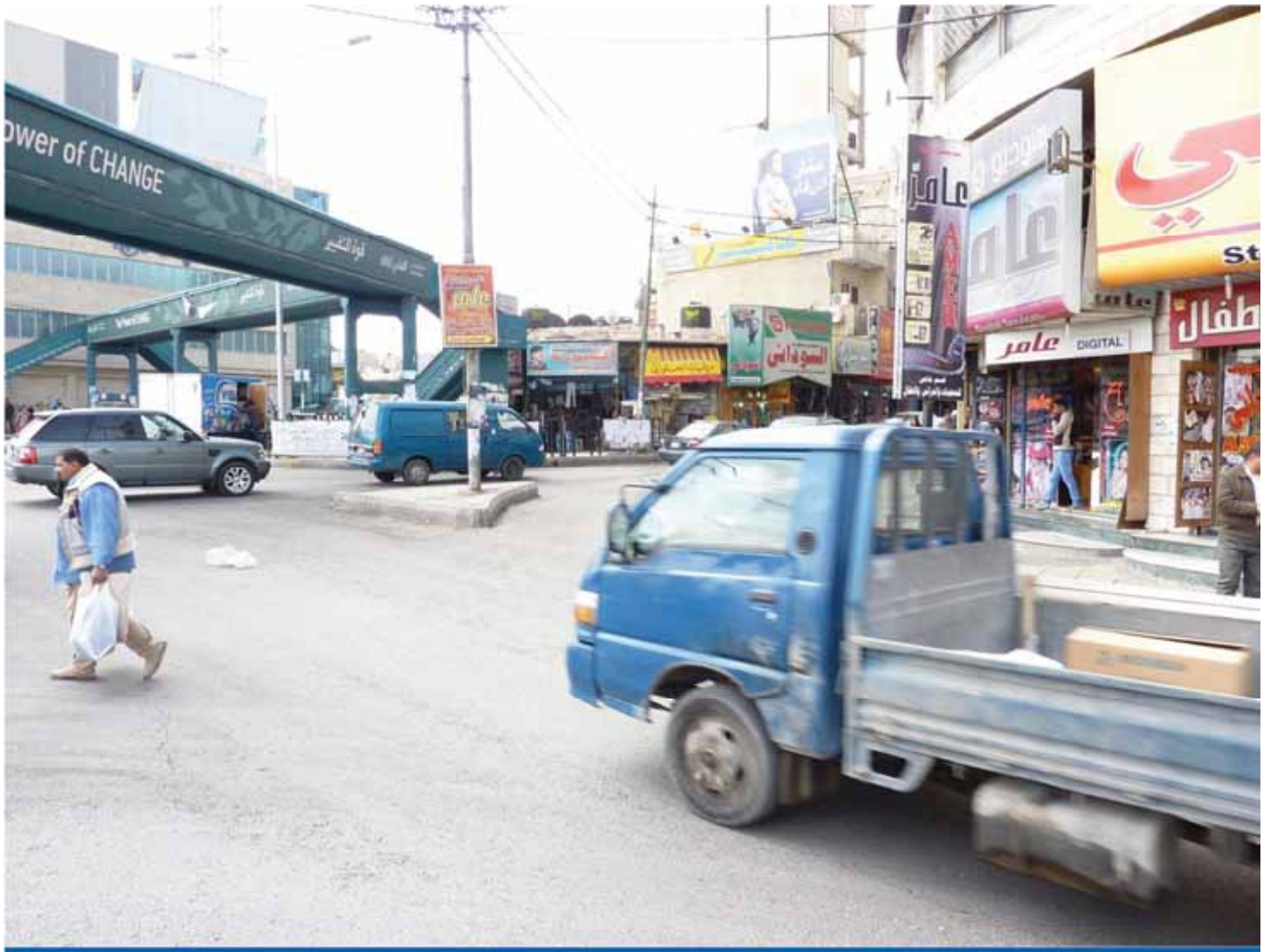
Report Number. 63551-JO



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

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Engineering & Environment

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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

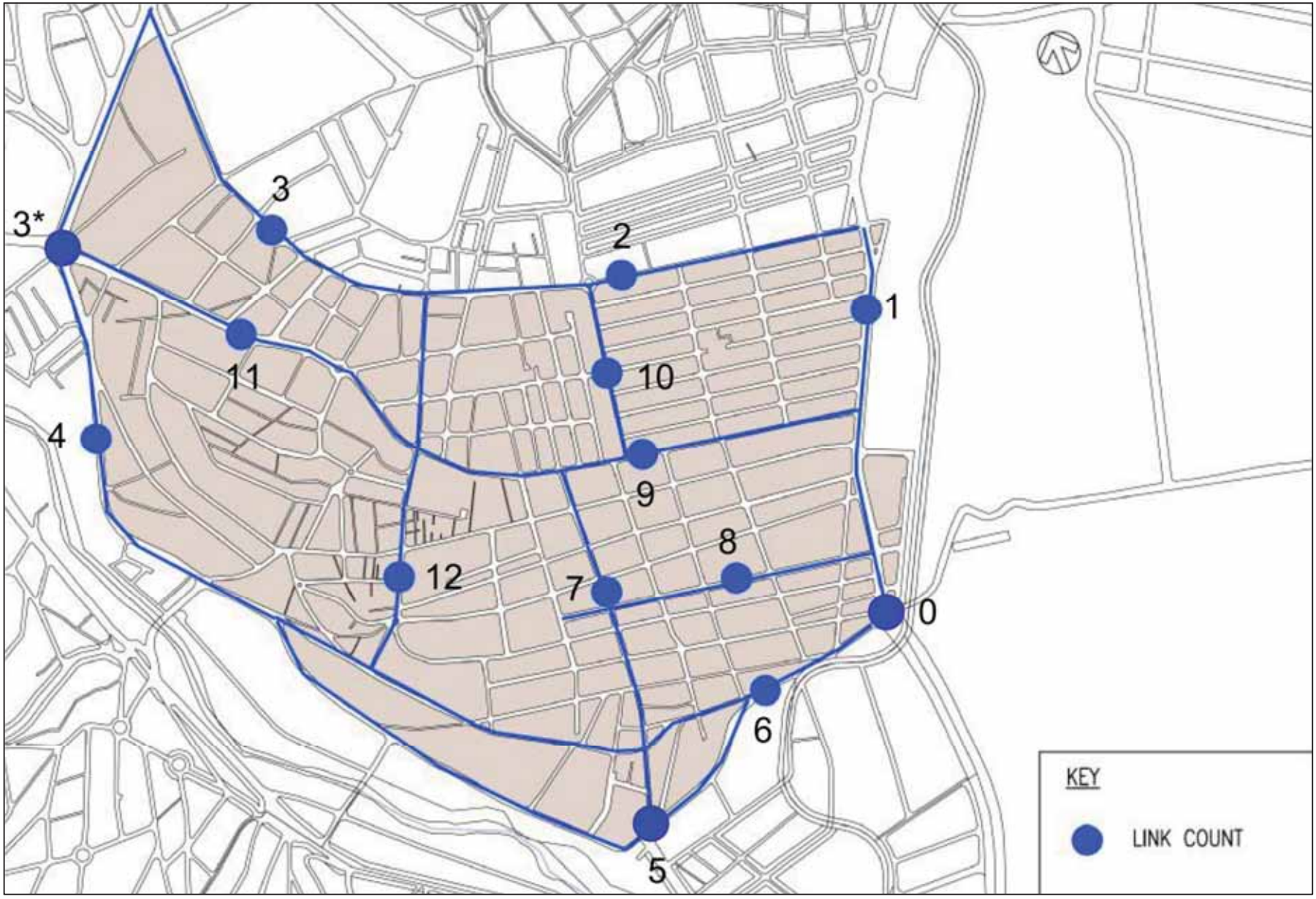
Traffic Survey Details

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

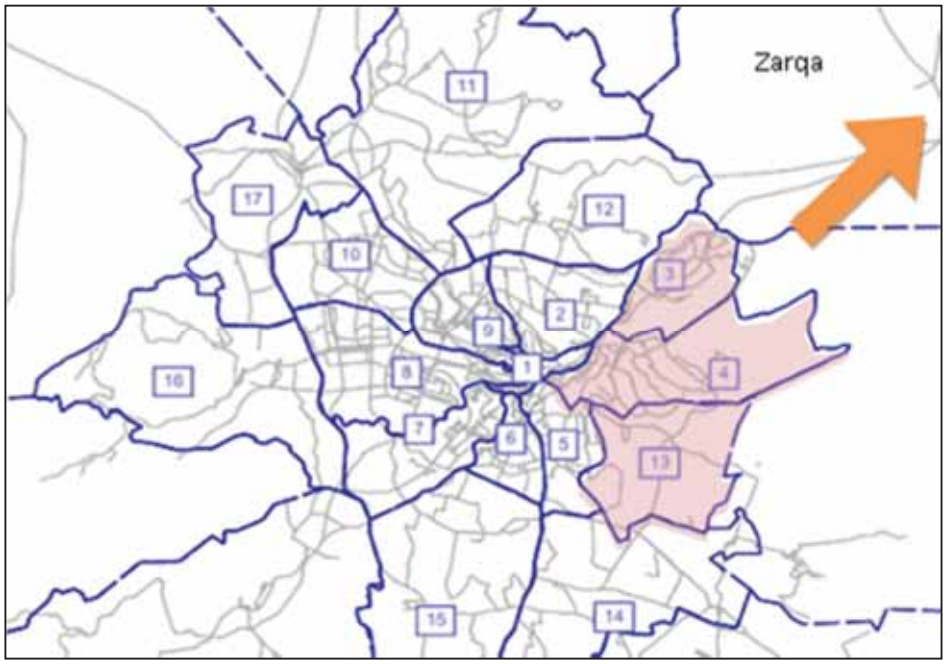
Trip Generation

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

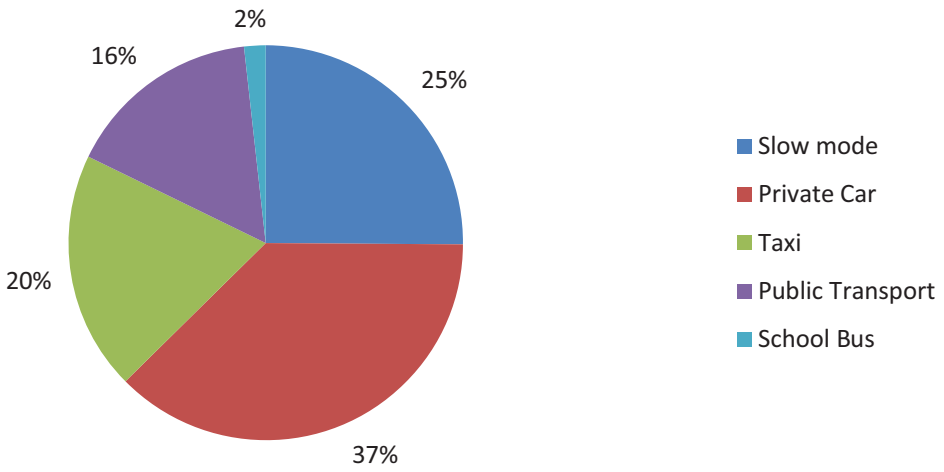
Source: The Hashemite Kingdom of Jordan Department of Statistics (DOS) Household Expenditures & Income Survey 2008 [2]

