Chapter 21. UMAWYEEN SQUARE UNDERPASS CONSTRUCTION PROJECT

21.1 Objectives of the Project

21.1.1 East-West Corridor Traffic Improvement

The road network pattern of the city basically depends on three main arterial roads from the central area to the directions of north, south and east with the absence of well-functioned ring roads. Traffic to the west direction is not well-connected with other arterial roads and consequently causes congestion at many locations and there are missing high-capacity links for uninterrupted traffic on the north-south corridor.

Traffic congestion on the east-west corridor of the city is currently observed at several low-capacity locations either at intersections or in narrow streets. On this corridor, the Umawyeen Square was selected under this feasibility study, however improving the traffic movement at one location on the corridor will negatively affect the traffic conditions at many other locations. Implementing the improvement schemes for the corridor must proceed under one comprehensive package of projects in stages under an implementation program covering the whole corridor. The planned projects to improve the movement on this corridor include the following projects which are shown on Figure 21.1.1.

C03: Al Umawyeen square grade separation project
C22: Victoria bridge extension project
B13: Old City north wall street
C19: Shiekh Raslan – Zablatani overpass
A02: Al Zablatani street widening project

Under the Implementation Program of the Master Plan for the road projects presented in Chapter 13, the Umawyeen square project (C03) is planned to be implemented first, then to be followed by projects B13, C22, C19 and A02. Implementing the package under this plan will require to proceed in land acquisition and required resettlement schemes as early as possible especially for the project B13 which will pass through residential and commercial areas near the Old City.

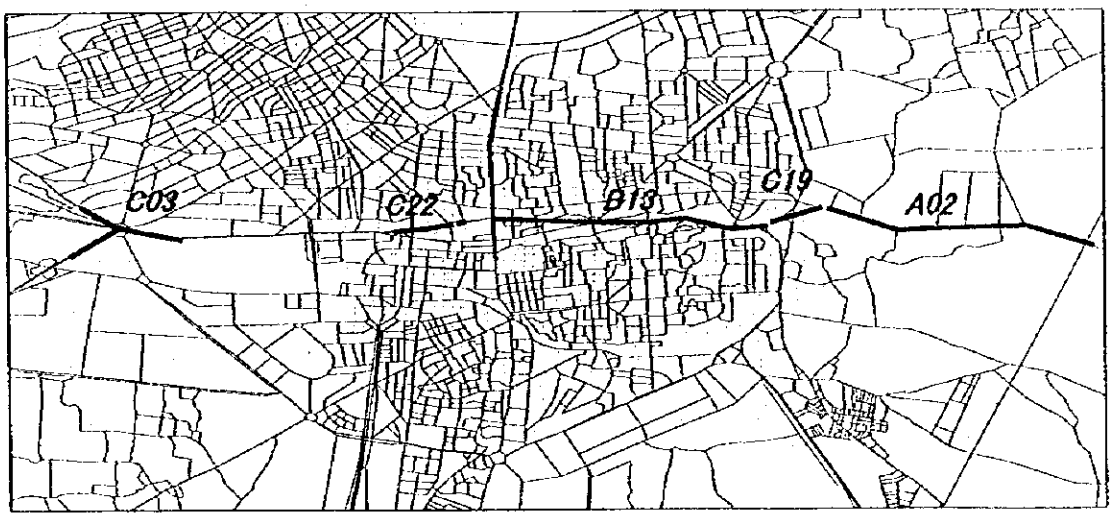


Figure 21.1.1 Planned Projects on East-West Corridor

21.1.2 Objectives of the Project

The Umawyeen square is characterised as a seven-leg rotary with about 8 lanes in road-width equipped with a signalization system composed of several signals installed either at some of the legs or on the rotary itself. With the high traffic volumes passing the square, this traffic control system results in a considerable delay and congestion due to the required several stops for vehicles in order to pass the square. Analysis of the traffic movements in the area showed that grade-separation between traffic movements is required as an urgent solution in order to alleviate congestion on the square.

Objectives of this Project can be stated as follows:

1) To alleviate traffic congestion on the square
2) To provide non-interrupted flow for main traffic directions
3) To reorganise the signalization system for optimum use
4) To decrease delay, travel time and vehicle operating cost
5) To improve safety and environmental conditions

21.2 Alternatives and Preliminary Selection

As the traffic problem at this location is well observed for long period in the past, different schemes were previously studied to provide grade separation structures for the square but many difficulties were observed either physically or from the landscape point of view. There are many physical control points in the area which should be carefully considered in order to get the optimum structural plan such as the branches of Barada river, the low elevation of the square and the railway bridge over Faez Monsour street.

Overpasses were basically excluded as they will disturb, distort and badly-affect the existing landscape of the square. The following several underpass schemes were studied in order to get the optimum alignment and structure plan. Table 21.3.1 presents a summary for all of the five alternatives under consideration with the parameters of the selection criteria as well as the prioritization results.

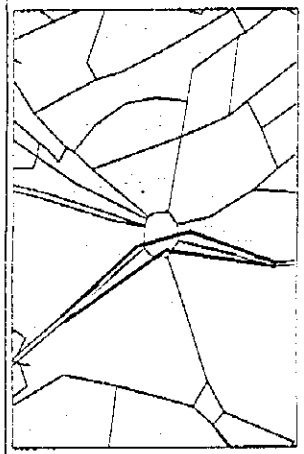
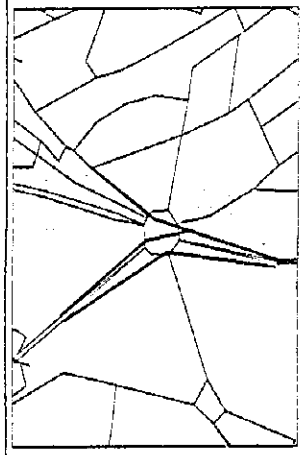
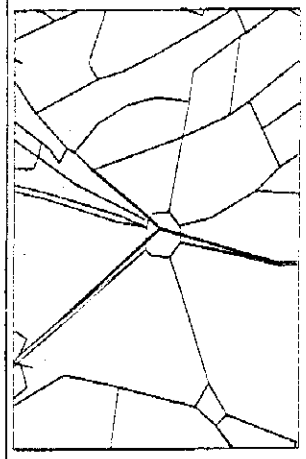
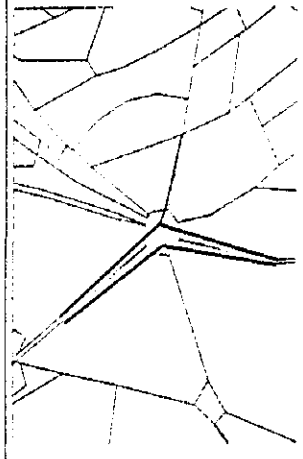
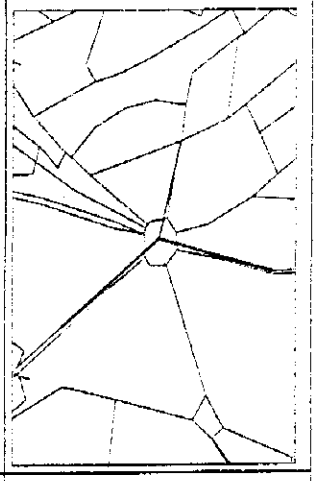
Under all the alternatives, the main concept is to handle the highest traffic volumes through an underpass in order to keep the at-grade square for only the directions of low traffic volumes. Based on the traffic volume surveys and forecast, the main heavy traffic is that connecting Shoukry Al Qouwatly street which is connected with the central area with Faez Mansour motorway (Mezze road).

Scheme-1:

This is the basic scheme, out of a total of five schemes, to provide a grade separation structure in which a 2-way underpass is proposed to connect Shoukry Al Qouwatly street, on the city center side, with Faez Mansour motorway, to the west of the city, with two lanes in each direction. The scheme will considerably alleviate the traffic congestion on the square as it will handle the traffic volumes of the highest two legs out of the seven legs of the square.

The scheme realizes the main objectives mentioned above and provides the advantages of keeping the landscape of the square without changes, decreasing the air and noise pollution in

Table 21.2.1 Alignment Alternatives of Umawyeen Square

Item		Scheme-1	Scheme-2	Scheme-3	Scheme-4	Scheme-5
Alignment						
Structure	Total Length (m)	530 (4-Lane)	740	740 (2-Lane)	740	740 (2-Lane)
	Open Section (m)	270 (4-Lane)	370	370 (2-Lane)	370	370 (2-Lane)
	Tunnel Section (m)	260 (4-Lane)	370	370 (2-Lane)	370	370 (2-Lane)
Construction Method		Open-cut method	Open-cut method	Open-cut method	Open-cut method	Open-cut method
Construction Period (month)		24	30	24	30	24
Economic Cost (million SP)		227.7	408.7	245.2	338.6	210.2
At-grade Intersection Saturation Degree	2005	1.11	0.92	0.93	1.14	1.14
	2020	1.23	1.02	1.03	1.26	1.26
Saturation Degree (with an extra at-grade lane at Shoukri Al-Qouwatly)	2005	0.91	0.79	0.80	0.94	0.94
	2020	1.00	0.87	0.88	1.03	1.03
Traffic Volume (vehicle/day)	2005	54,300	57,565	24,216	47,320	17,004
	2010	62,772	68,295	27,306	53,972	19,058
	2020	81,592	90,970	33,188	74,464	30,190
Grading		3	1	2	4	5

addition to the improvements of vehicular and pedestrian flows. The phasing system of the square signalization will be significantly improved to reduce directional conflicts and delay of vehicles.

Taking into consideration the operational requirements of the trunk bus system presented in the public transport plan, this scheme will be the most suitable as it will provide continuity for bus movement without interruption with other movements of traffic. The two lanes for bus exclusive-use, however, should be used for all vehicular traffic in the underpass as its total number of lanes is only four lanes.

The scheme has one main disadvantage from the traffic point of view, that there will not be enough improvement to another high future traffic volume expected in the direction from the city center to Dummar new town through Jawaher Lal Nahro street. Other technical problems include the interference of the underpass alignment with Barada river branches and the sewage network under the square.

Scheme-2:

In addition to the components of the first scheme, the second scheme has one more branch for the underpass to handle traffic in one direction from Shoukry Al Qouwatly street to Jawaher Lal Nahro. This extra traffic volume passing though the underpass will require one more lane for its entrance at Shoukry Al Qouwatly street. In such case, the existing width of the street will not be enough and extra width must be acquired.

In addition to the advantages mentioned for scheme-1, this scheme has the extra advantage of handling more traffic through the underpass that will provide more space for at-grade traffic.

The scheme will facilitate the fast exit of outbound traffic from the city center and will keep the inbound traffic at the same level of scheme-1. The signal system of the at-grade square can be operated in only two phases with less number of signals. Pedestrian movement on the square will be improved due the decreasing of conflict points with vehicular traffic.

Considering the disadvantages of the scheme, it will also face the same technical problems of scheme-1 in regard to the interference between the underpass alignment with Barada river branches and the sewage network under the square.

Scheme-3:

The basic concept and target of this scheme is to provide fast exits for outbound traffic from the city center to the west for the two main directions of Mezze and Dummar. Facilitating this traffic movement, through one entrance at Shoukry Al Qouwatly street and two exits to both of Faez Mansour and Jawaher Lal Nahro streets, will improve the traffic condition at the congested intersections of the city center, as well as to some extent, on the square itself.

This scheme may provide some advantages only for the city center and outbound traffic in the short-run. On the long-run, other directions of traffic will face congestion problems on the square as this scheme will only solve the problem partially. With the comprehensive planning of the transport system of the city, smooth flow can be provided through other multi-directional schemes. Considering the cost and the passing traffic volumes through the underpass, this scheme will not show economical viability when compared with other schemes.

In addition to the main disadvantages of the high cost per traffic volume not-providing long-term solutions to the inbound directions of traffic by this scheme, it will face also the same technical problems of the interfering between the underpass alignment with Barada river branches and the sewage network under the square.

Scheme-4:

This scheme provides two entrances and one exit to the proposed underpass in order to facilitate more the outbound traffic from the center area than the inbound traffic. The two entrances are located on Shoukry Al Qouwatly and Adnan Malki streets, with two lanes for each to discharge the city center traffic from two congested locations. The exit, with three lanes, is located on Faez Mansour street as the western direction to Mezze. For the inbound traffic to the city center, there is only one link from Faez Mansour street to Shoukry Al Qouwatly with two lanes.

The scheme has many of the advantages determined in previous schemes including the improvements in the function of the signalization system. However, the resulting merging conflict inside the underpass between two directions of traffic is not preferable as safe sight distances can not be geometrically provided for traffic coming from the two entrances.

This merging conflict situation will cause also disturbance for the flow of the trunk bus system of the public transport. In addition, with the development of other parts in the road network, traffic coming from Adnan Malki is not expected to provide high share in volumes on the square in the future, which give this scheme one more disadvantage.

Scheme-5:

This scheme also has the main concept and target of scheme-3 which is to provide fast exits for outbound traffic from the city center to the west of the city and to discourage inbound traffic. The difference is that the underpass in this scheme has two entrances and one exit instead of one entrance and two exits.

Disadvantages of this scheme are composed of those for scheme-3 and scheme-4 which are mainly the short-run and local concept in planning to discourage inbound traffic to the city center, high cost per traffic volume, the interfering between the underpass alignment with Barada river branches and the sewage network under the square, the merging conflict inside the underpass between two directions of traffic and the expected disturbance for the flow of the trunk bus system of the public transport. In addition, the technical interference with Barada river branches and the sewage network is still exists as in all the schemes.

Scheme Selection:

In conclusion, and after assessing the prioritization criteria parameters of the different alternatives and comprehensive discussions with the authorities concerned in Damascus, Scheme-2 was selected as it gives the best saturation degree for the at-grade movement especially with the utilization of additional lanes in Shoukry Al-Qouwatly street. This scheme, however, has the highest total cost compared with all other alternatives but it provides better traffic conditions in the long-term as it has two exits for the traffic from the central area against only one entrance. It also provides high B/C ratio for the road network and high ratio of unit cost per passing traffic volumes in the underpass. The plan of the selected scheme is presented in Figure 21.1.1.

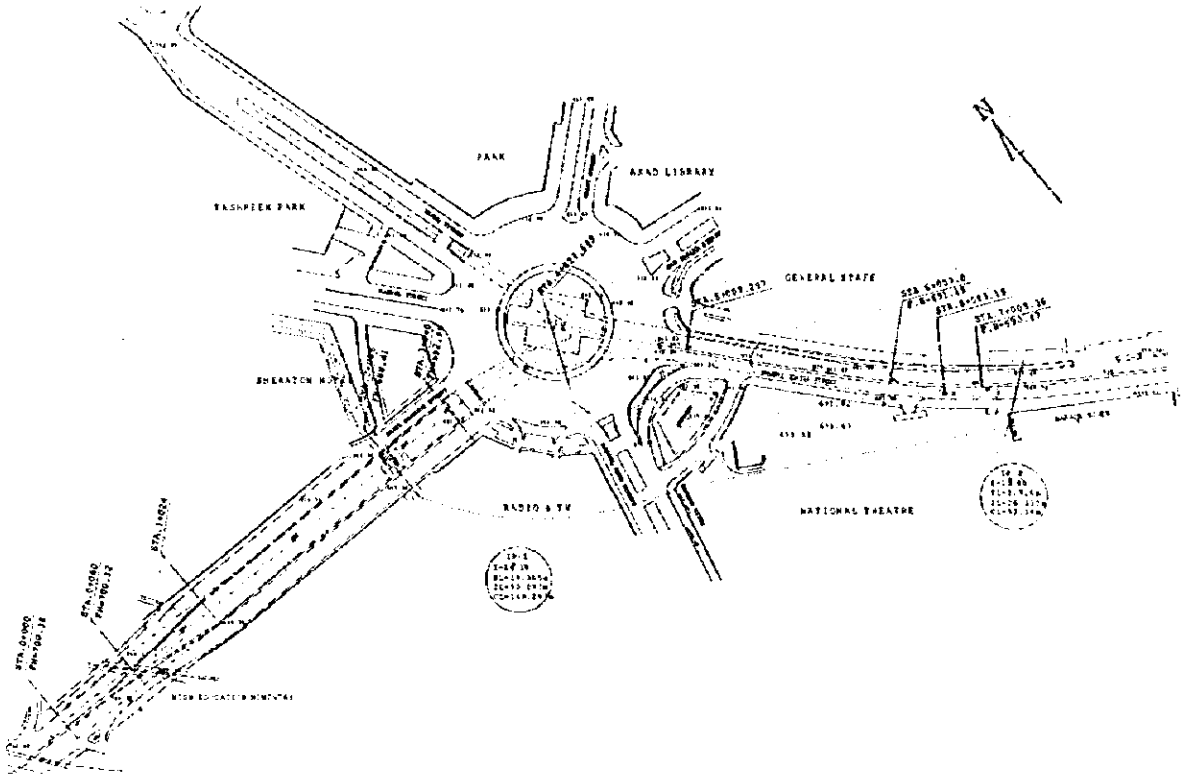


Figure 21.2.1 Plan of Umawyeen Underpass

21.3 Traffic Demand

The present rotary-type intersection has a high number of seven legs and handles high traffic volumes at present. The intersection is expected to handle very high volumes in the future with the development of the south-western areas of the city. Without improvement, the Saturation Degree is estimated as follows:

Year 1998	1.16
Year 2005	1.36
Year 2020	1.50

The movement on the at-grade level was analyzed for each of the five schemes under consideration for this underpass to estimate the saturation degree. Scheme-2 gives the minimum saturation degree comparing with other schemes as presented in Table 21.3.1 which presents the results of the analysis.

