor modelling were used in support of the scheme options.

The short-term strategy has been developed into an action plan for priority investments. The programme will be implemented over the period starting late 2011 and ending 2015. The programme includes a priority implementation strategy with associated costs and benefits.

The medium term measures have also been identified from site reconnaissance and traffic surveys, forecast and emission modelling. These include area-wide demand management measures, and larger-scale improvements such as bus rapid transit infrastructure provision.

The programme over the 10 year time frame is detailed below. Table 9.5 provides a summary of the core and strategic projects. Tables 9.6 and 9.7 detail the core and strategic project investment per annum respectively. Figure 9.1 below illustrates the investment profile. This figure shows that the programme is designed to allow for the implementation of the core projects ahead of the strategy projects, thus resulting in the major expenditure taking place during the period from 2013 to 2016.

Figure 9.1: Ten Year Investment Profile

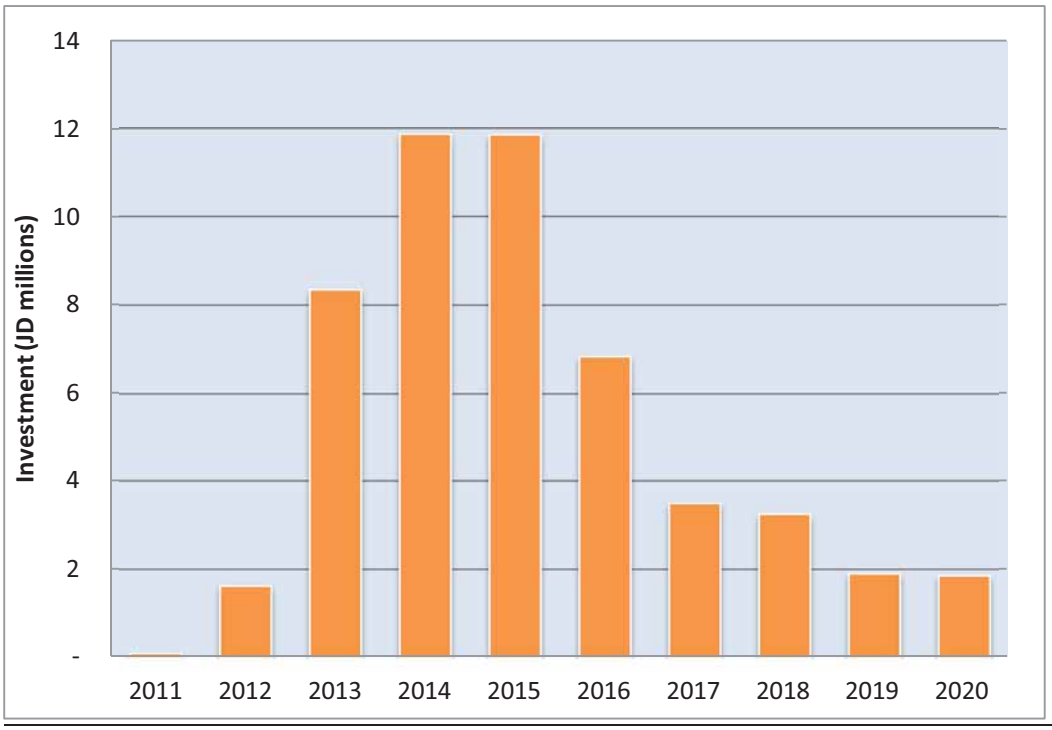


Table 9.5: Summary Work Programme and Indicative Costs - Core and Strategy Projects

PROJECT	PROJECT DESCRIPTION	SHORT TERM					MEDIUM TERM					CORE Project Cost	Strategy Project Costs
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	JD	JD
CORE PROJECTS	PROJECT DESCRIPTION												
1	Co-operation with GAM											-	
2	Traffic Count Equipment											15,000	
3	Air Monitoring Equipment											62,000	
4	Detailed Assessment of the KABAAC											See Project 6	
5	Develop Zarqa Traffic Model											600,000	
6	Zarqa Urban Master Plan											1,000,000	
7	Zarqa Municipality Institutional Strengthening											135,000	
8	Introduction of the transport policy for Traffic Impact Studies											250,000	
STRATEGY PROJECTS	PROJECT DESCRIPTION												
1	Integrate Land Use and Transport Planning Through New Bus Routes and Policy Changes												2,375,000
2	Public Transport Services Improvements: Purchase of 43 new buses with lease payments of between 10-15 years												11,122,800
3	Improve Accessibility to the Proposed LRS Terminal												5,974,000
4	Public Transport Terminal Improvements												14,277,500
5	Public Transport Ticketing Changes												400,000
6	Public Transport Infrastructure Improvements												123,000
7	New Low-Emission Vehicles												4,878,000
8	Walking Infrastructure improvements												250,000
9	Install ITS Measures												2,100,000
10	Junction and Highway Improvements												2,000,000
11	Parking												5,300,000
12	Public Awareness Scheme												300,000
										Total Costs (JDs)		2,062,000	49,100,300

Table 9.6: Work Programme and Indicative Costs for Core Projects

PROJECT	PROJECT DESCRIPTION	SHORT TERM					MEDIUM TERM					ITEMISED COSTS	TOTAL COSTS
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	JD	JD
CORE PROJECTS	PROJECT DESCRIPTION												
1	Co-operation with GAM											-	-
2	Traffic Count Equipment												15,000
		15,000										15,000	
3	Air Monitoring Equipment												62,000
			62,000									62,000	
4	Detailed Assessment of the KABAAC											See Project 6	
5	Develop Zarqa Traffic Model												600,000
			300,000	300,000								600,000	
6	Zarqa Urban Master Plan												1,000,000
			500000	500,000								1,000,000	
7	Zarqa Municipality Institutional Strengthening												135,000
			45,000	45,000	45,000							135,000	
8	Introduction of the transport policy for Traffic Impact Studies												250,000
			83,333	83,333	83,333							250,000	
	Annual Expenditure	15,000	990,333	928,333	128,333	-	-	-	-	-	-		
										Total Costs (JDs)		2,062,000	2,062,000
										Contigency Costs		10%	206,200
										Management Costs		10%	206,200
										Grand Total			2,474,400

Table 9.7: Work Programme and Indicative Costs for Strategy Projects

STRATEGY PROJECTS	PROJECT DESCRIPTION	SHORT TERM					MEDIUM TERM					ITEMISED COSTS	TOTAL COSTS
1	**Integrate Land Use and Transport Planning Through New Bus Routes and Policy Changes**												2,375,000
	Project 1 Cost Profile			1,187,500	1,187,500							2,375,000	
2	**Public Transport Services Improvements: Purchase of 43 new buses with lease payments of between 10-15 years**												11,122,800
	Transport Surveys	75,000	75,000									150,000	
	Software Development		10,000									10,000	
	Vehicle Purchase			1,287,500	1,287,500	1,287,500	1,287,500	1,287,500	1,287,500	1,287,500	1,287,500	10,300,000	
	Bus Lane Development		131,400	131,400								262,800	
	Driver Training		44,444	44,444	44,444	44,444	44,444	44,444	44,444	44,444	44,444	400,000	
3	**Improve Accessibility to the Proposed LRS Terminal**												5,974,000
	Plan and Design Bus Lanes				87,500	87,500						175,000	
	Purchase, Plan and Design Park and Ride			504,750	504,750	504,750	504,750					2,019,000	
	Purchase BRT Buses					2,700,000						2,700,000	
	Purchase of Park and Ride Buses				1,080,000							1,080,000	
4	**Public Transport Terminal Improvements**												14,277,500
	King Abdullah			2,173,333	2,173,333	2,173,333						6,520,000	
	Prince Rashid				1,610,833	1,610,833	1,610,833					4,832,500	
	New Zarqa						975,000	975,000	975,000			2,925,000	
5	**Public Transport Ticketing Changes**												400,000
	Electronic Ticketing Machines			200,000	200,000							400,000	
6	**Public Transport Infrastructure Improvements**												123,000
	Bus Stops and Bus Shelters			41,000	41,000	41,000						123,000	
7	**New Low-Emission Vehicles**												4,878,000
	Purchase of Hybrid White Taxis		375,000	375,000	375,000	375,000						1,500,000	
	Add CNG Costs			422,250	422,250	422,250	422,250	422,250	422,250	422,250	422,250	3,378,000	
8	**Walking Infrastructure improvements**												250,000
				125,000	125,000							250,000	
9	**Install ITS Measures**												2,100,000
	Install Signals at new Junction and Repair Old signals + new SVD				550,000	550,000						1,100,000	
	Plan and Build Urban Traffic Control Centre				250,000	250,000	250,000	250,000				1,000,000	
10	**Junction and Highway Improvements**												2,000,000
	Road Markings				50,000	50,000						100,000	
	Junction Traffic Management Improvements				380,000	380,000	380,000	380,000	380,000			1,900,000	
11	**Parking**												5,300,000
	Plan and Expand Existing Autopark System			200,000								200,000	
	Modernise Existing System			100,000								100,000	
	Enforcement Strengthening			100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	800,000	
	Plan, Design and Build Multi Story Car Park			500,000	1,233,333	1,233,333	1,233,333					4,200,000	
12	**Public Awareness Scheme**												300,000
	Travel Awareness Campaign			42,857	42,857	42,857	42,857	42,857	42,857	42,857		300,000	
	Annual Expenditure	75,000	635,844	7,435,035	11,745,302	11,852,802	6,850,968	3,502,052	3,252,052	1,897,052	1,854,194		

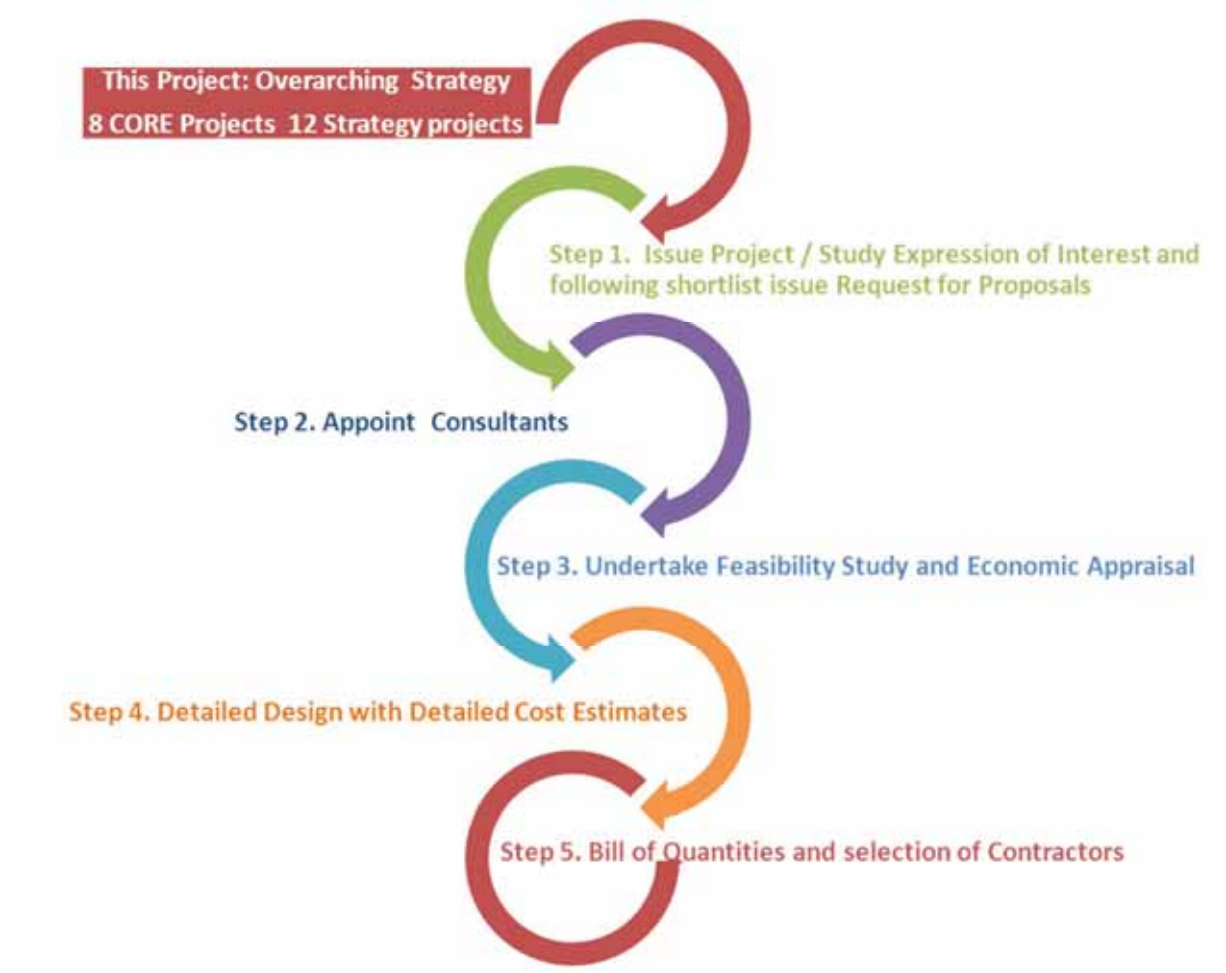
Total Costs (JDs)	49,100,300	49,100,300
Contigency Costs	10%	4,910,030
Design/Management Cost	10%	4,910,030
Grand Total		58,920,360

9.6 PROJECT IMPLEMENTATION AND DELIVERY

Having developed the Zarqa Downtown strategy, the implementation of the strategy projects will work through an indicative process as shown in Figure 9.2 below. The process will start with individual scopes of work developed for each project. Following a process of invitation and evaluation, a consultant should be appointed to undertake a feasibility study, detailed design and cost estimates. Once completed, a similar process of evaluation should be undertaken to appoint the contractor.

Depending upon the complexity and size of the project, Zarqa Municipality may be able to undertake some of the construction work through the use of the Municipality team. This may include traffic management, junction improvements and pedestrian facility improvements. However, larger schemes such as the park and ride, car park construction and expansion of the urban traffic control system will require specialist contractors.

Figure 9.2: Project Implementation and Delivery Process



10 Summary and Conclusions

10.1 CONCLUSIONS

Without intervention, Zarqa City faces increasing levels of traffic congestion and air pollution due to a growing population, the new KABAAC development to the east of the city, and increasing levels of car ownership resulting in a modal shift toward travel by private vehicles.

Consequently fuel consumption, particularly gasoline, is predicted to increase in line with vehicle demand. The result of the rapidly increasing fuel consumption and vehicle trips is significant growth in GHG emissions. CO2 emissions per capita are predicted to reach 741kg/capita/annum in 2020.

This Study presents a Strategy which recommends in total, 8 core projects and 12 strategy projects. It will provide a solid foundation for Zarqa to deliver a multi-faceted mobility strategy for the next ten years. It is important to note that the core projects need to be implemented in order to provide the Municipality with the necessary equipment, knowledge and skills to understand better the existing conditions, and to implement and monitor the strategy going forward.

The strategy projects would be planned for and implemented over a 10 year time horizon, starting in 2011 and finishing in 2020.

The total investment required to implement the Core Projects is approximately JD 2.5million, including contingency and management costs.

The total investment cost for Strategy Projects over the 10 year period is JD 58.9 million, including contingency and management costs, which is equivalent to JD 5.89 million per year investment.

The recommended strategy has been tested and found to:

- Reduce total vehicle emissions of CO2 by 25% compared with 2020 Do Minimum scenario;
- Reduce vehicle travel time by 10%;
- Reduce private vehicle demand by 19% compared with 2020 Do Minimum scenario; and
- Reduce fuel consumption by at least 13% compared with 2020 Do Minimum scenario.

It will also:

- Provide a solid foundation for Zarqa to take forward the proposed strategy;
- Provide dedicated transport links to the Zarqa LRS/BRT terminal;
- Integrate the KABAAC development in terms of transport and land use; and
- Provide Zarqa Municipality with the necessary equipment, knowledge and skills to understand better the existing conditions, and to implement and monitor the strategy going forward.

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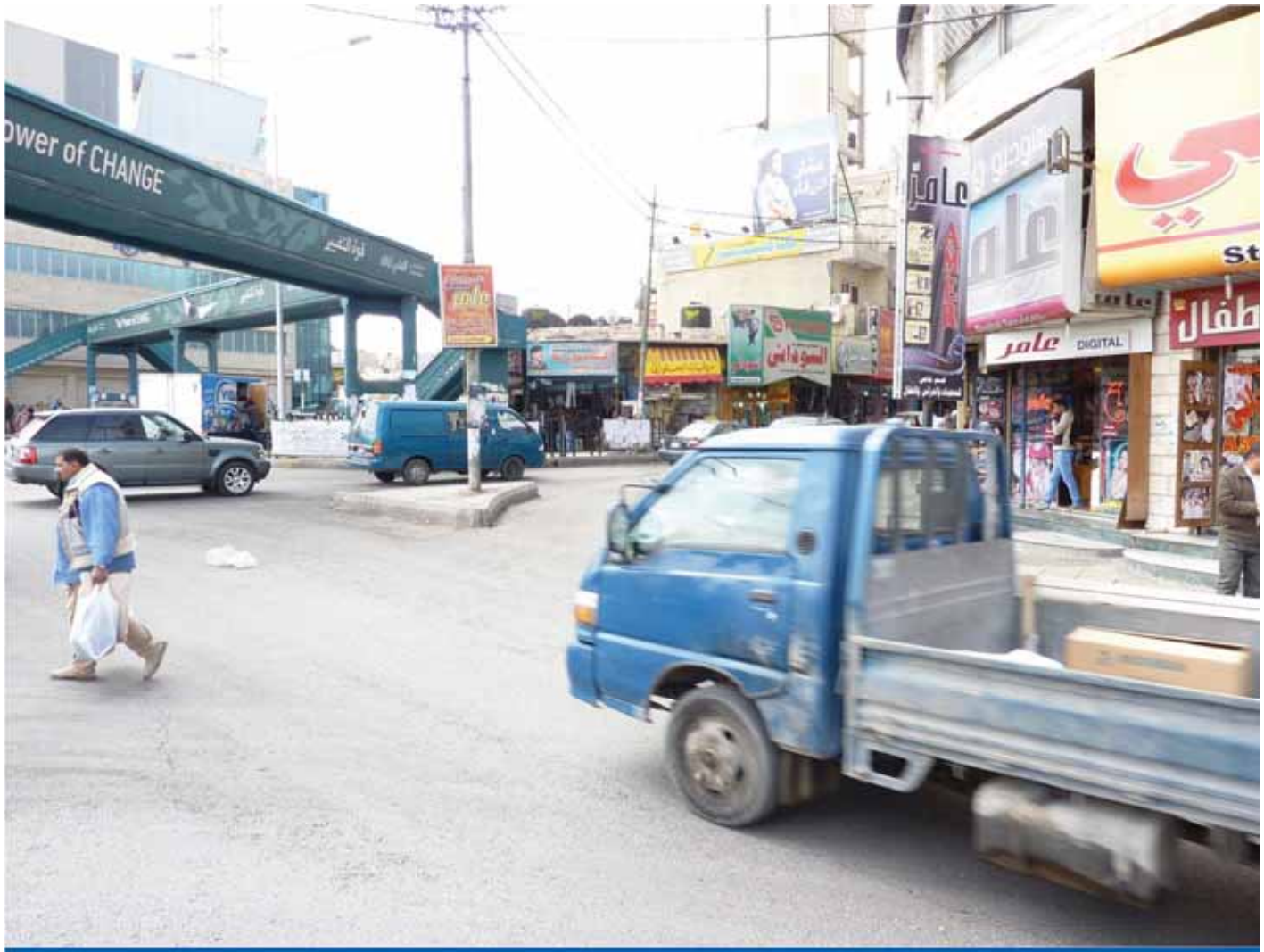

Developing an Energy Efficient Urban Transport Plan for Zarqa City Downtown Area

Final Report – Volume 2

World Bank / ESMAP

November 2011

UNITED BY OUR DIFFERENCE

WSP

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CONSOLIDATED CONSULTANTS

Engineering & Environment

ESMAP

Energy Sector Management Assistance Program

Document of the World Bank

ESMAP Mission
The Energy Sector Management Assistance Program (ESMAP) is a global knowledge and technical assistance trust fund program administered by the World Bank and assists low- and middle-income countries to increase know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth.

Contents

Appendix A Traffic Survey Results Summary

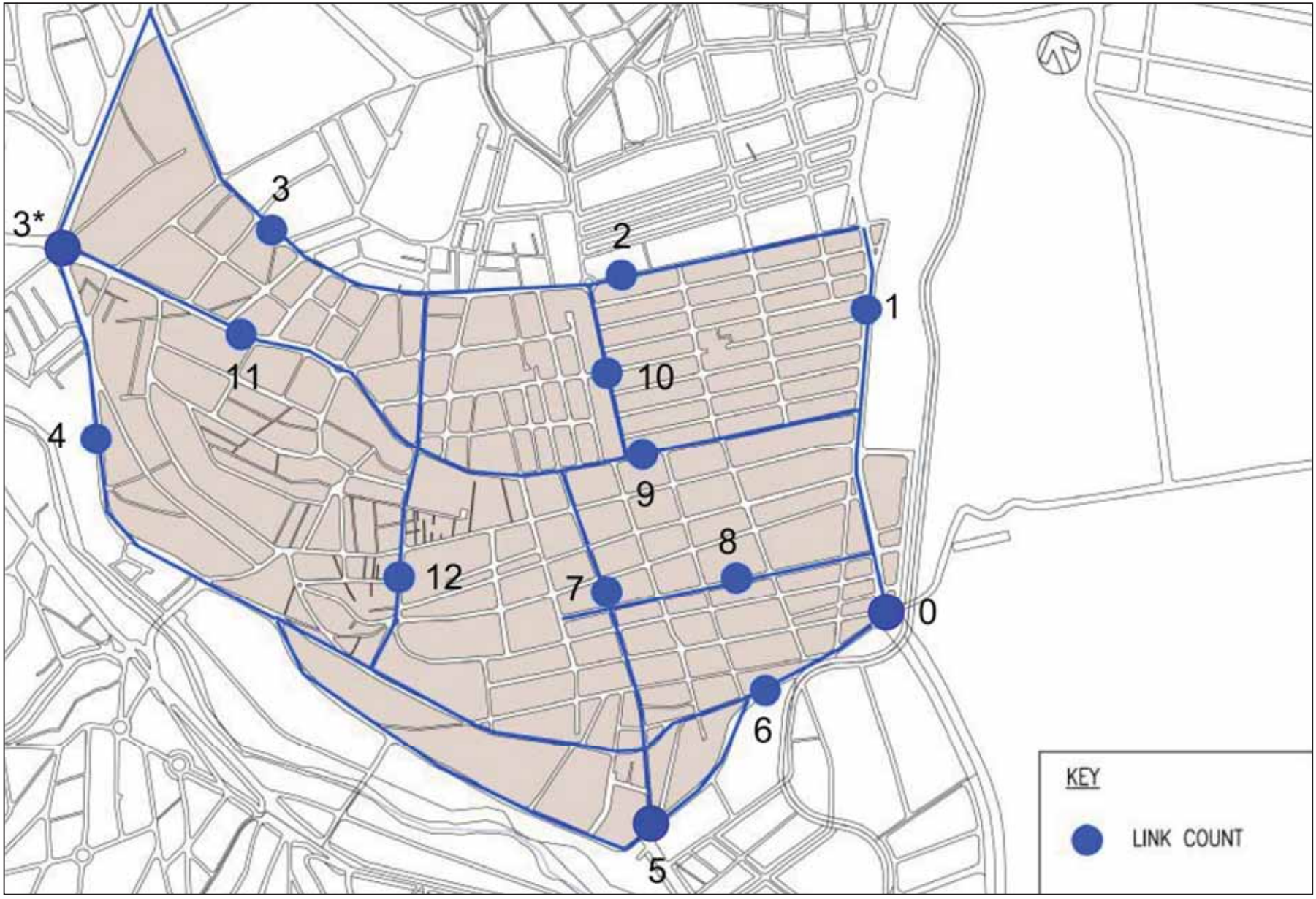
Traffic Survey Details

Survey Date	12th March 2011 – 19th March 2011
Survey Time	07:00 – 14:30
Survey Duration	15 minute time periods
Survey Location	Downtown Zarqa – 14 Junctions (See Figure A1)
Survey Rationale	To quantify traffic levels in downtown Zarqa and ascertain the vehicle composition (e.g. proportion of HGVs, private vehicles)
Survey Approach	14 junctions were selected to be surveyed. The proposed locations cover major roads through the downtown area to indicate both link flows and demand at junctions. A number of junctions on the downtown ring road were selected to observe traffic entering the downtown area, and the volume of traffic accommodated on the peripheral route (including the main Zarqa – Amman highway). Survey staff were stationed on each major link at a junction and tasked with noting each vehicle by vehicle type during the 15 minute time period. Traffic counts were separated by direction of flow.
Survey Classification	Vehicles were classified by the following categories: - Private Car - Pick Up - Van - Taxi - Service - Minibus - Large Bus - Heavy Vehicle

Table A1: Traffic Survey Results Summary

		1 Hour Flows		1 Hour Flows (Two Way)	
LOCATION	Street / Direction	All Vehicles	Private Car + Taxi	All Vehicles	Private Car + Taxi
0	inside tunnel to north	456	366		
0	inside tunnel to south	1,038	790	1,494	1,156
0	right turn to north	88	64		
0	right turn to south	672	426	760	490
0	**TOTAL**	**2,254**	**1,646**	**2,254**	**1,646**
1	to north	1,670	810		
1	to south	2,056	870	3,726	1,680
1	**TOTAL**	**3,726**	**1,680**	**3,726**	**1,680**
2	toward roundabout	256	180		
2	toward jesh street	304	216	560	396
2	**TOTAL**	**560**	**396**	**560**	**396**
3	toward makka street	734	536		
3	toward roundabout	580	410	1,314	946
3	**TOTAL**	**1,314**	**946**	**1,314**	**946**
3*	north	980	760		
3*	south	1,082	910	2,062	1,670
3*	**TOTAL**	**2,062**	**1,670**	**2,062**	**1,670**
4	north	700	508		
4	south	1,140	756	1,840	1,264
4	**TOTAL**	**1,840**	**1,264**	**1,840**	**1,264**
5	zohour street	414	282	414	282
5	king Talal street from yajoz	978	714	978	714
5	king Talal street	608	420	608	420
5	bareed street	326	208	326	208
5	**TOTAL**	**2,326**	**1,624**	**2,326**	**1,624**
6	to west	1,480	370		
6	to east	1,224	344	2,704	714
6	**TOTAL**	**2,704**	**714**	**2,704**	**714**
7	to south	588	456	588	456
7	**TOTAL**	**588**	**456**	**588**	**456**
8	to west	460	394		
8	to east	402	350	862	744
8	**TOTAL**	**862**	**744**	**862**	**744**
9	to east	370	238		
9	to west	412	294	782	532
9	**TOTAL**	**782**	**532**	**782**	**532**
10	toward roundabout	518	390	518	390
10	**TOTAL**	**518**	**390**	**518**	**390**
11	to east	882	568		
11	toward roundabout	792	512	1,674	1,080
11	**TOTAL**	**1,674**	**1,080**	**1,674**	**1,080**
12	Anas bin Malik str	1,218	620	1,218	620
12	**TOTAL**	**1,218**	**620**	**1,218**	**620**

Figure A1 - Traffic Survey Location Plan



Appendix B Energy and Emissions Modelling Methodology

Trip Generation

Emission Factors

Future Baseline Forecasting

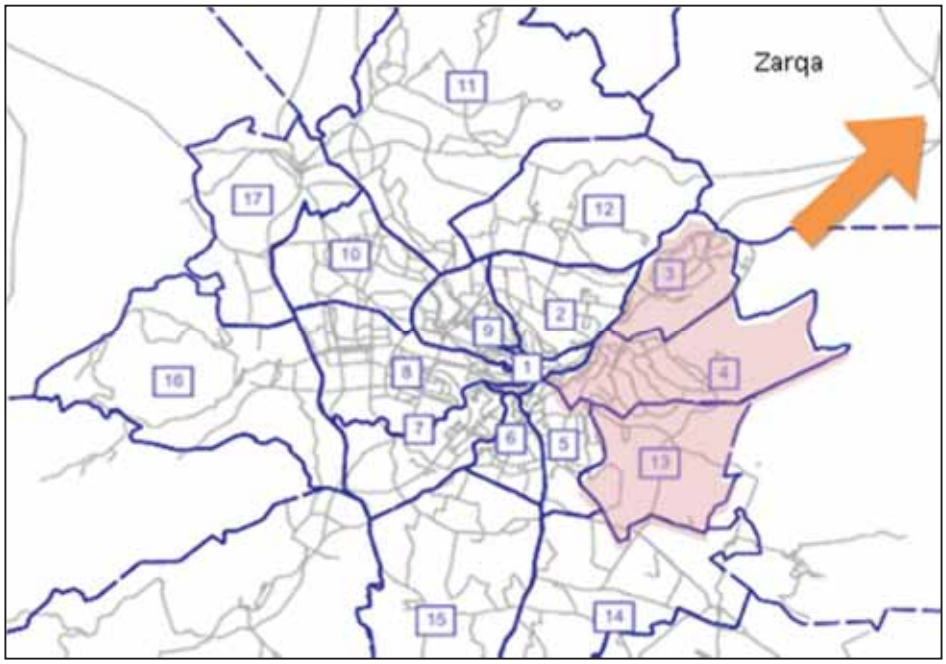
Trip Generation

There is limited data available relating to Zarqa City, and specifically there is no household survey data. However, data exists for the nearby city of Amman, which due to the close proximity in location and the comparable characteristics of certain areas of the two cities, is considered the closest representation to Zarqa that is possible for this assessment.