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

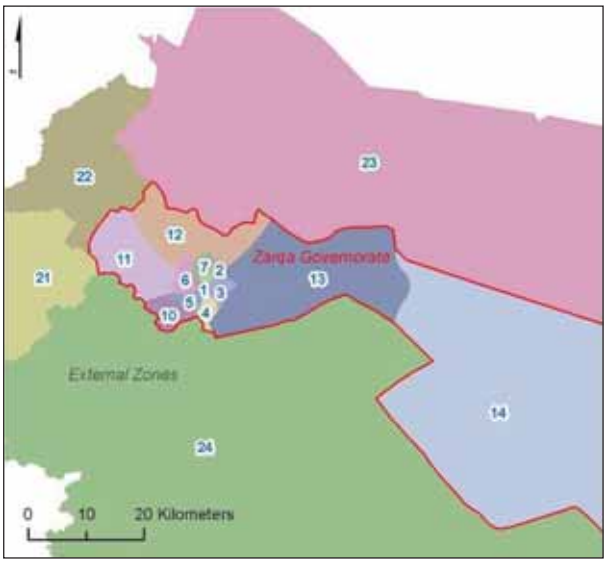
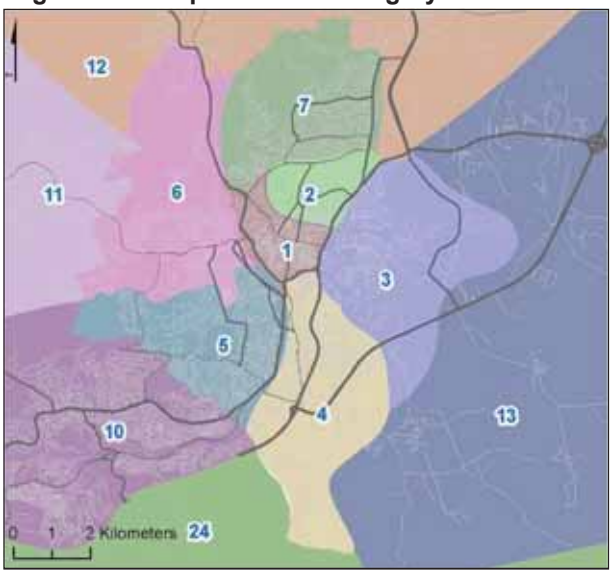
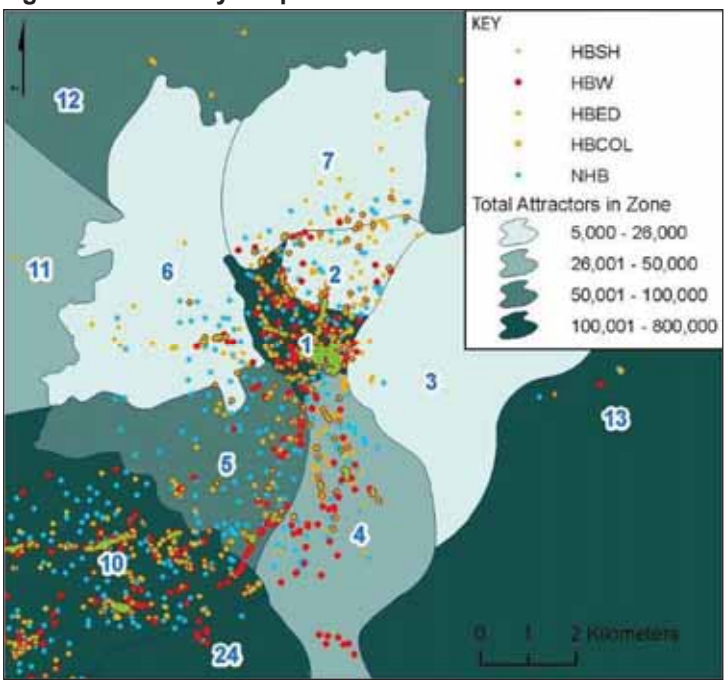


Figure B4: Zarqa Internal Zoning Systems



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

Drawn By: ukkxm021

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

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

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

File: G:\WGP_UK\WGP_DI\Jobs\Projects\Amman_DTRO Bus Restructure 41690223\Analysis\ArcGIS\MapDocuments\DT1\City Maps\Others.mxd

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

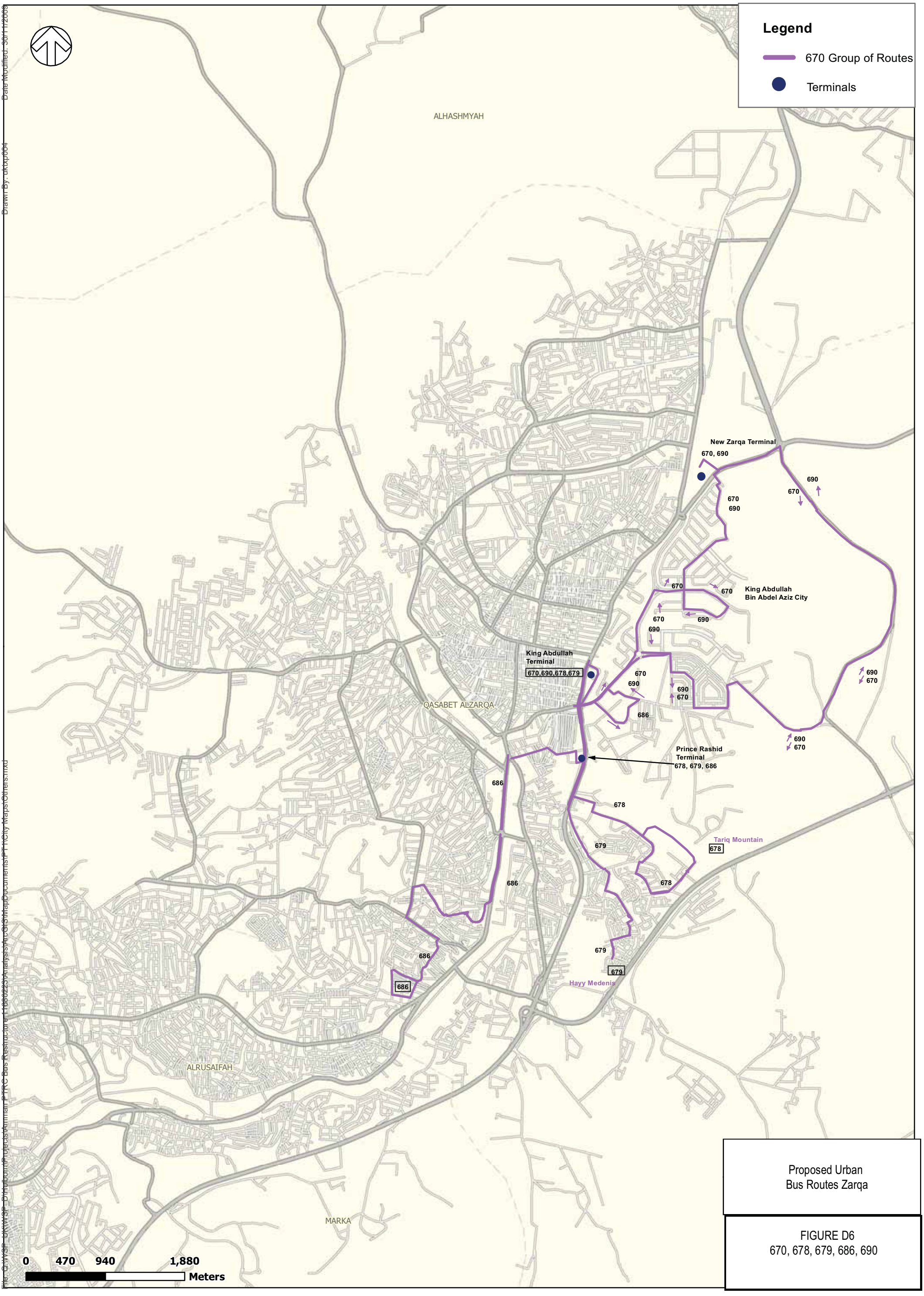
MARKA

0 420 840 1,680
Meters

Proposed Urban Bus Routes Zarqa

FIGURE D5
668,669

Date Modified: 30/11/2009
Drawn By: ukfxp004
File: G:\WSP_UKWSP_Dir\Jobs\Projects\Amman_BRC Bus Restructure\110602\GIS\Analysis\ArcGIS\Maps\Documents\BRT Hi City Maps\Others.mxd