Table 21.3.1 Umaweyeen Square Saturation Degrees

Scheme	Saturation Degree		
	1998	2005	2020
1	0.94	1.11	1.23
2	0.78	0.92	1.02
3	0.79	0.93	1.03
4	0.97	1.14	1.26
5	0.97	1.14	1.26

Table 21.3.2 gives a comparison between the daily traffic volumes passed in each of the five schemes for the feasibility-study target year of 2005. Scheme-2 handles the highest volumes.

Table 21.3.2 Traffic Volumes in Umaweyeen Underpass - 2005

Scheme	Traffic Volume				
	P. Car	Taxi	M. Bus	Truck	Total
1	19,932	23,300	8,452	2,616	54,300
2	21,625	25,395	9,160	2,970	59,150
3	13,224	15,624	5,505	1,971	36,324
4	20,955	25,210	8,795	2,605	57,565
5	9,330	11,007	3,825	1,344	25,506

21.4 Preliminary Design

21.4.1 Design Criteria

The main items of the established design criteria for the geometrical and structural design of the selected underpass scheme are as follows:

- Design speed
- Geometrical elements
- Clearance limit
- Design loading

1) Design speed

Design speeds for urban arterial roads generally range from 60 km/h to 100 km/h and occasionally it may fall as low as 50 km/h. Lower speeds of less than 60 km/h are generally applied in the central business district and intermediate areas. The adopted design speed for this underpass is 60 km/h.

2) Geometrical elements

a. Radius of horizontal curves

The minimum radius is a limiting value for curvature for a given design speed for safe maneuvering to be determined from the maximum rate of super-elevation and maximum side friction factor selected for design. In general, the recommended standards for the minimum radius for horizontal curve for the different design speeds are based on the AASHTO standards as shown in Table 21.4.1.

Table 21.4.1 Minimum Radius

Design Speed (km/h.)	Standard Radius (m)	Special Radius (m)
80	280	250
60	150	125
50	100	100
40	60	60

For the adopted design speed of 60 km/h, a minimum radius of 125m can be applied for the horizontal curvature of the underpass, however, a larger radius is applied based on the geometric characteristics of the square.

b. Grade

The values of maximum grade of AASHTO for vertical slopes, to be applied for entrance and exit ramps of the underpass, are presented in Table 21.4.2 for different design speeds.

For the applied design speed of 60 km/h and due to the limitations in available space and different control points to be avoided, the maximum grade of 7% is applied for either the entrance or exit ramps of the underpass. This maximum grade will provide also the shorter and most economic length for the structure.

Table 21.4.2 Maximum Grades

Design Speed (km/h)	Grade (%)
50	8.0
60	7.0
70	6.5
80	6.0
90	5.5
100	5.0

c. Radius of vertical curves

The minimum radius of vertical curves is estimated here based on AASHTO standards taking into consideration values applied in Syria through the use of some standards from Russia. Table 21.4.3 presents the minimum values of the radius of vertical curves as well as the values to be applied in special cases.

Table 21.4.3 Vertical Radius

Design Speed (km/h)	Curve Length (m)	Curve Radius	
		Minimum (m)	Special (m)
80	5000	2000	1000
60	2500	1500	600
50	1500	1200	400
40	1000	1000	300

d. Length of vertical curves

Due to the different constraints and control points in establishing the geometric profiles of structure works in the central area of Damascus, the applied values are those of the specifications of Japan, shown in Table 21.4.4, which gives more shorter and economic length and almost similar to those applied in other projects in Syria.

Table 21.4.4 Vertical Curve Length

Design Speed (km/h)	Curve Length (m)
80	70
60	50
50	40
40	35

c. Vertical and horizontal clearance

The standard vertical clearance applied in this preliminary design of 5.0 meters is that desirable clearance applied in international specifications and in Syria in other projects. The recommended minimum clearance is 4.4 meters.

The applied horizontal clearance to accommodate two lanes of traffic (2 x 3.5m) is 8.0 meters to include side clearance (2 x 0.5m). For three lanes of traffic, the applied horizontal clearance is 11.5 meters.

21.5 Design Loading

The structure is designed to carry the following loads and forces.

- Dead load
- Live load
- Impact on dynamic effect of the live load
- Effect of earthquakes

The following loading points were considered in the different stages of the structural design of the underpass.

a. Live load

The live load adopted in the design is the standard highway loading HS35-44 as specified in the "Standard Specifications for Highway Bridges" 12th Edition, 1977, which is adopted by the American Association of the State Highway and Transportation Officials (AASHTO). This consists of a standard truck or equivalent for lane loading, as shown in Figure 21.5.1. These loads are considered equivalent to HA loading specified in BS5400.

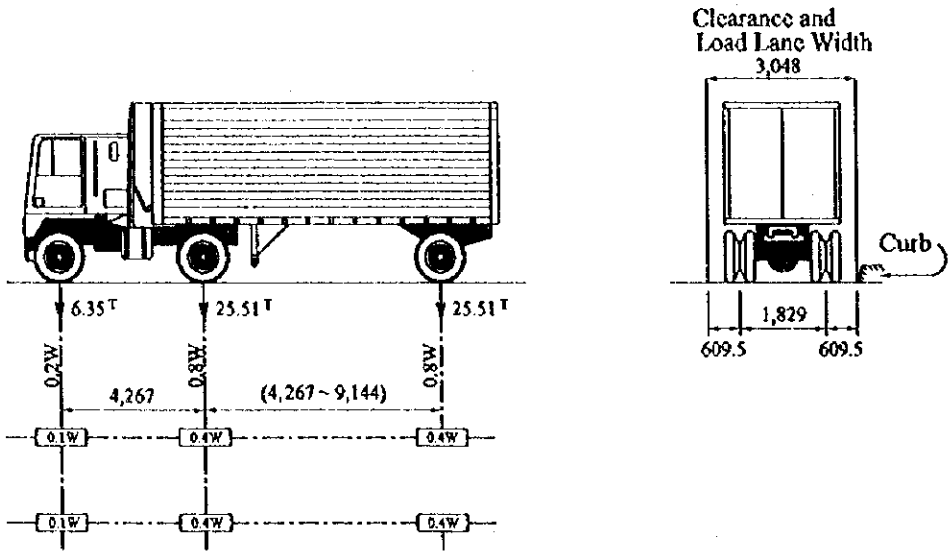
The structures have also been checked for special cases of loading, which consist of either a military tank or transporter. These loads are regarded to be inclusive of impact and equivalent to HB Loading in BS5400.

The live load, usually adopted in designing highway bridges according to "Standard Specifications for Highway Bridges" 14th Edition 1989, is HS20-44 or an equivalent lane loading as shown in the figure. In the Middle East region, a multiplier should be applied to HS 20-44 to encounter the unexpected increase in live load due to any overloading of trucks. The design loading adopted in this project is equivalent to 1.75xHS20-44, which is between the loading adopted in other regional countries of Jordan and Saudi Arabia.

b. Temperature loading

According to data published by the Meteorological Department of the Ministry of Defense in 1977, the absolute maximum yearly temperature range that occurs at Ariha is 48.5 C°.

A temperature range of 50 C° has therefore been applied in the design which is considered appropriate.

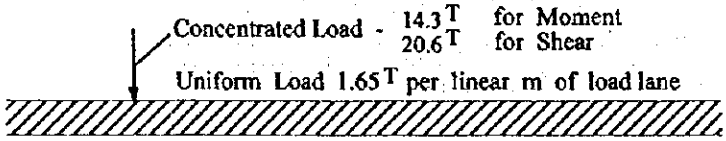


W = Conbined weight on the first two axles which is the same as for the corresponding H . truck.

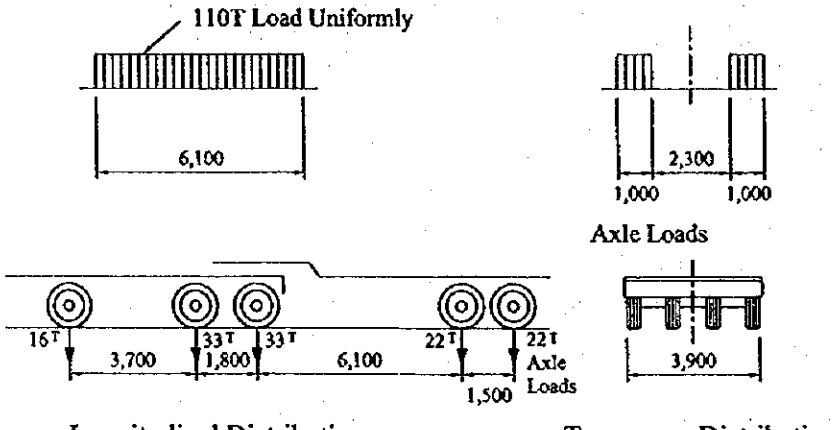
V = Variable Spacing - 14 feet to 30 feet inclusive, spacing to be used is that which produces maximum stresses.

(AASHTO x 1.75)

Longitudinal Distribution - Transverse Distribution
Standard Truck Loading



Equivalent Lane Loading
Standard Higway Loading



Longitudinal Distribution Transverse Distribution

Transporter Loading - 2

Figure 21.5.1 Design Loading

c. Seismic loading

All structures in this study have been designed to withstand without damage the effect of seismic ground acceleration of 0.15g horizontally and 0.1g vertically.

21.5.2 Structure Design

The following sections summarize the main elements of the structural design.

1) Covering

The minimum covering over the top of the structural section is taken 2.5 meters from the ground level to the top of the slab for load distribution purposes and in order to secure enough space for other underground utility pipes.

2) Alignment

The horizontal alignment applied for the carriage-way centerline of the underpass tunnel is basically to align it in the center of road. The applied vertical alignment for the profile of the tunnel would be less than 7.0 % which is the maximum slope of a design speed of 60 km/h..

3) Boundary distance

As a boundary distance from the road edge, a minimum lateral clearance of 1.0 meter is applied.

4) Control points

The main control points for the alignment, either horizontally or vertically, in the project area are as follows:

- Barada river
- Pier foundation of railway bridge
- Underground water level (-2.5m)

a. Barada River

The underpass was planned to have the shortest possible length in regard to its vertical slopes and other control points. This alignment, however, required that Barada river should be shifted few meters towards the square to allow more space for the underpass approaches. Shifting the river alignment was opposed by the Syrian side and a new alignment was prepared keeping the river in-place. Some modifications in the river's cross section were required to decrease its depth and increase the width. The new alignment resulted in increasing the underpass length for about 200 meters in total. Consequently, the economic construction cost increased from 408.7 million SP to 531.3 million SP.

b. Railway Bridge

The extended length of the underpass, to avoid shifting Barada river, will reach the railway bridge over Faez Mansour motorway. To avoid interference between the underpass and the bridge, the two underpass approaches for the two traffic directions in the street are planned to accommodate the foundation of the railway bridge in-between.

c. Underground Water Level

The underground water level in the project area has a depth of only 2.5 meters which should be taken into consideration in the design of the underpass structure and operation. With a minimum covering of 2.5 meters, the underpass is designed to be completely submerged under the water level. In addition, the structural design of the underpass is providing enough weight to resist any water pressure either from down or on the sides. Elements of the structure are designed to prevent water leakage inside the underpass, however, during the future operation, periodical pumping system for drainage requirements may be necessary.

5) Cross section

The applied typical cross section of the underpass is presented in Figure 21.5.2 for the open-section and depressed-section in case of two lanes of each direction. The details of design are presented in a separate volume of the report for "Drawings".

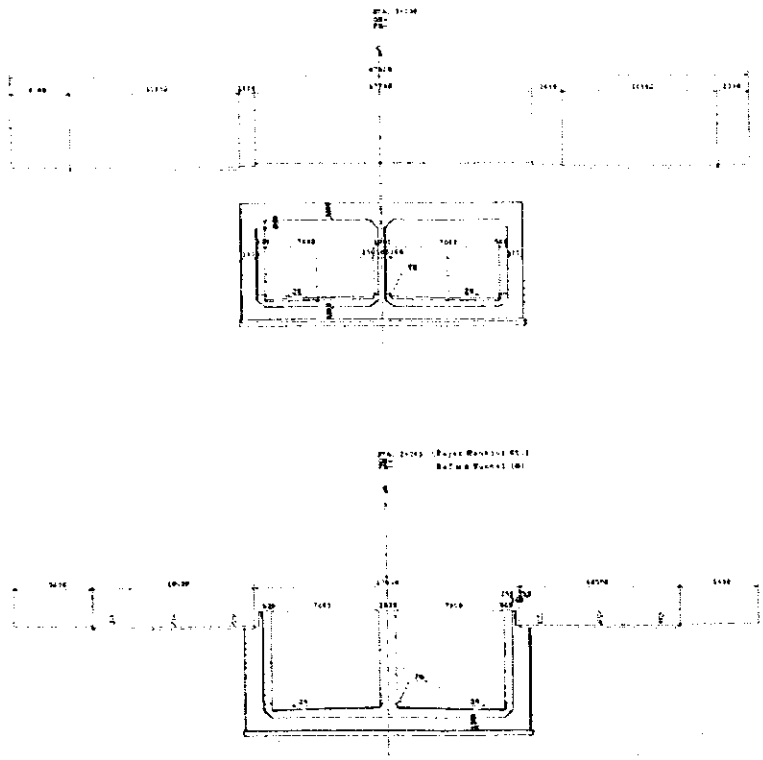


Figure 21.5.2 Underpass Cross Section

21.6 Cost Estimate

Costs are estimated here by applying the concluded unit cost for each work items as presented in Chapter 13. Costs include the use of sheet piles during the earthwork. The breakdown of the quantities for the different schemes of the Umawyeen underpass project as well as the applied unit cost for each major work item are presented in Table 21.6.1.

Table 21.6.1 Major Work Item Quantities

Work Item	Unit	Unit Cost (SP)	Scheme					
			1	2	3	4	5	2m
Length – No. of lanes	m		530-4	740-4	740-2	740-4	740-2	940-4
Clearing and Grubbing	SQM	15	10,600	19,026	11,415	15,764	9,785	24,168
Excavation	CM	140	77,980	139,964	83,978	115,970	71,982	177,792
Backfill	CM	305	25,312	45,432	27,259	37,644	23,365	57,711
Reinforced Concrete	CM	5,850	21,033	37,752	22,651	31,280	19,415	47,955
Plain Concrete	CM	3,125	965	1,732	1,039	1,435	891	2,200
Boulder	CM	2,500	1,929	3,462	2,077	2,869	1,781	4,398
Asphalt Pavement	CM	1,400	223	400	240	332	206	508

The economic cost of the five schemes proposed for the project are presented in Table 21.6.2 as well as the financial cost which includes 10% contingency, 20% profit and 30% taxes.