As part of the Amman Transport and Mobility Master Plan (TMMP) [(1)] project, the consultants developed the Amman Trip End Model which formed an element of the Greater Amman Multi-Modal Transportation model. The Amman Trip End Model was built using data from transport and household surveys [(2)] conducted to establish key transport and socio economic characteristics and relationships in Amman in 2008.

The Amman Trip End Model has therefore been modified for use in this project by only considering the three zones (3, 4, and 13, as illustrated below in Figure B1) which are most comparable with Zarqa in terms of socio-economic characteristics, primarily household income which has a significant influence on car ownership.

Figure B1: Amman Trip End Model Zones



Source: Consultant

The characteristics of the three zones shown in Figure B1 above and of Zarqa City are set out in Table B.1 below.

Table B.1: Amman Zone Characteristics

Zone	Household Monthly Income (JD)	Household Size (people)
Amman 3	416.8	4.5
Amman 4	395.5	4.6
Amman 13	446.8	4.7
ZARQA CITY	**465.0**	**5.5**

The amended trip end model uses Zarqa specific data (population, household income, and household size) in combination with transport and socio economic characteristics from the three representative zones in Amman to calculate multi-modal person trip generation by journey purpose for Zarqa City.

Details regarding the calculation of Zarqa income are presented below.

Calculation of Zarqa Residents Income

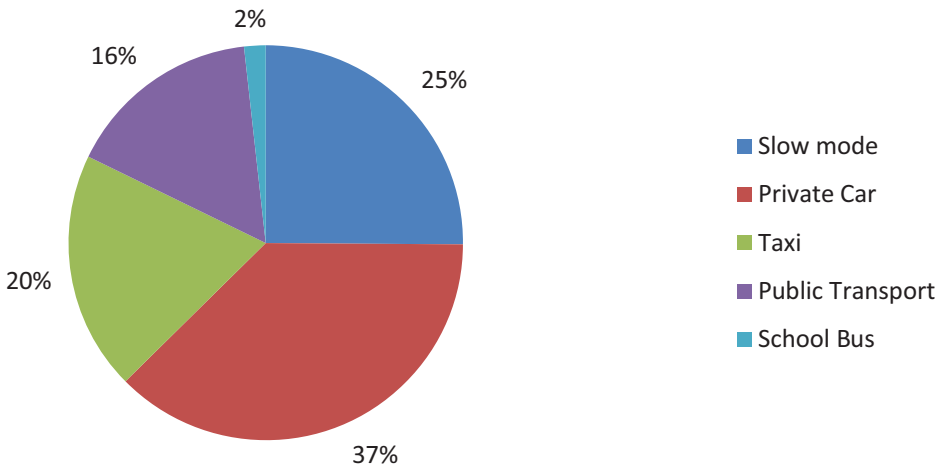
Source: The Hashemite Kingdom of Jordan Department of Statistics (DOS) Household Expenditures & Income Survey 2008 [2]

Income Type					Annual Income in JD	To be included?	Total (by Type)
Income from Rent-	Building Rent-	Occupied by Owners			565.1	Y	790.7
		Rented			179.8	Y	
	Other Rents				45.8	Y	
Own Account Income-					1070.7	Y	1070.7
Income from Employment-	Payments in Kind-				25.4	Y	3151.7
	Wages & Salaries in Cash-	Net Income			2943.8	N	
		Gross Income			3126.3	Y	
Property Income-	Profits & Dividends				75.3	Y	75.3
	Interests-	Bonds			0	Y	
		Deposits-	Outside Jordan		0	Y	
			Inside Jordan		0	Y	
	Land Rent				0	Y	
Other Current Transfer Income-	Transfers Income-	Gifts-	In Kind		36.6	N	506
			Cash		97.5	N	
		Received Insurance Claims			0.3	N	
		Social Security Benefits			21.3	N	
		Pensions			506	Y	
	Other Current Transfer -	Non-Residents			83.4	N	
		Residents-	Government		264.3	N	
			Non-Government-	Households	246.6	N	
				Non-Profit Insititutes	2.6	N	
				Others	1	N	

Type	Income in JD
Income from Rent	790.7
Own Account Income	1070.7
Income from Employment	3151.7
Property Income	75.3
Other Current Transfer Income	506
Total annual income	**5594.4**
Monthly income	**466.2**

Using the above approach, the 2008 mode share for Zarqa calculated in the model is presented in Figure B2 below.

Figure B2: 2008 Mode Split



Source: Consultant

An approximate journey purpose split calculated using the trip end model is set out in Table B.2 below.

Table B.2: Zarqa City Trip Journey Purpose Proportions

Journey Purpose Type	Proportion of Trips (%)
Home-Based Work	28.1%
Home-Based College	6.2%
Home-Based School	34.0%
Home-Based Shopping	7.1%
Home-Based Others	13.5%
Non Home-Based	11.0%

The model estimates that on average, each person in Zarqa City makes 1.7 one-way trips per day. The results of the model therefore provide an indication of multi-modal person trip generation with an estimate of journey purpose for all trips.

Travel Demand - Private Vehicle

As set out above, the trip end model provides an estimate of the total person trip generation for Zarqa City, along with a modal split. Using typical private vehicle and yellow taxi occupancy levels (1.3 people and 1.4 people respectively) from the Amman study [(1)] for best representation of Zarqa, it is possible to convert the private vehicle person trips into an estimate of vehicle trips.

The distribution of private vehicle trips, and hence calculation of vehicle distance travelled, has been based on Geographical Information System (GIS) [(3)] data that allows demand to be spatially modelled and analysed.

Zarqa City has been split into 7 zones, with an additional 9 zones representing areas external to the city as shown in Figure B3 and Figure B4 below. These zones were derived from the zone structure of the Zarqa Masterplan. Zones 1 to 7 represent the internal Zarqa city zones with zone 1 being Zarqa downtown. The KABAAC housing development is represented in Zone 3. Zones 7 to 16 are external zones.

Figure B3: Zarqa Zoning Systems

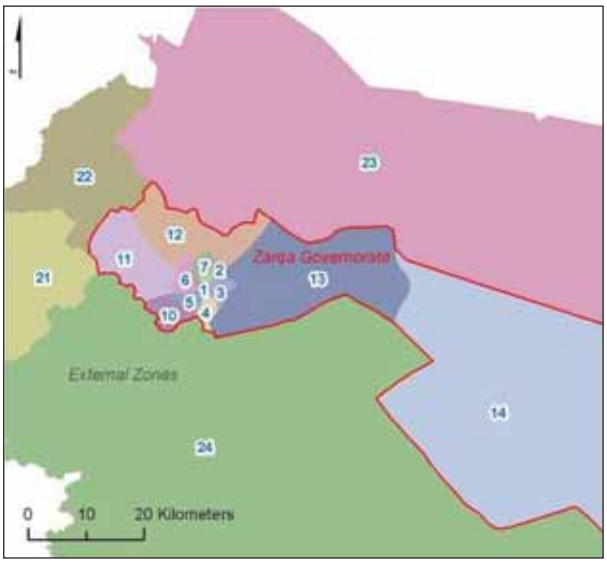
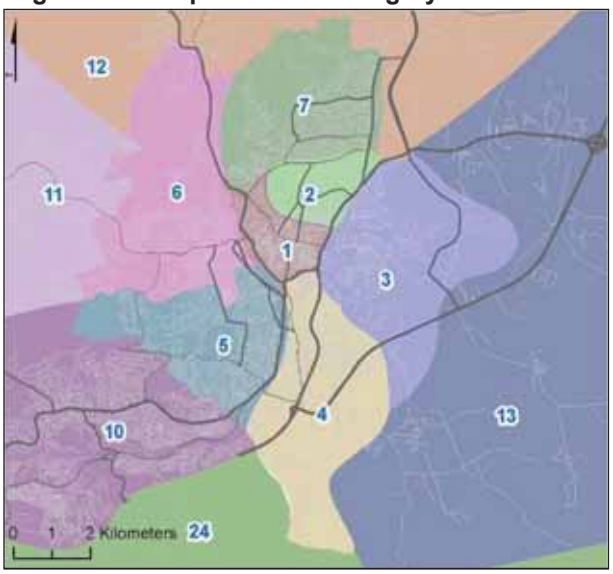
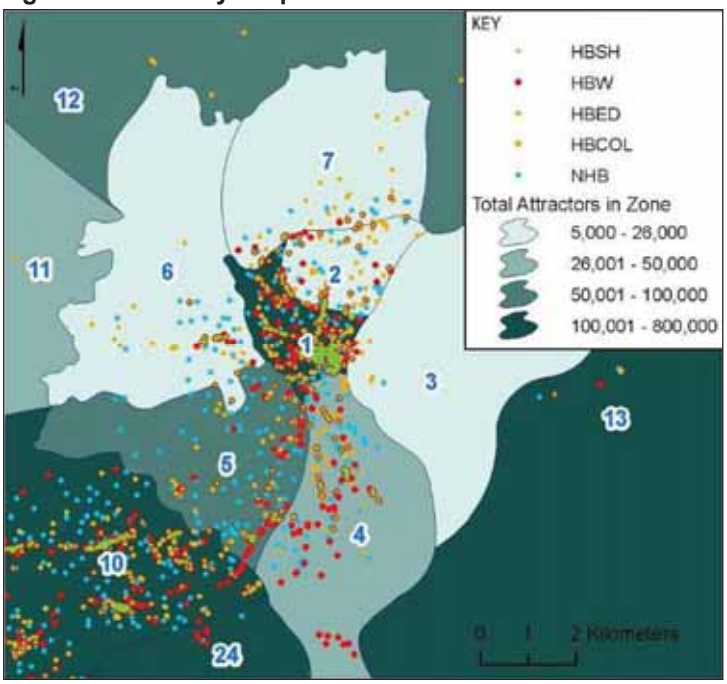


Figure B4: Zarqa Internal Zoning Systems



A key influence on trip distribution is the location and density of attractions within Zarqa and external zones such as the amount of employment, retail and education establishments in each zone. Figure B5 below illustrates the distribution of attractions by journey type which has been calculated using GIS.

Figure B5: Journey Purpose Attractors



HBSH Home Based Shopping
HBW Home Based Work
HBED Home Based Education
HBCOL Home Based College
NHB Non Home Based

Source: Consultant

Furthermore, the distribution of private vehicle trips also takes into account the following factors:

- Zonal Attractiveness
- Journey Time which relates to journey distance and speed;
- Vehicle Operating Costs i.e. costs of running and maintaining a private car;
- Value of Time;
- Vehicle Occupancy; and
- Parking Costs.

The vehicle trip distribution for private vehicles and yellow taxis has been adjusted using traffic count data [4] for key highway corridors leading to external zones. This process has ensured that the number of vehicles predicted to travel externally from Zarqa City is representative and in line with observed levels of traffic.

The final output of the trip generation and distribution process is a value for the total distance travelled by private vehicles and yellow taxis per day, as set out in Table B.3 below.

Table B.3: Private Vehicle Travel Demand (2008)

Transport Mode	Daily Vehicle Distance Travelled (km)
Private Vehicle	2,703,700
Yellow Taxi	1,350,400

Source: Consultant

Travel Demand – Public Transport

White Taxi, Minibus, Bus

Due to the variation in public transport occupancy levels it was not deemed appropriate to convert passenger trip generation into vehicle travel demand for public transport modes. An alternative method has therefore been used to calculate public transport travel demand.

A first principles approach has been used to estimate public transport demand in terms of vehicle trips and distance travelled for white taxis, mini-buses, and buses. The approach uses data provided by LTRC for the WSP-CC Jordan Bus Network Restructuring project [5], such as number of vehicles serving internal and external routes in combination with route lengths measured from GIS, and assumptions regarding the utilisation and average speed of vehicles to calculate the typical number of journeys carried out per vehicle per day, and the overall vehicle distance travelled by public transport modes. Key assumptions used are as follows:

- Average Speed on intra-governorate routes = 25km/h, and inter-governorate routes = 35km/h
- Assume 4 hour Peak Period with 100% utilisation, 8 hour off-peak period with 50% utilisation
- Assume an addition of 10% to journey time for turn-around between trips
- Assume each vehicle is in use 5 days out of 7

School Buses

A similar process was undertaken to estimate the vehicle demand for school buses, associated with private schools in the city.

The precise number of private schools in Zarqa City is not known, therefore the estimate has been made based on advice from the CG members to provide a realistic school bus trip generation and mode share for school bus travel.

Assumptions for school bus trip generation are as follows:

- There are approximately 443 schools in Zarqa City [6];
- Although 38% of schools in Jordan are private [6], it is estimated that the proportion in Zarqa is far lower. Therefore it has been estimated that there are 50 private schools in Zarqa City (i.e. approx. 11% of schools);
- The number of pupils per private school has been based upon the average for Jordan (i.e. 2,126 private schools accommodating 330,489 pupils = 155 pupils per school) [6];
- Bus capacity is approximately 20 pupils, and average distance travelled per bus per day is 20km (two-way);

All Public Transport

The total travel demand for public transport is summarised in Table B.4 below.

Table B.4: Public Transport Travel Demand (2008)

Public Transport Mode	Daily Vehicle Distance Travelled (km)
White Taxi	19,100
Minibus	127,200
Bus	30,600
School Bus	4,500

Source: Consultant

Emission Factors

The International Vehicle Emissions (IVE) model [7] is used to generate emission factors (kg/veh-km) for input into the Emission Model. The emissions of interest include CH4, CO2, N2O, NOX, PM and SOX.

The IVE model is a computer model designed to estimate emissions from motor vehicles. The IVE model development was funded by the U.S. Environmental Protection Agency and developed by University of California at Riverside, College of Engineering, Centre for Environmental Research and Technology (CE-CERT), Global Sustainable Systems Research (GSSR), and the International Sustainable Systems Research Centre (ISSRC).

The IVE model requires two main input files, 'Fleet' and 'Location', which describe the vehicle fleet and vehicle activity (i.e. driving behaviour). A third optional input file is used for calibration purposes.

Five vehicle fleet types were created for Zarqa: Private Cars, Yellow Taxis, White Taxis, Minibuses and Buses. Using vehicle age data derived from Jordan's Statistical Yearbook, along with vehicle fuel type data from the Driving License Department, the distribution of vehicles between vehicle type and mileage has been inputted to the IVE model. Further details regarding the assumptions used in the IVE model are set out below:

- Vehicle Age has been based on Amman data from Amman as a close representation of Zarqa, provided by GAM [8];
- Fuel characteristics have been based on Jordan's Gasoline and Diesel specs from the 'Middle East Fuel Quality Overview Presentation' by Hart Energy Consulting to UNEP Jordan National Post Lead Workshop [9]
- Driver behaviour characteristics have been based on the Istanbul profile within the IVE model [7]
- Vehicle fleets have been chosen using representative vehicle models for characteristics such as weight, age, fuel type (Jordan Driving Licence Department Statistics for Amman and Zarqa) [10]
- School buses are similar to minibuses therefore one factor is calculated for both modes
- Emission factors for CO2, NOX, PM and CO have been compared with known emission factors [11] to ensure they are in line with typical values.

The emissions factors are applied to the vehicle distances calculated in the trip generation process to estimate the total emissions from passenger transport in Zarqa City.

Future Baseline Forecasting Methodology

The assumptions made for the future baseline modelling are set out below.

Private Vehicle Trip Generation

- Trip Generation is dictated by the Trip End Model
- Increase the population at an annual rate of 2.2% in line with Jordan Statistical Yearbook [6]
- Increase household income in line with predicted GDP per capita growth for Jordan (forecast from International Monetary Fund, World Economic Outlook Database [12])
- Income affects the Car Ownership. The modelled car ownership has been checked and validated against forecast car ownership levels using Jordan Statistical Yearbook [6] as shown Table B.5 below.
- Journey Purpose, Trip Rate, and Mode Share are impacted by forecast car ownership and income levels

Table B.5: Forecast Income and Car Ownership

Year	GDP per Capita (JD)*	Monthly Income (JD)**	Cars per 1000 People (Trip End Model)***	Cars per 1000 People (Jordan Statistical Yearbook)****
2008	2,754	465	159	159
2010	3,147	531	174	175
2015	4,280	723	228	229
2020	5,367	906	270	283

*2008 – 2015 data provided by International Monetary Fund, World Economic Outlook Database, 2020 forecast using this data. (12)

** 2008 taken from Household Expenditure and Income Survey, forecast using GDP per Capita Growth (2)

*** Forecast using Trip End Model (1)

**** Forecast using 1998 – 2008 data on Number of Licenced Cars / Population in Zarqa and Amman (8)

King Abdullah Bid Abdul Aziz City

The KABAAC site to the east of Zarqa city is envisaged to house 500,000 people. The new trips generated by the development have been accounted for separately to the population growth included in the trip end model. This study assumes the same trip rate, mode split, and journey purpose split as the existing Zarqa City. Where possible, data has been extracted from the KABAAC Transport Impact Assessment [13] with regard to population numbers.

Population for KABAAC has been accounted for as follows:

- 2010 – No development complete
- 2015 – Phase 1 complete (22,460 people)
- 2020 – Phase 1 plus half of Phase 2 complete (56,433 people)

Private Vehicle Trip Distribution

The private vehicle trip distribution process remains the same in 2010 as it stands in 2008, using attractors in each zone to distribute traffic. In the 2008 baseline, the volume of traffic travelling to external zones was validated using traffic surveys. The same proportion of total vehicles travelling to external zones has been used for future baseline years.

However, in 2015 and 2020, the attractors in Zone 3 (KABAAC) have been edited to introduce demand for travel to and from this area. Furthermore, the Value of Time (VOT) and Vehicle Operating Costs (VOC)

which impact the distribution of private vehicles and yellow taxis in the model have been forecast for future years to account for improvements in vehicle efficiency and the changing cost of fuel.

Public Transport Trip Generation

For the purpose of predicting future baseline emissions, it has been assumed that no significant expansion of the public transport network will be made beyond a growth in vehicle provision in line with population growth to accommodate additional demand. Therefore, the number of vehicles in use in future years has been calculated as a factor of population growth, with average route lengths and service structure remaining the same. The same methodology has been applied to the growth of school bus services, which have been factored in line with predicted population expansion leading to increased number of private school pupils.

Emission Factors

No changes have been made to the future baseline scenarios to retain a 'do minimum' prediction of conditions in 2010, 2015 and 2020.

Appendix C Project 1

Integration of Land Use and Transport Planning

PROJECT 1: INTEGRATE LAND USE AND TRANSPORT PLANNING THROUGH NEW BUS ROUTES AND POLICY CHANGES

Implementing Bus Services for New Development

The most significant development currently under construction in the area is the King Abdullah Bin Abdul Aziz City housing development, to the east of the Zarqa Downtown area. Although the planning area concerned does not currently come under the jurisdiction of Zarqa Municipality, its close proximity to Zarqa and the strong interconnectivity of trips between the new development and the various facilities in Zarqa City, including the Downtown area, make it absolutely essential that public transport services are developed to provide an attractive alternative to the private car.

In considering the current state of build-out for this development, a number of problems are apparent. New construction is not concentrated in one particular area, a number of sites have been completed, or are under construction, which are some distance from each other. In addition, the housing types vary from villas to apartments, and many are not normally of the type of housing that attracts public transport usage.

These types of problem are not unusual with such large scale development, and our recommendation would be for the introduction of a circular 'loop' type of bus service, operating on a 15 minute frequency in both clockwise and anti-clockwise directions connecting the main areas of construction with both New Zarqa and the King Abdullah Terminal for the Downtown area. In addition, it is recommended that an existing route is extended to serve the housing and industrial area to the immediate south west of this new development area. In the context of the service grouping concept, described in Proposal 2 of this Report, these two routes would form part of a group of 7 services, which would primarily cover new housing and other development to the east and south east of the Downtown area.

It is suggested that the operators involved in the 18 contracts currently covering this group of services are encouraged to join together to operate a single new contract, which will include the new services for King Abdullah Bin Abdul Aziz City, and which will require 35 midibuses and 8 medium sizes buses rather than the 24 minibuses currently licensed. One approach to assisting with the capitalisation required for investment would be for the public sector to purchase the required 43 vehicles, and lease them back to the new company, partnership or co-operative formed to operate the contract. If CNG facilities can be provided, it would be preferable to invest in this type of fuel for the new vehicles, which would need to be to a suitable specification.

A map showing the relevant proposed bus services is shown in Figure D6 of Appendix D.

Appendix D Project 2

Public Transport Services Improvements

PROJECT 2: PUBLIC TRANSPORT SERVICES IMPROVEMENTS

Components of the Proposal

In seeking to address the problems regarding public transport outlined in the main report, we have adopted the following approach:

- The greatest emphasis has been placed on local services which operate within the urban envelope of Zarqa and terminate in the Downtown area, as these account for the largest proportion of movements into the Downtown area;
- The interrelationship between public transport trips within the Amman to Zarqa corridor and university movements has been given consideration because of the problems created and the relevance to future development of a rapid transit system along this corridor;
- Bus services have been analysed and placed into groups that generally relate to geographic areas;
- Suggestions for reorganisation of the structure of bus operation are considered, as moving from the current system to a restructured one presents the most difficult challenges within this proposal;
- The most suitable routeing through the Downtown area for buses has been given particular attention, particularly in relation to bus priority measures;
- It is accepted that, for those local bus services traversing the Downtown area of Zarqa, operation will need to continue to be undertaken by small vehicles, due to the street conditions, although ideas for the introduction of more modern, attractive midibuses are explored;
- Bus services which primarily cover just the Downtown area of Zarqa are considered to be most suitable for operation by white taxis, whilst services to the outer urban areas of Zarqa are most suited to larger vehicles. This has resulted in some vehicle type changes between routes in our proposed bus service network.
- Accessibility to the Downtown area is very important, thus the retention of well-located terminals, such as King Abdullah, the Downtown White Taxi terminal and to a lesser extent, Prince Rashid, is a key element of the proposal. However, it is envisaged that new terminal facilities located at New Zarqa and at Al-Sukneh Street will also enable additional interchange facilities and operate as Park and Ride sites, as described in more detail in Project 3.
- The Downtown area of Zarqa is always likely to be busy with traffic, with some congestion, despite proposed improvements, therefore to enhance accessibility and increase footfall, it is very important to develop bus priority measures. In order to facilitate this need, a small number of bus priority corridors have been identified, and bus services other than those operated by white taxis have been rerouted to use these corridors. Bus services from surrounding towns and villages and the longer distance core network services are routed to avoid having to enter the Downtown area, whilst still serving King Abdullah and/or Prince Rashid Terminals to provide good access to the Downtown area.

The proposed bus service network to serve the urban areas of Zarqa is shown in a series of tables (Tables D1 to D3) and maps divided into proposed contract groups (Figures D1 to D11) within this Appendix. These are based on the groups of services mentioned above, and offer the opportunity to make structural changes in a phased way, rather than having to implement all changes simultaneously. A map showing all these services together is shown at Figure D13, whilst a street plan of Zarqa Downtown area, showing the proposed streets requiring bus priority measures, can also be found within this Appendix as Figure D12.

Implementation

In order to achieve a successful implementation of the proposed changes, the following stages will need to be undertaken. These stages require a mixture of the following skills:

- Transport planning – data needs to be collected and analysed, and frequent checks need to be made to enable the core detailed designs to be adjusted in line with the emergence of more detailed information and any changing circumstances;
- Organisational structure – the changes are only likely to be successful through joint engagement of key players, such as the LTRC (who would lead the process), the Municipality and the bus operating industry. Such joint working and agreeing of detailed plans also needs to be accompanied by adequate staffing levels with the requisite skills;
- Human relationships – transforming a fractured and small scale industry into a more coherent and integrated number of operating units is extremely challenging, and will require tact, diplomacy and persuasion together with adequate resources to ensure that all those affected by change are not financially disadvantaged as a result;

- Financial resources – although the ultimate intention is to create a stable, more financially profitable operating industry, this will not be possible without some degree of 'pump priming' and possible on-going subsidy payment for elements of the required network which are inherently non-profitable. In addition, new investment will be essential to make using buses more attractive and to achieve the objective of increased energy efficiency.

Stage 1. Form a joint working partnership between the key stakeholders (primarily LTRC, the Zarqa Municipality and a credible representative organisation for the bus operating industry) and agree a programme in principle;

Stage 2. Undertake a full survey of current bus services to ascertain trip characteristics and load factors. This is most easily achieved through the use of surveyors and manual counts, although the gathered data can then be entered into a simple software suite. Funding needs to be identified for this exercise, although it should not be overly expensive – for example, students might be used, provided that they are adequately supervised.

Stage 3. The collated data should be analysed by comparison with the planned network to ensure that capacity and frequency match current and future loading patterns and that current trip patterns are successfully covered by the proposed services. An examination of planned development should also be undertaken to ensure that planned route networks can accommodate their transport needs.

Stage 4. Discussions should take place with the operators currently holding contracts for each group of proposed routes, with a view to understanding:

- Peak vehicle requirements and the degree to which vehicles are underutilised during the non-peak period;
- Revenue income, as set against operating costs;
- A business case for the new proposed network in terms of the number and type of buses required the projected income and any income shortfalls.

Stage 5. Organisational structures need to be discussed with the relevant operators. These could take the form of:

- The formation of a co-operative to agree on sharing revenue income and expenditure and agree individual contributions;
- The creation of a holding company constituting a small business with agreed shareholdings between the current operators;
- Incorporating the bus operators into an existing bus company operation, which would require agreement for purchase of buses and offer of employment;
- This exercise would need to have the benefit of experienced business advisers from the relevant Government Department, and the development of a compensation procedure for the inevitable reduction in the number of buses required, and also for any operator wishing to withdraw from the market. Opportunities to access sources of investment capital for replacing existing vehicles and equipment also need to be provided;
- It would also require agreement with regard to possible subsidy requirements, dependent on a detailed assessment of operating costs against potential income. In the event of subsidy payment, this might be handled through the use of 'open book' accounting for a fixed period, for example five years, during which income and expenditure would be monitored, with a guaranteed profit level being provided.

Stage 6. If agreement can be reached on these points, detailed timetables and publicity need to be developed, together with staffing requirements, together with the finalisation of business plans, including critical aspects such as cash flow projections.

Stage 7. LTRC should consider organising staff training facilities, particularly for those small operators which are being reorganised into larger units such as driver training, customer care and 'green driving' techniques.

In terms of the provision of bus priority measures, these can be designed separately from the restructuring of routes and operations by concentrating on those roads within and around the Downtown area which are currently utilised, and will continue to be used under the network re-planning exercise. Required measures would include bus priority lanes, and priority turns at intersections, as described elsewhere in this report.