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

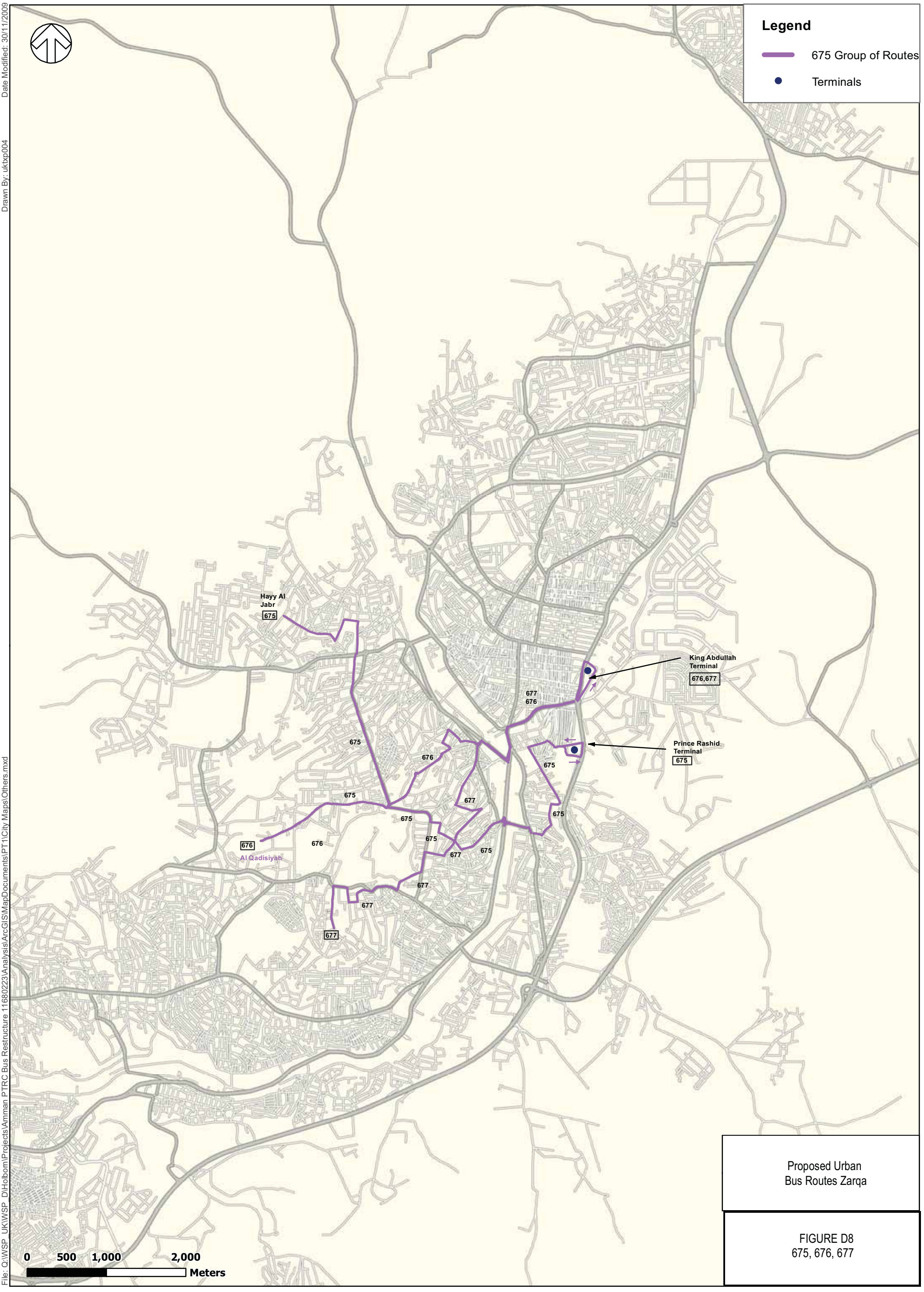
Russeifa 674

MARKA

0 420 840 1,680 Meters

Proposed Urban Bus Routes Zarqa

FIGURE D7
671, 672, 673, 674



Proposed Urban Bus Routes Zarqa

FIGURE D8
675, 676, 677

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

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

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

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

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

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

- 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.

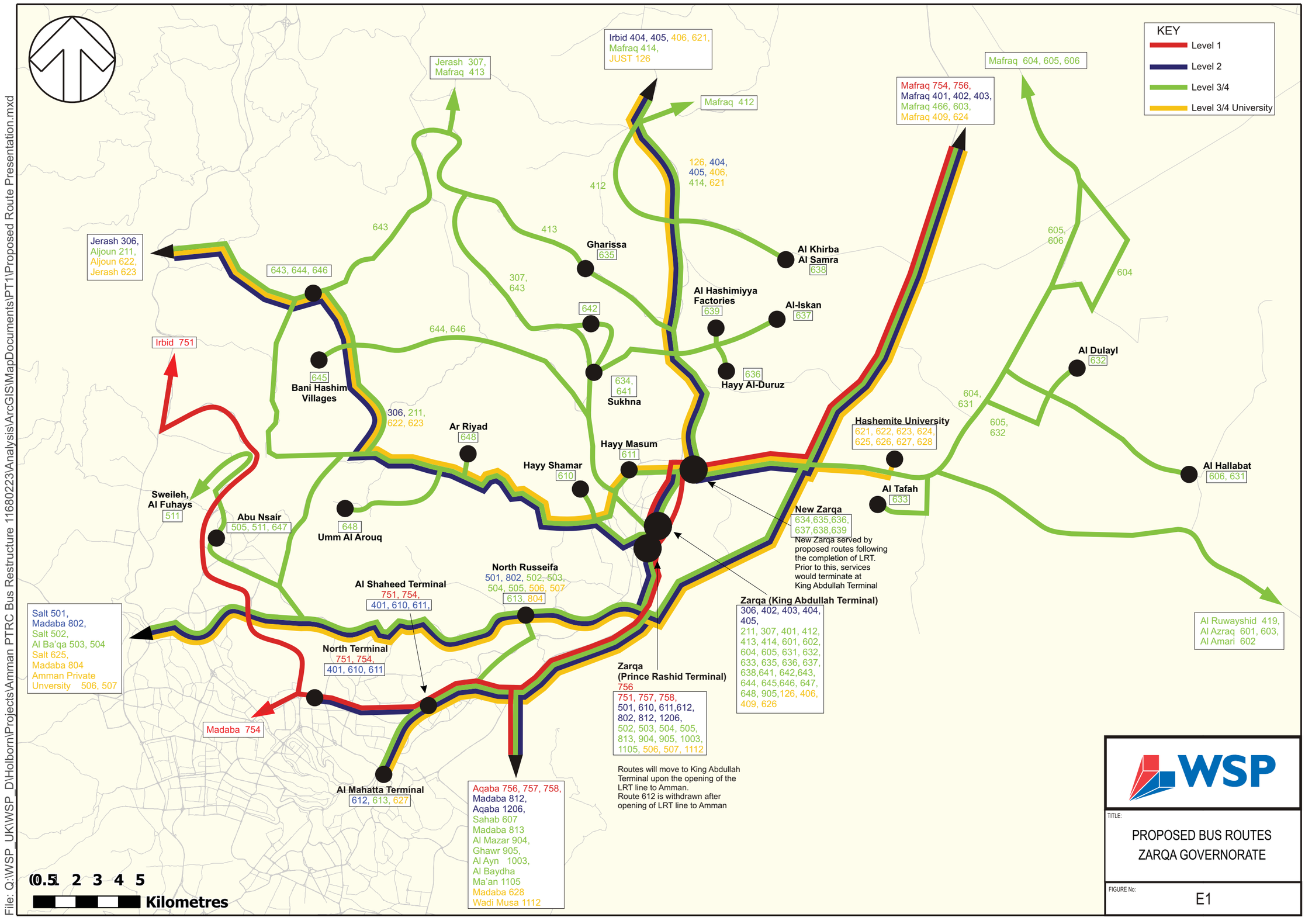
Shuttle Bus Service Strategy

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.

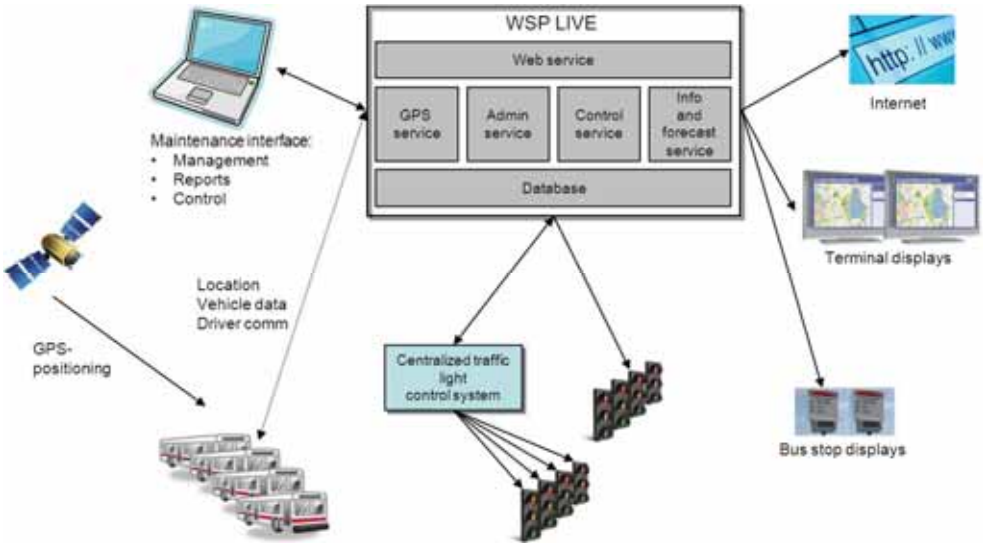
Manual for Streets states that bus stops should be located to ensure they can be easily accessed by foot. The location of bus stops depends on issues including the need to avoid noise nuisance, visibility requirements, and convenience of pedestrians and cyclists.