Table 21.6.2 Umawyeen Underpass Project Cost

Sch-eme	Construction Cost			Contingency		Tax	Profit	Engin-eering	Financial Cost('000 SP)			Economic Cost		
	F	L	Total	F	L	L	L		Foreign	Local	Total	Foreign	Local	Total
1	112,500	37,500	150,000	11,250	3,750	49,500	33,000	29,700	138,600	138,600	277,200	138,600	89,100	227,700
2	201,923	67,308	269,231	20,192	6,731	88,846	59,231	53,308	248,769	248,769	497,539	248,769	159,923	408,693
3	121,154	40,385	161,538	12,115	4,038	53,308	35,538	31,985	149,261	149,261	298,522	149,261	95,954	245,215
4	167,308	55,769	223,077	16,731	5,577	73,616	49,077	44,169	206,123	206,123	412,247	206,123	132,508	338,631
5	103,846	34,615	138,462	10,385	3,462	45,692	30,462	27,415	127,939	127,939	255,878	127,939	82,246	210,185
2m*	262,500	87,500	350,000	26,250	8,750	115,500	77,000	69,300	323,400	323,400	646,800	323,400	207,900	531,300

* Scheme-2 is the modified scheme-2 to avoid shifting Barada river

21.7 Implementation Schedule

The tentative implementation schedule proposed for the project is consisting in total of the first four years of the plan. Breakdown of the schedule is presented in Table 21.7.1 for the different implementation tasks.

Table 21.7.1 Tentative Implementation Schedule

Task	Year 1		Year 2		Year 3		Year 4	
Fund Allocation	■							
Consultant Selection	■							
Detailed Design		■	■					
Tendering			■					
Contractor Selection				■				
Construction					■	■	■	■

21.8 Environmental Consideration

21.8.1 Environmental Impacts

From the environmental point of view, the protection of Barada river is most important. This issue can be resolved by designing the underpass to avoid shifting the river. No other significant environmental impact is identified although minor impacts are identified especially during the construction such as traffic management, wastes and landscape. Summary of the impacts is shown in Table 21.4.4.

Table 21.8.1 Summary of Environmental Impacts-Umawyeen Underpass

Environmental Impacts	Project Stages		
	Pre-Construction	Construction	Operation
1. Traffic Management		O	
2. Waste/dust		O	
3. Landscape		O	O

Note: ●:significant, ◎: medium, O: minor

21.8.2 Environmental Considerations and Countermeasures

Some minor environmental impacts are identified on this project.

1) River

The underpass is designed to avoid shifting the river.

2) Traffic Management

During the construction, the work disturbs traffic flow so that proper traffic management is required such as alternative routes.

3) Waste Management

Construction waste is caused by excavation. Proper management of transport of the waste and proper disposal site are required.

4) Landscape

Barada River aligns beneath the existing square and the people in Syria are keen to water resources even it is already improved. The original alignment shall not be changed. In addition, large scale of structure is constructed so that the design shall be harmonized with the area to mitigate visual impact.

21.9 Conclusion

For the grade-separation scheme of Umawyeen square, scheme-2 was selected after assessing the prioritization criteria parameters of the different alternatives and comprehensive discussions with the authorities concerned in Damascus, as it gives the best saturation degree for the at-grade movement especially with the utilization of additional lanes in Shoukry Al-Qouwatly street.

To keep Barada river without shifting its alignment, a modified alignment was planned which resulted in increasing the underpass length for about 110 meters in Faez Mansour street and 90 meters in Shoukry Al-Qouwatly street to become 940 meters in total. Consequently, the direct construction cost increased from 408.7 million SP to 581.3 million SP.

This scheme, however, has the highest cost in absolute value compared with all other alternatives but it has a high value of passing traffic volume per unit cost, as well as it provides better traffic conditions in the long-term as it has two exits for the outbound traffic from the central area against only one entrance for inbound traffic.

The implementation of this project should be under the implementation program of the identified package in the first section of this chapter to improve the east-west corridor of the city as a whole. Improving only the local traffic movement on this square without proceeding in other projects of the package will not provide the target benefits of improving the traffic condition in the city center as well.

Chapter 22. AL YARMOUK SQUARE UNDERPASS CONSTRUCTION PROJECT

22.1 Objectives of the Project

An underpass is required under Al Yarmouk square in order to provide continuity and smooth movement for the heavy traffic on the inner ring road and to separate through traffic from local movements. The Al Yarmouk underpass (C14) can be extended to include the nearby project of the intersection with Al Quds street (C15) in one package. Providing one structure for the two intersections will facilitate the north-south movement on the proposed road project (B06) connecting Aal Al Bait with Al Quds streets. Connecting these two streets will provide a north-south main arterial to discharge traffic from the city center to the south direction through Al Quds street.

The road project (B06) will function as an extension to the main northern arterial of Ath Thawra street and will directly connect it to the inner ring road and south bypass which is provided at this location by an interchange. It is planned to be a one-way street for the inbound traffic to the Old City and city center, with Khaled Ibn Al Walid for outbound traffic under a comprehensive management plan. It depends on the implementation of several projects including the Al Hejaz – Ath Thawra tunnel and the pedestrianization of the area in front of the Old City.

Project B06 will result in an intersection with the inner ring road which is planned to be solved as grade-separated underpass (C15) for the continuity of the ring road traffic movement. In addition, constructing a grade-separation structure at this square will allow to provide two-directional movements on Ibn Assaker street which is used now as one-way street in this area. The opposite direction of traffic has to use a detour route through Al Kahira street. Other streets connected to the square have high traffic volumes as the area is closed to the Old City and city center.

The main objectives of implementing this project can be summarized as follows:

1. To alleviate traffic congestion on the Al Yarmouk square
2. To provide non-interrupted flow for main traffic directions on the inner ring road
3. To reorganize the signalization system in the area for optimum use
4. To decrease delay, travel time and vehicle operating cost
5. To improve safety and environmental conditions

22.2 Alternatives and Scheme Selection

Four grade-separation alternative structures were planned and studied for this project which are all underpasses in order to keep the landscape of the area without changes in such area close to the Old City. As the priority is given to the traffic flow on the inner ring road than traffic of other intersecting directions, all the proposed schemes are directed to provide non-interrupted movement for the ring road traffic. In addition, all the schemes have the same construction method of open-cut.

Table 22.2.1 presents a summary for all of the four alternatives under consideration with the parameters of the selection criteria as well as the prioritization results, while the following sections present a summarized description for each of the four alternatives.

Scheme-1:

This is the basic scheme which was planned first just to solve the traffic problem of the square through an underpass with a total of four lanes for the two traffic directions and connecting the two streets of Al Mojtahed and Ibn Assaker. The scheme provides the required continuity for the main traffic on the ring road without interruption at the square, which will give also more space for other traffic directions. Other advantages include the improvement in environmental conditions and safety of pedestrians.

The scheme has, however, some problems, as the road width at the entrances and exits of the underpass is not wide enough to provide space for at-grade traffic. Roadsides are occupied with big buildings, which make it difficult to acquire lands for widening purposes. It will not also solve the traffic crossing problem at the nearby intersection with Al Quds street which will require a separate structure on a short distance.

Scheme-2:

This scheme is based on a cost-reduction concept and modification on the first scheme to provide the underpass only for one direction of traffic with the minimum required length. All other directions of traffic can be handled as at-grade movements with signals. In such case, the underpass will be used for traffic from Al Mojtahed to Ibn Assaker and traffic from Al Midan street will have only right-turn movement to eliminate the crossing with the ring road traffic from Ibn Assaker to Al Mojtahed.

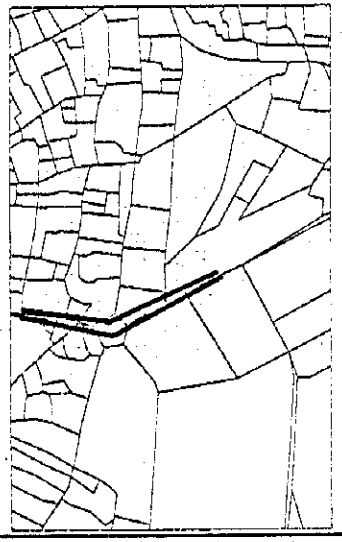
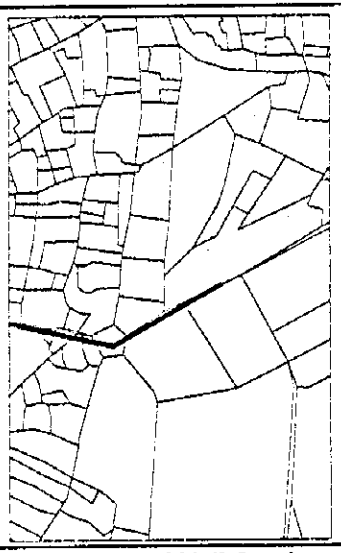
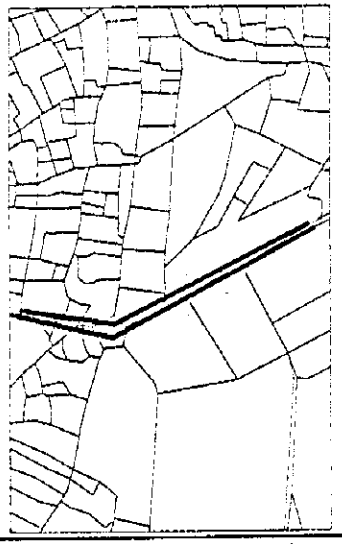
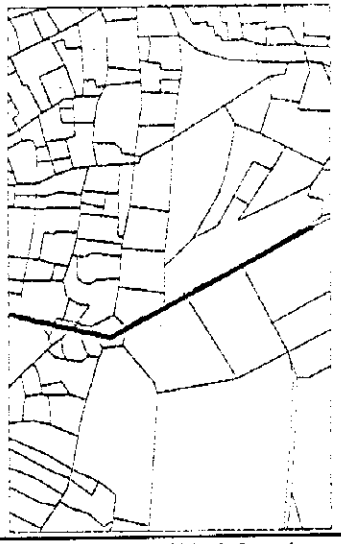
With a one-direction underpass the cost will be significantly reduced while the opposite direction will be accommodated on at-grade movement on the square. The street width, in this case, can accommodate the entrance and exit for the two lanes of the underpass without the need for any widening or land acquisition schemes. Other advantages are the relative improvement in environmental and pedestrian safety conditions. In addition to the above disadvantages of Scheme-1, another disadvantages include the interruption of the at-grade opposing traffic with other crossing movements.

Scheme-3:

This scheme is to merge the two projects of C14 and C15 in one structure by which the congestion problem at two nearby locations will be solved. The underpass will cover the two intersections of Al Yarmouk square and Al Quds intersection with a total length of about 600 meters compared with 300 meters for above schemes.

The long underpass will provide high functionality level and all the main directions of traffic will move without interruption in the area of the two intersections. Signals can control the movement of minor directions as well as the pedestrian crossing areas.

Table 22.2.1 Alignment Alternatives of Al Yarmouk Square

Item		Scheme-1	Scheme-2	Scheme-3	Scheme-4
Alignment					
Structure	Total Length (m)	300 (4-Lane)	300 (2-Lane)	600 (4-Lane)	600 (2-Lane)
	Open Section (m)	300	300	600	600
	Tunnel Section (m)	0	0	0	0
Construction Method		Open-cut method	Open-cut method	Open-cut method	Open-cut method
Construction Period (month)		24	15	30	20
Economic Cost (million SP)		139.2	79.1	277.2	158.1
At-grade Intersection Saturation Degree	2005	0.43	0.65	---	---
	2020	0.47	0.72	---	---
Traffic Volume (vehicle/day)	2005	60,472	29,990	47,452	25,932
	2010	69,300	34,560	52,924	29,912
	2020	93,080	47,228	67,240	39,176
Concluding Remarks		- No enough width for the street to provide required number of lanes	- The problem will be solved only for few traffic directions	- This scheme will replace two grade-grade-separation schemes (C14+C15) - Approaches can be accommodated in a wider cross section	- The problem will be solved only for some directions
Grading		2	3	1	4

This scheme will avoid the need for vertical slopes and curves between two nearby structures, as they will be merged in one structure only. In addition, providing one structure for the two intersections will facilitate the north-south movement on the proposed road project (B06) connecting Aal Al Bait with Al Quds streets.

The problem of the narrow road width of Ibn Assaker street, which is difficult to accommodate required entrances of the underpass, will be avoided here as the new entrance location, after extended the underpass, can be easily widened to provide enough space for at-grade traffic. Cost will be the only disadvantage if it is considered as an absolute value, but when considering other advantages and benefits, this scheme will be a good alternative.

Scheme-4:

Only one-way underpass is proposed in this scheme to pass under the two intersections with the total length of about 600 meters. Two lanes will be required to handle the traffic in the same direction as scheme-2 from Al Mojtahed to Ibn Assaker street, which will be the only direction without interruption. Other movements of traffic will be controlled by means of signalization and crossing conflict points should be eliminated through the implementation of control measures such as compulsory right-turn at some locations.

The scheme will partially solve the traffic problem in the area with some improvements in pedestrian crossing. The cost will be significantly reduced but the traffic movement will not be well improved, as many directions will be under signal control on the inner ring road, which is supposed to be an arterial distributor with non-interrupted movement. The function of the north-south arterial through the B06 road project will not be achieved and the necessity to construct it will be uncertain. In such case, the cost will be relatively high when compared with the benefits of passing traffic volumes.

Scheme Selection:

In conclusion, after assessing the prioritization criteria parameters of the different alternatives and comprehensive discussions with the authorities concerned in Damascus, Scheme-3 was selected. It gives the best solution for all traffic movements especially with the improving the road width to accommodate underpass entrance as well as the at-grade movements.

This scheme will avoid the need for vertical slopes and curves between two nearby structures, as they will be merged in one structure only. In addition, providing one structure for the two intersections will facilitate the functionality of the north-south traffic movement on the proposed road project (B06) connecting Aal Al Bait with Al Quds streets.

This scheme, however, has the highest total cost compared with all other alternatives but it provides better traffic conditions in the long-term as it has two exits for the traffic from the central area against only one entrance. It also provides high B/C ratio for the road network and high ratio of unit cost per passing traffic volumes in the underpass.

22.3 Traffic Demand

The traffic saturation was calculated on the inner ring road for two main directions approaching the intersection with the highest traffic volumes. Results presented in Table 22.3.1 for the three years of 1998, 2005 and 2020 show that the saturation degree will exceed the 1.0 level in 2005 which shows the need for a grade separation scheme at that location.

Table 22.3.1 Saturation Degree of Al Yarmouk Square

Approach	Peak Hour Volume (veh/hr)			Saturation Degree		
	1998	2005	2020	1998	2005	2020
Al Mojtahed Street	2,257	2,663	2,934	0.42	0.49	0.54
Ibn Assaker Street	5,011	5,913	6,514	0.46	0.55	0.60
Total				0.88	1.04	1.15

The proposed underpass is expected to improve the traffic conditions in the area including the flow of pedestrian at crossing areas and the natural environment condition by decreasing noise and air pollution. In regard to the estimated saturation degree after implementing the project, Table 22.3.2 presents the values for the two cases of "without project" and "with project". It is clear that the project will significantly improve the traffic condition up to the target year of 2020.

Table 22.3.2 Saturation Degree of Al Yarmouk Underpass

Case	Saturation Degree		
	1998	2005	2020
"Without Project" Case	0.88	1.04	1.15
"With Project" Case	0.37	0.43	0.47

Table 22.3.3 gives a comparison between the daily traffic volumes passed in each of the four schemes for the feasibility-study target year of 2005, in which scheme-3 handles the second highest volumes after scheme-1, as sheme-1 handles more local traffic than scheme-3 in addition to the targeted through traffic. This can be considered as an another advantage for the selected scheme-3, which separates local traffic from through traffic in the area.

Table 22.3.3 Traffic Volumes in Al Yarmouk Underpass - 2005

Scheme	Traffic Volume				
	P. Car	Taxi	M. Bus	Truck	Total
1	21,424	26,712	9,552	2,784	60,472
2	10,600	13,230	4,758	1,402	29,990
3	16,660	21,072	7,520	2,200	47,452
4	9,096	11,516	4,096	1,224	25,932

Figure 22.3.1 presents a plan for the selected scheme-3. As the area is comprehensively connected with the center of the city, a traffic management plan for all streets in the area should be revised with the progress in implementing other project of the master plan in order to get a management plan with optimum benefits.