Date Modified: 30/11/2009

Drawn By: uktxp004

File: Q:\WSP_UK\WSP_DiHolborn\Projects\Amman PTRC Bus Restructure 11680223\Analysis\ArcGIS\MapDocuments\PT1\City Maps\Others.mxd

Legend

'Service' White car routes

Terminals

ALHASHMYAH

653

651

652

652

652
653

651

QASABET ALZARQA

654

Service Terminal
651,652,653,654

Hayy Umm Bayandha

654

ALRUSAIFAH

MARKA

0 420 840 1,680

Meters

Proposed Urban Bus Routes Zarqa

Figure D1

651, 652, 653, 654

Date Modified: 10/05/2011

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File: Q:\WSP_UK\WSP_D\Holbom\Projects\Amman PTRC Bus Restructure 11680223\Analysis\ArcGIS\MapDocuments\PT1\Zarqa Maps - 0400511\City Routes Proposed - Zarqa 660 Routes.mxd

Legend

660 Group of Routes

Terminals

ALHASHMYAH

667

660, 666

666

660

New Zarqa Terminal
660, 667

666

667

657

666

667

660

657

666
667

King Abdullah
Terminal
657,660
667,666

660

QASABET ALZARQA

660

ALRUSAIFAH

MARKA

0 500 1,000 2,000
Meters

Proposed Urban
Bus Routes Zarqa

FIGURE D2
657, 660, 666, 667

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ALHASHMYAH

Legend

661Group of Routes

Terminals

Hayy Ma'sum

661

661

QASABET ALZARQA

661 King Abdullah Terminal

ALRUSAIFAH

0 280 560 1,120

Meters

Proposed Urban
Bus Routes Zarqa

FIGURE D3
661

Date Modified: 30/11/2009

Drawn By: uktxp004

File: Q:\WSP_UK\WSP_DiHolborn\Projects\Amman PTRC Bus Restructure 11680223\Analysis\ArcGIS\MapDocuments\PT1\City Maps\Others.mxd

Legend

662 Group of Routes

Terminals

ALHASHMYAH

Hayy Al Jadida

663

Hayy Batrawi

662

665

662,663
665

655

662,663,665

King Abdullah Terminal

655,662,663

QASABET ALZARQA

ALRUSAIFAH

MARKA

0 420 840 1,680

Meters

Proposed Urban Bus Routes Zarqa

Figure D4

655,662,663,664,665

Date Modified: 30/11/2009

Drawn By: aktxp004

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Legend

668 Group of Routes

Terminals

ALHASHMYAH

Northern Hayy
668

668

New Zarqa Terminal
669

669

668

668,669

King Abdullah Terminal
668,669

QASABET ALZARQA

Prince Rashid Terminal
668, 669

ALRUSAIFAH

MARKA

0 420 840 1,680
Meters

Proposed Urban Bus Routes Zarqa

FIGURE D5
668,669

Date Modified: 30/11/2009
Drawn By: ukfxp004
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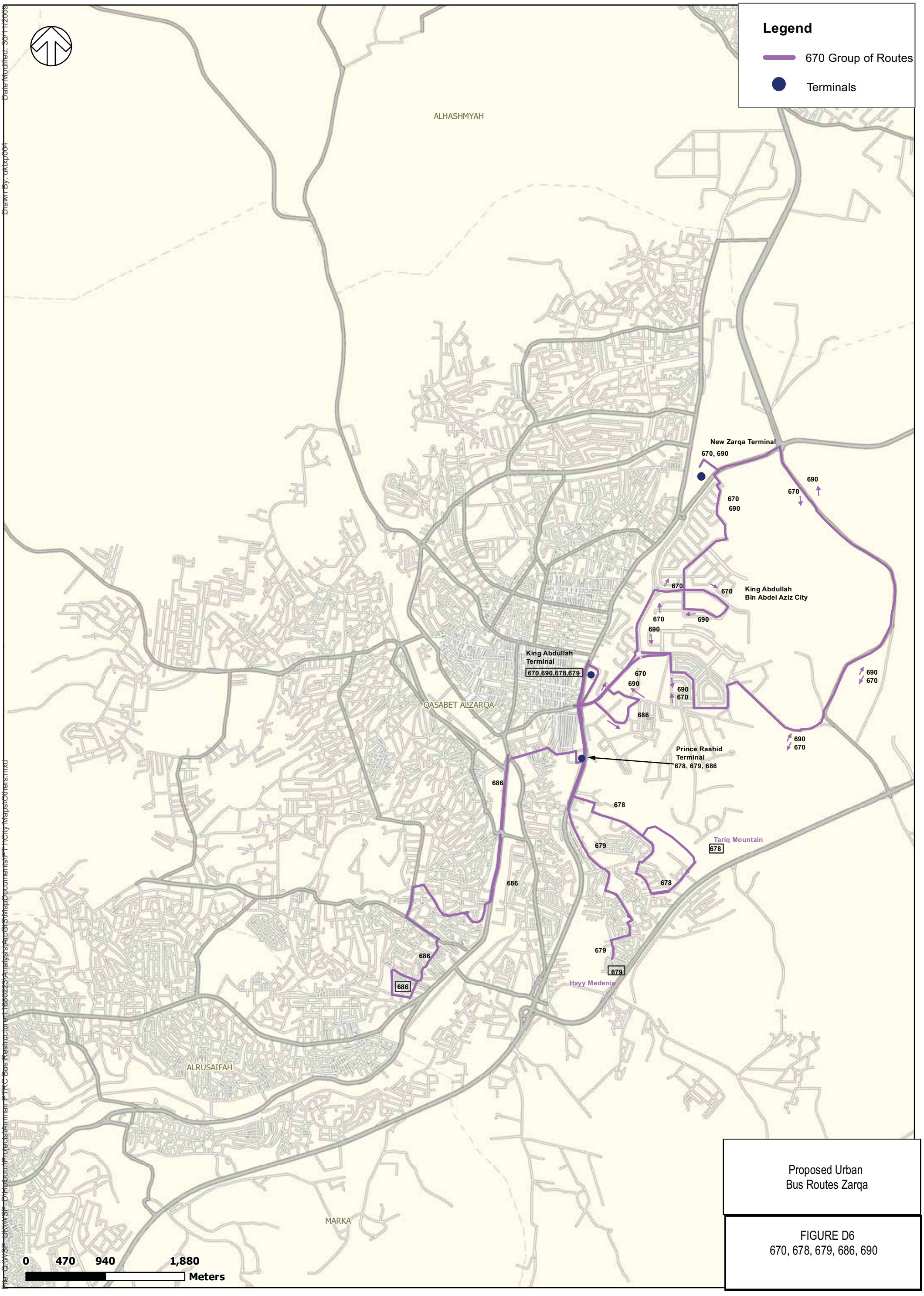

Proposed Urban
Bus Routes Zarqa

FIGURE D6
670, 678, 679, 686, 690

Date Modified: 30/11/2009

Drawn By: uktxp004

File: Q:\WSP_UK\WSP_D\Holbom\Projects\Amman PTRC Bus Restructure 11680223\Analysis\ArcGIS\MapDocuments\PT1\City Maps\Others.mxd

Legend

671 Group of Routes

Terminals

ALHASHMYAH

Hayy Shumar 671

Hayy Al Junayna 672

Dhahiyat Al Quss 673

673,674

674

QASABET ALZARQA

671 673

672

King Abdullah Terminal 671,672,673,674

Al Qadisiyah

684

Hayy Mashayeifuh

ALRUSAIFAH

Russeifa 674

MARKA

0 420 840 1,680 Meters

Proposed Urban Bus Routes Zarqa

FIGURE D7
671, 672, 673, 674

Date Modified: 30/11/2009

Drawn By: uktxp004

File: Q:\WSP_UK\WSP_D\Holbom\Projects\Amman PTRC Bus Restructure 11680223\Analysis\ArcGIS\MapDocuments\PT1\City Maps\Others.mxd

Legend

675 Group of Routes

Terminals

Hayy Al Jabr
675

King Abdullah Terminal
676,677

Prince Rashid Terminal
675

677
676

675

676

675

675

677

675

675

675

676

676
Al Qadisiyah

675

677

675

677

677

677

0 500 1,000 2,000
Meters

Proposed Urban
Bus Routes Zarqa

FIGURE D8
675, 676, 677

Date Modified: 30/11/2009

Drawn By: uktxp004

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Legend

680 Group of Routes

Terminals

ALHASHMYAH

QASABET ALZARQA

ALRUSAIFAH

MARKA

King Abdullah Terminal
680,681

Prince Rashid Terminal
682,683

680, 681

680
681
682
683

680
681
682
683

680
681
682

682

Hayy Mashayeifuh

682

683

Hayy Masani

680

681

Wadi Al Ushsh Military Faculty

0 420 840 1,680

Meters

Proposed Urban Bus Routes Zarqa

FIGURE D9
680, 681, 682, 683

Date Modified: 30/11/2009

Drawn By: uktxp004

File: Q:\WSP_UK\WSP_D\Holborn\Projects\Amman PTRC Bus Restructure 11680223\Analysis\ArcGIS\MapDocuments\PT1\City Maps\Others.mxd

Legend

684 Group of Routes

Terminals

ALHASHMYAH

QASABET ALZARQA

King Abdullah Terminal

685

Prince Rashid Terminal

685

684

684

685

684

685

685

684

685
691

Hayy Mashayeifuh

684,685

691

692

Hayy Rashid

ALRUSAIFAH

691,692
684

Russeifa

684,691
692

MARKA

0 420 840 1,680

Meters

Proposed Urban
Bus Routes Zarqa

Figure D10

684, 685, 691, 692

Date Modified: 30/11/2009

Drawn By: uktxp004

File: Q:\WSP_UK\WSP_DiHolbom\Projects\Amman PTRC Bus Restructure 11680223\Analysis\ArcGIS\MapDocuments\PT1\City Maps\Others.mxd

Legend

687 Group of Routes

Terminals

ALHASHMYAH

QASABET ALZARQA

ALRUSAIFAH

MARKA

Prince Rashid Terminal

687

Russeifa

687

687

687

687

0 420 840 1,680

Meters

Proposed Urban Bus Routes Zarqa

FIGURE D11
687

Date Modified: 10/05/2011

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File: Q:\WSP_UK\WSP_D\Holborn\Projects\Amman PTRC Bus Restructure 11680223\Analysis\ArcGIS\MapDocuments\PT1\Zarqa Maps - 0400511\City Routes Proposed - Park and Ride.mxd

Key

Roads Requiring PT Priority

Terminals

ALHASHMYAH

New Zarqa Terminal

AL-Sukneh Street Terminal

King Abdullah Terminal

QASABET ALZARQA

Prince Rashid Terminal

ALRUSAIFAH

MARKA

0 0.3 0.6 1.2 1.8 2.4

Kilometres

PROPOSED URBAN
BUS ROUTES ZARQA

FIGURE D12

Date Modified: 30/11/2009

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File: Q:\WSP_UK\WSP_D\Holbom\Projects\Amman PTRC Bus Restructure 11680223\Analysis\ArcGIS\MapDocuments\PT1\City Maps\Others.mxd

Legend

- Urban Bus Routes
- 'Service' White car routes
- Terminals

ALHASHMYAH

Northern Hayy 668

Hayy Al Jadida 663

Hayy Batrawi 662

Hayy Shumar 671

Hayy Ma'sum 661

Hayy Al Junagna 672

Dhahiyat Al Quss 673

QASABET ALZARQA

King Abdullah Bin Abdel Aziz City

New Zarqa Terminal
660,667,669

King Abdullah Terminal
655,657,660,661,662,663,664,665,666,667,671,672,673,674,676,677,678,679,680,681,685,687,690
668,669,670,686

Service Terminal
651,652,653,654

Prince Rashid Terminal
678, 679, 680, 681, 685, 686
668, 669, 670, 675, 682, 683, 684, 687

Hayy Umm Bayadha 654

Al Qadisiyah 676

Hayy Mashayeifuh 682, 685, 691

Tariq Mountain 678

Hayy Medenis 679

Hayy Masani 680

Hayy Rashid 692

ALRUSAIFAH
691,692
674,684

Russeifa
674,687
684,691
692

MARKA

Wadi Al Ushsh 681

0 420 840 1,680 Meters

Proposed Urban Bus Routes Zarqa

FIGURE D13

Table D1: Zarqa Urban Area Current and Proposed Bus Services

Group of Routes Number	New Bus Route Number	Line Name	Type of Buses Required						Current Contract Numbers	Types of Buses Currently Operated			TOTAL NUMBER OF BUSES (CURRENT)	TOTAL NUMBER OF BUSES (NEW)
			White Taxi	Minibus up to 15 seats	Midibus 16 to 22 seats	Medium Bus 23 to 40 seats	Large Bus 41+ seats	Proposed Frequency		White Taxi	Minibus	Large Bus		
650 (White Taxis)	651	Zarqa (IS)- Hayy Al-Husayn	15	0	0	0	0	Every few minutes	252	10	15	0	25	
	652	Zarqa (IS) - Hayy Ramzi	15	0	0	0	0	"	552	0	2	0	2	
	653	Zarqa (IS) - Hayy Amir Muhammad	15	0	0	0	0	"	834	0	1	0	1	
	654	Zarqa (IS) - Hayy Umm Bayadha	15	0	0	0	0	"	1163	0	1	0	1	
									4309	0	1	0	1	
									310	5	8	0	13	
									717	7	5	0	12	
									758	1	0	0	1	
									620	12	3	0	15	
									1451	0	1	0	1	
			60	**0**	**0**	**0**	**0**			**35**	**37**	**0**	**72**	**60**
660	657	Zarqa (KA)- Ibn Umm Maktum Street	0	0	11	0	0	8 mins	292	0	6	0	6	
	660	Zarqa (KA) - Hayy Hamza - New Zarqa (LRT Station)	0	0	8	0	0	10 mins	1134	1	20	0	21	
	666	Zarqa (KA) - Hayy Barrakh	0	0	10	0	0	8 mins	251	0	2	0	2	
	667	Zarqa(KA) - State Hosp. - New Zarqa (LRT Station)	0	0	10	0	0	8 mins	2352	0	1	0	1	
									2801	0	1	0	1	
									571	0	9	0	9	
									635	0	1	0	1	
									932	0	1	0	1	
									938	0	2	0	2	
									1581	0	1	0	1	
									1985	0	1	0	1	
									2926	0	3	0	3	
			0	**0**	**39**	**0**	**0**			**1**	**48**	**0**	**49**	**39**
661	661	Zarqa (KA) - Hayy Ma'sum	0	0	16	0	0	5 mins	309	1	8	0	9	
									436	0	2	0	2	
									535	0	1	0	1	
									3447	14	14	0	28	
									3958	0	2	0	2	
			0	**0**	**16**	**0**	**0**			**15**	**27**	**0**	**42**	**16**
662	655	Zarqa (KA) - Hayy Ramzi	0	0	10	0	0	8 mins	79	0	17	0	17	
	662	Zarqa (KA) - Hayy Batrawi	0	0	6	0	0	15 mins	1173	0	6	0	6	
	663	Zarqa (KA) - Hayy Al-Jadlda	0	0	6	0	0	15 mins	1400	0	1	0	1	
	664	Zarqa (KA) - Al-Hashimi St-Hayy Al-Hurafiyyin	0	0	6	0	0	15 mins	3248	0	1	0	1	
	665	Zarqa (KA) -Hayy Al-Hurafiyyin-Al-Hashimi St	0	0	6	0	0	15 mins	1430	0	1	0	1	
									1597	20	6	0	26	
			0	**0**	**34**	**0**	**0**			**20**	**32**	**0**	**52**	**34**
668	639B	Zarqa - Al-Hashimiyya Factories	0	0	0	4	0	Peak Hours	332	0	1	0	1	
									494	0	3	0	3	
									1247	0	3	0	3	
									4336	0	1	0	1	
	668	Zarqa (PR) - Northern Hayy	0	0	6	0	0	15 mins	304	1	0	0	1	
	669	Zarqa (PR) - Jaysh Street - New Zarqa (LRT Station)	0	0	10	0	0	8 mins	1138	0	1	0	1	
									2747	0	1	0	1	
									3091	0	1	0	1	
									3318	0	1	0	1	
									3326	0	2	0	2	
									1237	0	8	0	8	
									1433	0	4	0	4	
									1472	0	2	0	2	
									5047	0	1	0	1	
									5118	0	1	0	1	
			0	**0**	**16**	**4**	**0**			**1**	**30**	**0**	**31**	**20**

	633	Zarqa - Al-Tafah	0	0	0	2	0	Peak Hours	3321	0	1	0	1	
									3938	0	1	0	1	
									4082	0	1	0	1	
	633A	Zarqa - Kaww	0	0	0	6	0	15 mins	101	0	9	0	9	
									103	0	2	0	2	
									1564	0	1	0	1	
	670	Zarqa (KA) - King Abdullah Bin Abdel Aziz City - Zarqa (KA) ((clockwise)	0	0	4	0	0	15 mins	1473	0	2	0	2	
	690	Zarqa (KA) - King Abdullah Bin Abdel Aziz City - Zarqa (KA) ((anti-clockwise)	0	0	4	0	0	15 mins		0	0	0	0	
670	678	Zarqa (KA) - Tariq Mountain	0	0	8	0	0	15 mins	969	0	1	0	1	
	679	Zarqa (KA) - Hayy Madaris	0	0	6	0	0	15 mins	1036	0	3	0	3	
	686	Zarqa (KA) - Hayy Al-Malik Talal	0	0	13	0	0	8 mins	1234	0	1	0	1	
									1245	0	2	0	2	
									2544	0	1	0	1	
									2545	0	1	0	1	
									1140	0	5	0	5	
									1258	0	4	0	4	
									1758	0	2	0	2	
									3691	0	1	0	1	
									3775	0	1	0	1	
			0	**0**	**35**	**8**	**0**			**0**	**24**	**0**	**24**	**43**
	671	Zarqa (KA) - Hayy Shumar	0	0	8	0	0	10 mins	334	0	1	0	1	
	672	Zarqa (KA) - Hayy Al-Junayna	0	0	8	0	0	10 mins	2042	0	2	0	2	
	673	Zarqa (KA) - Dhahiyat Al-Quss	0	0	6	0	0	15 mins	2160	0	1	0	1	
	674	Zarqa (KA) - Hayy Al-Qamar - Russeifa	0	0	6	0	0	15 mins	2420	0	1	0	1	
									3375	0	1	0	1	
									3378	0	2	0	2	
									929	3	4	0	7	
									2407	0	1	0	1	
									1073	0	2	0	2	
									1843	0	1	0	1	
671									2198	0	1	0	1	
									2458	0	1	0	1	
									2500	0	1	0	1	
									2596	0	1	0	1	
									3210	0	1	0	1	
									576	0	3	0	3	
									1132	0	1	0	1	
									1225	0	1	0	1	
									1232	0	3	0	3	
									1359	0	1	0	1	
									1392	0	1	0	1	
									1735	0	1	0	1	
									3786	0	1	0	1	
									814	0	3	0	3	
			0	**0**	**28**	**0**	**0**			**3**	**36**	**0**	**39**	**28**
	675	Zarqa (PR) - Hay Al-Jabr	0	0	8	0	0	10 mins	1051	0	5	0	5	
	676	Zarqa (KA) - Al-Qadisiyah	0	0	8	0	0	10 mins	1599	0	1	0	1	
	677	Zarqa (KA) - North Awjan	0	0	10	0	0	8 mins	1849	0	4	0	4	
									2673	0	2	0	2	
									2679	0	1	0	1	
									1227	0	1	0	1	
675									1360	0	1	0	1	
									2899	0	6	0	6	
									3054	0	5	0	5	
									76	15	8	0	23	
									933	0	2	0	2	
									943	0	1	0	1	
									1924	0	2	0	2	
									2674	0	1	0	1	
									2748	0	3	0	3	
			0	**0**	**26**	**0**	**0**			**15**	**43**	**0**	**58**	**26**

680	680	Zarqa (KA) - Hayy Masani	0	0	4	0	0	20 mins	1113	0	1	0	1	
	681	Zarqa (KA) - Wadi Al-'Ushsh	0	0	4	0	0	20 mins	3066	1	1	0	2	
	682	Zarqa (PR) - Hayy Mushayrifah	0	0	8	0	0	10 mins	4296	0	1	0	1	
	683	Zarqa (PR) - Hayy Mansani	0	0	2	0	0	Peak Hours	2164	0	8	0	8	
									20	0	3	0	3	
									1087	0	1	0	1	
									1110	0	2	0	2	
									1222	0	1	0	1	
									1227	0	1	0	1	
									2398	0	1	0	1	
									3281	0	1	0	1	
									4305	0	1	0	1	
									165	0	1	0	1	
									1069	0	1	0	1	
									1233	0	1	0	1	
									3764	0	1	0	1	
									4349	0	0	0	0	
			0	**0**	**18**	**0**	**0**			**1**	**26**	**0**	**27**	**18**
684	684	Zarqa (PR) - Jabal Shamali - Russeifa	0	0	8	0	0	10 mins	216	0	6	0	6	
	685	Zarqa (KA) - Highway - Hayy Musharifah	0	0	2	0	0	peak hours	634	0	3	0	3	
	691	Russeifa (Centre) - Hayy Musharifah	0	0	8	0	0	10 mins	873	0	1	0	1	
	692	Russeifa (Centre) - Hayy Rashid	0	0	8	0	0	10 mins	1087	0	1	0	1	
									1141	0	1	0	1	
									1393	0	1	0	1	
									2701	0	1	0	1	
									2714	0	1	0	1	
									3414	0	1	0	1	
									976	0	12	0	12	
									2411	0	1	0	1	
									2737	0	1	0	1	
									3624	0	1	0	1	
									3630	0	1	0	1	
									4359	0	1	0	1	
									4360	0	1	0	1	
									4451	0	1	0	1	
									1226	0	2	0	2	
									1346	0	2	0	2	
									1347	0	4	0	4	
									4107	0	1	0	1	
									890	0	8	0	8	
			0	**0**	**26**	**0**	**0**			**0**	**52**	**0**	**52**	**26**
687	687	Zarqa (PR) - Hayy Al-Jundi - Russeifa	0	0	10	0	0	8 mins	1251	0	13	0	13	
									1260	0	2	0	2	
									5171	0	5	0	5	
			0	**0**	**10**	**0**	**0**			**0**	**20**	**0**	**20**	**10**
695 Park and Ride	695(A)		0	0	12	0	0	5 mins	976	0	12	0	12	
	696(B)		0	0	12	0	0	5 mins						
			0	**0**	**24**	**0**	**0**			**0**	**12**	**0**	**12**	**24**
TOTAL Buses			**60**	**0**	**272**	**12**	**0**			**91**	**387**	**0**	**478**	**344**

Contracts no longer on LTRC Database

IS = Internal 'Servees' Terminal
PR = Prince Rashid Terminal
KA = King Abdullah Terminal

Table D2: Longer Distance Current and Proposed Services to/from Zarqa City

Group of Routes Number	New Bus Route Number	Line Name	Type of Buses Required						Current Contract Numbers	Types of Buses Currently Operated			TOTAL NUMBER OF BUSES (CURRENT)	TOTAL NUMBER OF BUSES (NEW)
			White Taxi	Minibus up to 15 seats	Midibus 16 to 22 seats	Medium Bus 23 to 40 seats	Large Bus 41+ seats	Proposed Frequency		White Taxi	Minibus	Large Bus		
209	211	Ajloun - Jerash - Zarqa (KA)					5	peak hours	1184	0	4	1	5	
									3639	0	2	0	2	
			0	**0**	**0**	**0**	**5**			**0**	**6**	**1**	**7**	**5**
641	306	Jerash - Surut - Zarqa (KA)				4		60 mins	1852	0	2	0	2	
									2886	0	3	0	3	
									3030	0	2	0	2	
									3109	0	1	0	1	
									3688	0	1	0	1	
									3988	0	1	0	1	
	307	Jerash - Khirbet Dahl - Zarqa (KA)					3	peak hours	1296	0	1	0	1	
									1722	0	6	1	7	
									2005	0	3	0	3	
	641	Zarqa (KA) - Al-Sukhna				3		30 mins	340	0	5	0	5	
									815	0	0	0	0	
									1054	0	1	0	1	
									1255	0	1	0	1	
									1257	0	3	0	3	
	642	Zarqa (KA) - 'Ayn Al-Namrah				3		30 mins	1256	0	1	0	1	
									1263	0	1	0	1	
	643	Zarqa (KA) - Al-Sukhna - Al-'Aluk				2		120 mins	744	0	1	0	1	
									2467	0	1	0	1	
									3740	0	1	0	1	
	644	Zarqa (KA) - Surut - Al-'Aluk				2		120 mins	633	0	4	0	4	
	645	Zarqa (KA) - Surut - Bani Hashim Villages				2		peak hours	2201	0	1	0	1	
	646	Zarqa (KA) - Birin - Al-'Aluk				2		120 mins	1266	0	2	0	2	
									1852	0	2	0	2	
									3580	0	2	0	2	
	647	Zarqa (KA) - Benin - Anu Nusayr				2		120 mins	1503	0	2	0	2	
									2599	0	0	1	1	
	648	Zarqa (KA) - Berin - Anu Nusayr				2		peak hours	1424	0	2	0	2	
			0	**0**	**0**	**22**	**3**			**0**	**50**	**2**	**52**	**25**
401	402	Irbid - Mafraq - Zarqa (KA)					15	30 mins	378	0	0	0	0	
									1494	0	0	0	0	
									2503	0	0	0	0	
									4263	0	1	4	5	
									4315	0	0	0	0	
									5042	0	0	1	1	
									5132	0	0	0	0	
	403	Marfaq - Zarqa (KA)					4	30 mins	163	1	19	13	33	
									286	11	0	0	11	
									2147	0	2	0	2	
									2642	0	0	1	1	
	404	Irbid - Al-Husn - Bal'ama - Zarqa (KA)					12	60 mins	100	0	0	5	5	
									935	0	0	6	6	
									1546	0	0	0	0	
									2015	0	0	3	3	
	405	Irbid - Ramtha - Bal'ama - Zarqa (KA)					16	60 mins	2063	0	2	39	41	
									4315	0	0	0	0	
			0	**0**	**0**	**0**	**47**			**12**	**24**	**72**	**108**	**47**
412	412	Mafraq - Bal'ama - Zarqa (KA)				6		60 mins	415	0	1	0	1	
									1228	0	5	0	5	
									1500	0	1	0	1	
									2151	0	1	0	1	
									2187	0	0	0	0	
									2530	0	1	0	1	
									2927	0	2	0	2	
									4342	0	0	0	0	
									4432	0	2	0	2	
									4449	0	1	0	1	
	413	Mafraq - Al-Qunayyya - Zarqa (KA)				7		60 mins	710	0	1	0	1	
									778	0	1	0	1	
			0	**0**	**0**	**13**	**0**			**0**	**16**	**0**	**16**	**13**
410	414	Mafraq - Dayr Waraq - Zarqa (KA)					2	peak hours	1324	2	0	0	2	
									2185	0	0	0	0	
									2206	0	1	0	1	
									3896	0	1	0	1	
									4079	0	1	0	1	
			0	**0**	**0**	**0**	**2**			**2**	**3**	**0**	**5**	**2**

447	419	Al-Ruwayshid - Zarqa (KA)					2	peak hours	3545	0	1	0	1	
			0	0	0	0	2			0	1	0	1	2
501	501	Salt - Zarqa (PR)					10	30 mins	240	0	12	2	14	
									1434	0	1	1	2	
									3871	0	2	0	2	
									5133	0	0	5	5	
	502	Al-Baq'a - Zarqa (PR)					8	30 Mins	317	0	2	0	2	
									1077	0	5	2	7	
									1143	0	4	0	4	
									1383	0	2	0	2	
									1665	0	2	0	2	
									1854	0	1	0	1	
									2547	0	2	0	2	
									3593	0	1	0	1	
									4298	0	1	0	1	
	503	Mahis - Zarqa (PR)					4	60 Mins	1833	0	0	0	0	
									2064	0	4	0	4	
									2597	0	1	0	1	
	504	Dayr'Alla - Zarqa (PR)					8	60 Mins	1453	0	0	0	0	
									1851	0	1	0	1	
									2078	0	1	0	1	
									2292	0	1	0	1	
									2277	0	0	0	0	
									3427	0	1	0	1	
									4076	0	3	0	3	
	505	Abu Nusayr - Zarqa (PR)					5	30 mins	1658	0	2	0	2	
									2228	0	2	0	2	
									3142	0	1	0	1	
			0	0	0	0	35			0	52	10	62	35
601	601	Zarqa (KA) - Al-Azraq					7	60 mins	968	0	2	0	2	
									1253	0	5	0	5	
									1375	0	1	0	1	
									1593	0	8	1	9	
									2686	0	2	0	2	
	602	Zarqa (KA) - Al-Amari					2	irregular	950	0	1	0	1	
									3114	0	1	0	1	
			0	0	0	0	9			0	20	1	21	9
604	604	Zarqa (KA) - Al-Mushrifah - Mafraq				13		60 mins	385	0	1	0	1	
									420	5	6	0	11	
									1371	0	1	0	1	
									1904	0	1	2	3	
									2758	0	1	0	1	
									3107	0	2	0	2	
									4240	0	1	0	1	
	605	Zarqa (KA) - Al-Nasiriyah - Mafraq	0	0	0	13	0	60 mins	318	0	14	0	14	
									533	0	1	0	1	
	631	Zarqa (KA) - Qasr Al-Halabat	0	0	0	11	0	peak hours	970	0	1	0	1	
									1470	0	1	0	1	
									2655	0	2	0	2	
									2662	0	2	0	2	
									2803	0	2	0	2	
									3811	0	1	0	1	
									3861	0	2	0	2	
									4005	0	1	0	1	
									4210	0	1	0	1	
	632	Zarqa (KA) - Al-Dulayl	0	0	0	14	0	30 Mins	110	0	1	0	1	
									319	0	0	0	0	
									837	0	1	0	1	
									1471	0	14	0	14	
									1601	0	1	0	1	
									3259	0	1	0	1	
									4452	0	1	0	1	
			0	0	0	51	0			5	60	2	67	51
610	610	Zarqa (Hayy Shumar - Amman (N)					6	20 mins	982	0	2	0	2	
									1651	0	23	0	23	
									1653	0	22	0	22	
									1657	0	1	0	1	
									3358	0	1	2	3	
									3911	0	1	0	1	
	611	Zarqa (Hayy Masum) - Amman (N)					5	20 mins	??	0	0	0	0	
	612	Zarqa (PR) - Amman (Al-Mahatta)					9	8 mins	??	0	0	0	0	
	615	Zarqa (PR) - Russeifa - Amman (Al-Mahatta)					2	peak hours	??	0	0	0	0	
	616	Zarqa (PR) - The Highway - Amman (Al Mahatta)				3		peak hours	??	0	0	0	0	
			0	0	0	3	22			0	50	2	52	25