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

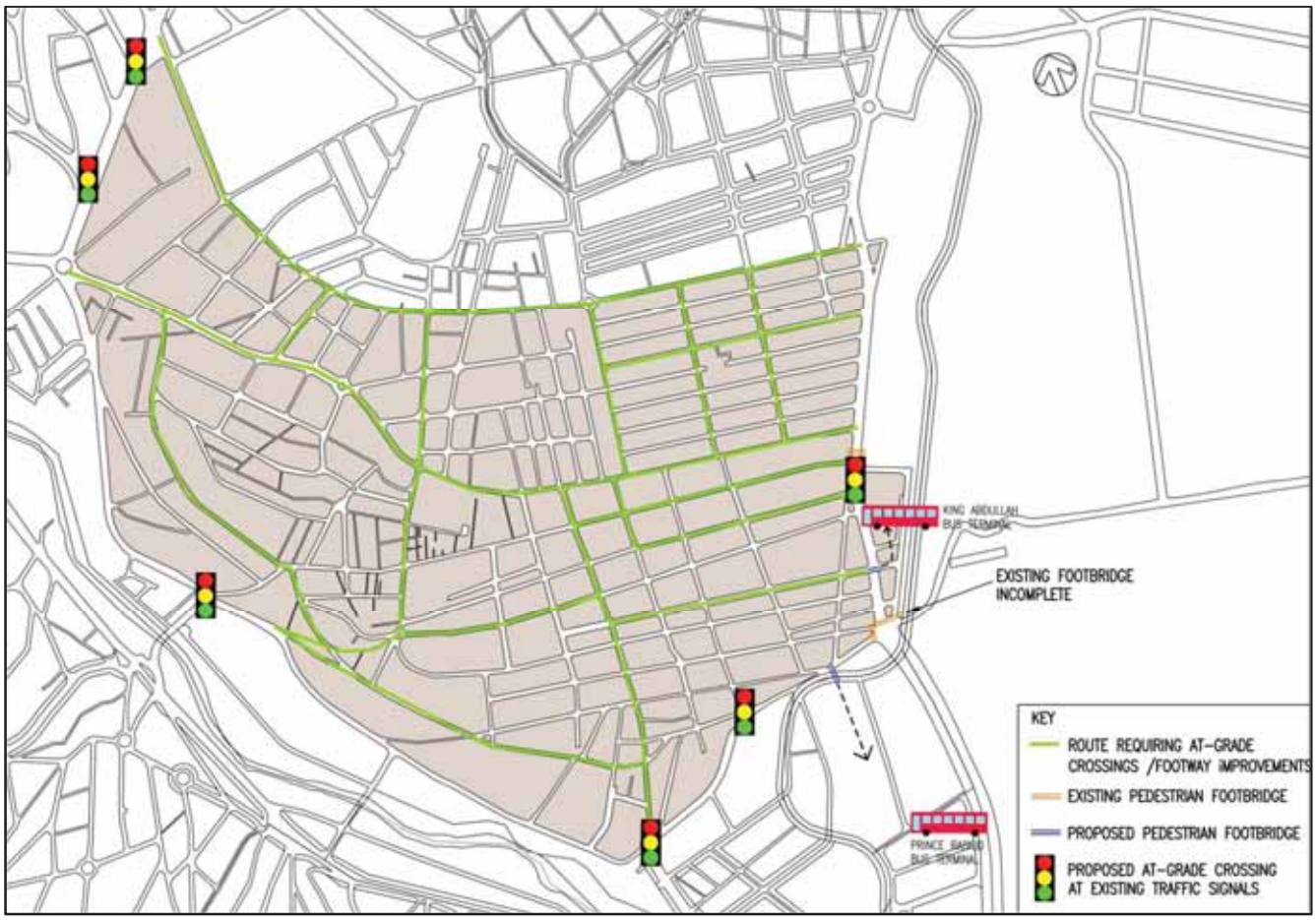
PROJECT 8: WALKING INFRASTRUCTURE IMPROVEMENTS

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

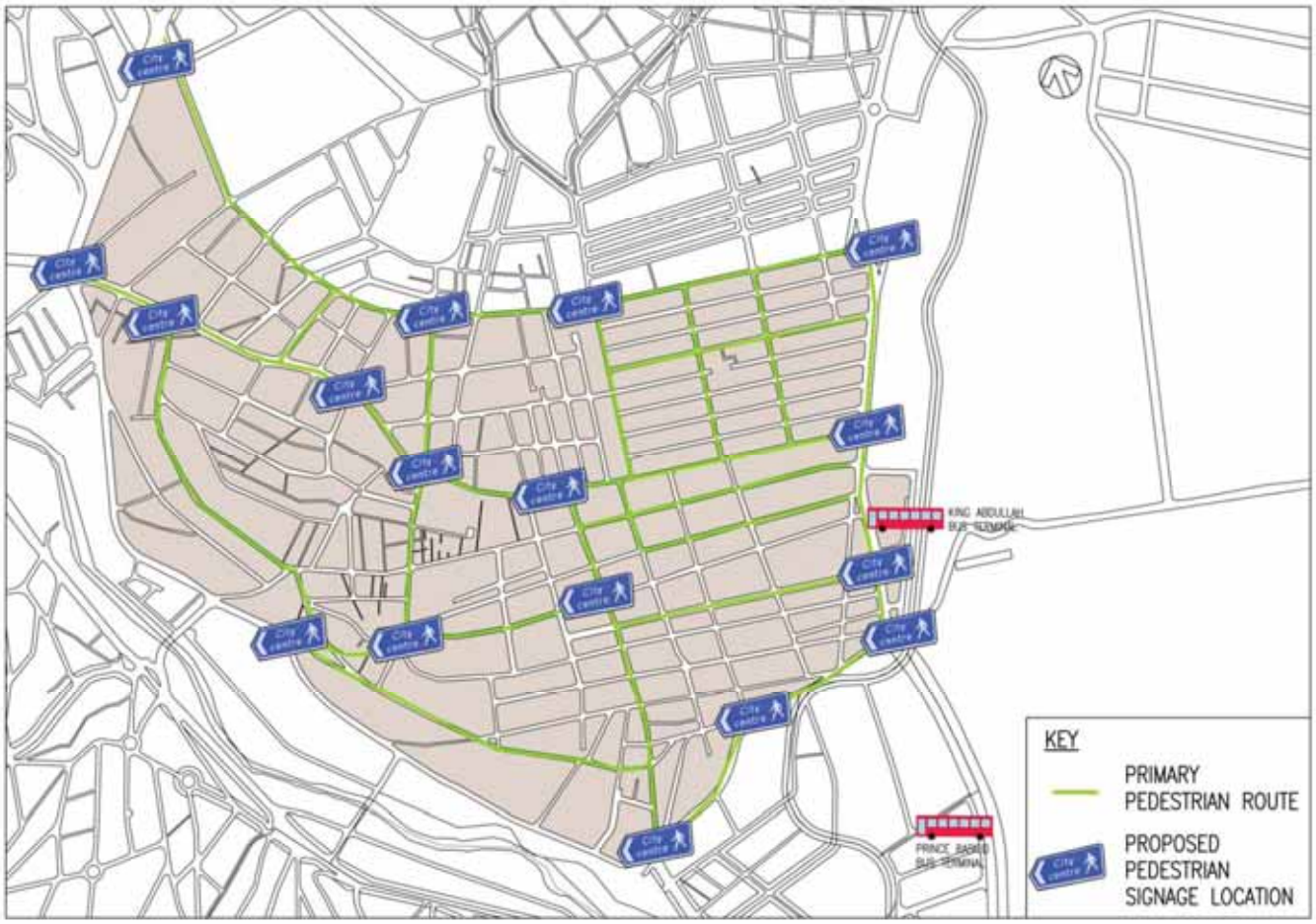
Stage 4: Pedestrian Signage

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.

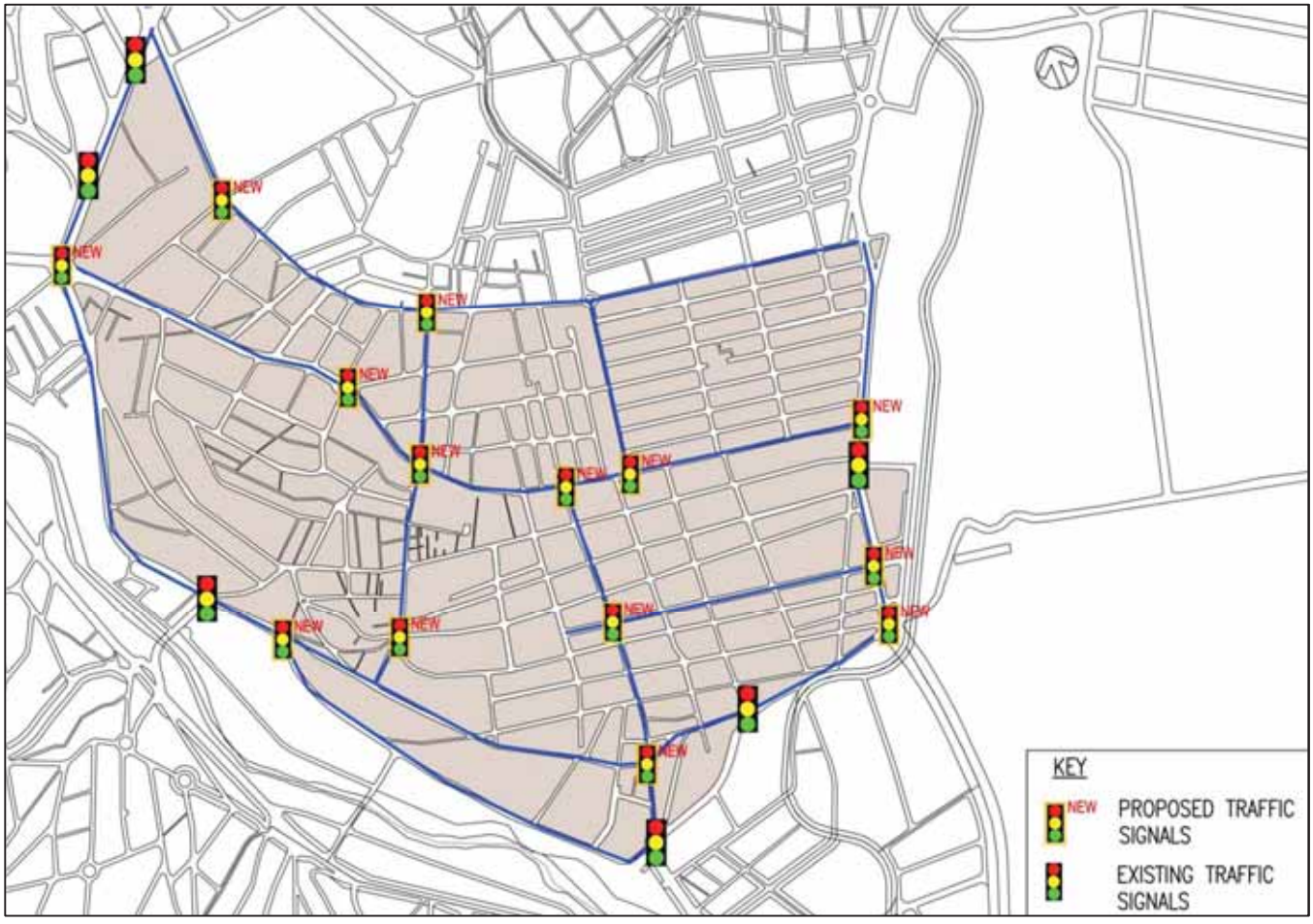
It is therefore recommended that improvements are made, with formal maintenance of the signals enforced to ensure on-going high performance.