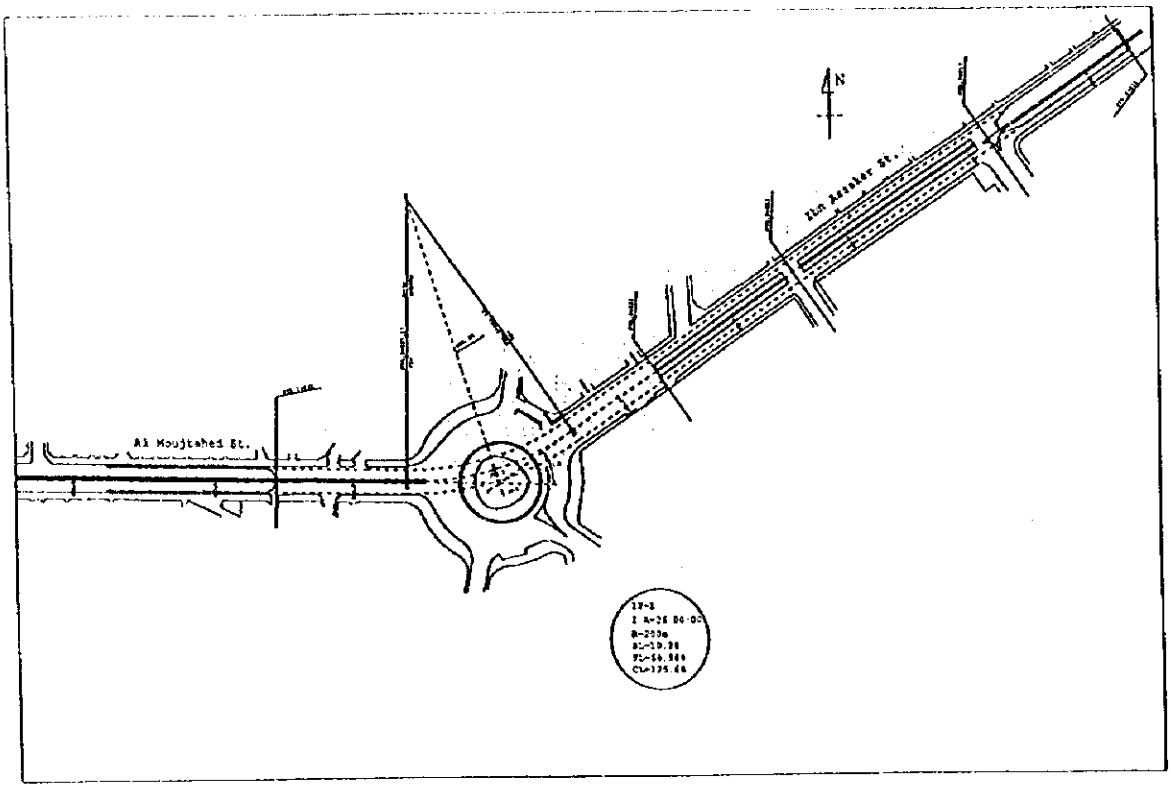


Figure 22.3.1 Plan of Al Yarmouk Underpass

22.4 Preliminary Design

The design criteria applied for this project is the same criteria of Umawyeen square underpass, presented in the previous chapter, regarding the design speed, geometrical elements, design loading and structural design.

The main control point for the underpass alignment, either horizontally or vertically, and for optimizing the structural length and positioning in this project area is the existing road width in order to avoid the need to acquire any extra space to accommodate the at-grade movements beside the underpass entrances.

When the underpass goes to its lowest level to provide the required vertical clearance for inside vehicles, there was the option of covering it to provide more space over it for the at-grade traffic. As this option will considerably increase the construction cost, it was designed to be partially covered to provide only the optimum space required to accommodate the at-grade traffic volumes.

The structural cross sections of the underpass are presented in Figure 22.4.1 for three locations. The first is for the road cross section at the project site, the second is for open section at the entrance of the underpass and the third is showing the partially-covered section.

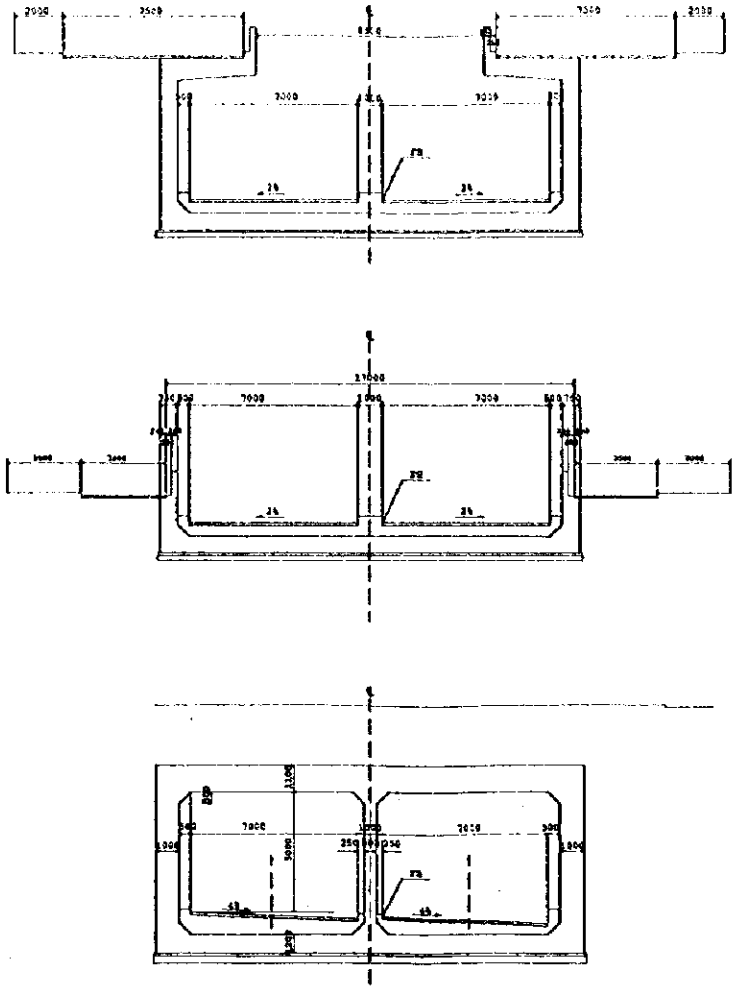


Figure 22.4.1 Al Yarmouk Underpass Typical Cross Sections

22.5 Cost Estimate

Applying the same procedure of estimating the project cost in Chapter 21, costs are estimated here by the use of the concluded unit cost of each work item as presented in Chapter 13. The cost includes the use of sheet piles during the earthwork task. The breakdown of the quantities for the different schemes of the Al Yarmouk underpass project as well as the applied unit cost for each major work item are presented in Table 22.5.1.

Table 22.5.1 Major Work Item Quantities

Work Item	Unit	Unit Cost (SP)	Scheme			
			1	2	3	4
Clearing and Grubbing	SQM	15	6,479	3,681	12,905	7,362
Excavation	CM	140	47,661	27,078	94,943	54,157
Backfill	CM	305	15,471	8,790	30,818	17,579
Reinforced Concrete	CM	5,850	12,855	7,304	25,609	14,607
Plain Concrete	CM	3,125	590	335	1,175	670
Boulder	CM	2,500	1,179	670	2,348	1,340
Asphalt Pavement	CM	1,400	136	77	271	155

The financial costs of the four schemes studied for the project are presented in Table 22.5.2 as which includes, in addition to the construction cost, contingencies (10% of construction cost), profits (20% of construction cost plus contingency), taxes (30% of construction cost plus contingency) and engineering costs. Engineering costs are considered based on the internationally financed projects as 10.7% of the financial costs. The economic cost is derived by excluding the taxes.

Table 22.5.2 Al Yarmouk Underpass Project Cost

Sch-	Construction Cost			Contingency		Tax	Profit	Engin-	Financial Cost ('000 SP)			Economic Cost		
eme	F	L	Total	F	L	L	L	eering	Foreign	Local	Total	Foreign	Local	Total
1	68,760	22,920	91,680	6,876	2,292	30,254	20,170	18,153	84,712	84,712	169,425	84,712	54,458	139,170
2	39,065	13,022	52,087	3,907	1,302	17,189	11,459	10,313	48,129	48,129	96,257	48,129	30,940	79,068
3	136,973	45,658	182,630	13,697	4,566	60,268	40,179	36,161	168,750	168,750	337,501	168,750	108,482	277,233
4	78,131	26,044	104,174	7,813	2,604	34,378	22,918	20,627	96,257	96,257	192,514	96,257	61,880	158,137

22.6 Implementation Schedule

The tentative implementation schedule proposed for the project is consisting in total of the first four years of the plan. Breakdown of the schedule is presented in Table 22.6.1 for the different implementation tasks.

Table 22.6.1 Tentative Implementation Schedule

Task	Year 1		Year 2		Year 3		Year 4	
Fund Allocation								
Consultant Selection								
Detailed Design								
Tendering								
Contractor Selection								
Construction								

22.7 Environmental Considerations

22.7.1 Environmental Impacts

No significant environmental impact is identified while minor impacts are identified especially during the construction such as traffic management, wastes and landscape. Summary of the impacts is shown in Table 22.7.1.

Table 22.7.1 Summary of Environmental Impacts- Al Yarmouk Underpass

Environmental Impacts	Project Stages		
	Pre-Construction	Construction	Operation
1. Traffic Management		○	
2. Waste/Dust		○	
3. Landscape		○	○

Note: ●:significant, ◎: medium, ○: minor

22.7.2 Environmental Considerations and Countermeasures

1) Traffic Management

During construction, the work disturbs traffic flow so that proper traffic management plan is required to provide alternative routes due to serve heavy traffic.

2) Waste Management

Construction waste is caused by excavation. Proper management of transport of the waste and proper disposal site are required. In addition, dust shall be managed during the construction.

3) Landscape

Large scale of structure is constructed so that the design shall be harmonized in the area due to Mosque next to the intersection.

22.8 Conclusion

Taking into consideration the main concept of short and long term planning the road network in the city to provide high level-of-service ring roads with non-interrupted traffic movement to function as arterial distributors, the selected scheme-3 is expected to be the optimum option. This scheme of providing two-way four-lane underpass for the traffic on the inner ring road under both of Al Yarmouk square and the intersection with Al Quds street will provide the most benefits for the traffic conditions in the area. It will solve the at-grade intersecting traffic problem at two locations on the inner ring road through the implementation of one structure.

Other expected benefit is the materialization of the road project plan of (B06) as a new north-south arterial road from the city center to Al Quds street in the south. Pedestrian movement will be safer and the environment will better in the commercial and highly populated area surrounding the square.

This scheme, however, has the highest cost in absolute value when compared with all other alternatives. It has the second highest passing traffic volume after scheme-1, which will attract and handle a portion of the at-grade volumes of local traffic. In this regard, the selected sheme-3 will provide better traffic conditions by separating the flow of through traffic from that of the local traffic in the area.

Chapter 23. ATH THAWRA-AL HEJAZ TRAFFIC IMPROVEMENT PROJECT

23.1 Objectives of the Project

The road network in the city of Damascus is planned on the basis of two main arterials of north-south and east-west. This project deals with the development of a high functionality link (tunnel) to connect the existing two strong arterials; the northern arterial from the city center to the north (Ath Thawra street), and the southern entrance of the city (New Deraa Highway).

The existing streets connecting the two arterials are the most congested streets at present in the central area of the city with socioeconomic activities. Through comprehensive volume-capacity analysis for the intersections in the area, it was found to be impossible to handle future traffic demand in the area by only means of traffic management and improvement of signalization system. It is also difficult to widen the streets in the area to increase their assumed capacity. It is also difficult to decrease the concentration of traffic volumes in the area by means of diverging traffic.

Without a strong connection between the two existing arterials, the central areas of the city will continue to suffer from traffic congestion. Such connecting north-south arterial link will function as an inner-city bypass for through traffic to discourage access to the city center and provide easy access to outside areas. The project will insure the pedestrian movement on the ground level and separate the through traffic from the local movement.

The main objectives of implementing this project can be summarized as follows:

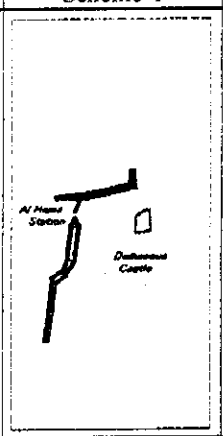
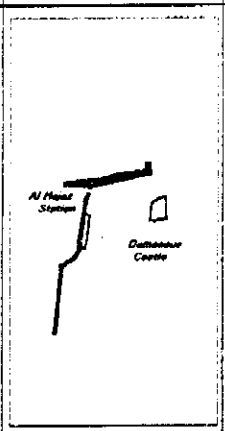
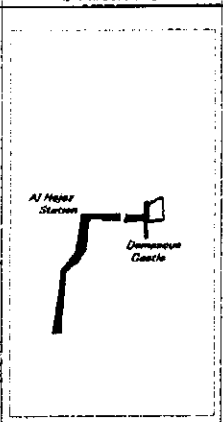
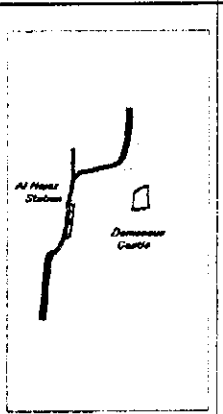
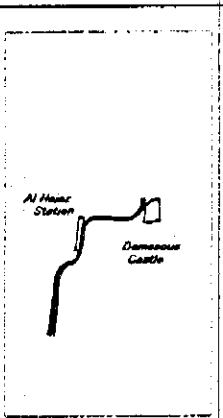
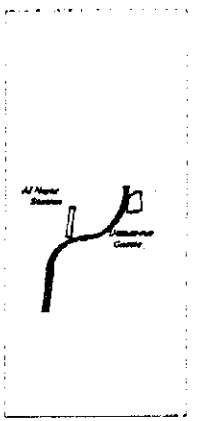
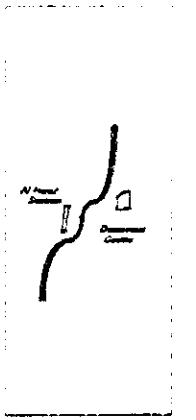
1. To alleviate traffic congestion in the central areas of the city
2. To provide non-interrupted flow on arterial distributors
3. To reorganize the signalization system in the area for optimum use
4. To decrease delay, travel time and vehicle operating cost
5. To improve safety and environmental conditions

23.2 Alternatives and Preliminary Selection

For this project, seven schemes were studied as alternatives with different planning concepts and construction methods in order to get the optimum alternative to be subject to a feasibility study. All the schemes have the same target of connecting Ath Thawra street with the south entrance through a grade-separated structure with two lanes for each direction of traffic.

Table 22.3.1 presents a summary for all the alternatives under consideration with the parameters of the selection criteria as well as the prioritization results, while the following sections present a summarized description for each of the proposed seven alternatives.

Table 23.2.1 Alignment Alternatives of Ath Thawra – Al Hejaz Tunnel

Item		Scheme-1	Scheme-2	Scheme-3	Scheme-4	Scheme-5	Scheme-6	Scheme-7
Alignment								
Structure	Total Length – m	1,160	1,160	1,560	2,120	1,460	1,420	1,860
	Open Section – m	460	460	760	940	720	710	720
	Tunnel Section – m	700	700	800	1,180	740	710	1,140
	Bridge Section – m	760	760	---	---	---	---	---
	Ramp Section (m)	80	80	---	110	---	---	---
Ground Level		Clear	Clear	Buildings (40–50 m)	Clear	Buildings (40–50 m)	Buildings (480 m)	Buildings (400 m)
Construction Method		- Open-cut method is possible	- Open-cut method is possible	- Open-cut method is possible, with low standard level in geometric design	- Open-cut method is possible	- Open-cut method is possible, with some difficulties at the corners	- Shield Method is required for 480 m	- Shield Method is required for 400 m
Construction Period (month)		36	24	26	36	25	24	32
Economic Cost (million SP)		1,639.4	1,366.2	752.9	1,024.7	704.4	1,259.9	1,373.8
Environment		---	---	- Near antique sites at the castle and Old City	---	- Near antique sites at the castle and Old City	- Near antique sites at the castle and Old City	---
Concluding Remarks		- High cost due to long- bridge construction	- High cost due to long- bridge construction	- High possibility of discovering antiques during construction	---	- High possibility of discovering antiques during construction	- High possibility of discovering antiques during construction	---
Grading		X	X	△	○	△	X	X

Scheme-1:

This scheme is composed of two separate structures of a viaduct and tunnel. It is based on the concept of extending Victoria bridge and turning it into Ath Thawra street and connecting it through a ramp, for only traffic from south to north, with a tunnel to the south entrance. The tunnel starts at Al Jaberee street in front of Al Hejaz railway station and goes south under both of its sides and Al Fahama square to be connected with the depressed section of New Deraa highway.