634	635	Zarqa (KA) - Gharissa	0	0	0	3	0	30 Mins	520	0	3	0	3	
									1231	0	4	0	4	
	636	Zarqa (KA) - Hayy Al-Duruz	0	0	0	2	0	30 Mins	1125	0	5	0	5	
									2546	0	1	0	1	
	637	Zarqa (KA) - Al-Iskan	0	0	0	2	0	30 Mins	629	0	7	0	7	
									3245	0	1	0	1	
									3733	0	1	0	1	
	638	New Zarqa - Al-Khirba Al-Samra (N.B. Does not serve Downtown)	0	0	0	2	0	peak hours	4188	0	2	0	2	
	639A	New Zarqa - Al-Hashimiyya Factories (N.B. Does not serve Downtown)	0	0	0	2	0	peak hours	1229	0	3	0	3	
									1308	0	0	0	0	
	640	Al-Misfah - Gharissa	0	0	0	2	0	peak hours	1246	0	1	0	1	
									4080	0	0	0	0	
									5029	0	1	0	1	
			0	**0**	**0**	**13**	**0**			**0**	**29**	**0**	**29**	**13**
802	802	Madaba - Sweileh - Zarqa (PR)					10	30 mins	919	0	10	7	17	
			0	0					1137	0	2	0	2	
									2449	0	2	0	2	
									2610	0	0	1	1	
									1666	0	0	0	0	
									3729	0	2	0	2	
			0	**0**	**0**	**0**	**10**			0	16	8	24	**10**
810	607	Zarqa (PR) - Sahab				5		30 mins	1811	0	1	0	1	
	812	Madaba - Umm Al-Hairan - Zarqa (PR)					8	30 mins	2455	0	12	2	14	
	813	Madaba - Zarqa (PR)					2	peak hours	2455	0	12	2	14	
			0	**0**	**0**	**5**	**10**			**0**	**25**	**4**	**29**	**15**
901	904	Al-Mazar - Karak - Zarqa (PR)					2	peak hours	881	0	0	1	1	
									2085	0	1	0	1	
									2191	0	3	1	4	
									2999	0	0	3	3	
									3268	0	1	0	1	
									3562	0	1	0	1	
									3986	0	1	0	1	
			0	**0**	**0**	**0**	**2**			**0**	**7**	**5**	**12**	**2**
902	905	Ghawr - Karak - Zarqa (PR)					5	peak hours	2230	0	0	1	1	
									3589	0	0	0	0	
									3709	0	0	2	2	
									4337	0	1	0	1	
			0	**0**	**0**	**0**	**5**			**0**	**1**	**3**	**4**	**5**
1001	1003	Al-'Ayn Al-Baydha - Zarqa (PR)					3	peak hours	2250	0	3	0	3	
			0	**0**	**0**	**0**	**3**			**0**	**3**	**0**	**3**	**3**
1104	1105	Ma'an - Zarqa (PR)					2	peak hours	1002	0	4	2	6	
			0	**0**	**0**	**0**	**2**			**0**	**4**	**2**	**6**	**2**
1204	1206	Aqaba - Zarqa (PR)					24	60 mins	1813	0	0	2	2	
									4264	0	0	5	5	
									Aq	0	0	0	0	
			0	**0**	**0**	**0**	**24**			**0**	**0**	**7**	**7**	**24**
TOTAL Buses			**0**	**0**	**0**	**107**	**181**			**19**	**338**	**119**	**476**	**288**

Contracts no longer on LTRC Database

PR = Prince Rashid Terminal
KA = King Abdullah Terminal

Table D3: Current and Proposed University Services in Zarqa

Group of Routes Number	New Bus Route Number	Line Name	Type of Buses Required						Current Contract Numbers	Types of Buses Currently Operated			TOTAL NUMBER OF BUSES (CURRENT)	TOTAL NUMBER OF BUSES (NEW)
			White Taxi	Minibus up to 15 seats	Midibus 16 to 22 seats	Medium Bus 23 to 40 seats	Large Bus 41+ seats	Proposed Frequency		White Taxi	Minibus	Large Bus		
121	126	Zarqa (KA) to JUST University	0	0	0	0	3	peak hours	170	0	0	2		
			0	**0**	**0**	**0**	**3**			**0**	**0**	**2**	**2**	**3**
401	406	Irbid to Zarqa (KA)	0	0	0	0	12	peak hours	2063	0	2	39		
	409	Mafraq to Zarqa (KA)	0	0	0	0	5	peak hours	1323	0	0	1		
			0	**0**	**0**	**0**	**17**			**0**	**2**	**40**	**42**	**17**
501	506	Zarqa (PR) to Amman Private University	0	0	0	0	1	peak hours	3207	0	1	0		
	507	Zarqa (PR) to Al-Balqa Applied University	0	0	0	0	1	peak hours	3384	0	1	0		
			0	**0**	**0**	**0**	**2**			**0**	**2**	**0**	**2**	**2**
1138	1112	Zarqa (PR) to Shawbak & Wadi Musa	0	0	0	1	0	peak hours	4086	0	1	0		
			0	**0**	**0**	**1**	**0**			**0**	**1**	**0**	**1**	**1**
621 Hashemite University Direct Services (do not serve Zarqa except for 626)	621	Irbid to Hashemite University					6	peak hours	5001	0	0	0		
	622	Ajloun to Hashemite University					4	peak hours	5004	0	0	4		
	623	Jerash to Hashemite University					2	peak hours	5003	0	0	5		
	624	Mafraq to Hashemite University					3	peak hours	5002	0	0	5		
	625	Salt to Hashemite University					6	peak hours	5006	0	0	5		
	626	Zarqa (KA) to Hashemite University					25	15 mins	737	0	4	0		
									5005	0	0	22		
	627	Amman (Al-Mahatta) to Hashemite University					4	30 mins	5209	0	0	0		
	628	Madaba to Hashemite University					11	peak hours	5007	0	0	4		
			0	**0**	**0**	**0**	**61**			**0**	**4**	**45**	**49**	**61**

Appendix E Project 3

Improve Accessibility of Proposed LRS Terminal

IMPROVE ACCESSIBILITY TO THE PROPOSED LRS TERMINAL

New Bus Routes linking to the LRS Terminal

If a BRT system between Zarqa and Amman were to use the highway network, there are a number of alternative options which could be used. In addition, the use of BRT would present new opportunities in terms of the locations which could be served. For example, it would be very sensible to consider a 'branch' of the BRT to operate between the King Abdullah Terminal and the Hashemite University to the east of Zarqa. Although there are direct bus services from various areas of Amman to this University, many students still have to interchange in Zarqa to access the University, and the use of BRT to access the University would have the following benefits:

- A reduction in the need for students to change buses in Zarqa and between the King Abdullah and Prince Rashid Terminals;
- Replacement of an existing contract to provide a shuttle service between King Abdullah Terminal and the Hashemite University;
- Opportunity to provide modern, more energy efficient vehicles with really high capacity (possibly articulated buses);
- Alternative routes could be considered – either by extending a BRT service north of the New Zarqa Terminal and then east to the University, or by operating through the King Mohammad Bin Abdul Aziz City, and then through to the main highway passing the University.

Park and Ride

A successful Park and Ride scheme needs to have the following features:

- Good location for car park sites, which need to be on the periphery of the urban area, but within reasonable travelling time of the Downtown area, and preferably close to the strategic highway network;
- A frequent and reliable connection to the Downtown area, preferably to a number of diverse locations;
- A pricing structure which gives some advantage to the Park and Ride – if parking is readily available and free at the journey destination, it is unlikely that Park and Ride will be attractive to users;
- A safe, secure and easily accessible Park and Ride car park;
- Allow some room for future expansion.

Implementation

Bus Service Strategy

In the light of the current uncertainty regarding the preferred public transport option for the Amman to Zarqa corridor, our proposed bus service strategy for Zarqa allows for:

- A concentration of connecting services radiating from three interchange points (Prince Rashid, King Abdullah and New Zarqa Terminals), all of which should be served by any LRS system, whether LRT or BRT;
- A review of the bus contracts currently connecting Zarqa with Amman, and their rationalisation; and
- A separation into distinct categories for services which are almost exclusively designed to accommodate students and those which have a wider utility for the general public;

Tables showing current and proposed bus services for university students and current and future general bus services between Zarqa and Greater Amman can be found in Appendix D, and a map illustrating the proposed services for the Zarqa Governorate area is shown below (Figure E1).

Examples of BRT services operated in Europe and South America are shown below.

BRT Zuidtangent Service, Netherlands – articulated bus

BRT Curtiba, Brazil – Volvo bi-articulated bus

Park and Ride Strategy

We believe that there are potentially three good locations in the Zarqa area from which Park and Ride could operate. The selected sites would cover the main approaches to the Downtown area from the northern, southern and western directions, and would also form an integral component of major bus interchange points. The proposed locations are shown on the map below, and are located at:

- 'New Zarqa Park and Ride', which would be constructed in the northern part of the triangle of land between Queen Noor Street and Al-Jaish Street, in association with a new bus terminal and the LRS scheme.
- 'Al-Sukneh Street Park and Ride', on the east side of Al-Sukneh Street, just below the main roundabout at the junction of Abdul Hamid Sharaf Street, Al-Farooq Street and Makkah Al-Mokaramah Street. This location would also be suitable for an interchange with local bus services and longer distance routes.
- 'Prince Rashid Park and Ride', which would be adjacent to the existing Prince Rashid (South) Terminal, on land immediately to the west and south.

The Park and Ride sites would need to be constructed on the level, with asphalt surfacing, waiting facilities, lighting and landscaping. Security measures such as fencing and the provision of CCTV should also be included.

Particular attention needs to be given to any pricing structure adopted for Park and Ride. Good practice experience (Park & Ride Great Britain, TAS Publications and Events Ltd., 2007) indicates that there are generally two approaches adopted for Park and Ride schemes:

- Parking provided free, with individual bus fares paid on board the shuttle service (discounted fares may apply, for example children travel free); or
- A charge is made for parking (normally a flat charge), and travel on the shuttle service is free.

If the Park and Ride shuttle service is also used as a means of distributing bus passengers around the Downtown area, the choice of charging depends to some degree on whether this service is provided free of charge – if so, it makes sense to charge for parking and allow free travel on the shuttle service. The ability to charge for parking will be determined by the cost in time and money for the alternative, which will normally be either off street or on street parking. These points are also covered in Project 10 on Parking in Appendix M.

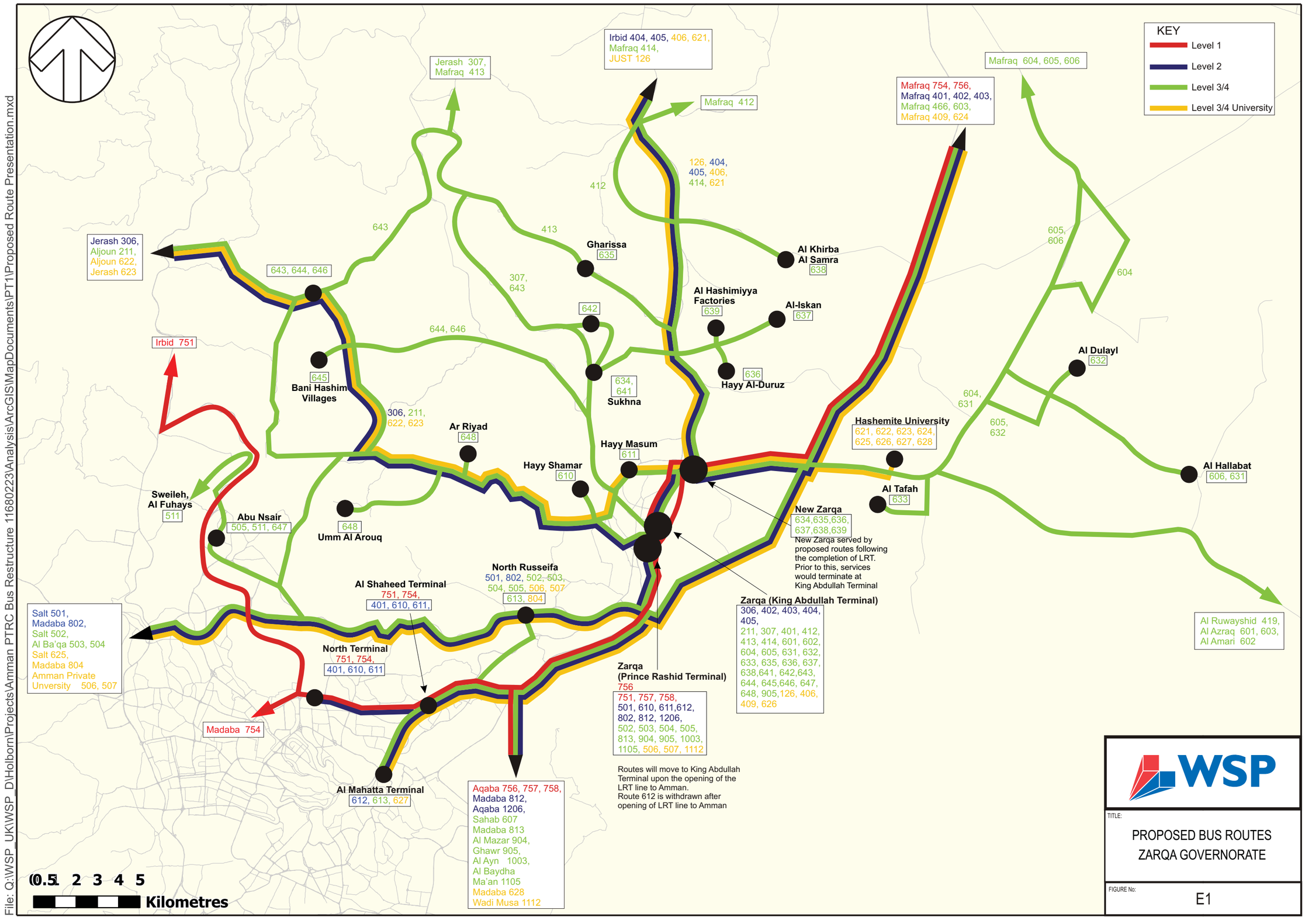
Shuttle Bus Service Strategy

The concept of the Shuttle Bus is to improve accessibility for those using public transport. It is particularly useful in situations where the commercial area of a city is spread out, or where public transport terminals are located on the periphery of the central area and in circumstances where people need to transfer from one terminal to another. In some cases, such as the Manchester Metro Shuttle in the UK, free travel is permitted with no fares being charged, whilst in other case, such as Mississauga in Canada, a comparatively low flat fare is charged (C$1 in the case of the latter city).

Whilst the Downtown area of Zarqa is not particularly spread out, there is more than one terminal, with at least one further terminal planned at a greater distance away, and there is a need for cross-Downtown accessibility as well as the need to access other commercial areas of activity, such as New Zarqa.

The proposed circular Shuttle Bus services are described above, which would connect the three proposed Park and Ride sites, together with the King Abdullah Terminal, and various other attractors within the commercial area of the City. It is suggested that the service should operate in both clockwise and anti-clockwise directions, and should operate to a minimum frequency of every 10 minutes. A map of the proposed routeing is shown below in Figure E2.

If the decision should be taken to charge for parking, but not for travel on the Shuttle Service, there will clearly need to be subsidy provided for its operation. However, such subsidy could be minimised through the use of the vehicles for advertising and by seeking commercial sponsorship from businesses that would benefit from increased patronage. In view of the relatively high vehicle usage generated in the Downtown area, and the high level of frequent boarding and alighting involved in the proposed shuttle services, it would be sensible to consider the use of modern design buses with a lower emissions profile than conventional vehicles. This possibility is covered in more detail under Project 7.


KEY
Level 1
Level 2
Level 3/4
Level 3/4 University
Irbid 404, 405, 406, 621, Mafraq 414, JUST 126
Jerash 307, Mafraq 413
Mafraq 412
Mafraq 754, 756, Mafraq 401, 402, 403, Mafraq 466, 603, Mafraq 409, 624
Mafraq 604, 605, 606
126, 404, 405, 406, 414, 621
412
643
413
605, 606
604
Jerash 306, Aljoun 211, Aljoun 622, Jerash 623
643, 644, 646
Gharissa 635
Al Khirba Al Samra 638
307, 643
Al Hashimiyya Factories 639
Al-Iskan 637
642
644, 646
Irbid 751
645 Bani Hashim Villages
636 Hayy Al-Duruz
634, 641 Sukhna
Al Dulayl 632
306, 211, 622, 623
Ar Riyad 648
604, 631
605, 632
Hashemite University 621, 622, 623, 624, 625, 626, 627, 628
Hayy Masum 611
Hayy Shamar 610
Al Hallabat 606, 631
Al Tafah 633
Sweileh, Al Fuhays 511
Abu Nsair 505, 511, 647
648 Umm Al Arouq
New Zarqa 634,635,636, 637,638,639
New Zarqa served by proposed routes following the completion of LRT. Prior to this, services would terminate at King Abdullah Terminal
North Russeifa 501, 802, 502, 503, 504, 505, 506, 507 613, 804
Al Shaheed Terminal 751, 754, 401, 610, 611,
Zarqa (King Abdullah Terminal) 306, 402, 403, 404, 405, 211, 307, 401, 412, 413, 414, 601, 602, 604, 605, 631, 632, 633, 635, 636, 637, 638,641, 642,643, 644, 645,646, 647, 648, 905,126, 406, 409, 626
Al Ruwayshid 419, Al Azraq 601, 603, Al Amari 602
Salt 501, Madaba 802, Salt 502, Al Ba'qa 503, 504 Salt 625, Madaba 804 Amman Private University 506, 507
North Terminal 751, 754, 401, 610, 611
Zarqa (Prince Rashid Terminal) 756 751, 757, 758, 501, 610, 611,612, 802, 812, 1206, 502, 503, 504, 505, 813, 904, 905, 1003, 1105, 506, 507, 1112
Routes will move to King Abdullah Terminal upon the opening of the LRT line to Amman. Route 612 is withdrawn after opening of LRT line to Amman
Madaba 754
Al Mahatta Terminal 612, 613, 627
Aqaba 756, 757, 758, Madaba 812, Aqaba 1206, Sahab 607 Madaba 813 Al Mazar 904, Ghawr 905, Al Ayn 1003, Al Baydha Ma'an 1105 Madaba 628 Wadi Musa 1112
0 0.5 1 2 3 4 5
Kilometres
WSP
TITLE:
PROPOSED BUS ROUTES ZARQA GOVERNORATE
FIGURE No:
E1
File: Q:\WSP_UK\WSP_D\Holborn\Projects\Amman PTRC Bus Restructure 11680223\Analysis\ArcGIS\MapDocuments\PT1\Proposed Route Presentation.mxd

Date Modified: 10/05/2011

Drawn By: ukkxm021

File: Q:\WSP_UK\WSP_D\Holborn\Projects\Amman PTRC Bus Restructure 11680223\Analysis\ArcGIS\MapDocuments\PT1\Zarqa Maps - 0400511\City Routes Proposed - Park and Ride.mxd

Key

Proposed Park & Ride Route

Terminals

New Zarqa
Terminal + P&R
A & B

AL-Sukneh Street
Terminal + P&R
A & B

King Abdullah
Terminal

Prince Rashid
Terminal + P&R
A & B

0 0.3 0.6 1.2 1.8 2.4
Kilometres

PROPOSED URBAN
BUS ROUTES ZARQA

FIGURE E2

Appendix F Project 4

Public Transport Terminal Improvements

PROJECT 4: PUBLIC TRANSPORT TERMINAL IMPROVEMENTS

General Principles

It is necessary to carefully consider the purpose of Bus Terminals, and what objectives they should be designed to meet. The following factors are most important in considering best practice experience for bus terminals.

- **Enabling Interconnectivity – modes/lines/routes**. A main objective of any bus terminal is to provide interchange between different routes (e.g. long distance to local services) and different modes (e.g. bus to taxi). Improving interconnectivity between services and modes encourages more people to use public transport as it allows more destinations to be reached more easily.
- **Ensuring Accessibility – journey attractors**. When deciding on a location for a Bus Terminal, an important factor is the proximity to key journey attractors. If a Bus Terminal is located next to key journey attractors, such as the main shopping or commercial districts, bus passengers are able to walk from the Bus Terminal to these key journey attractors. If a Bus Terminal is provided on the edge of a city, away from key journey attractors, bus passengers arriving at the Bus Terminal will have to use local bus or taxi services to reach their final destination, which would discourage some people from using public transport altogether. Where such terminals are necessary, it is important to ensure that frequent connecting services are available to enable passengers to access main attractions in the city concerned.
- **Optimising the number of bus terminals**. In larger cities, such as Zarqa, it is sometimes necessary to provide separate terminals for bus services arriving from different directions. If all bus services went to one Main Bus Terminal, for example in the East of the City, services from other parts of the City would have extended journey times to reach the Main Bus Terminal. However, providing too many Bus Terminals can lead to difficulties for those passengers wishing to interchange between services, as mentioned under the objective of accessibility. They may arrive at one terminal, but need to use a local bus or taxi to reach the terminal they need for their onward journey.
- **Implementing a Hierarchy of interchange facilities**. There are broadly four types of bus facilities. These are described below:
  - Bus Parking Area – Location designated for bus vehicles to wait between being required to operate bus services. The Bus Parking Area can be an area of a Bus Terminal or located in a separate location to the Bus Terminal. Facilities should be provided at the Bus Parking Area for bus drivers to use whilst they wait. As Bus Terminals are generally located in prime value locations in city centres, there is a case to be made for location of bus parking over extended periods to take place at other locations on the periphery of the urban area.
  - Bus Terminal – A Bus Terminal is normally where bus services start and finish. Bus services can also call at a Bus Terminal part way through their route. Facilities, for passengers, including waiting facilities, should be provided at a Bus Terminals, as they also provide an opportunity to interchange between different services and different modes (e.g from bus to taxi).
  - Bus Interchange Point – A Bus Interchange Point is an on street calling point where a number of different bus services call and it is possible to interchange between services.
  - Bus Stop – A Bus Stop is an on-street calling point which bus services call at part-way through their route. This allows passengers to start or end their journey at locations along the route, other than the Bus Terminal. A sheltered waiting area and information display board are normally provided adjacent to a bus stop. Waiting/parking restrictions are also normally required at bus stops to ensure minimum disruption to traffic flow.
- **Facilitating Reliability and predictability of services**. To encourage people to use bus services operating from a bus terminal they need to be reliable. Reliability leads to people having more confidence in the public transport network. Reliability also means that bus terminals are able to operate more efficiently, which could result, in the long term, to a reduction in the number of bus stands required at the bus terminal.

- **Providing High quality facilities – passenger/drivers**. A key objective for Bus Terminal improvements is the provision of high quality facilities for both passengers and drivers. This would include sheltered waiting areas, toilets, food outlets and information desks.
- **Delivering Information provision – legible network**. Information provision is an important objective for Bus Terminal improvements, Information should be provided on bus services, including times and fares. In some areas it may be possible, in the long term, to provide electronic displays showing 'real time' timetable information. Such an information provision facility could also sell tickets, particularly for Inter City travel, thus saving boarding times. Information desks should be provided to assist any passengers who may be new to the public transport network.
- **Achieving Flexibility – allow growth/land use changes**. A further important consideration for Bus Terminal improvements is to ensure terminals are designed to allow for future growth. Sufficient land area should be made available to allow the Bus Terminal to expand to cater for future increases in the number of bus services. Land Use changes over the Long Term may result in the need to reassess the effectiveness of existing bus terminal locations.

In drawing up further **improvement proposals** for both the existing Terminals and new, proposed Terminals, the following design principles should be applied:

- Ensure that entrance points for buses are separate to exit points, which will improve circulation of buses around the terminal. This is already the case with King Abdullah and Prince Rashid Terminals, but clear demarcation of where buses should circulate and park is necessary;
- The terminal layout should be designed to accommodate the heavier flows nearest the approach direction of customers; with smaller vehicles such as Minibuses or Taxis in less dominant locations within the terminal;
- Clearly marked bus bays with raised kerbing and equal spacing, between bays should be provided. To a large extent, this is provided at Prince Rashid Terminal, but not at King Abdullah Terminal;
- Marked bus bays with posts stating the bay number and the destination of related bus service should be provided;
- Ample space for segregated bus manoeuvre and straightening should be incorporated into the layout design;
- Unified type and height of kerb/platform should be incorporated;
- Where buses are permitted to park for 'layover' purposes, a separate area should be provided as far away from the area where passengers board buses as possible, and it should be clearly marked out accordingly;
- Clear surface marking to help segregate passengers and vehicles should be provided; and
- Ideally, there should be step free access to buses.

In terms of the **facilities** which need to be provided at Terminals, the following principles should be applied in undertaking a quality audit for each terminal;

- An adequate size of platform and waiting areas should be provided, taking careful account of bus sizes and the volume of pedestrians at the location;
- Segregation of pedestrians (other than bus staff) and vehicles should be applied on safety grounds;
- Shelter from sun, wind, rain and snow should be provided;
- Good, safe interchange between the terminating external services and the local urban network, including, if appropriate, a link between separate terminals within a town/city. Our proposed bus service changes, together with the Shuttle Bus concept, should address this requirement;
- Clear information about times of buses (including return times from external terminal and intermediate points) routes and fares should be provided;

- If available, provide Real Time Passenger Information (RTPI) – this is a current LTRC aspiration, and requires a restructuring of bus operations, as proposed in this report, in order that formal timetables can be determined;
- A help and Information office, which might also deal with Lost Property would be helpful, and the Bus Terminal should be staffed to improve security and assist passengers;
- Sufficient seating should be provided for waiting passengers;
- An outlet, where food and drink are available at reasonable prices, and incorporating adequate seating for those passengers with a lengthy wait should be provided, if feasible;
- Lavatories with washing facilities and baby changing facilities, as well as facilities for disabled passengers should be incorporated into the design;
- Adequate surface drainage must be provided, to avoid flooding; and
- There should be lighting to maintain visibility within the terminal and increase a sense of security and safety

Implementation

It is proposed that an audit should be undertaken of the two existing Terminals, King Abdullah and Prince Rashid, to assess how far the general design principles set out above are met, and where work needs to be carried out in order to make them compliant. This audit should be organised by the steering group that we recommend be formed between the LTRC, the Zarqa Municipality and representatives from the bus operators. Agreement can then be reached between the parties regarding priorities, a suitable improvement programme and reasonable timescales, taking into account the availability of financial resources.

The principles should also be adopted in the design of the new terminal facility at New Zarqa.

Particular attention needs to be given to checking the entry and exit geometry of the terminals, together with the interface with other traffic in order to minimise conflicting movements. Ensuring that buses can access and exit from the adjoining strategic highway network is a key requirement in minimising delays to services.

A final important requirement is that passengers must be able to freely move between the bus terminal and the Downtown area. This is a particular issue at the King Abdullah Terminal, where passengers have to cross a busy main road between the Terminal and the Downtown area. There are two possible solutions for this:

- Construct an at grade traffic light controlled pedestrian crossing; or
- Construct an over-bridge for pedestrians.

Both of these proposals have positive and negative implications. Traffic light controlled crossings are not normally provided in Zarqa, and thus it might be necessary to provide ‘education’ for both drivers and pedestrians on how they should be used correctly. An over-bridge has the advantage of completely separating pedestrians from traffic, but it is not accessible for those with almost any type of ambulant disability and there is a high likelihood of people preferring to ‘risk’ crossing the road at grade to save time, unless they are physically prevented from doing so by some form of barrier.

On balance, we consider that the over-bridge option is preferable, subject to available finance.

Appendix G Project 5

Public Transport Ticketing Changes

PROJECT 5: PUBLIC TRANSPORT TICKETING CHANGES

The proposed measures include:

- The introduction of a high quality premium fare scale for Level 1 services across Jordan serving Zarqa, and a standard class fare scale for an integrated Level 2 national network.
- Competitive pricing for public transport through the introduction of through ticketing for multi-part trips on Levels 3, 4 and 5 services.
- The introduction of Electronic Ticketing Machines (ETMs) to eliminate, or at least reduce, on board cash payments.

The first element of the first proposal is very much dependent on the timing and degree to which the relevant part of the Restructuring of the Bus Services in Jordan Master Plan is implemented. The concept is to develop a strategic network of high quality express coach services linking the main cities in the Kingdom, as a substitute for the type of first class heavy rail services which are part of the established transport infrastructure in many other countries.

In concept, such a network would be based on the quality and operation of services currently worked between Amman and Aqaba by certain bus companies, notably Jett. In the case of Zarqa, three such services have been proposed, namely:

- Zarqa (Prince Rashid Terminal) – Amman (North Terminal) – Irbid
- Zarqa (Prince Rashid Terminal) – Amman (South Terminal) – Aqaba
- Mafraq – Zarqa (Prince Rashid Terminal) – Amman (South Terminal) – Queen Alia International Airport – Ma'an – Aqaba

These services are considered to be ones which need to be commercially viable, therefore their introduction would be dictated by market conditions. There would be premium fares charged, but which would still represent good value for money. Whilst aimed at all potential travellers, the type of housing being built out in the King Abdullah Bin Abdul Aziz City housing development would suggest a good market for this type of service.