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

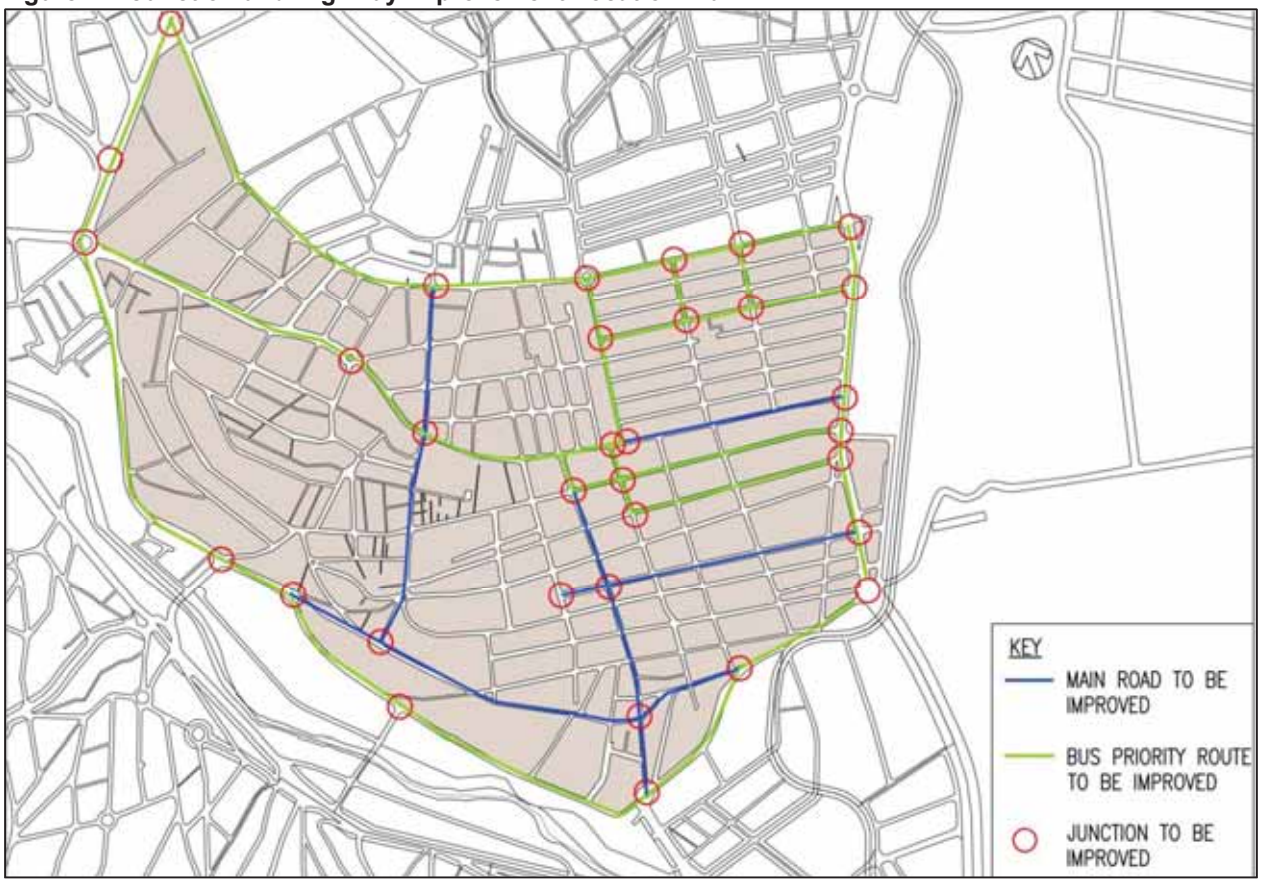


Figure L2: Example of Potential Junction Improvements

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.

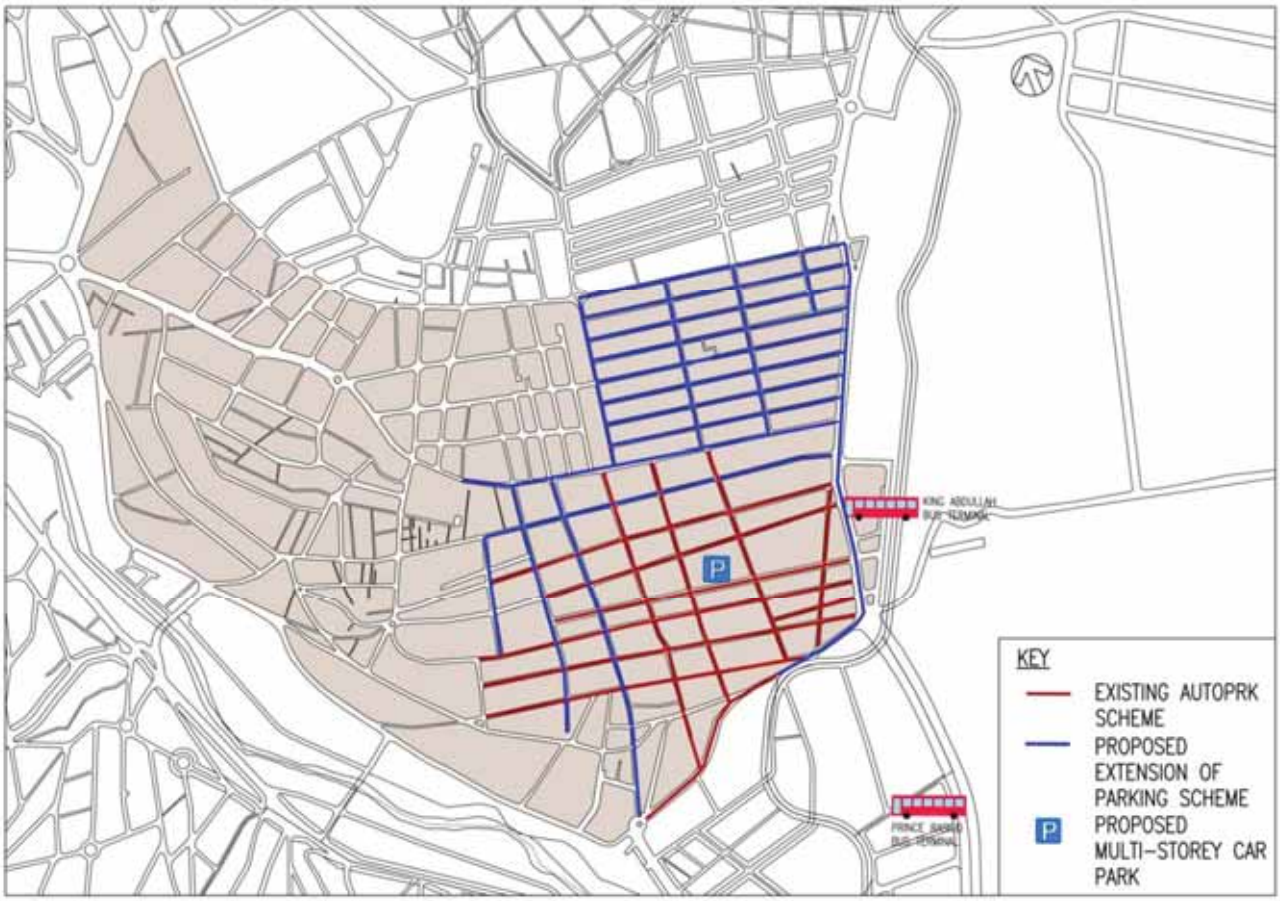
Comprehensive changes to the provision of parking within Zarqa will undoubtedly bring some public resistance. It is perhaps generally accepted that indiscriminate parking is a prevalent and as such is tolerated. This has led to a culture of parking for free by whatever means, where the risks of receiving 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

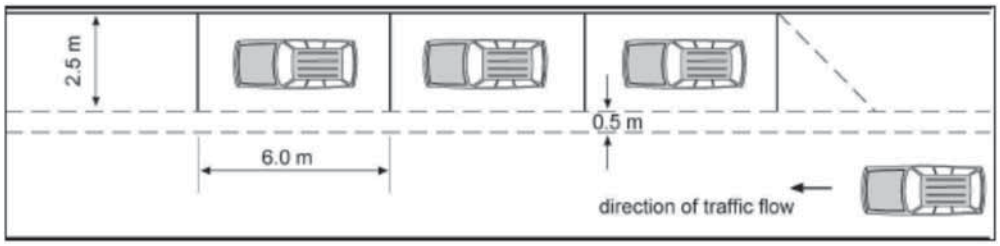
Duration of Parking	Typical Land use
Short term / high turnover (less than 2 hours)	Retail customers, banks, fast-food
Medium term / medium turnover (2 hour to 4 hours)	Leisure activities, cinema, restaurants
Long term / low turnover (greater than 4 hours)	Visitors, office employees, residential, airports, hospitals, hotels, industrial, university, schools

Parking Bay Design

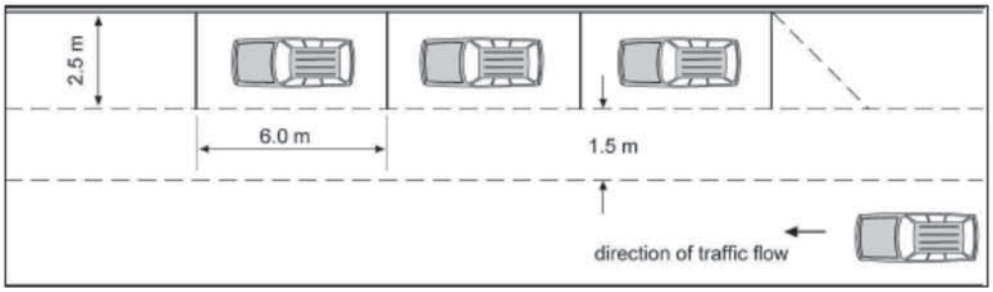
On street parking can be provided as either parallel parking, where the length of the bay is parallel to the kerbline, or as angled parking where the length is offset from the kerb line alignment.