This scheme will facilitate the smooth movement of traffic from south to north and from north to west, in addition to the south / center traffic flow. Improvement in traffic conditions will be noticed on many streets and intersections in the city center providing a higher safety level for pedestrian movement and better environmental conditions. In addition, less traffic will use streets in front of the Old City and its castle.

As the two segments composing the scheme, which are the viaduct and tunnel, are not directly connected, that will cause traffic interference between through and local movements and encourage the access of inbound traffic to the city center. Therefore, from the traffic point of view, this plan will not provide the required comprehensive solution to alleviate traffic conditions in the area. In addition, the scheme requires the partial or total demolition of the two existing overpasses of Ath Thawra and Victoria, and the construction of one long viaduct which will have high cost. Pedestrianization of the area in front of the Old City will not be possible and the construction activities will occupy wide areas for long periods.

Scheme-2:

This scheme is a modification of the first scheme in order to solve some of its problems. It is also composed of the two structures of a viaduct and a tunnel. The tunnel section is only for one-way traffic from the city center to the south in order to prevent the easy access to the city center. The north-west viaduct will get one additional exit ramp for traffic coming from north to south through the tunnel.

Most of the advantages of scheme-1 are also valid for this scheme as well as most of the disadvantages, interference between local and through traffic due to the discontinuity between the two structures. Through traffic will not get direct facility connected between north and south of the city. Construction activities of this scheme will include also the partial or total demolition of the two existing overpasses of Ath Thawra and Victoria, and the construction of one long viaduct which will have high cost.

Scheme-3:

Two separate structures are proposed here in order to connect the north-south arterial of the city. The first underpass, which connects Ath Thawra street with An Nasr street, with an extra entrance ramp from Saad Zaghloul street to the north, allows to realize the pedestrianization plan of the area in front of the Old City. The second tunnel goes from An Nasr street to the two sides of Al Hejaz railway station, to separately handle the two directions of traffic, and to be connected with the south entrance of the city. The side street of the railway station will be operated on two levels due to their limited width which can not accommodate an open tunnel.

The scheme will provide direct access between north and south with limited access to the central area. It will also utilize the planned project of connecting Saad Zaghloul street with Al Quds street to create new arterial in the area. Pedestrianization of the square will assist in

developing the area and promote different activities including tourism and commerce. This scheme can be implemented through open-cut method of construction which requires moderate costs.

Disadvantages of the scheme are mainly the possibility to go through antiques area in front of the castle, and the difficulty to provide acceptable radius for horizontal curves. As the applied standards for the geometric design is based on a design speed of 60 km/hr for grade-separation structures in the city, the 125-150 m radius can not be provided without acquiring lands and buildings at the corners of streets which will sharply increase the project cost.

Scheme-4:

The proposed plan here has the concept of providing only one structure to connect Ath Thawra street with the depressed south entrance through a long tunnel under Al Ittihad street. An extra entrance is provided for the outbound traffic from Yousef Al Azmeh square to the south. The alignment will avoid the antique area in front of the Old City and it goes under existing streets to allow the utilization of the open-cut method for construction. The tunnel will have two parallel cells on the same level for the two directions of traffic with two lanes each. Under the narrow street beside Al Hejaz railway station, the two cells will go on two levels as the available street width can not accommodate the total tunnel width of two directions. At the south end it will connected with the two depressed sides of the south entrance of new Deraa highway.

Scheme-5:

The same concept of scheme-4 is applied here to provide a tunnel connecting north with south arterials and applying the open-cut method for construction. The difference here is the high possibility of providing an at-grade pedestrian square in front of the Old City as the tunnel will pass under An Nasr street to handle all the vehicular traffic movements in the area. Other advantage is the shorter length and lower cost of the required tunnel. The problem of the interfering with high possibility antiquities areas is the main obstacle for this scheme as all other technical problems can be solved. Such problems include the provision of minimum required radius of horizontal curves, crossings with Barada river and its branches and starting the tunnel entrance in a short distance just after the ramps of Ath Thawra overpass. The scheme is widely accepted by local authorities, however, the antiquities issue will be the most important point to be solved.

Scheme-6:

This scheme depends on a different construction method, which is the shield method, to construct a tunnel connecting the north and south arterials. This method has the advantage of constructing the tunnel under buildings with flexible alignment on depths, which can not be achieved through the traditional open-cut method. Two parallel tunnels, with two lanes each, will handle the two directions of traffic between north and south. The method has another advantage of trouble-free construction period, as almost all of the construction activities will be carried out without any interference with the at-grade traffic.

The tunnel will function here as an inner-city bypass for through traffic between the two arterials without access for local traffic. The scheme will allow to implement the pedestrianization plans of some streets and will significantly improve both vehicular and pedestrian traffic as well as the environmental conditions.

To shorten the total length of the tunnel, the northern entrance of the tunnel is located near the Old City and its castle which may face the problem of interfering with antiquities areas. In addition, the cost of introducing the new technology of the shield construction method to the country will result in high construction cost for the project. Details of existing underground facilities and piping systems in the area are required to safely utilize this method.

Scheme-7:

To avoid the high-possibility of interfering with antiquities areas, the entrance of the tunnel proposed in scheme-6 is relocated here more to the north with some shifting in the alignment to pass as much as possible far from any protected areas. The same other advantages of scheme-6 are applied here with more limited access for local traffic.

This alternative will increase the tunnel length with about 440 meters, and consequently the construction cost of the project. Technical difficulties will be encountered during construction as the shield construction technology will be utilized for the first time in the road sector.

Scheme Selection:

Two types of schemes were excluded in this selection procedure. The first type includes the two schemes 1 and 2 which require the demolition of existing overpasses and to reconstruct new viaducts in the same area as these schemes will require high costs to implement in addition to the demolition of operated structures will not get high acceptance. The second type includes the two schemes 6 and 7 which require the utilization of the shield-method in construction. Equipment for this method are not yet available in the country and they should be designed and imported for this particular project which will result in high construction costs.

Sheme-3 was also excluded due to technical problems in which providing the geometric standards required for safe design was not possible. The maximum available radius at two horizontal curves was still far below the applied standards presented in the design criteria. In addition, this scheme has only local dimension and vision as it will improve the access to the city center which is not the target of planning this structure.

The remaining two schemes 4 and 5 were subject to comprehensive studies, evaluation and discussions with related authorities. The critical issue was the high possibility of digging the tunnel in an area with undiscovered antiques in front of the castle of Damascus. In this regard, scheme-4 is considered more realistic as its alignment avoids the area in front of the castle and it passes through Al Ittihad street, while scheme-5 is based on starting the tunnel in front of the castle to An Naser street.

Scheme-4 has more conservative alignment and its extra entrance, near Yousef al Azmeh square, will attract more outbound traffic from the city center. On the other hand, it is longer and more expensive than scheme-5, which may have other advantages of utilizing the space between its top part and the road level as a parking area for the heavily congested central area. It may help also in realizing the plan of pedestrianization area in front of the Old City and the citadel. The plan of the two selected schemes is presented in Figure 23.2.12.

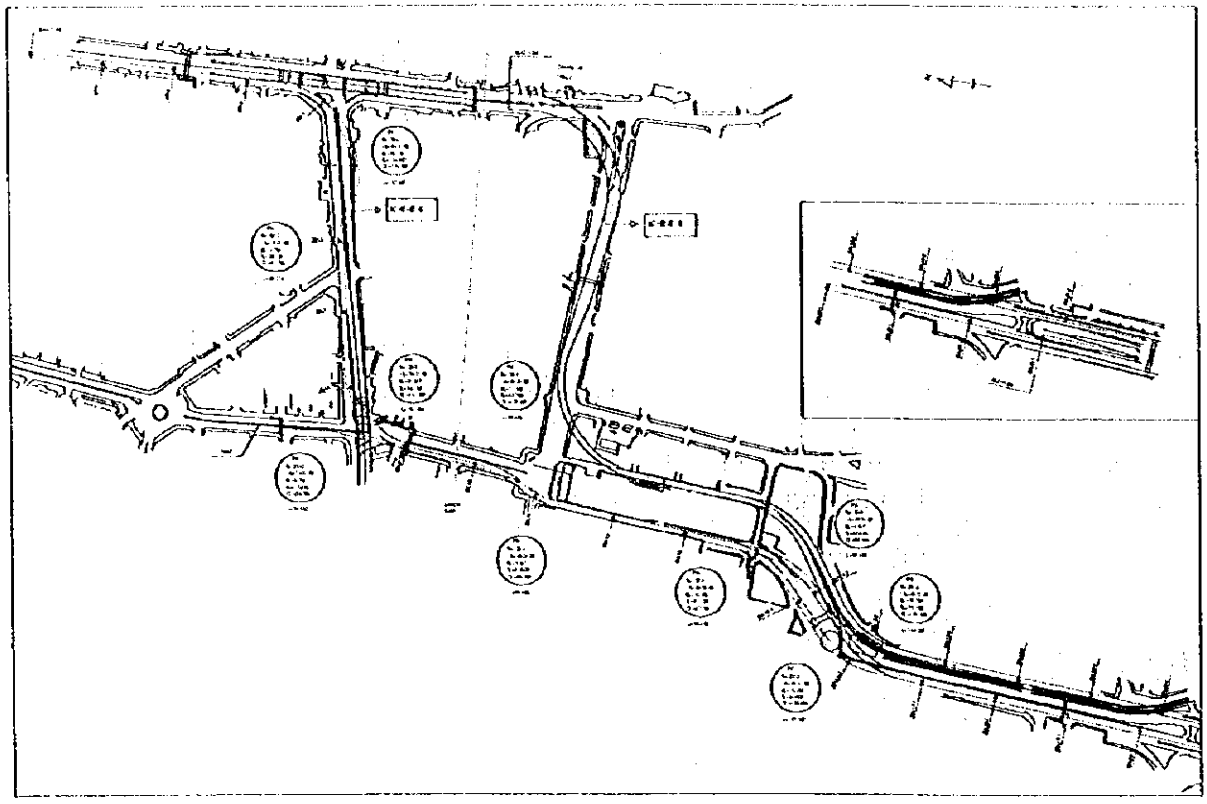


Figure 23.2.1 Plan of Ath Thawra – Al Hejaz Tunnel

23.3 Traffic Demand

Based on the data collected during the traffic surveys at intersections in the city, the present situation of the Ath Thawra – An Nasr at-grade intersection in front of the Old City is very critical. The saturation degree during peak hours is higher than the limit of 1.0 as presented in Table 23.3.1. The table presents the two cases of "without improvement" and "with improvement" for present and future years. The directions of Ath Thawra street to the north have the highest share of traffic saturation level followed by An Nasr approaches. The third approach is functioning as one-way for outbound traffic to the south with the lowest saturation degree.

Table 23.3.1 Ath Thawra – An Nasr Intersection Saturation Degree

Approach	Peak Hour Volume			Saturation Degree		
	1998	2005	2020	1998	2005	2020
Ath Thawra street – north	4,102	4,840	5,333	1.12	1.32	1.45
Ath Thawra street – south	862	1,021	1,125	0.20	0.24	0.26
An Nasr street	2,029	2,394	2,638	0.47	0.55	0.61
Total (without improvement)				1.59	1.87	2.06
Total (tunnel improvement)				0.69	0.82	0.90

The proposed tunnel, which will handle all the at-grade traffic in the intersection, has reasonable values of saturation for the feasibility study target year of 2005 and also the plan year of 2020. This solution allows to utilize the at-grade space as a pedestrian exclusive area for tourism and commercial development. Table 23.3.2 presents the traffic volumes in the tunnel with scheme-4 handling higher traffic volumes due to the southbound traffic access

from the city center through the additional entrance ramp.

For analysis and comparison purposes, the table presents also the traffic volumes estimated for scheme-4 without the additional entrance ramp at the city center. The results are almost similar to volumes in scheme-5.

Table 23.3.2 Traffic Volumes in Ath Thawra – Al Hejaz Tunnel

Scheme	Year	Daily Traffic Volume			
		Pass. Car	Taxi	Micro Bus	Truck
4	1998	24,214	31,052	9,751	4,674
	2005	27,268	34,044	10,814	5,009
	2010	31,818	37,570	12,155	5,369
	2020	46,008	39,311	13,293	5,313
5	1998	16,821	21,015	6,991	3,713
	2005	19,896	24,635	8,197	4,186
	2010	24,002	28,129	9,491	4,603
	2020	35,598	30,006	10,805	4,745
4	1998	16,813	21,005	6,987	3,712
(without additional ramp)	2005	19,437	23,954	8,002	4,124
	2010	23,913	28,026	9,453	4,592
	2020	36,099	30,241	10,896	4,647

23.4 Preliminary Design

The design criteria applied for the geometric and structural design of the different elements of this project is the same criteria applied in Umawiyeen square underpass, presented in a previous chapter which include such parameters of the design speed, geometrical elements, design loading and structural design.

The main control point for the tunnel alignment, either horizontally or vertically, and for optimizing the structural length and positioning in this project area is the existing characteristics of the road network and roadside in the project area. The basic and important concept is to preserve the area from any negative impact due to the construction of underground structures which may affect the nature and environment of the city center.

1) Alignment

The horizontal alignment of the tunnel structure was basically put under the center of the carriageway of the road. In order to meet the standard criteria of curved sections, the maximum available radius was used even with shifting the alignment near the corners of buildings. This practice was done also to avoid some antique and historical areas.

For scheme-4, location of the tunnel entrance at Ath Thawra street is planned to be as extension of the underpass under Baghdad street. As there is a historical school at the corner with Al Ittihad street, a wide curve is planned to avoid the school area and to provide a radius of 125 meters. The following curve of the tunnel going to Al Jaberee street will interfere with the foundation of Victoria overpass which should be strengthen and modified to allow smooth alignment for the tunnel.

An entrance ramp from Yousef Al Azmeh square will join the tunnel after this curve to handle southbound traffic from the city center. At any side of the railway station, the two cells of the tunnel will take a vertical positioning due to the limited width of the street. Next the tunnel will goes with parallel cells again under Al Fahama square to be connected with the depressed south entrance road of the city.

Scheme-5 has a different alignment for its northern part up to Al Hejaz station. The northern entrance is located at the end of Ath Thawra overpass ramps. The tunnel turns to An Nasr street with a curvature of 125 m and goes under it to turn again to the south beside the railway station. Following sections have the same conceptual alignment of scheme-4. The section of the tunnel under An Nasr street can be utilized as the floor of an underground parking which is strongly required in this center area.

Alignment of any of the two schemes will interfere at some points with existing utilities or small structures such as piping systems, sewage facilities, pedestrian underpasses and others which should be modified and reconstructed based on the requirements of the tunnel construction plan. The crossing points with Barada river and its branches are considered in the vertical alignment of the tunnel to avoid direct interference or shifting of the river. The alignment of the two schemes is shown on the plan presented in Figure 23.2.1.

2) Tunnel Cross Section

The components of the civil structure tunnel are basically retaining walls at the entrances and exits and two-cell box-type tunnel. With the adopted open-cut method for construction during any of the two selected schemes, the arrangements of the tunnel cross section will depend on the available at-grade width as the tunnel will be extended under different streets with different widths. With the adopted two cell type for the tunnel, the two cells will be placed horizontally on one level under wide streets, while under narrow streets, they will be placed vertically in two levels. Such alignment will be used under Jana street beside Al Hejaz station as its width is about 10.0 meters.