The second element of the first proposal would be intended to provide a highly affordable and more extensive network of services connecting major cities and other popular destinations in Jordan, which would enhance longer distance accessibility to work, education and leisure facilities and encourage activities such as visiting friends and relatives, which can be both a tedious and expensive process at the moment.

A total of 12 such core network services would be operated through Zarqa, serving destinations such as Salt, Jerash and Madaba, as well as the major cities covered by the Level 1 services.

In order to facilitate through ticketing, on either long distance or local journeys within a Governorate area, a radical change would need to be made to the current fares system. Under the current system, the policy principle adopted is to try to strike a balance between protecting passengers from excessive fares and, at the same time, permitting a reasonable level of profit for bus operators in order to attract investment into the industry. It is recognised that fares are the main revenue source available for bus operators in the absence of subsidy, and thus the calculation of fares to be charged is intended to allow a profit margin in the region of 10%.

Other policies adopted are to have an annual re-evaluation of fare levels to take into account inflation and fuel price changes, but to limit the adjustment ratio applied to fares to 10%.

The current system takes into account both fixed costs and variable costs, with the latter being applied to the relevant line length in kilometres. Detailed costings are calculated for both fixed and variable costs, and occupation ratios are assumed for the three main types of vehicle used (white taxis, minibuses and coaches).

However this system is clearly not currently functioning in achieving its objectives. A desire not to inflate fares excessively has resulted in the full impacts of fuel cost rises (the single highest cost element for

transport operation in Jordan) not being reflected in fares readjustments, with the result that bus operators' margins have been severely squeezed to the point where profitability is difficult to achieve and transport staff wages are, in many cases, reducing in real terms, causing industrial relations problems.

Advantages and Disadvantages of Current System

The table below sets out the advantages and disadvantages of the system currently adopted.

Advantages and Disadvantage of Current Public Transport Fare System

Advantages	Disadvantages
Protects public from excessive fare rises	Produces a wide variety of different fares with no integrated structure and, if not applied correctly, results in unprofitable bus operations
Attempts to provide 'reasonable' profit margin for operators	Despite the use of complex technical calculations, the total accuracy cannot be guaranteed – protection of fare rises appears to have a higher priority than bus operation profitability
Takes into account both fixed and variable costs	Annual review may be too long a period to allow for significant fuel price rises
Differentiates between different size vehicles	With fixed fares and no subsidy payments, the ability of commercial bus operators to optimise their profit is limited
Annual review prevents continuous changes to fares	The system does not allow for through fares, where more than one route needs to be used
Fares vary according to line lengths	A consequence is that, for sections of different routes that operate in parallel, there are often fares variations for otherwise identical trips

Under the current situation, with no ticketing systems or fares integration in operation, there are only three immediate alternatives to consider:

- Continue using the current system;
- Use the current system to establish a cap for maximum fares to be charged, and allow the operators to set fare levels within this cap as they see fit; and
- Use the current system to establish a cap for maximum fares to be charged, but also set a series of intermediate fares based on distance, with all fares 'rounded off' to easier to remember figures.

In our view, the first two options are not sustainable, and there is good justification for introducing the third approach, which would create a 'coarse' tiered system of fares, largely determined by trip distance, and which would enable anomalies to be smoothed out. A downside might be that, in 'rounding off' the existing fares, some increases would exceed the upper limit currently set at 10%.

However, any such change to the current system should be regarded as a temporary expedient until such time as a more integrated system could be introduced. The LTRC has a stated aspiration to establish a Ticketing Clearing House arrangement, whereby through tickets could be issued for the bus journeys to and from the main city terminals. Whilst this may not be within the scope and feasibility of this particular project, it may be possible that it is introduced it in the short to medium term, subject to the strategies and policies adopted by the LTRC.

In order to introduce any feasible type of integrated ticketing system, it is necessary to have the compulsory adoption of Electronic Ticket Machines (ETMs). Only with ETMs in use can a full assessment of fare revenue, changing usage and evolving trip patterns be established. In the first instance, full manual surveys of current bus services should be undertaken, but the introduction of ETMs once a restructuring of service operations is agreed will enable the following advantages:

- Transport planning would be greatly facilitated in terms of evolving bus services to meet changing trip patters and the introduction of new development;

- The ability to introduce through ticketing would be facilitated, provided that a clearing house system could be instituted – this could be considered on a localised basis for the urban area of Zarqa if a national system cannot be delivered in the short term;
- ETMs would provide evidence of revenue in order to establish the need or otherwise for revenue subsidy.

If subsidy were to be introduced for services which are considered socially necessary, but which cannot be operated at a profit, then the ability to manipulate fare levels to accommodate policy objectives becomes much easier to achieve. The information available on a regular basis also enables a planning and regulatory authority to adjust fare levels to optimise income or achieve policy objectives, as most appropriate, and also enables experiments in, for example, reducing fare levels to see whether additional usage is stimulated, which might result in overall revenue increasing.

The ultimate aim should be to produce a system which is:

- Easy for passengers to understand;
- Graduated on a distance basis with a 'coarse' approach, and which fits in well with the introduction of regular bus stops throughout urban areas. In the case of Zarqa, ultimately a flat fare zonal system is well worth considering;
- Designed to allow bus operators some leeway in being able to offer discounted fares, return fares and weekly and monthly season tickets;
- Designed to make it easy to introduce modern technology, such as smart cards; and
- Easy to monitor and check.

Summary of Proposal

As can be seen from the above, many of the changes regarding ticketing and fares are dependent to a large degree upon national restructuring and reform, to which the LTRC is fully committed, but which is likely to have to be rolled out in a phased programme. In the meantime, we believe that changes can be implemented in Zarqa in the short term, if the parties concerned can reach a suitable agreement. In some respects, such an agreement would provide an excellent pilot scheme to show how such arrangements could be implemented in the other large cities in the kingdom.

Consequently, we would recommend that the following actions should be undertaken with regard to bus fares and ticketing, in conjunction with the restructuring of the operating industry and the reorganisation of bus services described in Proposals 1 and 2 above:

- Concentrate on the restructuring and reorganisation of bus services in the urban area of Zarqa (Level 5);
- Once this has been established in principle, determine a cap for maximum fares to be charged, but also set a series of intermediate fares based on distance, with all fares 'rounded off' to easier to remember figures.
- Ensure that fares on different services with common sectors are identical;
- Set up a local clearing house (pooling) arrangement to enable tickets to be interchangeable on common sections of route and for the use of through fares, initially within the urban area of Zarqa;
- Equip the buses used on Level 5 services with ETMs to facilitate integrated ticketing; and

The joint partnership should liaise closely with the LTRC (which would, in any case, be a member of the partnership) to establish the timescales for the introduction of revised services and integrated ticketing on longer distance routes, and to ensure that the benefits from these improvements are fully applied to the Zarqa area.

Appendix H Project 6

Public Transport Infrastructure Improvements

PROJECT 6: PUBLIC TRANSPORT INFRASTRUCTURE IMPROVEMENTS

The LTRC recognises the importance of having identified and well located bus stops, and has the following guidance for determining their optimum location:

- Stop must be suitable with pedestrians' movement and gathering points and serve commercial activities and passengers' movement. In case of availability of a pedestrian path, a stop is to be positioned so that its distance corresponds with passengers' preferred walking time ranging from 5 minutes in town centre to 10 minutes in city-surrounding areas. This distance is estimated as follows.
- a. Walking distance inside city centre is a circle of 300-400m radius.
- b. Walking distance outside city centre is a circle of 400-500m radius.
- c. Walking distance in suburbs is a circle of 500-800m radius.
- Distance between bus stops must be 400-600m; and in any case it must be no less than 300m.
- Stops must be selected so they do not obstruct movement of vehicles and pedestrians and offer safety at passenger loading/unloading.
- Public transport stops must not face each other on bi-directional streets with no middle isle. In case of opposite stops they must be separated by no less than 50m of distance.
- In case of a stop near main intersections regulated by bridge, tunnel and traffic signals, it must be at least 150m away from intersection edge.
- Stops must not be positioned near turns, accelerating or decelerating lanes, and hilltops so as to offer a visibility of 60m in each direction.
- On a road with a significant gradient, a stop must go up and not down so as to ease vehicle stopping.

The proposal is thus for the location of fixed bus stops within the Downtown area of Zarqa, and extended into the urban area of the Municipality. Within the Downtown area, these stops should be located along the streets designated for bus priority measures, such as bus lanes. Inevitably, providing bus priority measures will displace existing on street parking, which will be partially replaced by additional off street parking facilities.

Real time information is a very useful system for providing information to passengers, operators and the regulatory authority. It provides a greater degree of certainty to bus users, particularly when congestion results in buses not operating to the published timetables, it provides an excellent management information tool for operators, providing them with the opportunity to intervene effectively to restore correct operation and it can provide the regulatory authority with data concerning running times and vehicle requirements.

However, in order for the system to operate effectively, a highly disciplined approach must be made in terms of its implementation, which is covered in more detail in the following section. We would recommend the installation of this type of system in Zarqa, but only after the structural reorganisation of bus operations and the installation of ETMs has been successfully achieved.

Implementation

The location of suitable bus stops within both the Downtown area and the greater urban area of Zarqa is a task best undertaken by Municipality engineers, who are very familiar with the circumstances and detail of the streets in question. However, it is useful to be able to draw on generic guidance principles from elsewhere in the world in order to provide a logical framework for assisting in the precise location for bus stops.

Transport for London (TfL) has produced a guidance document entitled ‘Accessible Bus Stop Guidance’ [(14)]. TfL believes that bus stop design and location should be recognised as a crucial element in the drive to improve the quality of bus services. Their concept of 'Total Journey Quality' recognises that bus passengers are also pedestrians at each end of the bus trip and requires that all aspects of the journey are considered.

The convenience and comfort of bus stops must not be overlooked. Thus it is important to view the bus stop as an interchange, rather than simply a location along a bus route where buses stop, comprising only a post with a flag, and a painted 'cage' laid on the road surface.

When reviewing individual bus stops, and their immediate environs, designers need to take account of the wide range of issues that are discussed within TfL's guide. Whilst the guidelines provide assistance with the decision making process, it should be recognised that each site is a unique location, with different characteristics to be taken into account.

The TfL guidance includes a diagram showing all the features of the Bus Stop Environment that need to be considered when locating and providing bus stops. This diagram is shown in the following diagram:

Figure H1: Features of the Bus Stop Environment (14)

Bus stops must be located to allow passengers to board and alight safely and conveniently. Ideally, they should also be situated near places of particular need, such as local shops, libraries, clubs, health facilities and housing areas. Final decisions on stop locations should be determined jointly by the LTRC, a representative of the bus operators, engineers from Zarqa Municipality and the police.

The TfL guidance also includes a diagram which sets out considerations which should be taken into account when determining bus stop locations. This diagram is reproduced below:

Figure H2: Considerations for Bus Stop Locations [14]

Further guidance on bus stops is also provided in Manual for Streets [15] which was published by the DfT in 2007. WSP led the team of experts that created this guidance.

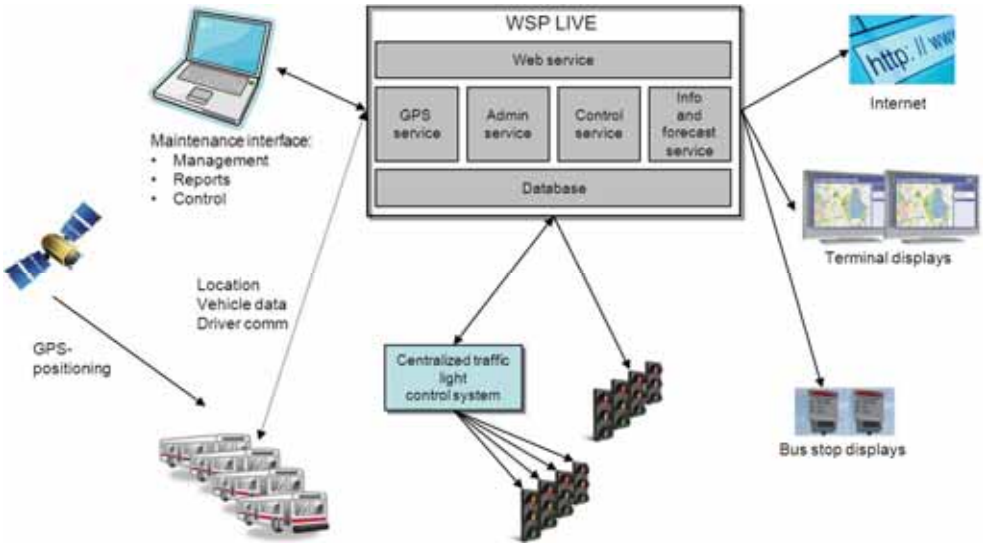
Manual for Streets states that bus stops should be located to ensure they can be easily accessed by foot. The location of bus stops depends on issues including the need to avoid noise nuisance, visibility requirements, and convenience of pedestrians and cyclists.

Bus stops should be high-quality places that are safe and comfortable to use. Footways at bus stops should be wide enough for waiting passengers while still allowing for pedestrian movement along the footway. This may require local widening at the stop. The bus stop must not hinder the free movement of pedestrians using the footway. Footways at bus stops should be wide enough for waiting passengers while still allowing for pedestrian movement along the footway.

Bus stops should be placed near junctions so that they can be accessed by more than one route on foot, or near specific passenger destinations (schools, shops, etc.) but not so close as to cause problems at the junction. On streets with low movement function, setting back bus stops from junctions in order to maximise traffic capacity should be avoided.

Real time passenger information systems are complex items of ITS, which require considerable effort in terms of staff resource commitment and expertise in order to function effectively.

The following diagram demonstrates a typical RTPI system and its components, in this case the system originally devised by WSP Finland for use by buses and trams in Helsinki.



It will be noted that, in this typical system, GPS positioning is used to determine the location of the vehicle, both the vehicle and the driver communicate with the central database, which in turn interfaces with bus stop displays, terminal displays, the relevant sites on the internet and with a centralised traffic light control system if RTPI is connected to a bus priority system. A maintenance interface with the database also allows the downloading of data and reports for on-going analysis.

However, in order for this complex system to function properly, the following factors have also to be present:

- Each bus must be correctly fitted with the appropriate equipment;
- Routine maintenance must take place on both static equipment and on-bus equipment, undertaken either by the operator or by the contractual supplier;
- Every day, the precise allocation of vehicles to route schedules must be completed by all participating operators, in order that the system is aware of which bus is supposed to be operating which particular individual journey;
- Drivers must correctly code their equipment on taking over a vehicle, otherwise the interface with the ETMs will not work;
- Any changes in vehicle allocation due to unforeseen circumstances, such as a breakdown, need to be reflected in correct adjustment to schedules, otherwise the RTPI system will not recognise the vehicle and the journeys operated will not appear on the tracking system.

It can clearly be seen from the above that the discipline required to make the system work correctly is unlikely to be present unless the operational restructuring proposed elsewhere in this report has been instituted.

Appendix I Project 7

New Low-Emission Vehicles

PROJECT 7: NEW LOW-EMISSION VEHICLES

Bus Specifications

In considering possible improved emission standards for vehicles used to provide bus services, the options affecting propulsion systems are critical. The current high sulphur content of diesel fuel in Jordan is a fundamental obstruction to the adoption of Euro 4 or 5 diesel engines. This is unfortunate, as adoption of the most modern diesel engine technology would probably have the most impact on emissions for the lowest per unit expenditure. However, in the absence of any firm date for the introduction of low sulphur content diesel in Jordan, we have considered a number of alternatives, the most obvious being the use of hybrid vehicles or the use of Compressed Natural Gas (CNG).

In a previous study undertaken for the LTRC [5], WSP/CC proposed that the current division of vehicle sizes by contract into white taxis, minibuses and large buses should be replaced by a more sophisticated hierarchy of six types. These are described below:

1. **White Taxi** (Type A) – standard saloon car seating 4 passengers plus the driver.

2. **Minibus** (Type B) – small bus seating up to 12 people plus the driver. This type of vehicle is primarily currently used for the operation of unlicensed services, but is considered to be a practical and more flexible alternative to the white taxi, and, in some rural instances where services use poorly maintained roads, the midibus.

Example **- LDV Maxus Wheelchair Accessible Minibus**

Other examples would include the Toyota Hiace and Nissan Escapade

3. **Midibus (Type C)** – mid size bus, typically a Toyota Coaster or similar seating no more than 22 passengers plus the driver.

Example **- Toyota Coaster 22 seat midibus**

4. **Medium bus** (Type D) – conventional full size bus in the range of 8 to 10 metres long, typically seating from 23 to 40 passengers, plus the driver.

Example **– Alexander Dennis Enviro 200** – from 8.9m to 11.3m with between 24 and 40 seats with low floor access

5. **Large bus** (Type E) – conventional full size bus over 10 metres and up to 15.2 metres in length, typically seating more than 41 passengers, plus the driver.

Example - **Volvo 7700 Citybus** – 32 passenger seats but capacity for up to 95 passengers with low floor access and standing - 9L Volvo Diesel, 12m option

6. **Coach (Type F)** – conventional full size vehicle up to 15.2 metres in length, typically seating up to 60 people plus the driver, with high floor, luxury seating and luggage space.

7. Example - Volvo B12M High Floor Intercity Coach – Volvo 12L Diesel (also available as 9L – B9R) – 12m or 15m configuration – up to 60 passenger seats as a 15m (55 seats as a 12m)

8. Example – Neoplan Skyliner – MAN Euro 4 Engine – 12m or 13.7m configuration – up to 77 passenger seats as a 13.7m (60 seats as a 12m)

Potential for more Fuel Efficient Vehicles in Zarqa

White Taxis. A significant number of local services in Zarqa are operated by white taxis. The services operated by this type of vehicle commence from a small terminal in the centre of the Downtown area, adjacent to King Hussein Bin Talal Street. As is customary with this type of service, there are no fixed departure times, consequently white taxis depart once they have sufficient passengers. Services are, however, very frequent. It is our view that white taxis are not necessarily always operating the most appropriate routes in Zarqa, and we have proposed a recasting of the service network so that white taxis are concentrated on the most local services in the Zarqa urban area, primarily in Downtown itself. This would result in a reduction in the overall white taxi fleet size used for Level 5 local services from 91 to 60 vehicles.

As white taxis are generally standard saloon (sedan) cars, we would recommend that these are replaced by hybrid cars as part of the bus operations restructuring proposed, as this would have a direct benefit to air quality in the Downtown area. Hybrid cars receive favourable tax treatment in Jordan, although it might also be necessary to arrange low interest loans for vehicle replacement purchases by licensed operators. Engine sizes should be restricted to below 2 litres.

Minibuses. Analysis of the make-up of the current bus fleet mix in Zarqa shows that, for the 265 bus contracts based on the whole of the Governorate of Zarqa, there were 119 white taxis, 722 minibuses and 121 large buses. By eliminating all contracts which do not serve the principal terminals in Zarqa and the Downtown area, and by adding contracts based on other Governorates (such as Amman) serving Zarqa, there were 110 white taxis, 694 minibuses and 206 large buses operating in the vicinity of the Downtown area. The majority of large buses are used on corridors carrying university students, in particular between Zarqa and Amman, with demand existing in both directions.

Our general approach is to recommend the upgrading of services to be operated by larger vehicles, thus providing greater capacity for similar frequencies of operation. However, minibuses are clearly by far the most popular current choice of operators, typically the Toyota Coater or Mitsubishi Fuso or similar. These minibuses are just over 2.0m wide, and vary in length from 6.3m to 7.7m, with a seating capacity between 16 and 28 people. Given the nature of the highway network within the Downtown area, it would be challenging to introduce any vehicles substantially larger than these dimensions, unless the bus priority measures recommended in Project 2 above are fully implemented.

A summary of the advantages and disadvantages of using these vehicles, which are extremely popular in many other countries, is shown below.

Coaster Type Vehicle - Advantages and Disadvantages

Advantages	Disadvantages
Low cost to purchase	Cramped accommodation for passengers
Easy maintenance and good spare parts availability	Lack of headroom not conducive to standing
Ideal size for the space available in the crowded and congested Downtown area of Zarqa	Unattractive for women passengers
Low operating costs	Difficult access with narrow entrance and steep steps
	Not easy to fit ticket machines and other equipment

Given that this size of vehicle is the most appropriate, at least in terms of those services operating in the Downtown area, we have considered potential alternative vehicles for future use which might be considered, and which might obviate some of the disadvantages listed in the table above. Any such vehicle needs to be assessed against these criteria:

- Does it provide equivalent or greater capacity than vehicles currently in use?
- Does it provide more internal circulating space than vehicles currently operated?
- Can the layout and seating arrangements be made more acceptable for women?
- Is access and egress (door width, step height etc) better than current vehicles?
- Do the dimensions permit standing passengers in more comfort than existing vehicles?
- Is the price premium over standard minibuses acceptable?
- Can buses be purchased that are more energy efficient and which have significantly lower emissions than current vehicles?
- Are maintenance costs and spare parts availability acceptable?

In accordance with the proposed introduction of 6 categories of vehicle (white taxi, minibus, midibus, medium bus, large bus and coach), we refer to replacement vehicles for the current fleet of Coaster type buses as 'midibuses' or medium buses, rather than minibuses, which under the new designation are buses with a seating capacity of no more than 12 people plus the driver.

Toyota Coaster Minibus operating in Zarqa.

Examples of midibuses similar in concept to the existing vehicles. Toyota produced a Hybrid version of their Coaster vehicle, but this ceased production in 2007. A special LPG version is still produced for the Hong Kong market, but this only has seating for 16 passengers and is right hand drive. There does not appear to be any alternative fuel versions of other current models, such as the Mitsubishi Fuso.

An alternative approach would be to consider the advantages and disadvantages of adopting the use of Compressed Natural Gas (CNG). Jordan receives some 80% of its natural gas from Egypt by pipeline, and although there have been recent problems with supply reliability, this fuel has some positive advantages for bus operation. It may also be cheaper than diesel, although this has to be set against the differences in vehicle cost and the installation cost of equipment at depots. Suitable size vehicles designed to utilise CNG are available from a number of sources, notably from a variety of Chinese manufacturers. The following illustrations are of such buses, and demonstrate their similarity to currently popular models being operated in Zarqa.

Nanjing Dongyu Auto Group CNG Minibus – Model NDY 6600
5.99 m long and 2.01m wide, Seats 17 passengers

Nanjing Dongyu Auto Group CNG Minibus – Model NDY 6740
7.40m long and 2.22m wide, Seats 24 passengers

Chongqing Wuzhoulong New Energy Auto Co CNG Minibus – Model QMB-6601C3E
5.99m long and 2,08m wide

Longxuan Industrial (China) Corporation CNG Minibus – Model LX6540
5.94m long and 2.02m wide Seats 17 -19 passengers

Buses to a significantly more modern standard, which are better suited to local bus operation are available from various manufacturers. Whilst these are may be ideal for intensive highly used urban services, they inevitably have higher purchase prices.

Examples of more modern, purpose built service midbuses or medium buses are the Optare Solo, from the UK, which is also available as an electric bus or a Hybrid bus, with series transmission, and the Van Hool A308 Hybrid from Belgium. The former is available in lengths from 7.1m to 9.5m, and is available in a 'narrow' 2.3m specification, with seating varying from 23 to 37 passengers. The A308 is, in appearance, more like a small conventional city bus than a minibus, and is 8.9 m long and 2.35m wide, and is designed to seat 17 passengers with space for standees.

Optare Solo Minibus

Van Hool A308 Hybid City Bus

A further example of modern design is the Mercedes Benz City Sprinter 65 (shown below), which, like the Toyota Coaster and similar buses is based on light van technology. However, this model has low floor technology, seats 13 with 17 standees at the front of the bus with proper facilities and adequate headroom. It is 7.7m long and just under 2m wide, so very similar to the Toyota Coaster in overall dimensions. Normal engine specification is Euro 4, although there are no electric or hybrid versions available.

Mercedes Benz City Sprinter 65 Minibus

The potential for the types of bus described above to be used in the Zarqa environment is discussed in more detail under the relevant Proposal.

We have calculated that the average age of current minibuses based in Zarqa is 10.3 years old. As these vehicles might be described as lightweight in comparison with larger buses, this is a very high average figure. The number of vehicles identified as being over 10 years old in this category, i.e. dating from 2000 or earlier, is just over 300. We would recommend that these buses should be a priority for early replacement, subject to the identifications of investment funding in the form of loans.

Large Buses. The large buses registered for operation in Zarqa tend to be newer on average than the minibuses, most being manufactured by BMC or King Long. As mentioned previously, these are almost exclusively operated on services for university students.

The economic viability of services for students where there is just one return trip per day is very questionable, even if this trip is 100% utilised. Currently, operators do not receive any subsidy for operation of services, although the students themselves are progressively receiving a 50% fares discount. In our proposed reorganisation of services, we have attempted to rationalise a number of anomalies by combining contract operations where there are university destinations at both ends of the journey and where a number of small buses can be replaced by a smaller number of large buses.

The inherent unprofitability of these types of service needs to be understood and the overall policy of bussing students over very long distances on a daily basis might require reviewing on a national basis to ensure that it remains the most appropriate policy option. Non-transport related options might include a more limited freedom of choice of university to attend in order to reduce trip lengths, or a concerted effort to provide additional student accommodation, preferably at the university locations themselves or at locations where

mass transit can easily be arranged over a short distance. Such an approach is well outside the remit of this report, however.

In order to assess the practicality of our proposals in terms of the numbers of buses suggested, a clearer understanding of the precise loadings is necessary. We have based our service simplification on available data, but the majority of this was collected some 5-6 years ago and thus may not represent current demand patterns.

We also recommend that the potential for a BRT service between the King Abdullah Terminal and the Hashemite University be explored, either as an extension of a potential Amman to Zarqa BRT corridor, or as a stand-alone project. This relatively short route, much of which would not require specific segregation or bus priorities, currently requires 22 large buses and 4 minibuses to cope with demand, and our proposal would be to operate this as a single route with 25 large buses suitable for BRT operation. The nature of this type of shuttle service is also likely to generate off-peak usage which we feel would provide a reasonable chance of a good business case to be made.

Fuel consumption goals. Setting fuel consumption goals, allied to appropriate driver training would represent an excellent KPI for demonstrating energy savings in terms of public transport operation. However, its practicality is dependent on successful structural reorganisation of the bus operating industry and an effective policy to introduce new vehicles with more favourable fuel consumption and emissions.

Rationalisation of School Buses. Our original assumptions on school buses were based on experience in Amman and elsewhere in the Middle East, where school buses represent a significant proportion of peak hour traffic. In Jordan, it is primarily the private schools, and sometimes the parents of children attending private schools, that organise school bus services. There is no national policy to provide school bus transport for children attending public schools. Subsequently, we have been informed that there are comparatively few private schools located in the Zarqa urban area, and thus the congestion and energy efficiency relating to this particular mode of transport is minimal, and does not offer any significant opportunities for improvements.

Our overall recommendations on improvements to energy efficiency for buses and improved emissions may be summarised as follows:

- All vehicles operating the revised white taxi network of routes should be replaced by hybrid cars as soon as is feasible;
- An investigation should be made into the feasibility of operating CNG powered buses, including a full assessment of practicalities, operating costs and purchase price implications;
- Consideration should be given to the practicalities of operating slightly larger midibuses on bus services in the local Zarqa area, taking into account the creation of bus priority lanes and measures;
- The proposed Park and Ride shuttle bus service should be operated by new buses, preferably to improved standards over current buses and in line with the outcome of the investigations proposed above;
- The revised group of bus services proposed to cover the King Abdullah Bin Abdul Aziz City housing development should be operated by new midibus type vehicles to improved specification, in order to attract usage from this growing area;
- Once an acceptable specification is determined for future buses and restructuring of the network planned, the 300 minibuses built before 2001 should be targeted for early replacement;
- Consideration should be given to the planning of a low cost BRT service between the King Abdullah Terminal and the Hashemite University, with particular regard as to whether such a service could also serve new development to the east of the Zarqa city area;

Government public sector ministries should work together to investigate how a ‘green’ fund could be established to provide the facilities for low cost loans to bus operators (primarily existing larger companies and the new organisations created as part of the bus restructuring exercise) in order for them to upgrade their fleets through the purchase of new energy efficient buses.