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

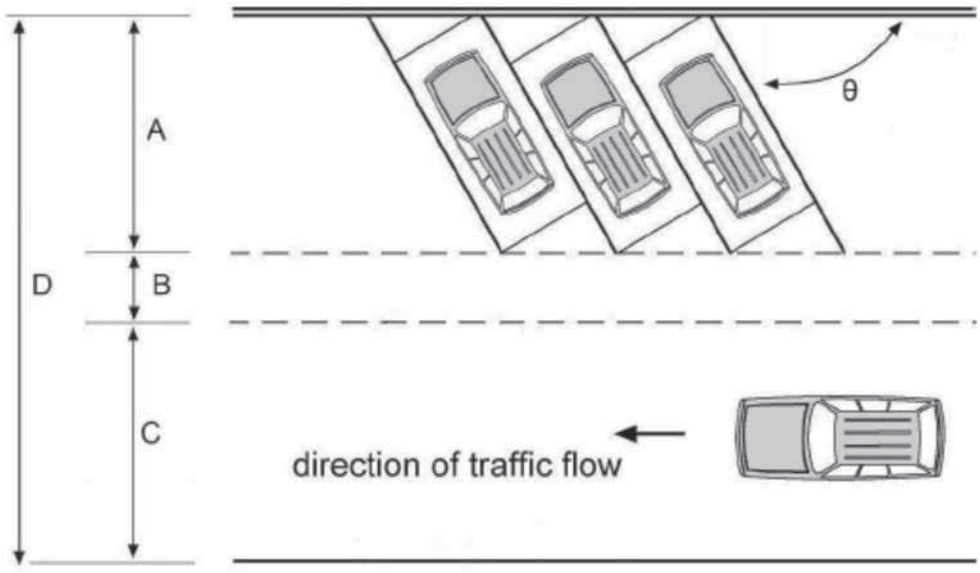


Angled parking allows greater parking capacity but should be employed on-street following consideration of the issues and parameters presented below:

- 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.

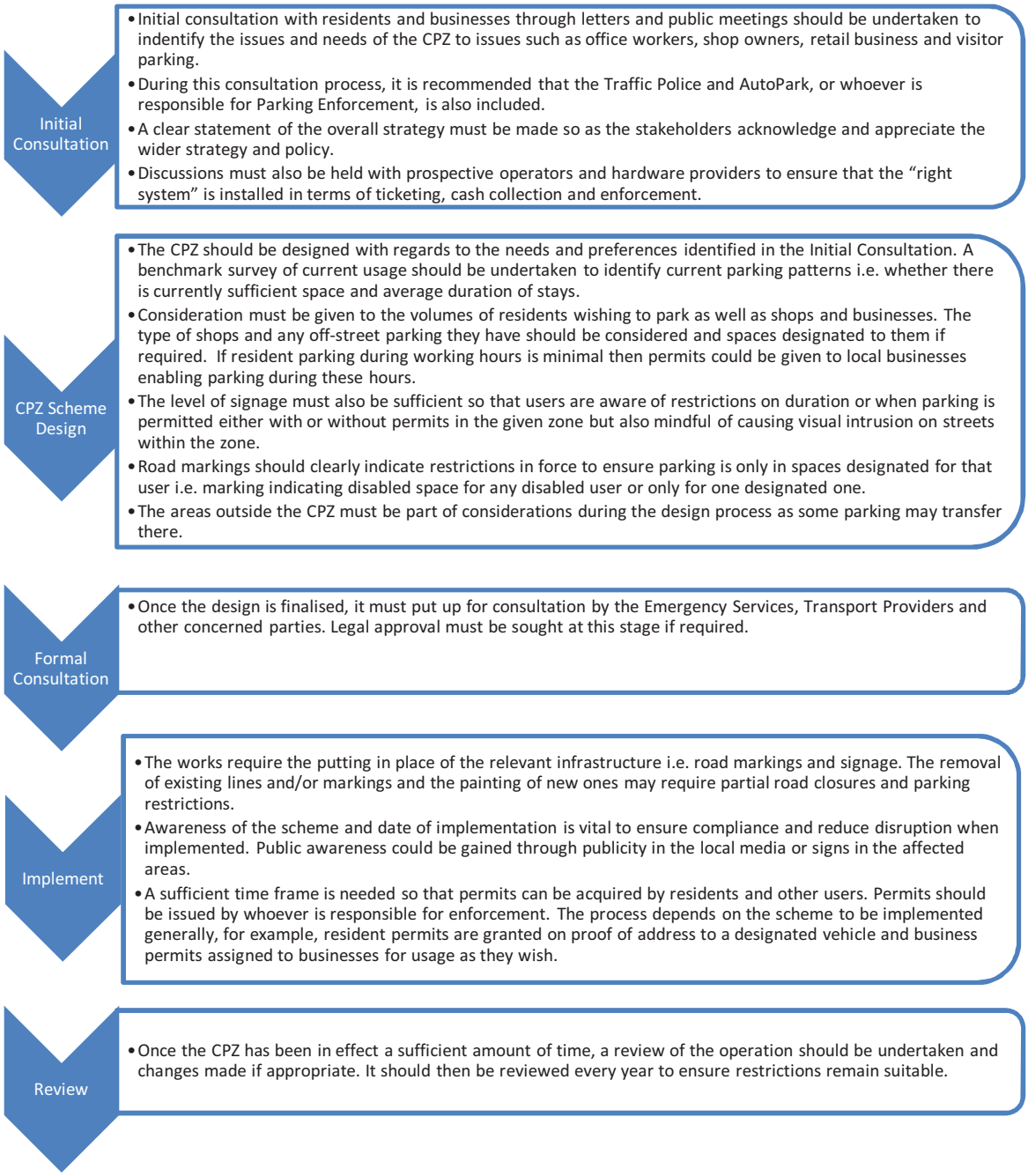
Administration processes are required, to register users and issue the appropriate parking permit. This needs to be accompanied with clear permit instructions.

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.

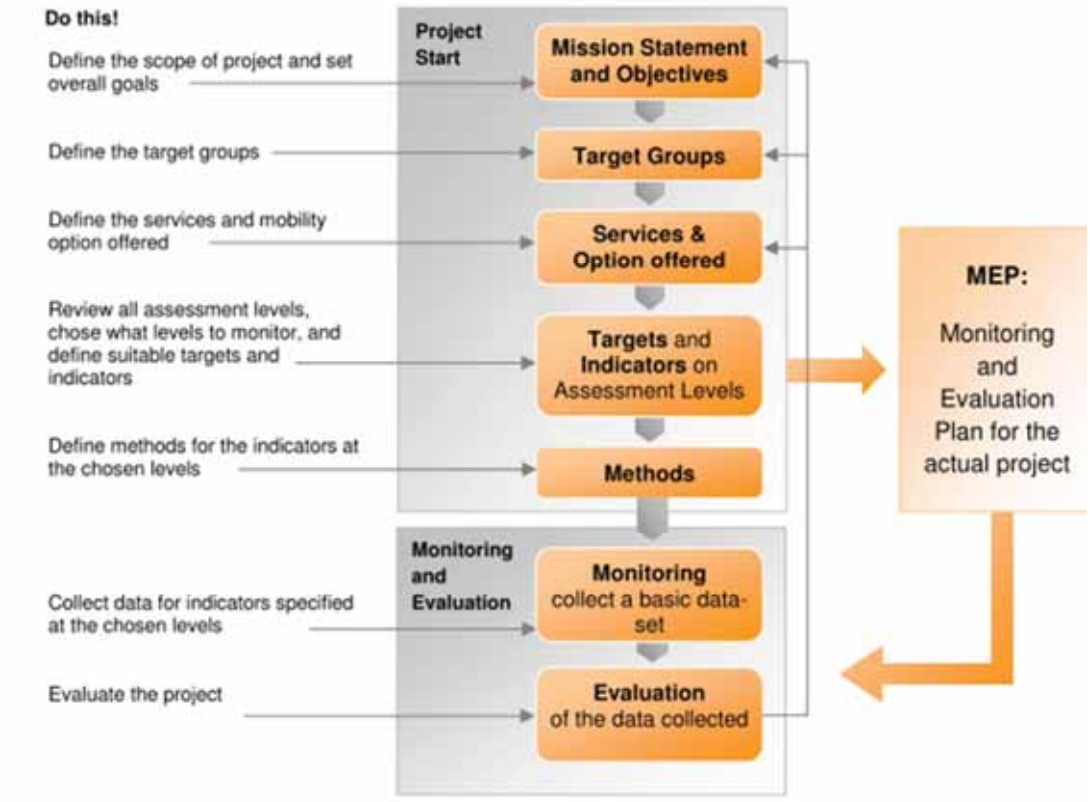
From this it will be seen that promoting a travel awareness scheme or campaign is much more complicated than simply advertising the benefits of improvements and changes, as the aim of the exercise is also to educate and persuade people to change their views and approach to transport issues.