The structural cross sections of the tunnel are presented in Figure 23.4.1 at two typical locations. The first is for the case of going under wide streets which can accommodate the whole width of the two traffic directions in four lanes as well as additional construction areas required to apply the open-cut method. And the second is at the narrow Jana street beside Al Hejaz railway station under which the two directions will go on two vertical levels to only utilize the available street width.

3) Facility Systems:

With the long length of the tunnel, different facility systems and utilities are required to be incorporated in its structural design. Such facility systems will provide high efficiency for the functionality of the tunnel in addition to coping with other safety and environmental requirements. The design of structural facility systems of the tunnel included the following items:

- Ventilation System
- Drainage System
- Lighting System
- Emergency System
- Water Supply System
- Electricity System
- Sign Plates

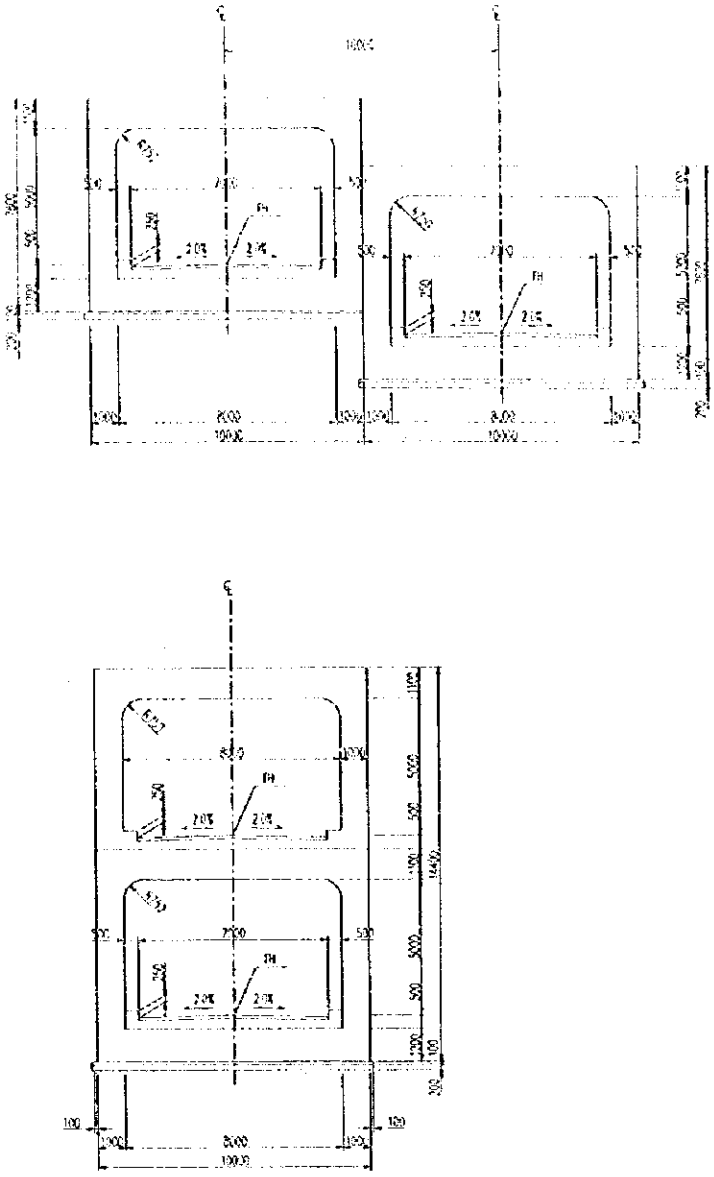


Figure 23.4.1 Cross Section of Ath Thawra – Al Hejaz Tunnel

23.5 Cost Estimate

The construction cost of the different schemes is estimated based on the preliminary design of the different structural elements and applied construction methods. Quantities are estimated in accordance with the items shown in the detailed drawings of each scheme. The unit cost of each item is determined as for the price level prevalent in Damascus in November 1998. As most of the schemes will require new technologies which are not yet available in the country and should be imported, costs of some of the items are determined based on foreign price levels.

Table 23.5.1 presents the estimated quantities for major work items based on the preliminary design of the tunnel, while Table 23.5.2 gives both the economic and financial cost for the civil works of the seven alternatives. The two selected schemes will require right-of-way acquisition and additional building-support costs to secure the required radius of curves at street corners.

Table 23.5.1 Major Work Item Quantities

Work Item	Unit	Unit Cost (SP)	Scheme						
			1	2	3	4	5	6	7
Clearing and Grubbing	SQM	15	76,320	63,600	35,051	47,700	32,789	58,653	63,953
Excavation	CM	140	561,456	467,880	257,854	350,910	241,218	431,489	470,479
Backfill	CM	305	182,246	151,872	83,698	113,904	78,298	140,060	152,716
Reinforced Concrete	CM	5,850	151,438	126,198	69,549	94,649	65,062	116,383	126,899
Plain Concrete	CM	3,125	6,948	5,790	3,191	4,343	2,985	5,340	5,822
Boulder	CM	2,500	13,889	11,574	6,379	8,681	5,967	10,674	11,638
Asphalt Pavement	CM	1,400	1,606	1,338	737	1,004	690	1,234	1,345

Table 23.5.2 Ath Thawra – Al Hejaz Tunnel Project Cost

('000 SP)

Sch-eme	Construction Cost			Contingency		Tax	Profit	Engin-Eering	Financial Cost			Economic Cost		
	F	L	Total	F	L	L	L		Foreign	Local	Total	Foreign	Local	Total
1	810,000	270,000	1,080,000	81,000	27,000	356,400	237,600	213,840	997,920	997,920	1,995,840	997,920	641,520	1,639,440
2	675,000	225,000	900,000	67,500	22,500	297,000	198,000	178,200	831,600	831,600	1,663,200	831,600	534,600	1,366,200
3	372,000	124,000	496,000	37,200	12,400	163,680	109,120	98,208	458,304	458,304	916,608	458,304	294,624	752,928
4	506,250	168,750	675,000	50,625	16,875	222,750	148,500	133,650	623,700	623,700	1,247,400	623,700	400,950	1,024,650
5	348,000	116,000	464,000	34,800	11,600	153,120	102,080	91,872	428,736	428,736	857,472	428,736	275,616	704,352
6	622,500	207,500	830,000	62,250	20,750	273,900	182,600	164,340	766,920	766,920	1,533,840	766,920	493,020	1,259,940
7	678,750	226,250	905,000	67,875	22,625	298,650	199,100	179,190	836,220	836,220	1,672,440	836,220	537,570	1,373,790

The cost of the required facility systems for the operation of the tunnel is estimated as shown in Table 23.5.3 based on the assumption that most of the facility systems will be composed of imported components.

Table 23.5.3 Tunnel Facility Cost

('000 SP)

Facility	Scheme-4	Scheme-5
Ventilation System	12,900	8,600
Drainage System	2,160	1,080
Lighting System	520	260
Emergency System	4,000	2,000
Water Supply System	5,840	2,920
Electricity System	4,000	2,500
Sign Plates	640	400

23.6 Implementation Schedule

The tentative implementation schedule proposed for the project is consisting in total of five years of the plan. Work in this project is scheduled to start after implementing the two underpass projects of Umawiyeen and Al Yarmouk due to fund arrangement requirements. The experience gained in the two underpass projects will help in implementing this project in more a time-efficient procedure. However, the detailed design stage is expected to require about 18 months due to the field investigations especially antique-related activities. Breakdown of the schedule is presented in Table 23.6.1 for the different implementation tasks.

Table 23.6.1 Tentative Implementation Schedule

Task	Year 1	Year 2	Year 3	Year 4	Year 5
Fund Allocation					
Consultant Selection					
Detailed Design					
Tendering					
Contractor Selection					
Construction					

23.7 Environmental Considerations

23.7.1 Environmental Impacts

From the environmental point of view, issues about Barada river and antiques are important. For the river, it is technically possible to avoid direct interference or shifting the river. However, the antiquities issue should be carefully treated.

Other environmental impacts such as traffic management, waste/dust and landscape are not significant. Summary of the impacts is shown in Table 23.7.1.

Table 23.7.1 Summary of Environmental Impacts- Ath Thawra–Al Hejaz Tunnel

Environmental Impacts	Project Stages		
	Pre-Construction	Construction	Operation
1. River			
2. Antiquities		◎	
3. Traffic Management		○	
4. Waste/Dust		○	
5. Landscape		○	○

Note: ●:significant, ◎: medium, ○: minor

23.7.2 Environmental Considerations and Countermeasures

1) River

The vertical alignment of the tunnel is designed to avoid direct interference or shifting of the river.

2) Antiquities

As the alignment of scheme-5 passes just in front of Damascus castle, interfere with buried antiquities is a high possibility. With the historical background of the city, even scheme-4 may interfere with other antiquities areas in the city center. To avoid breaking off of construction work halfway, related agencies and academic circles should discuss and reach a consensus on how to treat the issue when antiquities are discovered.

3) Traffic Management

During the construction, the work disturbs traffic flow so that proper traffic management plan is required such as alternative routes. This route is heavily congested at present. Proper traffic

management is strongly recommended.

4) Waste Management

Construction waste is caused by excavation. Proper management of transport of the waste and proper disposal site are required. In addition, dust shall be managed during the construction.

5) Landscape

This is a large scale structure to be constructed adjacent to the historical area of Damascus so that the design shall be harmonized in the area. In addition, there is a median with trees on the road where open cut construction method will be applied. Those trees shall be removed during the construction and reverted to the original place.

23.8 Conclusion

The two selected schemes 4 and 5 have almost the same basic concept and objectives with different alignments. Scheme-4 has a longer length and higher construction cost but it will avoid the area in front of the Old City and its castle where the likelihood of uncovering antiquities is very high, and will attract more traffic from the city center to the south through its extra entrance. With the historical background of the city, however, it may interfere with other antiquities areas in the city center.

Scheme-5 has a shorter length and less construction cost. It can facilitate the two plans of pedestrianization of the square as well as an underground parking facility under An Nasr street. On the other hand, it will start with a curve in front of the Old City where antiquities are highly likely to be buried and will require land acquisition to ensure an acceptable curve radius.

The issue of the areas with high possibility of interfering with antiquities, as well as the project cost and its economic viability will give the final decision in selecting one scheme for implementation as there are big similarities in other technical and practical issues.

Chapter 24. 8TH OF MARCH (ARNOUS) SQUARE UNDERGROUND PARKING

24.1 Objectives of the Project

Five (5) parking facility projects are proposed in the master plan study. In discussions with Damascus Governorate, it was decided that Arnous square is a candidate site to be given first priority for construction of the underground parking facility. Consequently the feasibility study will be implemented for the Arnous Square underground parking facility project.

The feasibility study for this project has two purposes. Firstly, the Arnous parking facility is the first project selected from among the 5 parking areas as a model case study to consider the most practical way of realization of the project. Secondly, improvement of traffic congestion should be done in conjunction with parking control for prohibition of on-street parking near the parking facility.

The parking facility will have two functions; it shall serve as a public infrastructure to relieve traffic congestion and shall be a commercial business venture generating revenue from the collection of user fees. Several methods may be considered for implementing this project, three of which are as follows. One method would be for Damascus Governorate to construct and operate the parking facility by its own finance in the same way as other infrastructure projects. A second method would be for the Governorate to construct the facility and turn its operation over to the private sector under a definite agreement as the example of the Cham Palace parking area. The third method would be for the private sector to construct and operate the facility by its own finance and hand it over to the Damascus Governorate after an agreed upon utilization period. In this case of "Build, Operate and Transfer (BOT)" system, the Governorate shall provide the land for the project.

At the candidate site (simultaneously referred to as Arnous Square and 8 March Square), there is an existing plan to construct a new building. Therefore, this study will be made for two cases, case 1 will be only an underground parking facility without the building project and case 2 will be the underground parking facility with the building project for Arnous Square. While case 1 may be applied as a model project for adoption in other sites, case 2 will reflect specific conditions of the Arnous Square where a building is already planned. The construction costs for each case have been estimated as 308.9 million SP for case 1 and 525.4 million SP for case 2.

In case 1 that is less expensive, the investment amount is nearly 50% of the total investment budget allocated to road projects in 1997 (total road projects investment is 644 million SP). Should the 1997 budget serve as a guideline it is considered difficult for the Governorate to budget this project. In this sense, possibility of financing from the private sector is studied. This will require verification of the project profitability through financial analysis. It is already identified that case 2 is not profitable from the viewpoint of business in private sector. So that case 1 is mainly discussed in this Chapter.

The construction of a parking facility will play a role in relieving traffic congestion in the surrounding area by minimizing on-street parking and increasing road capacities. Therefore, in order to realize this objective and also to ensure the parking demand for the facility, a condition for the project's success will be to strengthen on-street parking prohibition in the area.

24.2 Parking Demand

Arnous Square, where the proposed underground parking facility shall be constructed is located at the intersection of Ibn Abdul Aziz street, Jamal Abdel Nasser street, Al Malek street, Pakistan street and Al Hamra street (refer to Figure 24.3.1).

The area surrounding the square (within a distance of 250 ~ 300m) is largely divided into two zones in terms of land use. The zone covering the northern part of Ibn Abdul Aziz and Pakistan streets is characterized by mixed business and residential activities, while the second zone covering the southern part of these two streets has commercial and business activities.

In the northern part, there are several public facilities such as a hospital (there are some 50~60 car parking lots at the hospital site, but these are not enough), school, church, the Ministry of Finance (newly established 16 stories building for some 5000 staff without parking area), a commercial and business center (newly established 16 stories building without parking area), the Ministry of Environment and many shopping stores along Jamal Abdel Nasser street. In the southern part, there are many shopping stores along Al Hamra pedestrian mall and Pakistan Street. It is assumed that the purpose for car parking in this area is mostly for shopping, commercial and business trips.

Presently in the surrounding area on-street parking is prohibited on both sides of Ibn Abdul Aziz, Al Malek and Jamal Abdel Nasser streets and on one side of Al Hamra street. Sathiyeh street and some other streets are for pedestrian traffic only.

(1) Demand forecast in the master plan

According to the OD survey in zone No.17 for the master plan study, there are deficits in parking lots in the demand and supply estimated at 1,359 (total peak hour parking demand minus road parking capacity for two lane street) in 1998, 1,653 in 2005 and 3,197 in 2020. The Arnous Square parking facility is proposed to have a capacity of 500 car parking lots.

(2) Sample Survey near Arnous Square

In order to estimate the parking demand, a survey of on-street parking conditions in the surrounding area was carried out on 7th and 8th December 1998. The survey result shows that the peak parking demand periods are from 10:30 to 14:30 (4 hours) and from 17:00 to 21:00 (4 hours). In this area, more than 1,000 cars on average parked on-street are from outside the area. At 6:00 AM (starting time of the survey), some 800 cars were already parked on-street in the area. Thus there are some 1,800 cars parked on-street at the peak hours of 18:00 to 20:00 and more than 1,000 cars on average are parked on-street during 9:00 to 22:00.

(3) Parking conditions at the existing Arnous parking area

According to the survey for car parking at the existing parking area, the result shows two peak periods a day, 10:00~13:00 in the daytime and 17:00~20:00 in the evening. The highest peak hour is 17:00 to 18:00 a day (refer to Figure 24.8.1).

Occupation ratio of parking ranged between 12% and more than 100% at the peak hour.

According to the sample survey for on-street parking near Arnous Square, the number of potential users of the proposed parking facility is more than 1,000. In addition construction of some new buildings are being implemented or under planing near Arnous Square. Therefore the number of potential users is expected to increase by 650, as demand is generated by the

new office under construction for some 5,000 staff of the Ministry of Finance and the new 16 stories commercial and business center building (refer to Table 24.2.1)

Table 24.2.1 Forecast additional parking demand near Arnous Square

Parking demand generating site (street)		Demand generators	Estimated parking demand
1.	Ministry of Finance, Dept. of Damascus (16F)	New office for 5,000 staff to start operation at the beginning of November 1998. But no parking facility	Approx. 200
2.	Commercial and Business Center Bldg (16F)	This building is under construction and scheduled to be completed within one year	Approx. 150
3.	Italian Hospital	Hospital has parking area for 50~60 cars, but more parking lots are required	Approx. 25
4.	Hamra street	Commercial street (6 lanes)	Approx. 100
5.	Medium size business bldg. (5F)	Some clinics, Small shops	Approx. 25
6.	Medium size shopping bldg. (5F)	Building materials, foodstuffs shops	Approx. 25
7.	Min. of Environment	No parking area for officials and visitors	Approx. 25
8.	Behind the existing parking area	Visitors for shopping	Approx. 25
9.	Salhiych St. (pedestrian and commercial st.)	Visitors for shopping	Approx. 50
10	Loutfi Al Hafez St. (commercial street)	Visitors for shopping	Approx. 25
11	Commercial building at Arnous Square	Visitors and office managers	(Estimated)
	Total		Approx. 650

Note 1) The study team's assumption
2) In Case 2 the building will generate additional parking demand.