Appendix J Project 8

Walking Infrastructure Improvements

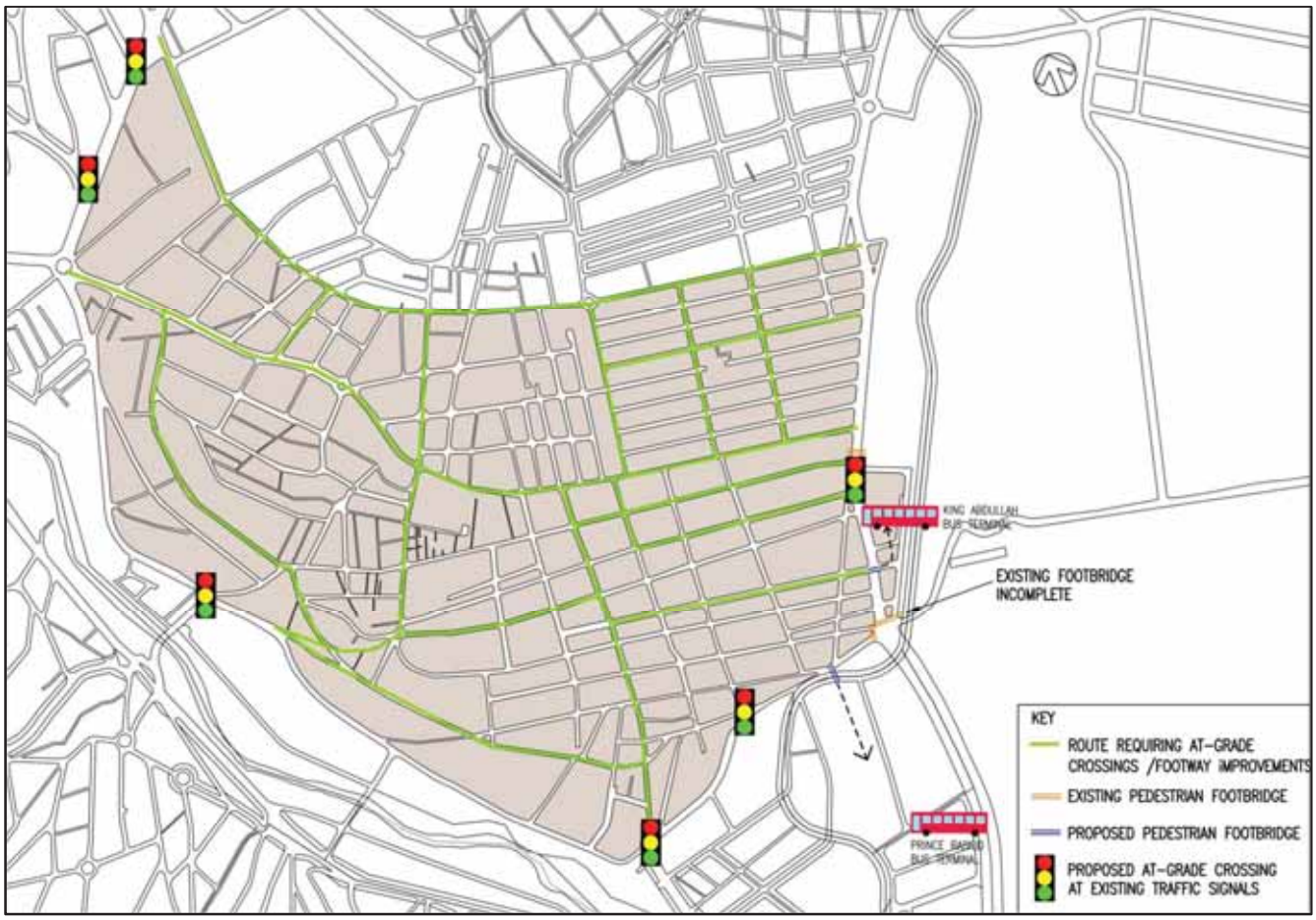
PROJECT 8: WALKING INFRASTRUCTURE IMPROVEMENTS

Within the scope of this project additional measures were considered, not only to encourage walking, but also to aid travel by bicycle. However, following discussions with Zarqa Municipality it was decided that measures to facilitate cycling would not be the best focus of resources. The view of Zarqa Municipality is that it would be unrealistic to target increasing the number of cyclists due to the impracticalities of cycling in the city, and there being no evidence of any current cycling activity to build upon. Therefore, this study does not recommend measures relating specifically to encouraging cycling in Zarqa.

This project presents a strategy for achieving improved walking infrastructure split into stages of implementation. Figure J1 below presents an overview plan of the strategy. The proposals would need to be refined following Stage 1, to identify in more detail the specific improvements that are required.

It is however noted that, aside from implementation of hard measures such as improved pedestrian facilities, the attitude of drivers and pedestrians will be difficult to change as this behaviour is part of the local culture and will be a longer term adjustment. It is considered by WSP-CC that the implementation of safer facilities is however the first step in changing the attitude towards pedestrian movement in the city.

Figure J1 - Walking Infrastructure Improvement Strategy Overview



Stage 1: Pedestrian Network Audit

It is recommended that the first action in improving walking infrastructure is to carry out an extensive detailed audit of the existing conditions for pedestrians in downtown Zarqa. In summary, the audit should include:

- Identification of any missing sections of footway where a continuous link is not provided;
- Review of the footway quality to identify sections in need of maintenance or clearance of obstructions;
- Identification of any crossing facilities that currently exist;
- Review of quality of pedestrian environment in public transport waiting areas;
- Review of interconnectivity for pedestrians between downtown Zarqa and public transport terminals; and
- Identification of any hazards for pedestrians.

The aim of the audit is to inform a detailed plan of improvements for downtown Zarqa and refine the proposals in this project, ensuring that they are focussed on the areas of the pedestrian network most in need of work, and to make optimum use of any existing facilities.

Stage 2: Footway Improvements

Further to the audit, it is proposed to create new footways where there are currently gaps in the network, remove any unnecessary obstructions, and repair damaged footways. Where footways are narrow and constrained, it is proposed to widen the footways to a minimum of 2 metres clear width to ensure adequate capacity for pedestrians.

The grid network of roads within the downtown area provides an excellent level of permeability for pedestrians, offering a wide choice of routes. As a result of this dense network of streets, although vehicles are typically channelled along main roads through the downtown district, pedestrians are more widely dispersed, and hence it is important to provide high quality footways across the full downtown area, as identified in Figure J1 above.

The creation of a continuous link of clear footways will help to segregate pedestrians from traffic. The benefits of this will both be in pedestrian safety, and in removing obstructions from the carriageway to allow vehicles to travel more freely on the roads. The image to the left below illustrates a poorly maintained footway in Zarqa City which is unattractive to pedestrians, whilst the image to the right below illustrates an example of a higher standard of footway found within the city. It is proposed to upgrade all footways to meet this higher quality standard.

Poor Quality Footway

Good Quality Footway

Stage 3: Pedestrian Crossings

Pedestrian safety will be further improved by the construction of new crossings. Given that there are currently very limited safe crossing facilities in Zarqa City, it is unrealistic to introduce crossings across the full downtown area and to change the current culture of walking amongst traffic to cross the road. Therefore, the introduction of pedestrian crossings will initially be focussed on the corridors with highest volumes of

traffic where safe crossings are required the most. The streets have been identified through analysis of accident data, to confirm which roads have concentrations of pedestrian incidents.

The main routes where at-grade crossings are recommended are illustrated in Figure J1 above. It is proposed to implement these with traffic signals in the form of pelican crossings, to ensure that drivers obey the crossing points and give priority to pedestrians to cross. Pedestrian crossings should also be introduced at traffic signal controlled junctions where they lie on pedestrian desire lines.

The image to the left below illustrates an example of current poor crossing practice that takes place in Zarqa, whilst the second image provides an example of a high quality signal controlled pedestrian crossing in the UK, which acts as an example of the desirable standard to be achieved in Zarqa.

Unsafe Pedestrian Crossing Point

UK Standard Pedestrian Crossing

Although the introduction of pelican crossings can create delays to traffic due to the necessity for vehicles to stop and the inter-green times required to allow pedestrians to cross safely, in the case of Zarqa it is anticipated that traffic will not be significantly affected. This is due to the crossings removing stray pedestrians from crossing haphazardly as they do currently, which is a significant contributing factor to existing congestion in the city.

The siting of at-grade crossings on the routes identified will need careful consideration in terms of pedestrian desire lines, local obstructions, and proximity to junctions. Furthermore, siting of crossing should be a minimum of 100 metres from any traffic signal controlled junctions unless they form part of the junction.

It may be necessary to install pedestrian guardrails in the vicinity of crossings, to assist with changing the culture of road crossings and encourage people to use the safer formal crossing points.

In addition to at-grade crossings, Figure J1 identifies locations where pedestrian bridges are recommended as more suitable forms of crossing due to the high volumes of traffic and wide carriageway links. Accident records show a high density of minor and severe accidents involving pedestrians on Al Jaish Street, which separates downtown from King Abdullah Terminal, and further accidents involving pedestrians on King Talal Street, which separates the district from Prince Rashid Terminal. These two locations are therefore recommended for pedestrian bridge crossings to improve safety and to improve the accessibility of the bus terminals.

Furthermore, it is recommended that the existing construction of a pedestrian bridge in the south eastern corner of downtown Zarqa, as identified in the image below, is completed to facilitate safe movements in this area.

It is acknowledged that pedestrian bridges do have their disadvantages, such as being unsuitable for disabled users, and also that the additional time and diversion to the journey to walk up the stairs provided to cross the bridge may discourage some users. However, without substantial downgrading of these main routes by diverting traffic elsewhere, these main roads are impractical for pedestrians to cross at street level, without significant hazards or significant disruption to traffic flows.

Existing Incomplete Pedestrian Footbridge

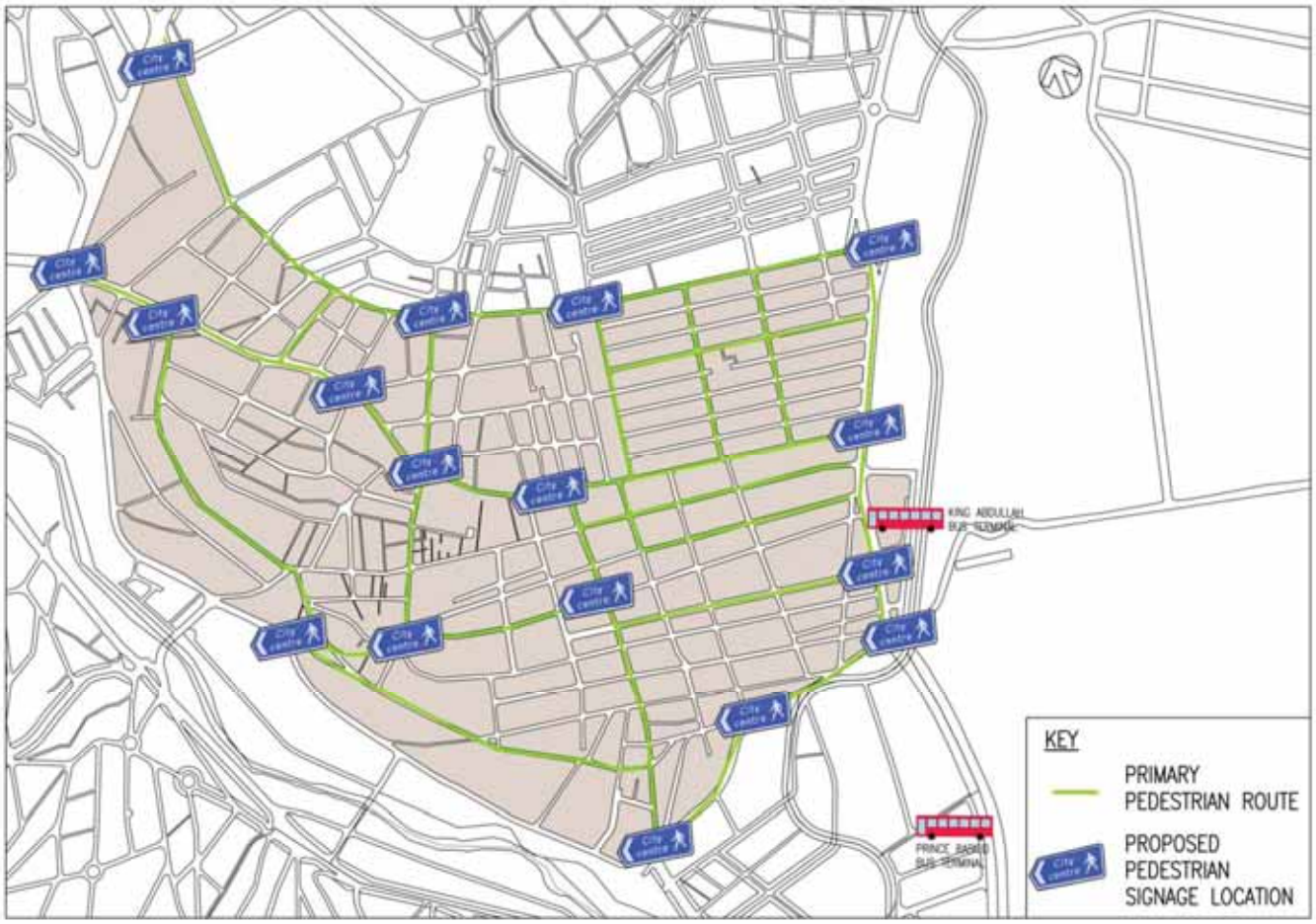
Stage 4: Pedestrian Signage

As a further measure to facilitate pedestrian movement in the downtown area, it is recommended that directional signage is provided to aid navigability between key points of interest. The optimum locations for signs are the main gateway points in and around the downtown area, such as at the bus terminals and major intersections. Signs directing pedestrians between key focal points in the city can help create a sense of public realm, as well as assisting pedestrians to understand their route. This will maximise the propensity to walk for short distance trips within the downtown district.

Typical signs may include distances to destinations, as well as a map identifying the current location. Development of a signage strategy to indicate the fastest routes to public transport terminals will help guide pedestrians along the upgraded routes with high quality footways and crossings. A best practice of example of pedestrian signage is illustrated below, whilst an indication of suggested locations of signage to be located is provided in Figure J2 below.

Best Practice Directional Signage and Information

Figure J2: Pedestrian Signage Suggested Locations



Appendix K Project 9

Installation of ITS Measures

PROJECT 9: INSTALLATION OF ITS MEASURES

Stage 1: Improvements to Existing Traffic Signals

The traffic signals that are currently present appear to be basic isolated installations using tungsten filament or tungsten halogen signal heads that have been installed purely to manage traffic conflicts as a basic safety measure.

These can be replaced with modern LED signals which offer improved optical performance, less maintenance and reduced energy needs. The energy efficiency of older traffic signals may be improved by use of night dimming. However, this may not be achievable with the traffic signal controllers installed or may result in poor optical performance if signal lenses are not maintained in a clean condition.

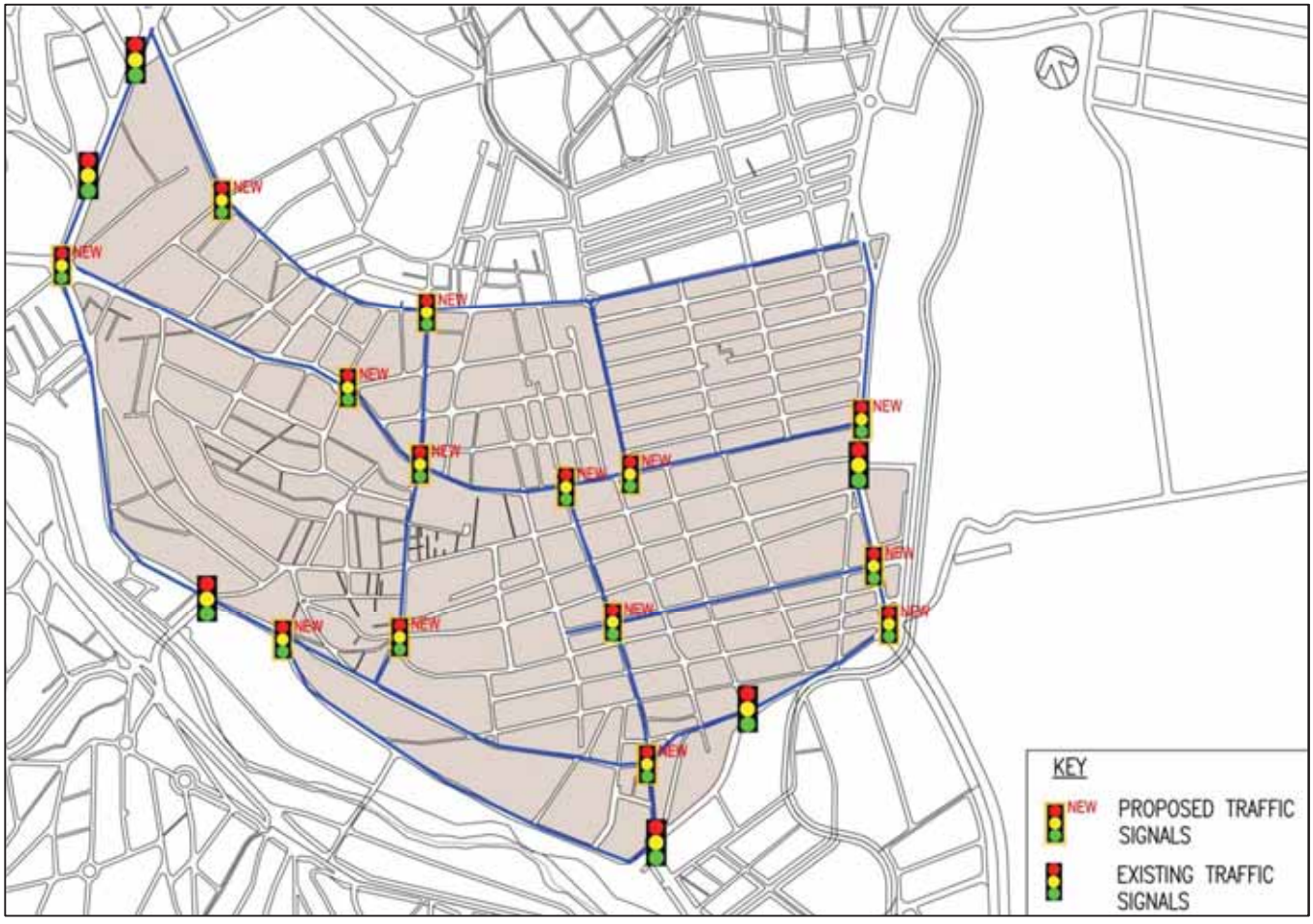
It is therefore recommended that improvements are made, with formal maintenance of the signals enforced to ensure on-going high performance.

In addition to upgrading the signals themselves, the signal controlled junctions can be improved with the introduction of high-quality road markings. Currently the traffic signal junctions lack any basic road markings such as stop lines to inform drivers. Therefore improvements to the operation and safety of the junctions could be made through new road markings formalising the structure of the junctions. Further details on road markings are provided in Project 10.

Stage 2: Installation of New Traffic Signals

The installation of traffic signals at additional junctions on the downtown ring road, and on major intersections within the downtown area will help the creation of a co-ordinated network to control traffic flows. Key junctions on the downtown ring road such as the main intersection in the south east between King Talal Street and Al Jaish Street would benefit from the clearer control provided by traffic signals. Figure K1 below illustrates an indication of the potential junctions to be converted to traffic signal control. Further analysis using the proposed traffic model would be required to confirm and identify the optimum locations for traffic signals prior to installation.

Figure K1: Proposed Traffic Signal Junctions



Stage 3: Urban Traffic Control

Benefits would be achieved by linking traffic signal controllers to a central fault monitoring system to ensure signals and controller equipment failures are detected and reported to the signal maintenance organisation. Further benefits would be gained by coordination of signals by a traffic adaptive central Urban Traffic Control (UTC) system.

Greater Amman Municipality (GAM) already operate a SCATS (Sydney Coordinated Area Traffic System) covering most of the signalised junctions in Amman. It is feasible that this system could be extended to monitor and control traffic signals along the transport corridor linking Amman to Zarqa. Such a system could be operated from the Amman system. Alternatively a regional SCATS server, operator workstations and a Control Centre could be developed in Zarqa.

The addition of centralised control of traffic signals should also aid implementation of a public transport priority system in the longer term, which provides LRT or BRT vehicles priority over other traffic at traffic signals that appear along this corridor.

Appendix L Project 10

Junction and Highway Improvements

PROJECT 10: JUNCTION AND HIGHWAY IMPROVEMENTS

Figure L1 below indicates the main highway corridors for which it is recommended that improvements are made according to the details set out in the Final Report. Figure L2 provides an indicative plan of the typical junction road markings layout which are proposed within this project.

Figure L1: Junction and Highway Improvement Location Plan

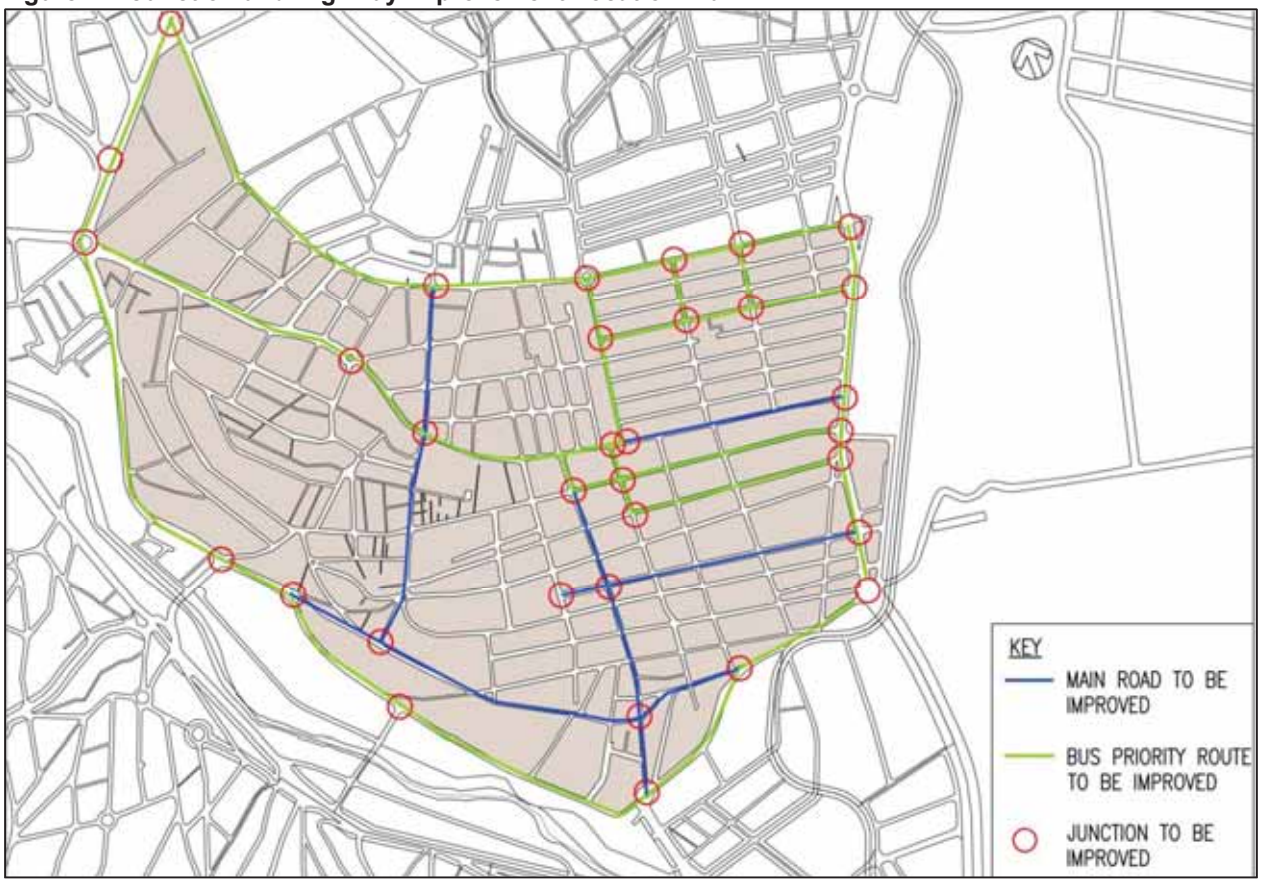


Figure L2: Example of Potential Junction Improvements

Appendix M Project 11

Parking

PROJECT 11: PARKING

Any parking approach and use of technology will only be successful if full enforcement procedures are in place, with penalties set at levels high enough to discourage future malpractice. It would also be beneficial to allocate penalty payment revenues to support transport measures within Zarqa. This will require the established of necessary legislation and re-organisation of parking enforcement roles within Zarqa.

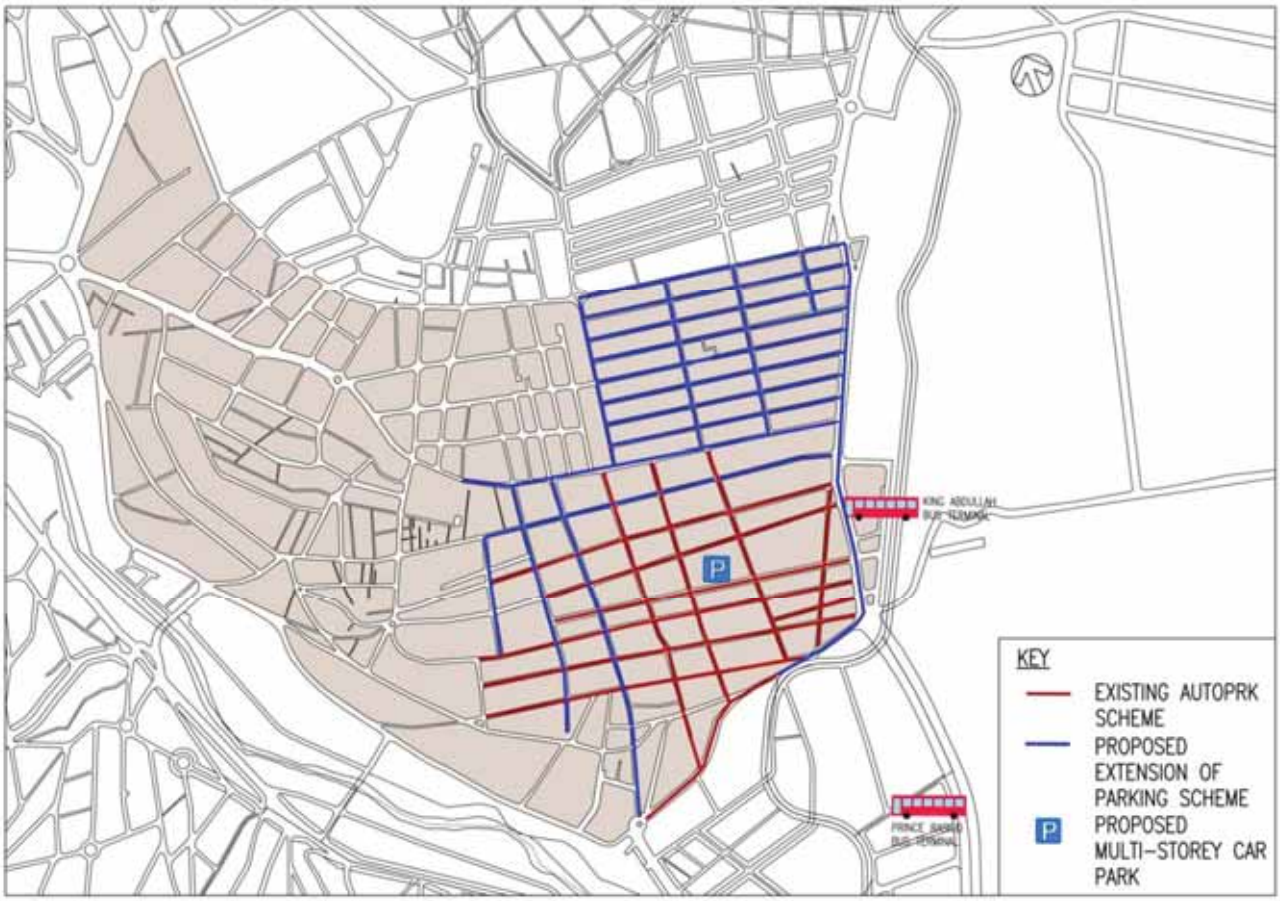
Comprehensive changes to the provision of parking within Zarqa will undoubtedly bring some public resistance. It is perhaps generally accepted that indiscriminate parking is a prevalent and as such is tolerated. This has led to a culture of parking for free by whatever means, where the risks of receiving a penalty are limited.

However, as parking pressures increase, the acceptance for the need to have a comprehensive Parking Strategy, that manages the demand for parking, supported by an integrated Mobility Vision for Zarqa, will increase, and paying for parking will become an established and accepted practice.

Ultimately, parking improvements will reduce congestion in downtown Zarqa through deterring trips and minimising the obstructions of indiscriminate parking.

Figure M1 below illustrates the overall parking strategy, setting out the proposed extension to the AutoPark scheme alongside recommended location for multi-storey car parks which was identified through consultation with Zarqa Municipality. The park and ride proposals are dealt with separately in Project 3.