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

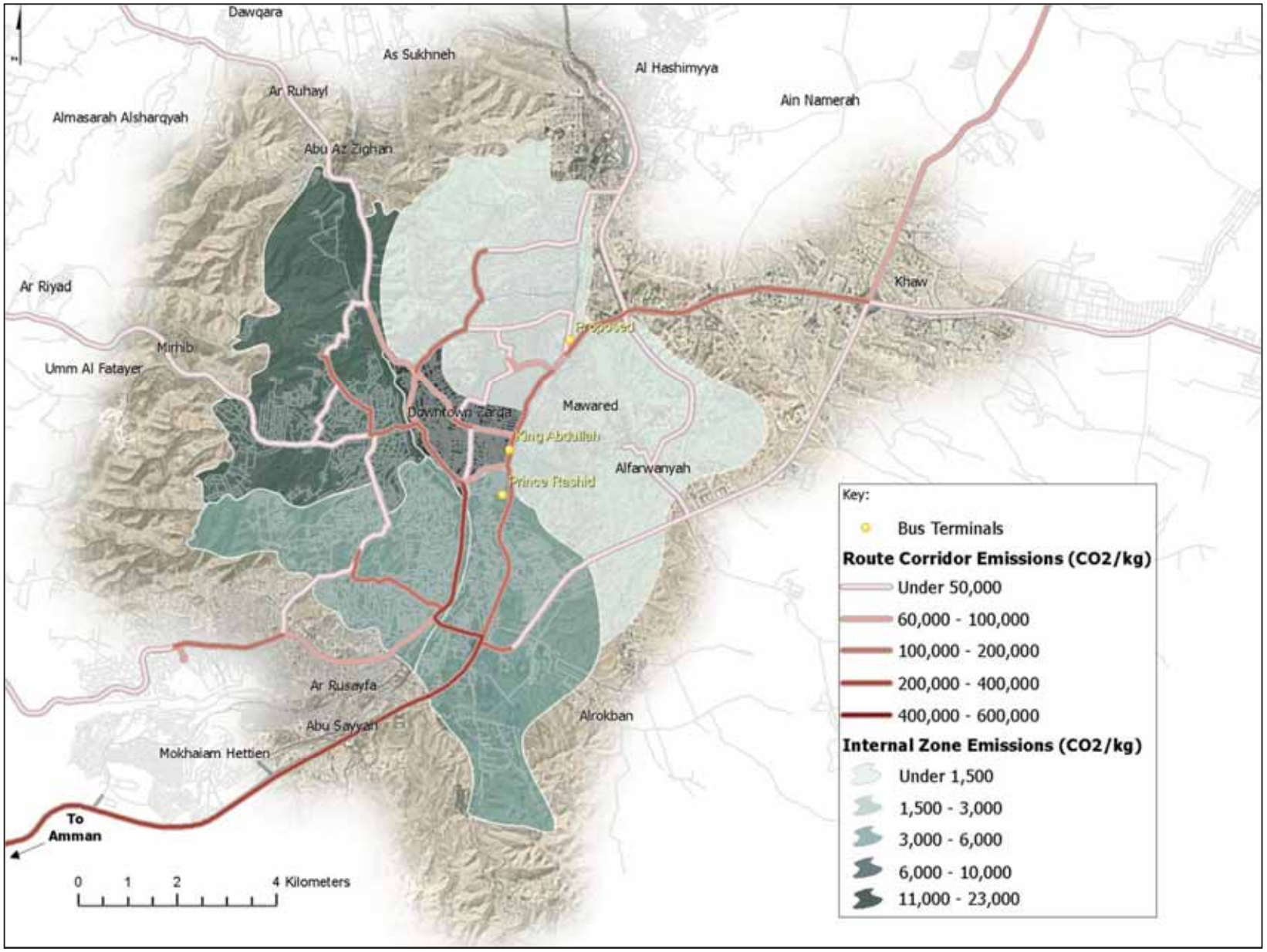


Figure O2: 2015 Baseline (Without Strategy) CO_2 Emissions

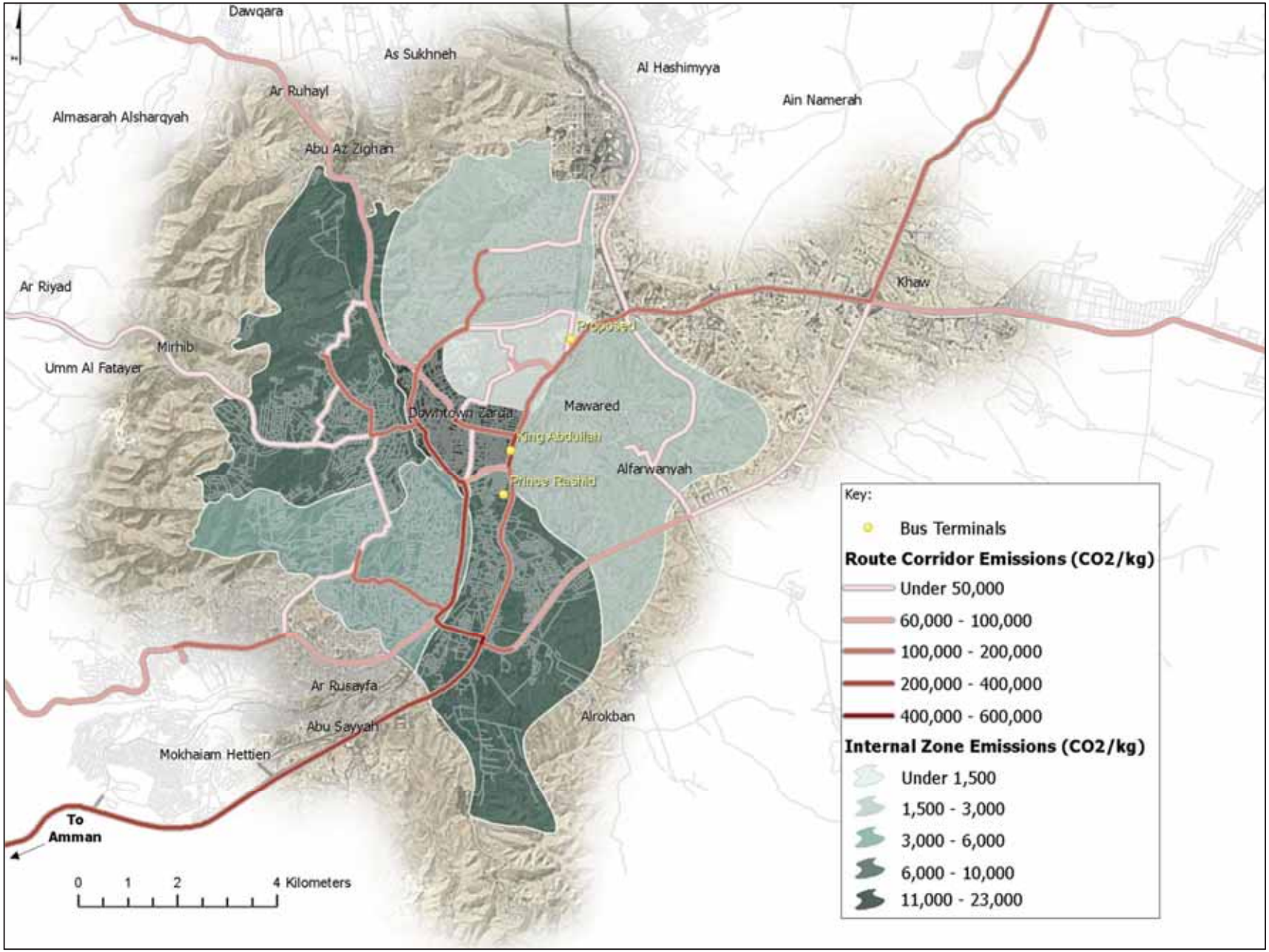


Figure O3: 2020 Baseline (Without Strategy) CO_2 Emissions

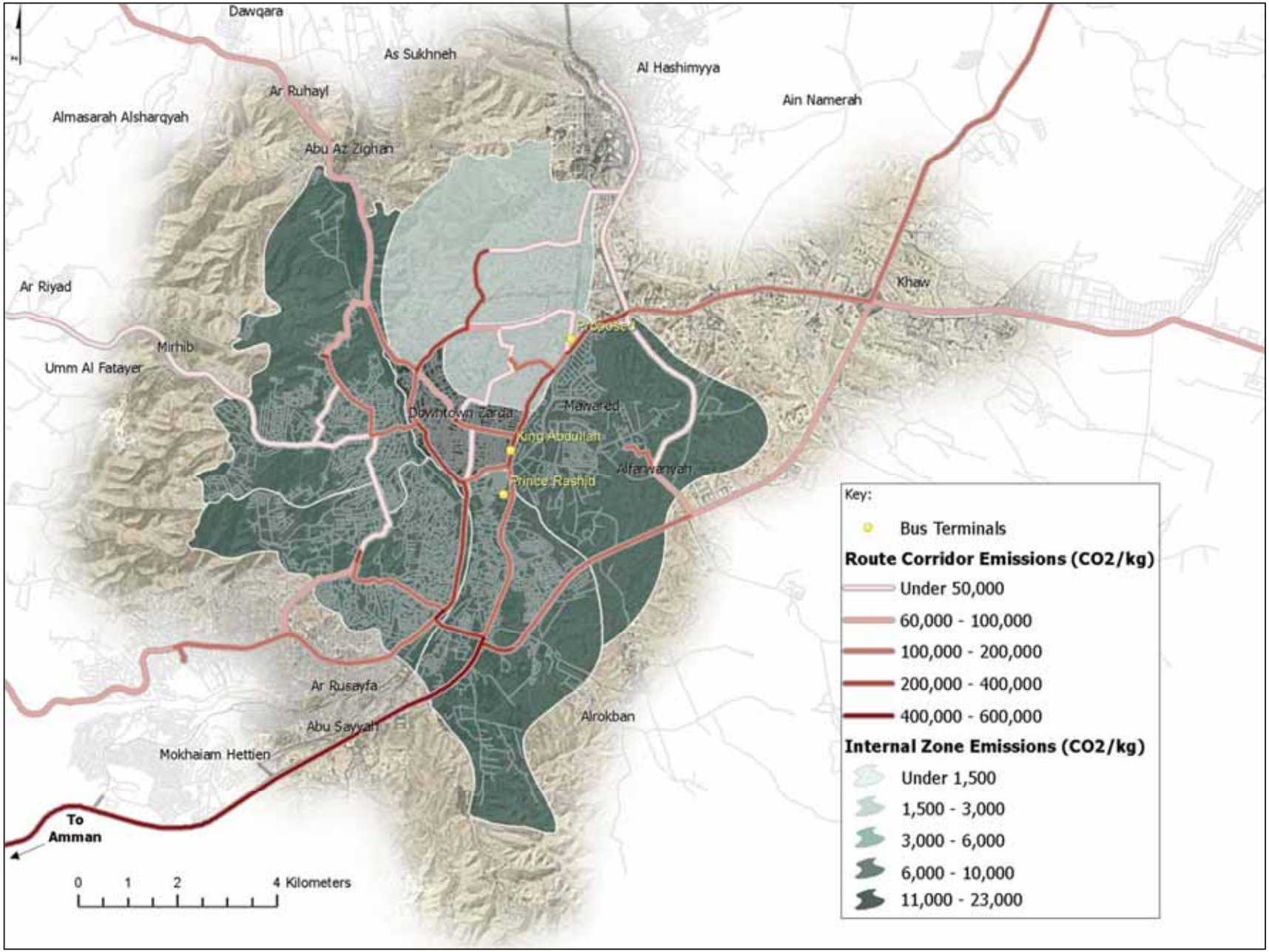


Figure O4: 2015 With Strategy – CO_2 Emissions

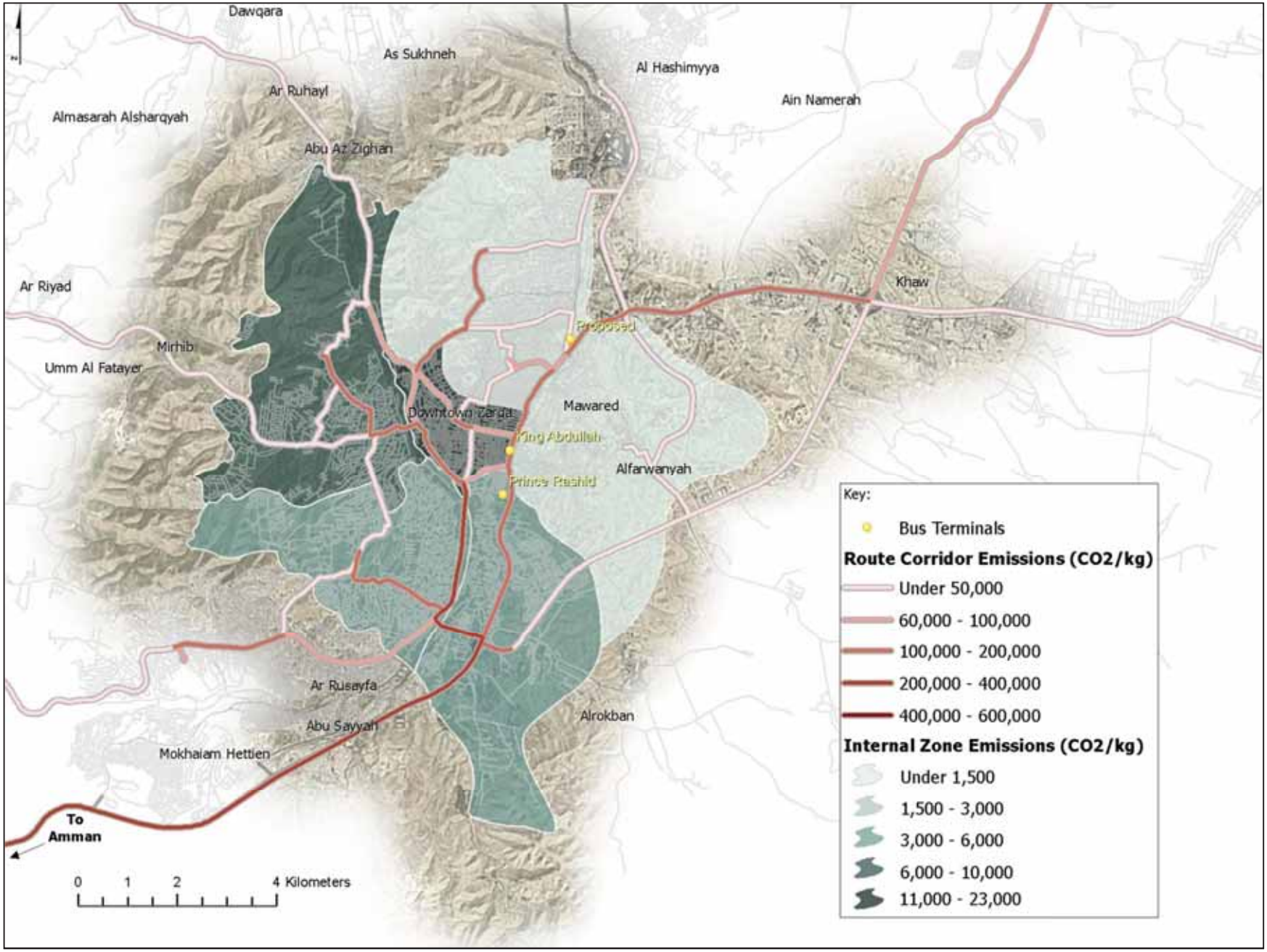
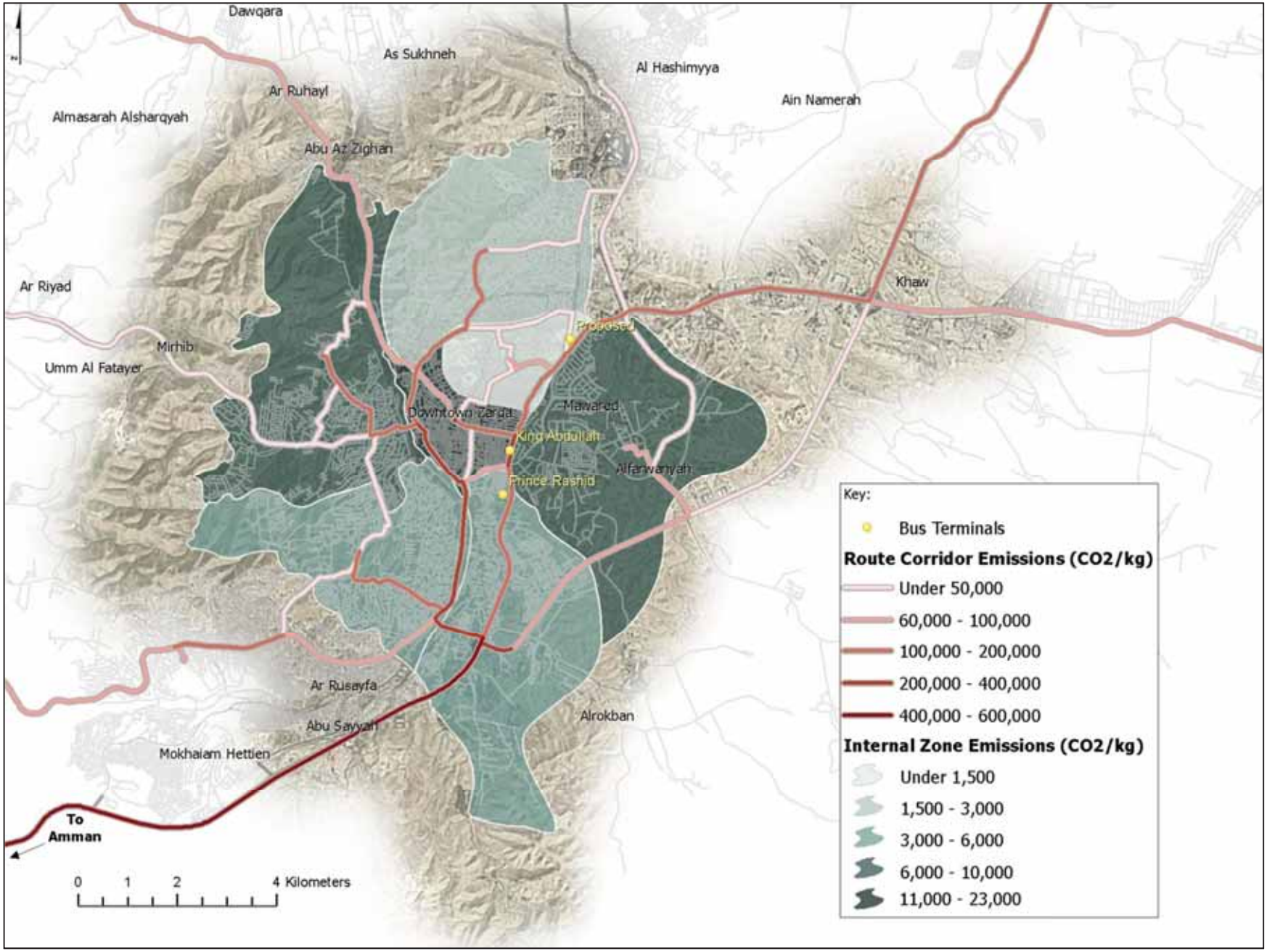


Figure O5: 2020 With Strategy – CO_2 Emissions



References

1. **WSP-CC.** Amman Transport Mobility Master Plan. 2010.
2. **The Hashemite Kingdom of Jordan, Department of Statistics.** *Household Expenditure and Income Survey Report.* 2008.
3. Zarqa GIS Model. s.l. : Royal Geographical Society, 2010.
4. Zarqa Traffic Surveys. s.l. : Ministry of Public Works, 2009.
5. **WSP-CC.** *Jordan Bus Restructuring Analysis.* 2010.
6. **The Hashemite Kingdom of Jordan, Department of Statistics.** *Jordan Statistical Yearbook.* 2008.
7. International Vehicle Emissions Model. *International Sustainable Systems Research Center.* [Online] 2010. http://www.issrc.org/ive.