24.3 Alternatives and Preliminary Selection

In case that the parking is prepared in front of Arnus Square, a study for future traffic flow should be required because there is a possibility that traffic congestion will occur in and around the Square. Consequently the influence on the future traffic demand of Arnus Square, and the influence of parking demand on the surrounding area was studied below.

24.3.1 Traffic Demand and Intersection Improvement in the Facility Vicinity

The traffic volume and the saturation degree in Arnus Square in 1998, 2005 and 2020 is shown in and the location of the access streets is shown in.

Table 24.3.1 Saturation Degree to the Traffic Demand

Approach No.	Approach Name	Peak Hour Volume(v/h)			Saturation Degree		
		1998	2005	2020	1998	2005	2020
①	Jamal Abdun Nasser St.	1,710	2,018	2,223	0.28	0.33	0.36
②	Al Melak Ala'adel St.	one way leg			—	—	—
③	Pakistan St.	one way leg			—	—	—
④	Al hurrieh St.	764	902	993	0.18	0.21	0.23
⑤	Amin Lutfi Al Hafez St.	446	508	580	0.15	0.18	0.20
⑥	Oman Bin Abdul Aziz St.	2,885	3,404	3,751	0.50	0.59	0.65
⑦	Amin Lutfi Al Hafez St.	one way leg			—	—	—
					0.96	1.13	1.24

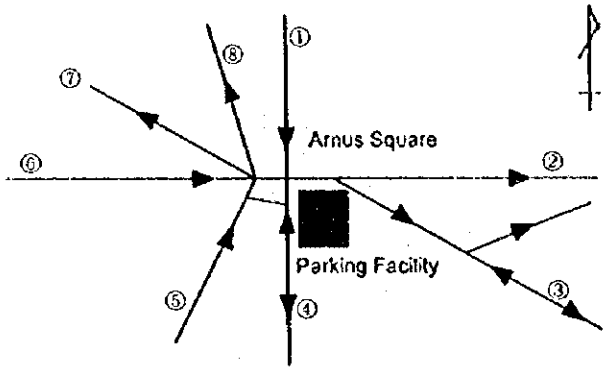


Figure 24.3.1 Arnus Square and Access Roads

From the estimate of saturation degree, Arnus Square has almost reached complete saturation in traffic and intersection improvement is necessary. In view of difficulty in widening the crossing streets and adjacent streets, the following alternatives for improvement are considered;

Case-1 : The parameters of traffic signal, road marking etc. will be improved. The flow of pedestrians will be regulated (3.5 m x 3 lanes).

Case-2 : In addition to Case-1, the lane width of Approach-6 will be changed to 2.75m - 3.00m and 4 lanes will be secured.

Case-3 : In addition to Case-2, one way regulation of Approach-5 (Amin Lutfi Al Hafez St.) will be changed to the in-coming direction to the Square.

The improvement plan for Case-2 is shown in Figure 15.2.3, Chapter 15 and Figure 24.4.1. As shown in Table 24.3.2 on the respective saturation degree, Case-3 was most advantageous for the traffic flow.

Table 24.3.2 Saturation Degree after Improvement

Case	Improvement	Saturation Degree		
		1998	2005	2020
Present Pattern	—	0.96	1.13	1.24
Case-1	Signal & Marking for Pedestrian	0.88	1.04	1.14
Case-2	(Case-1) + Channerization	0.77	0.90	1.00
Case-3	(Case-2) + Approach reguration	0.61	0.07	0.80

However because the change of one way direction of Amin Lutfi Al Hafez St. might be unfavorable in wider view point of urban planning and because the saturation degree will be below 0.90 until 2005 in Case-2, it is recommendable that Case-2 should be adopted until 2005 and after that change of one way regulation of Amin Lutfi Al Hafez St. or grade separation should be decided. The improvement plan of Arnus and the grade separation plan of this Square is described in Chapter 13 as Project C10.

24.3.2 Influence of parking demand on the surrounding roads

The relation of the parking, the intersection and the crossing / vicinity roads is indicated in Figure 24.3.2. The entrance of the parking is marked as "A". According to the survey by the JICA Study Team on December in 1998, the peak of entering to the parking was between 16:00 - 19:00 and the percentage of the entering route taken was as follows: Route-a 1%, Route-b 36%, Route-c 41% and Route-d 22%.

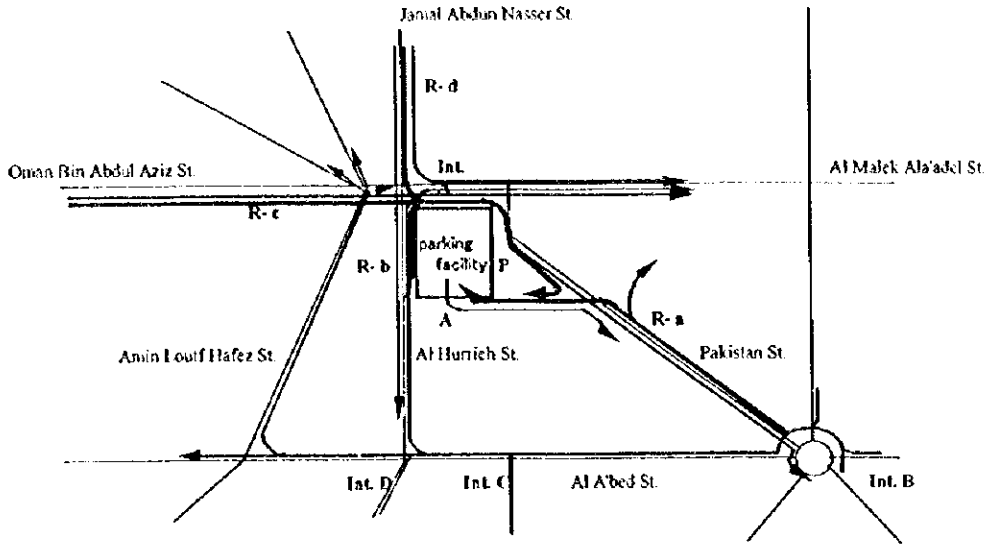


Figure 24.3.2 Access Routes to Arnus Square Parking

The saturation degree of the intersections will be below 0.9 respectively as shown in Table 24.3.3 in 1998 and 2005. Therefore the problematic impact around the square will not be anticipated when the parking facility is prepared.

Table 24.3.3 Saturation Degree of Intersections

Intersection No.	Intersection Name	Saturation Degree of Intersection	
		1998	2005
Int.A (70)	Arnus Square	0.73	0.86
Int.B (74)	Al-Sabe7 Bahrat Square	0.64	0.75
Int.C (75)	Al-aabad st. & Paliament st.	0.40	0.47
Int.D (81)	Kabbani-Kassem	0.46	0.55

24.4 Plan

24.4.1 Planning Options

Two options for planning are considered in the feasibility study of the underground parking area in Arnus square, which are with or without the building over the parking structure. Table 24.4.1 presents a summary for the area and capacity of the parking structure.

Table 24.4.1 Parking Options

Item	Unit	Option-1 Without Building	Option-2 With Building
Parking Area	m^2	17,672	17,672
Level-1	m^2	8,836	8,836
Level-2	m^2	8,836	8,836
Building Area	m^2	-	2,240
13 Floors	m^2	-	1,140
3 Floors	m^2	-	1,100
Parking Capacity	Car	560	500
Level-1	Car	280	250
Level-2	Car	280	250

Note: The approach slop for parking entrance and exit is not included.

Figure 24.4.1 shows a plan for the parking area and adjacent streets while Figure 24.4.2 presents a profile of the two levels of the underground parking area.

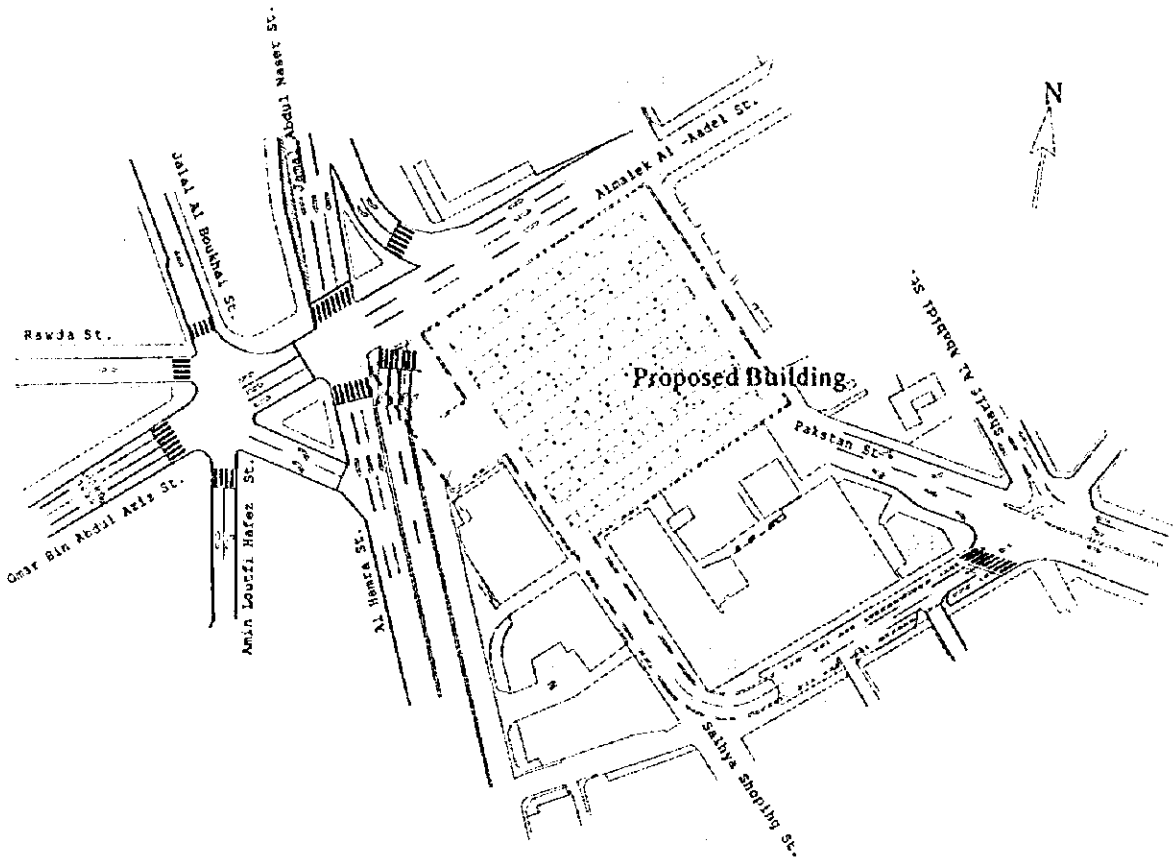


Figure 24.4.1 Plan of Parking Area

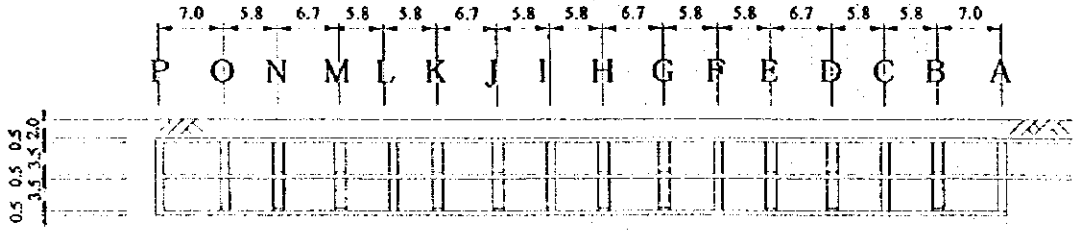


Figure 24.4.2 Profile of Parking Structure

24.4.2 Design Criteria

A design criteria was established for the main items used in the structural design which are as follows:

- Clearance Limit
- Design Loading
- Car Arrangement

(1) Clearance Limit

Two types of clearances were used in the vertical and horizontal planning of the parking structure.

Vertical clearance: The applied standard clearance limit for the underground parking structure is 2.3 meters which is the clearance recommended for passenger cars and other small-size vehicles including micro-buses.

Parking Clearance: The applied standard car space is the space recommended to accommodate a car with 5.8 meters length and 2.5 meters width, as applied in the cases of parking shown in Figure 24.4.1.

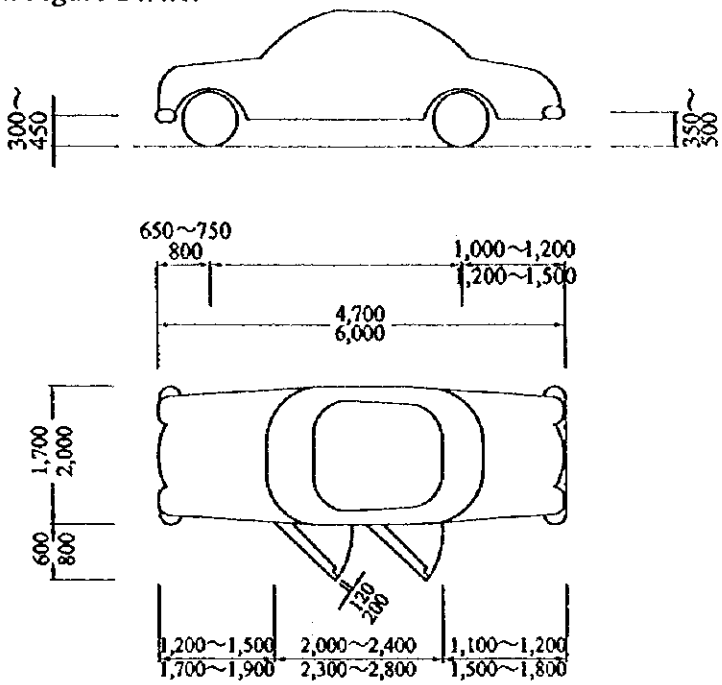


Figure 24.4.3 Vehicle Dimensions

(2) Design Loading

The structure of the underground parking is designed to carry the following loads and forces:

- Dead load
- Live load
- Impact and dynamic effect of the live load
- Effect of earthquakes

The following dead loads estimated for different sizes of vehicles, as presented in Table 24.4.2, were considered in the structural design of the underground parking.

Table 24.4.2 Vehicular Design Load

Size	Weight (t)	Area (m^2)	Loading (t/m^2)
Extra-large P. Car	2.3	12.0	0.192
Large Car	2.0	11.6	0.172
Medium Car	1.8	9.0	0.200
Standard Car	1.7	8.0	0.213
Small Car	1.2	6.9	0.174

Based on the values presented in the above table, the average design dead load for the floors (W), including the floor weight, was applied as:

$$W = 0.55\ t/m^2$$

The adopted live load in the design is the standard highway loading GS20-44 as specified in

the "Standard Specifications for Highway Bridge", 12th Edition, as adopted by the American Association of State Highway and Transportation Officials (AASHTO).

(3) Car Arrangement

The adopted parking type in the design is the standard parallel parking "Back-in Type" as shown in Figure 24.4.4. Dimensions of stall for the safe maneuverings of five different sizes of passenger cars and other vehicles are presented in the following Table 24.4.3, while Table 24.4.4 presents the different back-in type parking cases applied in the layout design of the parking area. Figure 24.4.5 shows the layout for the parking cases.