Figure M1: Proposed Parking Strategy



The Parking Project is split into four sections to deal with the different aspects of the proposals. The remainder of this project is structured as follows:

- Project 11A: On-Street Parking
- Project 11B: Off-Street Parking
- Project 11C: Parking Technology
- Project 11D: Parking Enforcement

PROJECT 11A: ON-STREET PARKING

AutoPark Improvements and Expansion

As stated previously, it is proposed to extend the existing AutoPark scheme. In addition to widening the area covered by the parking scheme, it is recommended that the existing scheme is upgraded to provide more formal parking spaces and information to drivers. Improvements include providing road markings to segregate the parking bays from the highway carriageway. Alternative alignments of parking bays may be considered depending on the carriageway width, and whether it is suitable to provide parking on one or both sides of the road. Details of dimensions and alignment guidance for both the existing AutoPark zone and the proposed extension area are provided below.

Parking Space Dimensions

The required size of parking space is generally determined by the parking class and vehicle dimensions, although often available space is a deciding factor. A parking bay needs to be, as a minimum, able to contain and allow safe and adequate manoeuvre of a vehicle. The level of manoeuvre required varies depending on parking type, with greatest manoeuvrability tolerances required for parallel parking bays.

Typically the length of a parallel parking space is 5.0 to 6.0 metres, a length deemed appropriate to accommodate the vast majority of private cars. These lengths reduce for angled parking (see below).

The width of a car parking space is determined by the design vehicle width in addition to added clearance for allowing vehicle door opening. The level of added clearance should be increased for car parking types where vehicle turnover is high. The generally accepted standard overall width is 2.5m with the minimum being 2.2m (See Table below)

Parking Space Clearance

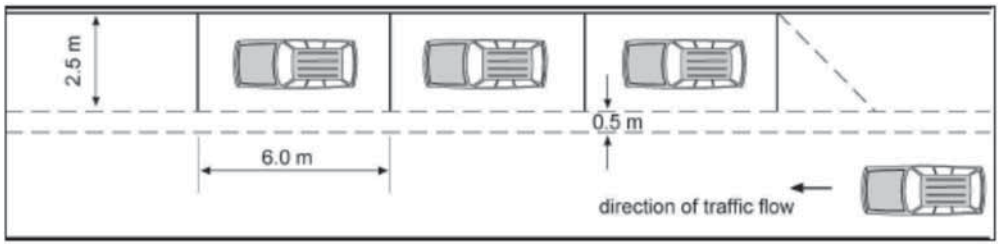
Duration of Parking	Typical Land use
Short term / high turnover (less than 2 hours)	Retail customers, banks, fast-food
Medium term / medium turnover (2 hour to 4 hours)	Leisure activities, cinema, restaurants
Long term / low turnover (greater than 4 hours)	Visitors, office employees, residential, airports, hospitals, hotels, industrial, university, schools

Parking Bay Design

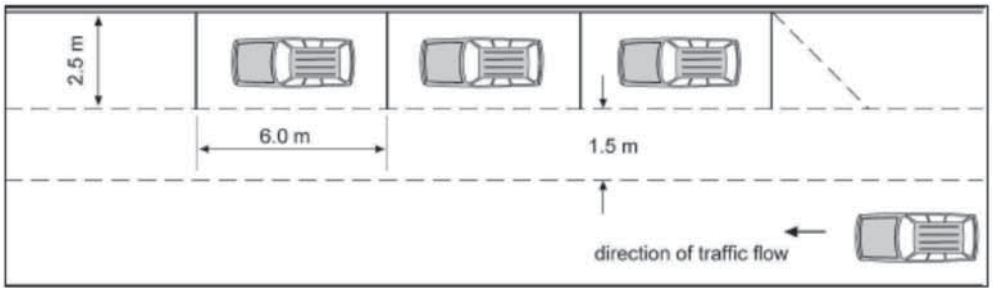
On street parking can be provided as either parallel parking, where the length of the bay is parallel to the kerbline, or as angled parking where the length is offset from the kerb line alignment.

Parallel parking is suitable on streets where highway width is a constraint and traffic speeds are below 50kph. The highway must be bordered with a footway. A suitable buffer to allow pedestrian clearance must also be incorporated into the design width. This will vary depending on traffic speeds as detailed for illustrative purposes below.

Geometry of parallel parking layout for up to 50kph



Geometry of parallel parking layout for 60kph

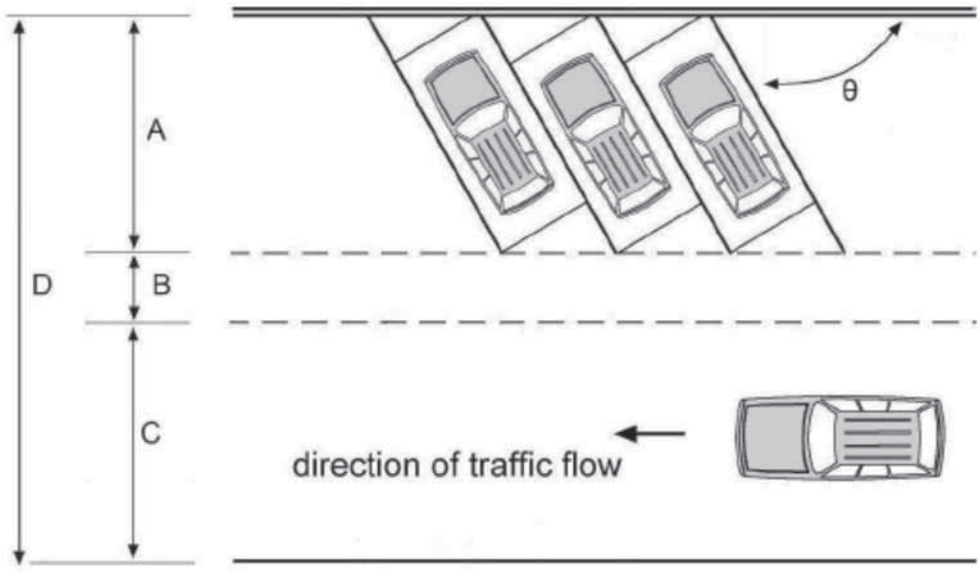


Angled parking allows greater parking capacity but should be employed on-street following consideration of the issues and parameters presented below:

- Width of road;
- Traffic volume;
- Type of traffic
- Traffic speeds
- Vehicle dimensions;
- Turnover; and
- Land use served.

When providing angled parking, adequate room to manoeuvre into and out of the space should be provided. This usually requires the adjacent through lane to be wider than standard. Where space permits, it is also advisable to provide a buffer lane between the edge of the travelled way and the nearest part of the parking bay. The image below illustrates geometry for angled parking.

Geometry for angled parking



Controlled Parking Zones

In addition to the AutoPark system, Controlled Parking Zones may also be considered for implementation in Zarqa.

Within a given area, it may be appropriate to allow some vehicles to park without restrictions, whilst limiting demand from other users i.e. in a predominantly residential area where residents' parking is unrestricted, but limits are put on the number of visitors or employment uses parking in the area. This is achieved by designating Controlled Parking Zones (CPZs). This ensures all on-street parking is controlled to keep roads

free from dangerous parking and give priority to particular users (usually residents and local businesses) who must display a valid permit.

CPZs are commonly supported with the implementation of on-street parking payment technologies such as Pay and Display to allow infrequent short stay visitors to park. Examples of CPZ signage are provided below.

CPZ Sign Examples

Controlled Parking Zones are commonly implemented by dividing an area up into separate zones with residents' permits only valid within the defined zones. These are clearly marked at the boundaries with on street signs. Those with the relevant zone permit can park without restriction. Commonly there is an annual permit charge and only residents can apply by providing their proof of address. To restrict the number of multi-car households, the cost of purchase additional parking permits is high.

Disabled spaces can be designated to a registered number plate which is indicated on the disabled parking sign. In controlled parking zones this ensures disabled drivers can park outside their own homes/place of work.

To allow non-permit holders to park for short durations, Pay and Display ticket machines need to be installed. Alternatively, specific parking bays can be demarked for short stay parking and Parking Meters can be installed.

Controlled Parking Zones require the following support/back-office functions to be in place:

- Registration and Administration;
- Charge Collection / Processing (where paid on street parking is also provided); and
- Enforcement.

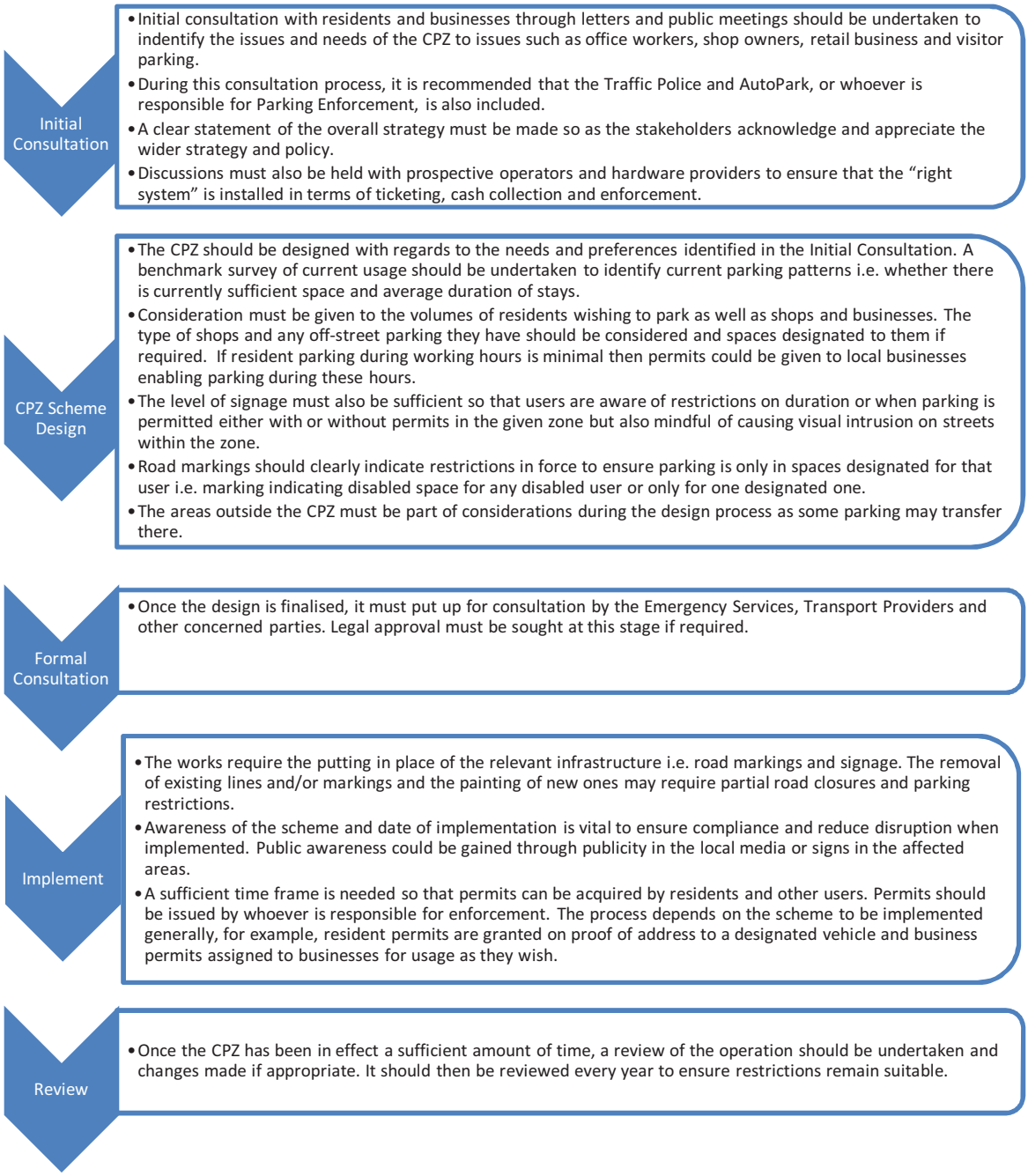
Administration processes are required, to register users and issue the appropriate parking permit. This needs to be accompanied with clear permit instructions.

Where paid on street parking is also provided, cash collection is required. This is discussed in detail above within the Pay and Display section.

As for the other on street parking types, enforcement is required to ensure parking restrictions and payment requirements are being adhered to. Enforcement is commonly carried out through visual checks by officers on foot carrying out sporadic checks in a given area. Penalty notices can then be issued where valid parking tickets are not presented.

The overview processes that are required to implement a CPZ are presented below.

Implementation Process for a CPZ



PROJECT 11B: OFF-STREET PARKING

Proposed Multi-Storey Car Park

It is proposed to introduce a multi storey car park within downtown Zarqa to accommodate parking spaces that are lost through new parking restrictions introduced in the district. The benefit of providing a multi-storey car park is the removal of parked cars from streets, thereby freeing up highway capacity.

Discussions were held with Zarqa Municipality over the most appropriate location for a car park based on availability of land and accessibility / attractiveness to drivers. Zarqa Municipality has indicated that the optimum location within the downtown district is in the south eastern corner, in the area where the existing white taxi terminal is located.

The availability of open space in the Downtown area is limited, but the white taxi services currently depart from an open area surrounded by buildings. We would propose that the possibility of constructing a multi-storey car park within this space is investigated. Given that the land is currently in use by white taxis, it may be possible for them to continue to operate by using a specially reserved area on the ground floor of this proposed multi-storey car park. Up to 400 spaces could be provided on a multi-level car park above the white taxi stands. The proposed location of the multi-storey car park is shown in Figure M1 previously.

Car Park Design

When considering the design of an off street car park, consideration is required of the following parameters;

- Bay dimensions;
- Layout and circulation; and
- Access design;

Bay dimensions for off-street parking spaces are similar as for on street angled parking spaces and the consideration for swept path, clearance and buffers remain.

The parking circulatory system, incorporating roadways and aisles should form a clear hierarchy leading vehicles effectively from the entry to the parking spaces and then to the exits. This should be supplemented with appropriate signage. One-way circulatory systems require reduced roadway and aisle widths compared to standard two-way circulatory systems. Refer to Table below.

Standard Car Parking Layout Dimensions

Angle of Parking	Parking Type	Space Width (m)	Space Width Parallel to Aisle (m)	Space Length (m)	Aisle Width (m)
30 (one way aisle)	1 (short term)	2.7	5.4	5.5	4.0
	2 (medium term)	2.6	5.2	5.5	4.0
	3 (long term)	2.5	5.0	5.5	4.0
45 (one way aisle)	1 (short term)	2.7	3.8	5.5	4.5
	2 (medium term)	2.6	3.7	5.5	4.5
	3 (long term)	2.5	3.5	5.5	4.5
60 (one way aisle)	1 (short term)	2.7	3.1	5.5	6.0
	2 (medium term)	2.6	3.0	5.5	6.0
	3 (long term)	2.5	2.9	5.5	6.0
90 (one way aisle)	1 (short term)	2.7	2.7	5.5	8.0
	2 (medium term)	2.6	2.6	5.5	8.0
	3 (long term)	2.5	2.5	5.5	8.0

Access design needs to accommodate suitable stopping distance, to minimise vehicle and pedestrian conflict and disruption to through traffic. Consideration should be given to the following factors when designing access and egress for off-street car parks;

- Traffic influx should be largely free-flowing;
- Accommodate queuing off the highway and in particular away from junctions;
- Impact of vehicle access and egress on pedestrians and other non-motorised transport modes; and
- Access should be close to arterial roads.

PROJECT 11C: PARKING TECHNOLOGY

On-Street Parking Technology

On street parking can be provided free of charge or at cost to the user for a range of parking types and durations. The only limit on provision is capacity and this can be managed through applying restrictions where parking can be located.

When providing on-street parking the following factors need to be considered;

- Level of demands for parking;
- Likely duration and turnover of spaces;
- Type of land uses in proximity;
- Quantum of parking provision provided in proximity; and
- Level of restriction required to manage the provision.

Free on-street parking is only suitable in locations where competing demands for spaces is limited and principally only where residential land uses are in proximity, with limited or no commercial or retail land uses. This ensures there is no competing demand for spaces and payment restrictions are not required. However it should be noted that in residential areas where car ownership levels are high, but where on plot or off street parking is not available, some form of on-street parking management is often required.

In locations where there are competing demands for varying land uses, paid on-street parking is an appropriate mechanism to control demand. On-street parking charges can be targeted at certain potential users as a means of managing demand. Pricing structures can also be applied to discourage parking duration by weighting the charges appropriately i.e. high charges for durations over 2 hours. Parking revenues that are generated by paid on-street parking are potentially a significant stream of funding.

In locations where paid on-street parking is deemed the most appropriate parking approach to manage the level of demand for parking, a suitable mechanism for collecting the generated revenue needs to be implemented. To decide upon the most appropriate mechanism a range of factors need to be considered:

- User-friendliness of system,
- Speed of payment;
- Level of parking charges;
- Cost of implementation and management;
- Revenue collection processes; and
- Method of enforcement.

There are a huge range of technologies that can be utilised to collect parking revenues from on-street parking. These technologies range from payment in advance systems using cash, to contactless systems where mobile phone technology is utilised. Each of the technologies brings benefits and dis-benefits against the factors listed above and the suitability of each technology needs to be considered on a zone by zone basis. For this reason many cities have a range of technologies in operation across their administrative area.

The AutoPark scheme currently in place uses a Pay and Display system to collect revenue. It is therefore recommended that this system is maintained and expanded. Further details on Pay and Display are provided below.

Pay and display machines are used for regulating and controlling parking in urban street or in car parks. They are one of the most common parking technologies used to collect revenue associated with on-street parking and have been successfully implemented across many urban areas around the world. An example of a Pay and Display ticket machine is presented below in comparison with an existing parking meter in downtown Zarqa.

Parking Meter in Zarqa

Pay and Display Example

On street machines issue parking tickets to drivers, which are then displayed on the dashboard, or inside the windscreen of the vehicle. This allows enforcement officers to identify those vehicles that have valid parking.

Users firstly park in an available parking space before accessing the ticket machine. Drivers then use the ticket machine to pay in advance for estimated parking time needed. This is achieved by selecting the appropriate tariff and pressing the corresponding button, or entering the appropriate amount of cash as displayed in the fare structure. The issued ticket displays details such as zone of validity, expiry time, fee paid and time issued.

Tariff structures are usually on an hourly basis (i.e. up to 1 hour, 1 to 2 hours etc) although flat charges are commonly applied when parking duration exceeds a given period. Restrictions can also be applied to limit the level of parking duration that can be purchased. Payment is most commonly made by cash and appropriate coin denominations need to be accepted by the ticket machine. The ticket machines can be programmed to give change or be exact cost only.

Recent technology advances and the rise of tariffs in busy city centres have led to the development of credit/debit card or smartcard payment at ticket machines. Users are prompted to enter their card as a method of payment and instructions to proceed are presented in the digital displays. Alternatively mobile phone payment can be used.

The use of this cashless technology provides the following advantages although it should be noted that additional back office support processes are required (discussed below):

- An addition to coin payment;
- Less risk of fraud or theft from ticket machines; and
- Reduces collection frequency and processing costs.

One pay and display ticket machine can serve up to 50 metres of parking spaces with appropriate signage to ensure it is location is clearly visible to drivers. Machines can also serve parking spaces on both sides of the carriage way. Consideration does however need to be given to level of machine use and if demand is high (due to high turnover of spaces) then additional machines will be required.

Each ticket machine needs to be easily accessible to all users, including disabled users and consideration to pedestrian safety is required. The fare structure must be visible to users and is either presented on the ticket machine or adjacent on a separate display board.

Each ticket machine requires a separate power supply. This is commonly provided through mains electricity, but in remote locations high charge batteries can be used (these requires routine changing). Increasingly, solar power technology is being utilised with each machine incorporating solar panels to charge an internal

battery. This reduces power supply costs, whilst ensuring the machines work at night. Where solar powered ticket machines are used, locating the machines in direct sunlight is preferential.

Typical installation costs for an individual ticket machine including purchase are €2,000 to €5,000 per unit, depending on the range of technologies used.

Pay and display parking systems require support/back-office functions to be in place. The support back/office functions required to operate a successful parking system include:

- Monitoring and Maintenance;
- Fare Collection / Processing; and
- Enforcement;

It is common for Pay and Display parking machines to be linked to a central system, where machine status can be monitored. Communication options include GSM, GPRS, GPS and WiFi. The machine status can be logged and data collated on the following:

- Cash amount in cash box;
- Transaction details;
- Maintenance alerts;
- Cash collection dates and times;
- Power supply levels; and
- Ticket roll alerts;

This information can then form part of the monitoring and cash collection process. Appropriate response and maintenance protocols can be established to ensure the ticket machines are regularly serviced and operating correctly.

An important back office function is cash collection from the ticket machines where cash payment is made. Cash collection is commonly undertaken by a contractor who also undertakes any maintenance required. Cash collection is usually undertaken by removing the internal cash box from the machine and replacing it with an empty cash box. The cash box is then taken to a secure counting office and the cash is processed. The machines log all transactions and this serves as a cash audit trail, reducing incidences of fraud. A mechanism for cash collection need to be established, with appropriate timings, to avoid cashbox becoming full, rendering the machine out of order, or indeed becoming a target for theft.

Enforcement is required to ensure parking restrictions and payment requirements are being adhered to. Enforcement is commonly carried out through visual checks by officers on foot carrying out sporadic checks in a given area. Penalty notices can then be issued where valid parking tickets are not presented. To remove the need for on-street enforcement, automatic number plate recognition (ANPR) can be used. When purchasing parking tickets from the pay and display machine users input their number plate data into the machine when paying for parking registering that car as having paid to park.

Enforcement can be carried out by static cameras or by vehicles equipped with ANPR technology, which scan the number plate. This can then be cross matched with information from the parking machines. Number plates of those who have not paid are logged and letters sent to the registered owner. This removes any confrontation for enforcement officers.

In addition ANPR can be used in areas with limited free parking to stop users returning later in the day or moving to an adjacent street at the end of their free parking.

Off-Street

Off street parking can be provided free of charge or at cost to the user for a range of parking types and durations. The only limit on provision is capacity and parking policy restraints which seek to limit the use of private vehicles in urban areas.

Free off-street parking is only suitable in locations where competing demands for spaces is limited.

In locations where there are competing demands for varying land-uses and there is land available to build off street car parks, paid parking is an appropriate mechanism to control demand. As in the case of on-street parking, charges can be targeted at certain potential users as a means of managing demand. Pricing structures can also be applied to discourage parking duration by weighting the charges appropriately e.g. high charges for durations over 2 hours.

There is a range of technologies that can be utilised to collect parking revenues from off-street parking, many of which are adaptations of on-street parking technologies. Pay-on-foot is considered to be the most suitable method for Zarqa. Further details of the technology required for these systems are provided below.

Pay-on-Foot

Pay-on-foot parking systems are used for regulating and controlling parking in off street car parks controlled by barrier entry. They are a common parking technologies used to collect revenue and have been successfully implemented across many urban areas around the world. Examples of Pay-on-Foot systems are presented below.

Pay-on-Foot Parking Systems

On approaching the off street car park, drivers take a ticket from the entry machine to raise the barrier for entry. They then park in an available space. On departing the driver takes the ticket to a pay machine which are located and clearly signed, with, typically, one or two machines per level. The driver then pays the appropriate fee and the ticket is validated and used at the exit barrier to exit the car park.

This method enables drivers to pay only for time used (rounded up to the nearest time tariff) and car park capacity can be monitored. Capacity data can then be used as part of a UTC system, to advise drivers of parking availability.

A variety of payment methods can potentially be used including cash, credit/debit cards and smart cards.

Pay-on-foot parking systems require the car park to be barrier controlled. Barriers need to be located at the entrance and exit of the car park, in sufficient quantum to accommodate the forecast level of demand and space turnover. A typical car park barrier costs €500 to €1500 to be supplied and installed. Barriers need to be connected to appropriate power sources and alert protocols need to be established to manage failed barriers.

To take payment, ticket machines need to be provided with appropriate signage to ensure their location is clearly visible to drivers. Consideration does need to be given to level of machine use and if demand is high (due to high turnover of spaces) then additional machines will be required.

Each ticket machine needs to be easily accessible to all users, including disabled users and consideration to pedestrian safety is required. The fare structure must be visible to users and is either presented on the ticket machine or adjacent on a separate display board.

Each ticket machine requires a separate power supply. This is commonly provided through mains electricity, but in remote locations high charge batteries can be used (these requires routine changing). Increasingly, solar power technology is being utilised with each machine incorporating solar panels to charge an internal battery. This reduces power supply costs, whilst ensuring the machines work at night. Where solar powered ticket machines are used, locating the machines in direct sunlight is preferential.

Typical installation costs for an individual ticket machine including purchase are €2,000 to €5,000 per unit, depending on the range of technologies used.

Pay on foot parking systems require support/back-office functions to be in place. The support back/office functions required to operate a successful parking system include:

- Monitoring and Maintenance;
- Fare Collection / Processing; and
- Enforcement;

It is common for Pay and Display parking machines and barriers to be linked to a central system, where machine status can be monitored. Communication options include GSM, GPRS, GPS and WiFi. The machine status can be logged and data collated on the following:

- Cash amount in cash box;
- Transaction details;
- Maintenance alerts;
- Cash collection dates and times;
- Power supply levels; and
- Ticket roll alerts;

This information can then form part of the monitoring and cash collection process. Appropriate response and maintenance protocols can be established to ensure the ticket machines are regularly serviced and operating correctly.

An important back office function is cash collection from the ticket machines where cash payment is made. Cash collection is commonly undertaken by a contractor who also undertakes any maintenance required. Cash collection is usually undertaking by removing the internal cash box from the machine and replacing it with an empty cash box. The cash box is then taken to a secure counting office and the cash is processed. The machines log all transactions and this serves as a cash audit trail, reducing incidences of fraud. Mechanism for cash collection need to be established with appropriate timings to avoid the cashbox becoming full, rendering the machine out of order, or indeed becoming a target for theft.

Enforcement is controlled by the barrier system, which prevents vehicles that have not made the appropriate payment from leaving the car park. No on-foot enforcement offices are therefore required. Mechanisms need to be established to manage issues such as lost tickets.

PROJECT 11D: PARKING ENFORCEMENT

Enforcement of parking restrictions will be a key component of the Parking Strategy for Zarqa. Parking enforcement can be undertaken by on-street enforcement of camera enforcement. This section provides a review of these enforcement approaches that could be adopted within Zarqa.

The most common form of parking enforcement is undertaken by on street officers, usually Traffic Wardens or Police Officers. These officers patrol streets on-foot checking for parking infringements and where necessary issue parking tickets. Recent technology advances allow officers to use handheld PDAs to issue tickets on the spot and attach to the offending vehicle.

Alternatively, it may be possible to introduce enforcement by cameras, although this requires the necessary legislation to be established and a national car database. There are three common types of camera enforcement. These are:

- Portable Enforcement Camera (PEC)
- Vehicle Mounted Camera (VMC)
- Closed Circuit TV (CCTV)

PECs are mobile, wireless cameras that can be fixed a specific location particularly in areas of high numbers of parking contraventions. These are monitored by two officers and infringements recorded. These are passed to a Traffic Officer for review and a fixed penalty charge notice, PCN, issued where contravention has occurred.

VMCs are cameras mounted on a vehicle. These vehicles are equipped with automatic number plate recognition (APNR) technology enabling reading and recording of number plates, GPS which monitors the location of the car cross-referencing with its database of parking restrictions and will, in the future, have banking encryption standards, wireless transmission and high speed broadband connectivity.

CCTV uses fixed cameras in fixed locations to monitor parking infringements. These are commonly located in Parking Enforcement Zones of high strategic importance where congestion is an issue. Operators are able to pan and zoom and hence cover a large area. Images can be recorded for evidence in order that a fixed penalty charge notice can be issued.

It is considered that on-street officers undertaking on-foot patrols would be most suitable for Zarqa. As set out above, this would involve either traffic wardens or police officers checking for parking infringements and where necessary issuing parking tickets.

Appendix N Project 12

Travel Awareness Scheme

PROJECT 12: TRAVEL AWARENESS SCHEME

Purposes of Travel Awareness

Travel awareness, in its simplest sense, is an attempt to ensure that people (in general, but sometimes specifically targeted at discrete groups of people) are made aware of travel and transport opportunities.

Thus travel awareness campaigns aim to improve the general public's understanding of the problems caused by current patterns of travel and use of the private car. They often focus on traffic growth and its impacts and then seek to encourage people to think about their own travel behaviour in this context.

Associated with travel awareness campaigns are travel plans, which seek to influence organisations to encourage travel to the workplace, education, retail or leisure places by other means than the car.

Planning a Travel Awareness Scheme

Unfortunately, generic travel awareness campaigns which simply exhort people to change their means of transport on the basis of improved health or moral issues, such as tackling the problems of climate change, do not have a particularly successful track record. Latest thinking in this area has resulted in a much more sophisticated approach to travel awareness, which draws on marketing techniques and skills.

Travel awareness is also a means of promoting the 'mobility management' concept, which is at the heart of the strategy proposed for the downtown area of Zarqa. At the core of Mobility Management are "soft" measures (e.g., information or coordination of existing user services), which enhance the effectiveness of "hard" measures within urban transport planning (e.g., new or improved bus services, new roads and new pedestrian facilities).