8. Amman Vehicle Production Data. *GAM's Comments on the Draft Interim Report for "Developing an Energy Efficient Urban Transport Plan for Zarqa City Downtown Area".* s.l. : Greater Amman Municipality, 2010.
9. **Consulting, Hart Energy.** Middle East Fuel Quality Overview. 2008.
10. Vehicle Registration Data. *Jordan Driving Licence Department.* 2011.
11. **Abu-Allaban, Mahmoud, et al., et al.** *Emission Rate of Gaseous Pollutants from Motor Vehicles.* 2007.
12. World Economic Outlook Database. *International Monetary Fund.* [Online] October 2010. http://www.imf.org/external/pubs/ft/weo/2010/02/weodata/index.aspx.
13. Mawared Traffic and Transportation Study.
14. *Accessible Bus Stop Guidance.* s.l. : Transport for London, 2006.
15. *Manual for Streets.* s.l. : Department for Transport, 2007.
16. EU Max Project. *Successful Travel Awareness Campaigns and Mobility Management Strategies.* [Online] 2009. http://www.max-success.eu/index.phtml.
17. *Marketing and social marketing in the social change marketplace.* **Andreason, AR.** s.l. : Journal, Vol. 21.
18. *Merchandising Commodities and Citizenship on Television.* **Wiebe, G D.** s.l. : Public Opinion Quarterly, 1952.
19. MAX Project. *European Platform on Mobility Management.* [Online] http://www.epomm.eu/index.phtml?Main_ID=2174.