Mobility Management is primarily a demand-orientated approach to transport. Its aim is to support and encourage a change of attitude and behaviour to reduce single car use and to strengthen sustainable modes of transport. Co-operation between public and private institutions enables solutions which fulfil public as well as individual objectives in mobility and transport. Mobility Management measures are based on information, communication, organisation, coordination, and promotion.

Mobility Management measures need to be integrated into bundles of measures which can additionally include planning, constructing and operating infrastructure, supplying mobility and further services, legal and regulatory measures, and/or pricing and fiscal approaches to gain enhanced synergistic impacts. This is broadly the approach we have taken in our package of interlocking projects proposed for the downtown area.

In order to design and implement Mobility Management strategies or measures within a holistic marketing approach, the needs of the target groups have to be explored; products, services or messages have to be defined; prices have to be fixed; and communication strategies have to be developed. Information can be provided to the public or to a defined target group within a campaign to change attitudes or mobility behaviour. Alternatively, information on concrete products or mobility services can be delivered to a single person or a target group to motivate them to use or buy these products or services.

In the UK there has been much debate on whether travel awareness campaigns are worthwhile in isolation, or are best thought of as part of other initiatives which make improvements to travel services. Whilst their independent role can be justified by psychological and marketing theories that better awareness of the alternatives is necessary before people are able to change their behaviour, in the case of Zarqa, we believe that significant improvements need to be undertaken before a travel awareness campaign should be undertaken.

Implementation

In order to have a successful travel awareness scheme or campaign, it is necessary to understand the theories and mechanisms behind advertising and marketing, and how these make products appeal to people. This is particularly the case where the message is not simply about product purchase, but is trying to persuade people to change their views in certain areas. One of the most definitive recent studies into what makes a travel awareness campaign successful is the EU MAX Project (Successful Travel Awareness Campaigns and Mobility Management Strategies – 2009) [(16)]. This section about travel awareness techniques and procedures draws heavily on the contents of the final report of that Project. The final MAX Report notes that social marketing has been defined by Kotler and Zaltmans (1971,p7) as "the application of

marketing to the solution of social and health problems". The authors also refer to it being as a planned process to "package the social idea to a targeted audience in a manner which their target audiences find desirable and are willing to purchase".

In recent decades the core marketing principles relating to the satisfaction of consumer needs through the exchange process have been embraced by social marketers, and it has become an accepted approach within democratic societies for bringing about change. In the main, social marketing has grown principally in the field of health care but increasingly it has been extended to social welfare (such as reduction of anti-social behaviour), equity and developing countries (fairtrade), and the environment (replenishment of fish stocks). With travel awareness, it has now been extended to cover transport issues and climate change.

It is important in this context to distinguish between the marketing of services such as public transport provision as a commercial exercise, and the adoption of a social marketing approach to transport provision. They are different. Service marketing seeks to attract and satisfy customers using different forms of public transport for commercial purposes and in many cases to make a profit. The consumer exchange is simple in that the customer is offered a trip or journey from A to B in comfort, safety and often speedily, to meet people's requirements to travel for different purposes. The organisations involved target market segments in a way which fits their lifestyle and plans a product or service, marketing communication, service delivery and monitoring as part of this process. The customer in turn pays for the journey and has the means to do so.

Social marketing is principally about welfare exchange and this is the key difference. It is a more complicated process involving moral judgements about the quality of life, about public goods (as they do not have market values) and in the case of transport and climate change about the very survival of the planet. In essence it is about engaging a target population to bring about behavioural change to enhance the welfare of not only the individual or household concerned but also for the greater societal benefit in the long run.

Social marketing is more complex, firstly, because it is essentially about changing attitudes and doing so voluntarily. This requires a substantial input on the part of the individual, household or neighbourhood involved. There may be considerable resistance to change; attitudes are often ingrained. The benefits offered are not always short term. If a person buys a product or service, such as a take away meal, gratification is often immediate. In the case of social marketing the benefits are likely to be intangible and take a much longer time to realise. Walking for health, for example, requires a considerable commitment on the part of the individual to forego short car trips and the benefit of being healthier might not be noted until after a year or more. In order to differentiate social marketing, Andreasen [(17)] sets out six characteristics or benchmarks which are core features of a campaign:

(a) Behavioural change is the key goal and the design of the campaign should aim, if at all possible, to allow this to be measurable;

(b) Pre campaign research is a pre-requisite to assess the needs of the target group and to test how they might be best motivated to change;

(c) Segmentation of key segments of the market;

(d) The campaign needs to create an attractive motivational stance to gain welfare exchange [i.e. the triggers which motivate people to engage voluntarily in the behavioural change];

(e) The campaign should use the 4 Ps (Product, Price, Place and Promotion); and

(f) The campaign is conversant with competition faced, which might act as barriers to desired behavioural change.

The nature and form of social marketing therefore makes it more difficult to monitor in comparison to commercial marketing with straightforward objectives. One early approach undertaken by Wiebe [(18)] argued that social marketing campaigns are likely to achieve a greater success if five factors are present:

(1) The person(s) has a predisposition towards the campaign objectives;

(2) The campaign is aware of how and when to 'consummate' the motivation of the audience;

(3) The existence of an 'agency' [enabling something to be done] that enables a person to move from motivation to action;

(4) The ability and effectiveness of the 'agency' to allow the perform the task; and

(5) The campaign provides a net gain over the amount of energy required to move from motivation to action.

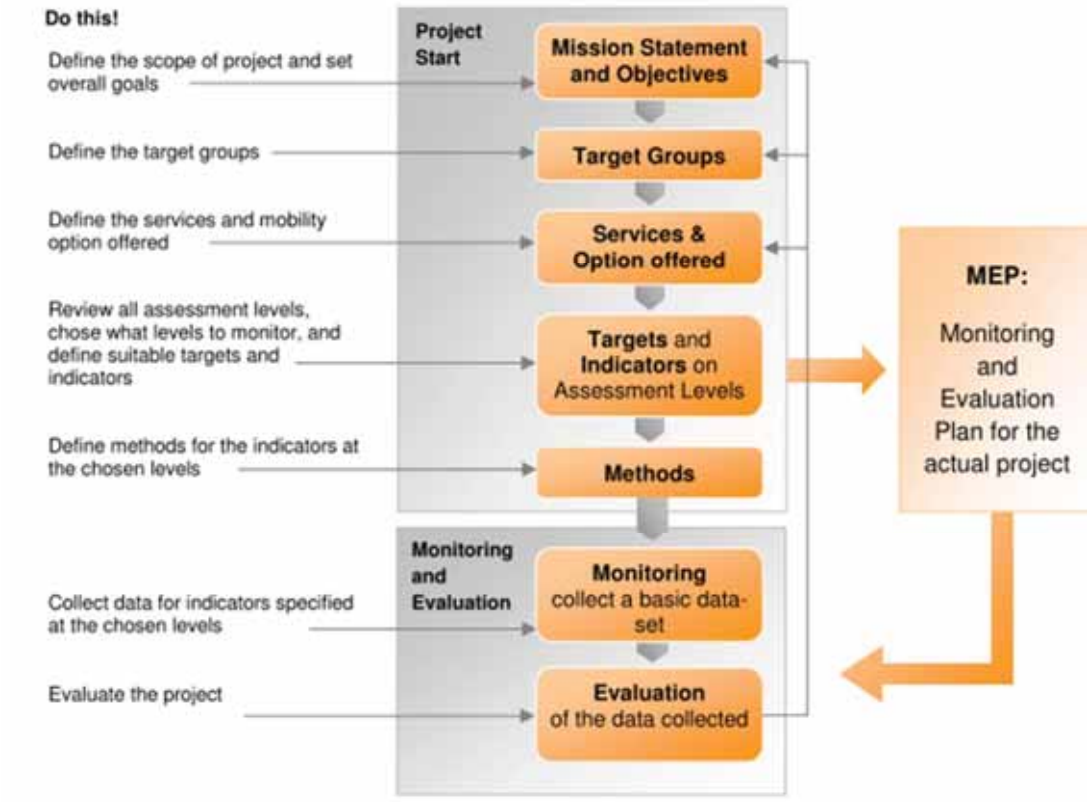
From this it will be seen that promoting a travel awareness scheme or campaign is much more complicated than simply advertising the benefits of improvements and changes, as the aim of the exercise is also to educate and persuade people to change their views and approach to transport issues.

However, a good example of some easy to understand advice and practical lessons have been provided by Chris Rose, an environmental campaigner and communications consultant who has worked for Greenpeace, Friends of the Earth, WWF and several other organisations based in the UK, and thus has been very experienced in social marketing, as it is adapted to major contemporary environmental issues. According to Rose, the adoption of a communication strategy for campaigns is like chess, there is no absolute right answer. It should follow the generic theory of sender-message-receiver, and Rose explains how this process can be refined to good effect. His general advice for the strategy/design of a campaign is:

- Keep it short and simple;
- Be visual;
- Create events;
- Tell stories about real people;
- Be pro-active – don't just respond;
- Get your communication in the right order; and
- Communicate in the agenda of the outside world - don't try to export an internal agenda, plan, jargon, or message.

The MAX Project has developed a number of very useful tools for practitioners to use, which may be found on the European Platform on Mobility Management (EPOMM) website [19]. The image below is from the MAXSumo process, a multi-step procedure initiated when starting to plan a project.

Figure N1: Multi-step Procedure



Finally, it is important to ensure that the scheme or campaign is closely integrated with the roll out programme of improvements, so that there is no disconnect between the messages and promises of the campaign with what is actually happening on the ground. A typical example of this type of problem is how to keep people 'on-side' during major construction work for a BRT or LRT system, where the promised benefits often seem to be outweighed by the immediate disruption and dislocation experienced. A successful campaign needs to address these issues with great subtlety and care.

Appendix O CO_2 Emissions Images

Figure O1: 2010 Baseline (Without Strategy) CO_2 Emissions

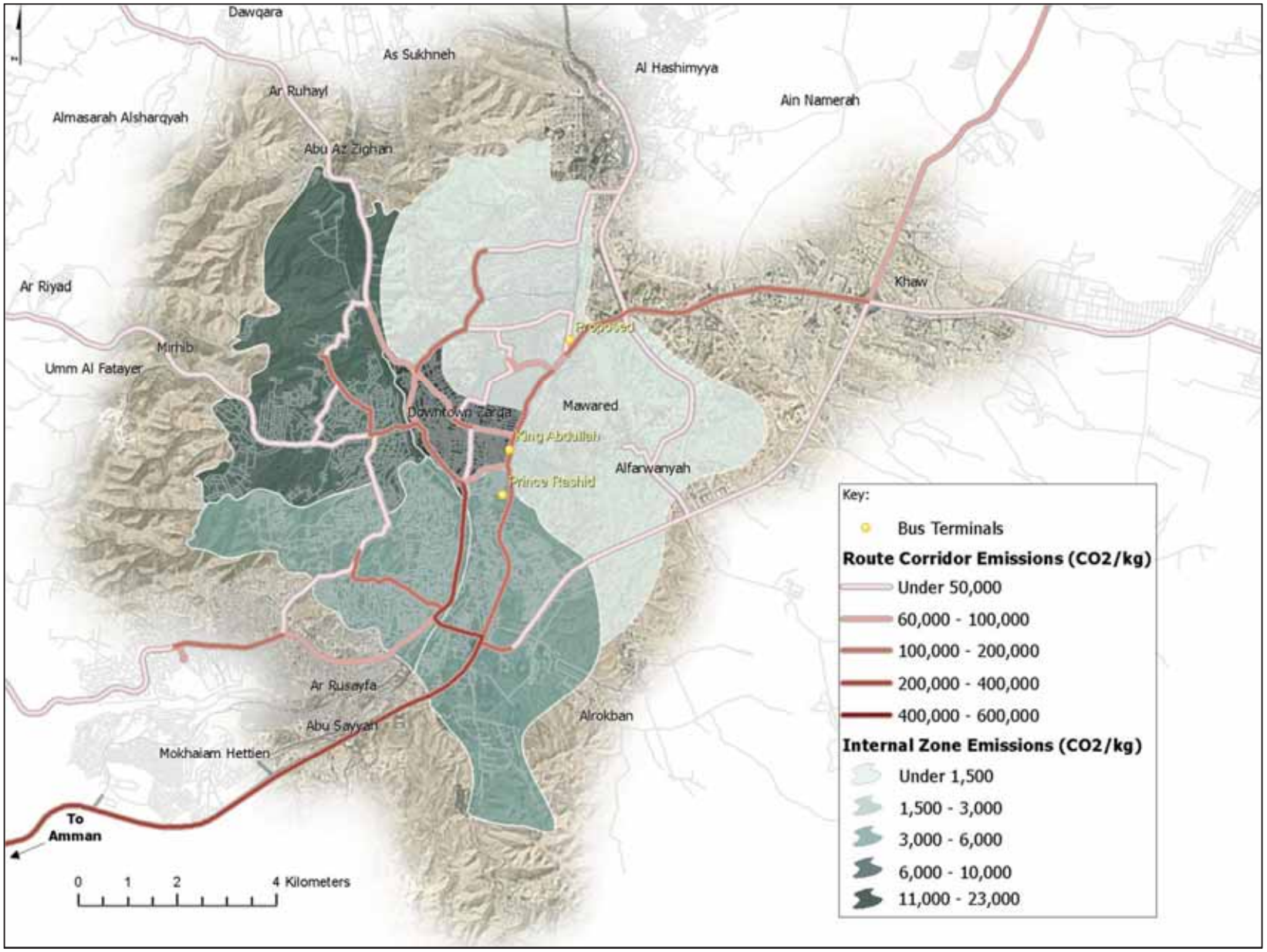


Figure O2: 2015 Baseline (Without Strategy) CO_2 Emissions

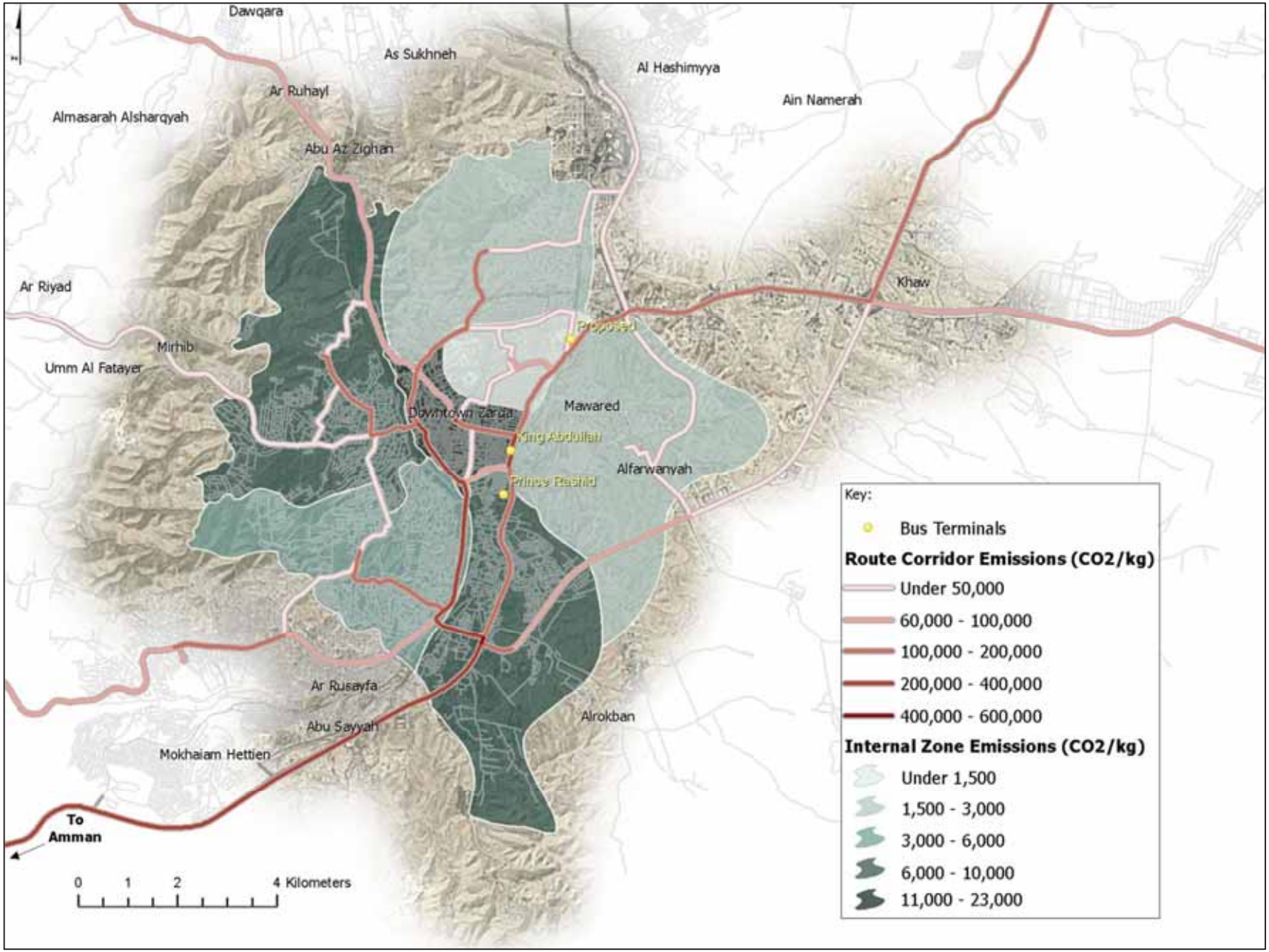


Figure O3: 2020 Baseline (Without Strategy) CO_2 Emissions

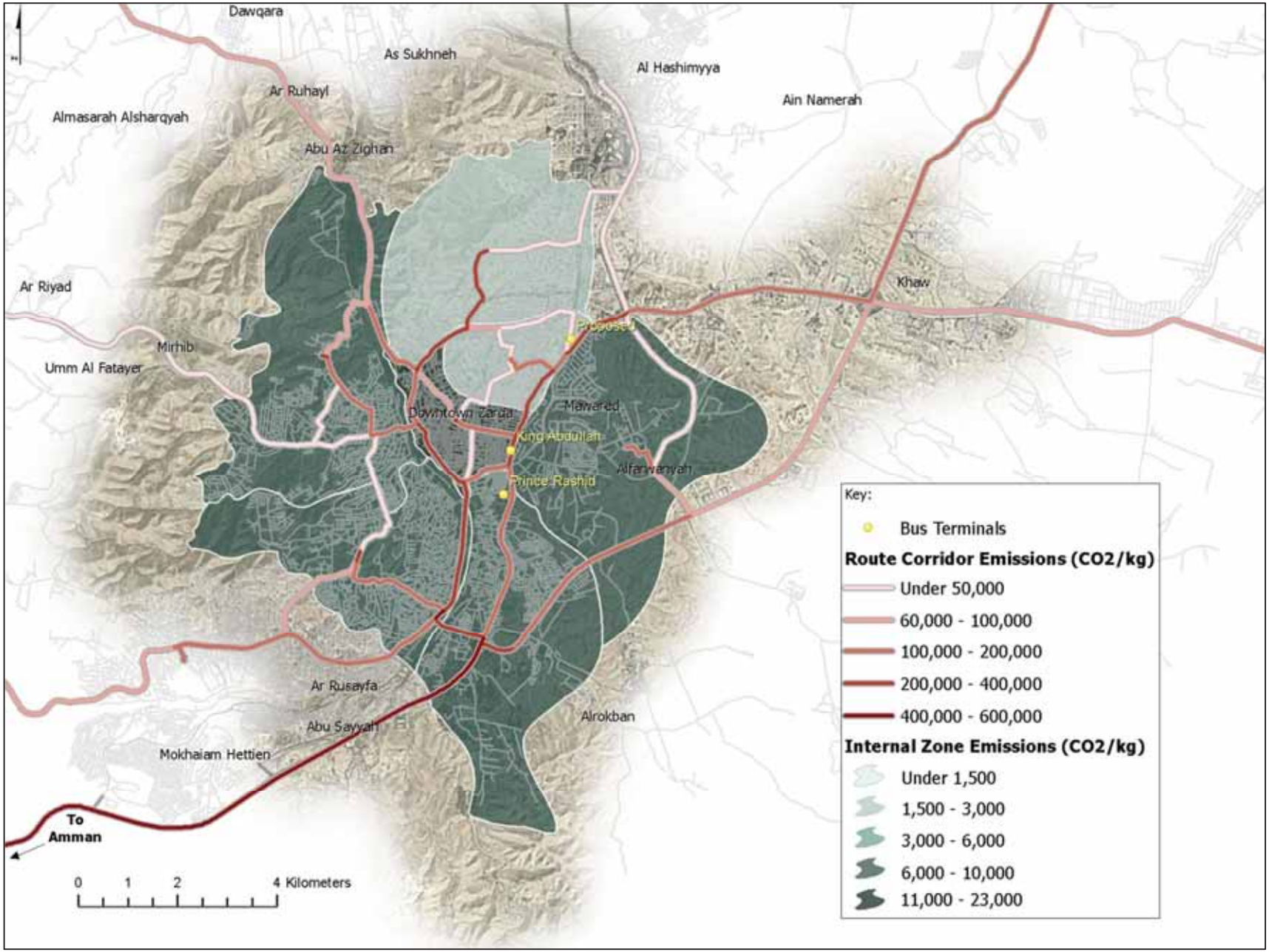


Figure O4: 2015 With Strategy – CO_2 Emissions

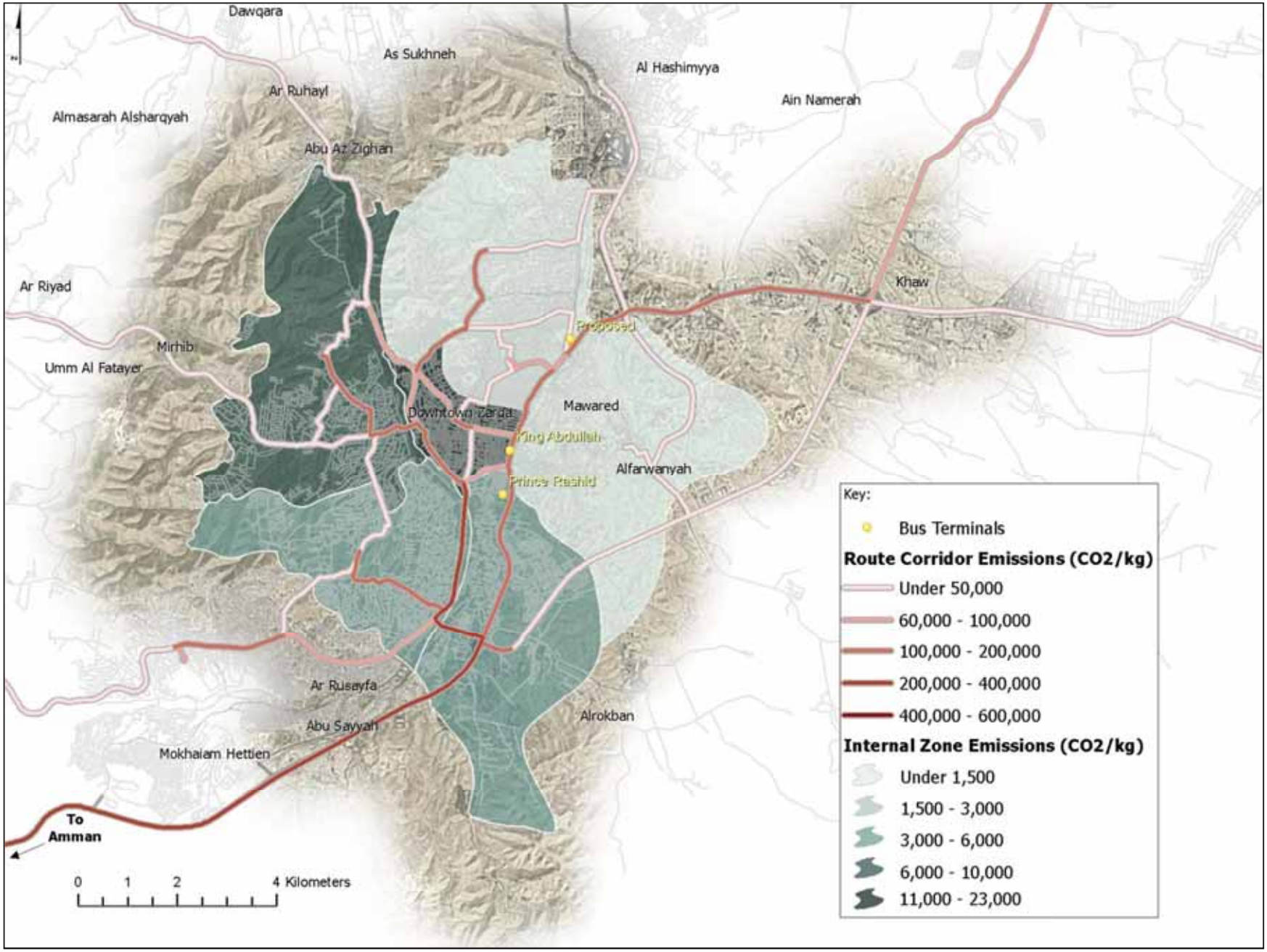
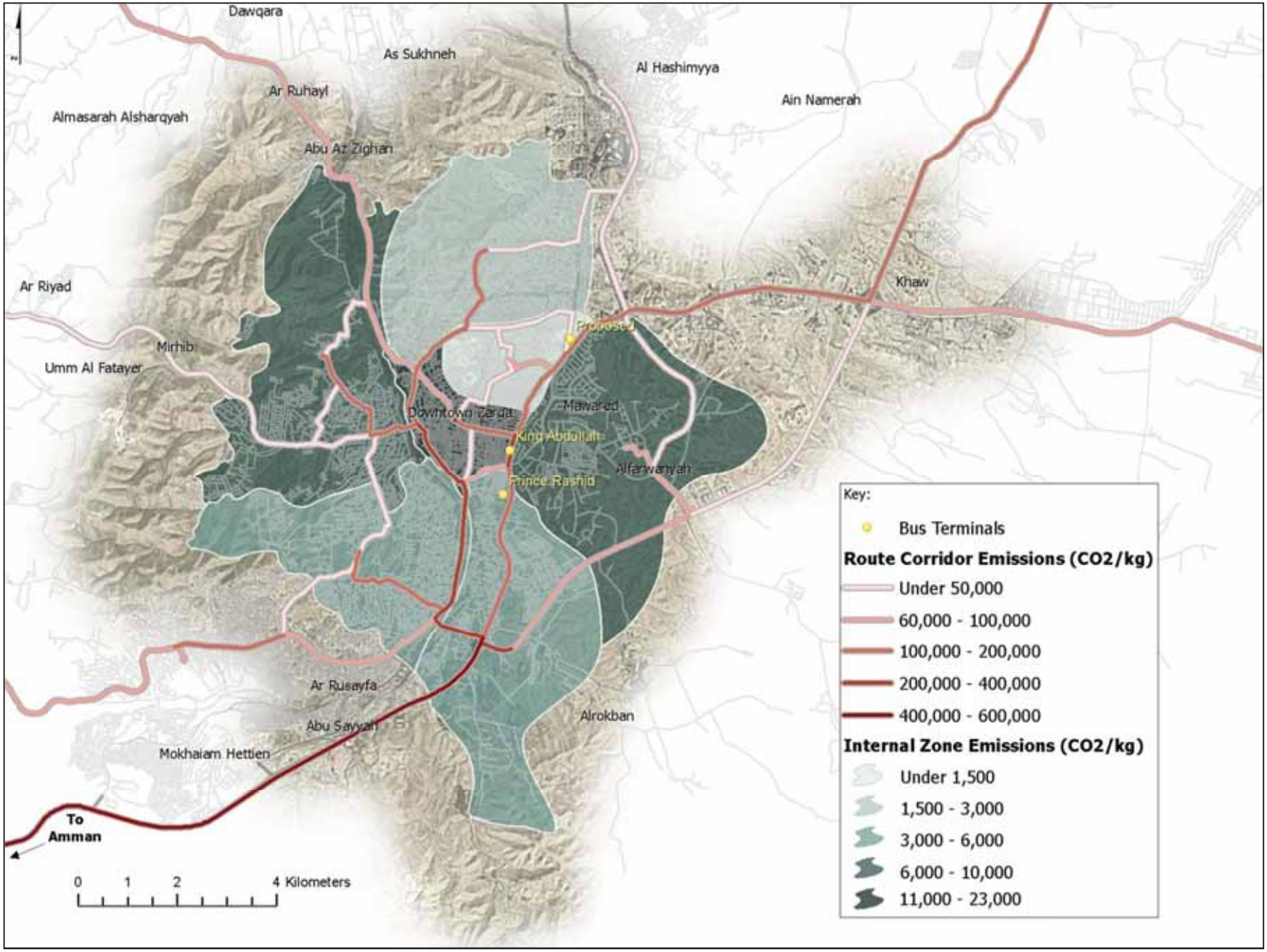


Figure O5: 2020 With Strategy – CO_2 Emissions



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