Table 24.4.3 Vehicular Dimensions

Vehicle Size	Length (m)	Width (m)	Height (m)	Gauge (m)	Weight (t)	Radius (m)
Extra-large P. Car	6.0	2.0	2.0	3.7	2.3	7.2
Large Car	5.8	2.0	2.0	3.5	2.0	7.0
Medium Car	5.0	1.8	2.0	3.3	1.8	6.5
Standard Car	4.7	1.7	2.0	3.0	1.7	6.0
Small Car	4.3	1.6	2.0	2.8	1.2	5.5

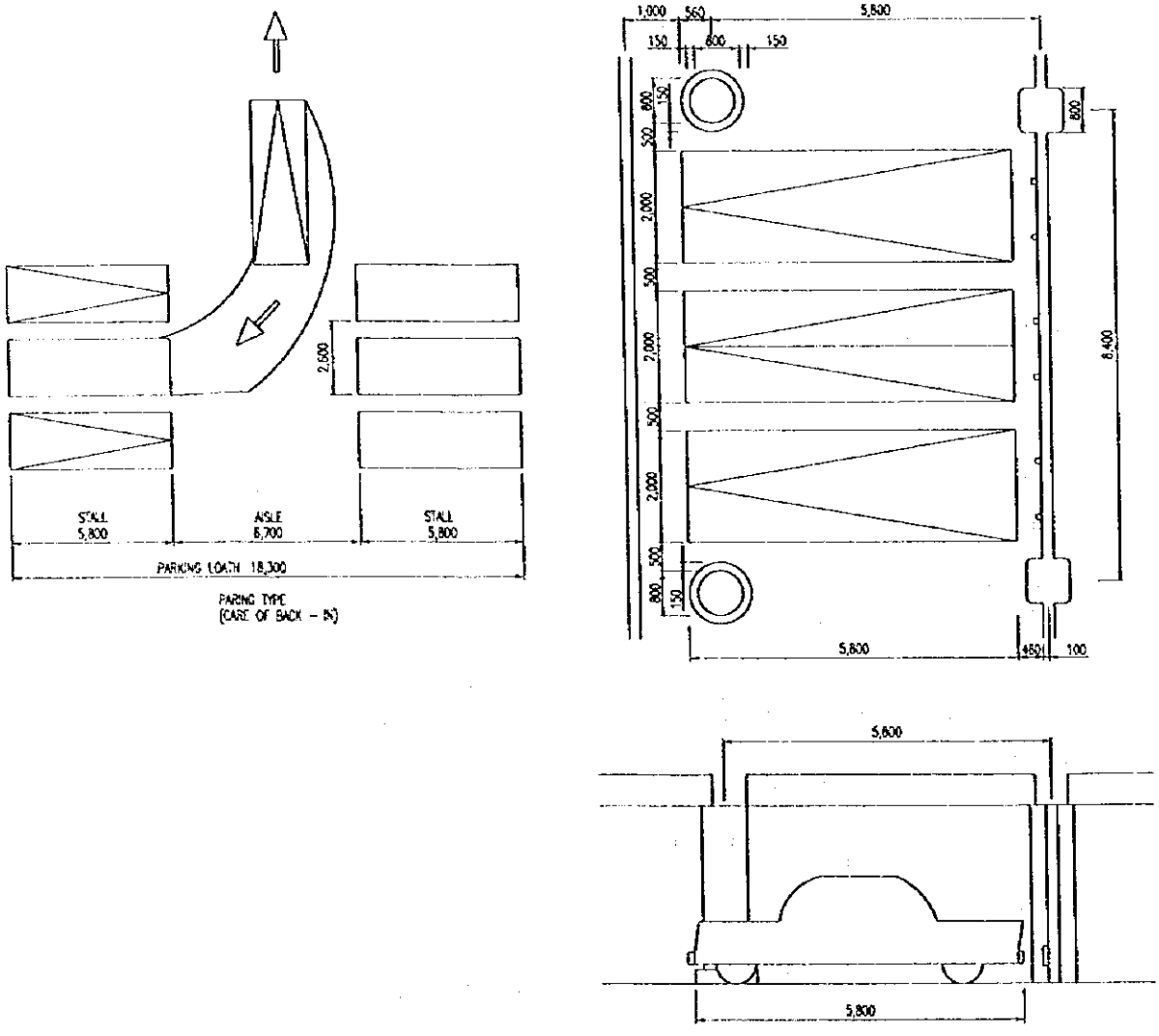


Figure 24.4.4 Parking Details

Table 24.4.4 Cases of Back-in Type Parking

Parking Cars	Effective Width (m)	Effective Length (m)
3 Large	7.60	5.80
2 Large + 1 Medium	7.30	5.80
1 Large + 2 Medium	7.00	5.80
3 Standard	6.70	4.70

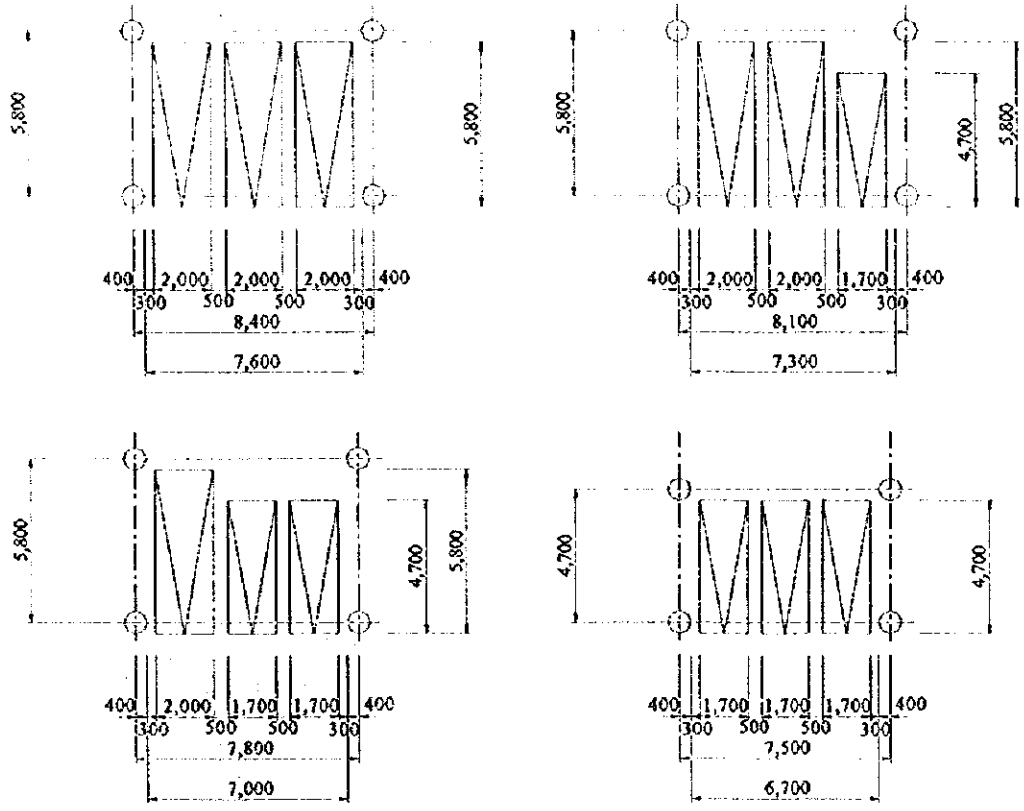


Figure 24.4.5 Parking Cases

24.4.3 Structure Design

The main features considered in the structural design of the underground parking structure are summarized as presented below.

(1) Covering

The minimum covering over the top of the structural section is taken 3.5 meters from the ground level to the top of the slab for load distribution purposes and in order to secure enough space under the proposed building for the different underground utilities. In the option of "without building", a covering depth of only 2.0 meters is applied.

(2) Boundary Distance

As a boundary distance from the road edge, a minimum lateral clearance of 1.0 meter is applied.

(3) Control Point

The underground water level, with a depth of about 15 meters under the road surface in the area, was the control point for planning, positioning and designing the foundation of this structure.

(4) Facilities

The design of structural facility systems of the underground structure of the parking area included the following items:

- Ventilation System
- Drainage System
- Lighting System
- Emergency System
- Water Supply System
- Electricity System
- Sign Plates

24.5 Cost Estimate

The construction cost of the two cases of "without building" and "with building" is estimated based on the preliminary design of the different structural elements and applied construction method. Quantities are estimated in accordance with the items shown in the detailed drawings of each case. The unit cost of each item is determined at the price levels prevalent in Damascus in November 1998. Costs of some of the items, which are not available locally in Syria, are determined based on foreign price levels. Results of cost estimation are presented in Table 24.5.1.

Table 24.5.1 Financial Cost of Parking Area

Item	Without Building (million SP)	With Building (million SP)
Parking Structure	95.65	212.82
Facilities	71.51	71.51
Construction Cost	167.16	284.33
Contingency (10%)	16.72	28.43
Subtotal-1	183.88	312.76
Tax (30%)	55.16	93.83
Profit (20%)	36.78	62.55
Subtotal-2	275.82	469.14
Engineering (12%)	33.10	56.30
Financial Cost	308.92	525.44

24.6 Organization and Management

It is envisaged that this project will be implemented under the BOT system. This would be the first project to be implemented by BOT in Damascus, but the Governorate has some experience in construction of parking facility and appointment of a management and operation company. Two existing parking facilities are operated by private companies. Regarding legislative issue, "Act No. 10" has been established for promotion of investment.

Firstly, selection of a capable investor is a critical point. It is therefore recommended that the Implementation Committee under the traffic department of the Governorate should be formulated for the smooth implementation of the project.

The Governorate should formulate the new organization and management system for the project implementation taking into account the following matters that may arise during implementation of the project.

- Getting approval for inclusion of this project under "Act No.10" from the Supreme Investment Council
- Provision of the land of Arnous Square to the potential investor
- Supply of necessary information and data to the potential investors at the time of tender
- Necessary documents to be submitted by the potential investors at time of tender
- Evaluation criteria for tenders
- Communication manner of the Committee's decisions to investors and traffic police or the related authorities concerned
- Securing consent of inhabitants in the area of Arnous Squrare
- Taking-over conditions of parking facility at the time of contract termination

For successfully implementing the matters stated above, the members of the Committee should comprise financial experts, legal experts, traffic control experts, civil engineers, etc. The primary duty of the Committee should be to clarify the roles and responsibilities of each of the Governorate and the investor involved in the parking facility.

24.7 Environmental Consideration

24.7.1 Environmental Impacts

No significant environmental impact is identified while minor impacts are identified especially during the construction such as traffic management, waste generation and landscape. Summary of the impacts is shown in Table 24.7.1.

Table 24.7.1 Summary of Environmental Impacts- Arnous Underground Parking

Environmental Impacts	Project Stages		
	Pre-Construction	Construction	Operation
1. Traffic Management		O	
2. Waste		O	
3. Landscape		O	

Note: ●:significant, ◎: medium, O: minor

24.7.2 Environmental Considerations and Countermeasures

1) Traffic Management

During the construction, the work disturbs traffic flow and parking so that proper traffic management is required such as alternative routes or parking space because this area is heavily congested at present.

2) Waste Management

Construction waste is caused by excavation. Proper management of transport of the waste and proper disposal site are required. In addition, dust shall be managed during the construction.

3) Landscape

Large scale of structure is constructed adjacent area of shopping area so that the design shall

be harmonized in the area. There exist some trees on the park. Those trees shall be removed during the construction and reverted to original place, for open cut construction method.

24.8 Financial Evaluation

An analysis for the case 1 stated in Chapter 19 has been prepared to show its financial viability from the viewpoint of the investor working under the BOT development system.

24.8.1 Preconditions for the Financial Analysis

The following preconditions for financial analysis are assumed based on the field survey in Damascus city.

(1) Financial Income

The financial income will be based upon the planned period the facility will be operated by the Investor, number of users, parking tariff of unit rate and number of operating days per year.

1) Number of permanent users

Income projection will be assumed for permanent users and casual users to be the same as the present condition of parking demand. According to the parking demand in Section 24.2, permanent users are roughly assumed to be in the range of 50 to 350. The minimum number of 50 is adopted for income projection in 500 parking lots. The remaining 450 parking lots are assumed to be used by casual users.

2) Number of casual users

Number of users is assumed based on occupation ratio of the parking area which mostly depends on location of parking area (prohibition area of on-street parking or traffic congestion) and tariff rate.

If operation hours are fixed at 12:00 hours a day and according to the parking survey at the existing Arnous parking, the results show almost full occupation (more than 50) at the peak period during 2 hours between 17:00 and 19:00, in the second peak period occupation ratios are expected to be between 50% and 75% during 5 hours from10:00~14:00 and 19:00~20:00 and occupation ration between 12% (6 cars) and 26% (13 cars) during off-peak periods of 5 hours from 9:00 to 21:00 (refer to Figure 24.8.1).

On-street parking survey for the Arnous parking area also shows that the peak period is between 18:00 and 20:00 and the second peak period is between 11:00 and 13:00. The weighted average of occupation ratio is predicted at 60% in the year 2001 and onward based on the assumption of the peak and off-peak periods mentioned below.

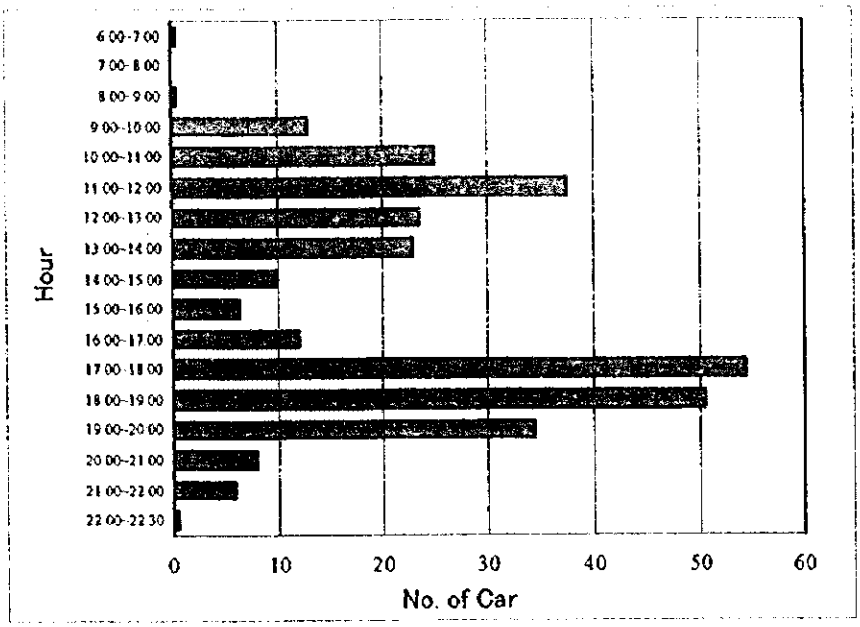


Figure 24.8.1 Avarage Number of Car Parking at Hourly Basis

Duration	Occupation Ratio
1.Peak hour (2 hours a day)	100%
2. Second peak hour (5 hours a day)	60~90%
3. Off-peak hour (5 hours a day)	20~30%
4. Weighted average for 12 hours	60%

3) Parking tariff

In Damascus city there are only 4 toll parking facilities. Each parking facility establishes its own parking tariff which is subject to the approval of Damascus Governorate. The parking tariff differs between 50~25 SP/hour depending upon the facility. The parking tariff at the present Arnous parking facility is 40 SP for the first one hour, 35 SP for the second and 25 SP for the third and onward. The operating company sets a 1,500 SP fee for monthly subscribers for 15 car lots in Arnous parking facility and 2,000 S.P in Marje parking facility. There are large differences in parking tariffs between hourly base and monthly base, and between the two parking facilities of Fardos and Arnous. In this study, the parking tariff will be applied with an average rate of 40 SP. per hour for casual users and 2,000 SP. for monthly subscribers.

4) Operating days and hours

Number of operating days of the parking facility is calculated by the following formula.

Number of operating days = 365 days per year – (Fridays + Holidays) = 294 days
Where,

Fridays: 52 days
Holidays: 19 days

The operating hours are set at 12 hours a day from 9:30 to 21:30 a day, the same as the existing Arnous Parking Area.

(2) Cost

Costs calculated for both cases include the capital (fixed) cost, the operation and maintenance costs and other costs related to the project.

1) Capital cost

The capital costs of Case-1 and Case-2 for underground parking facility at Arnous Square are shown in Table 24.8.1. The project costs are estimated at 1999 prices.

Table 24.8.1 Estimated Capital Cost

(Million SP)

Case	Case-1 (without building)	Case-2 (with building)
Concrete structure including civil works	176.8	393.3
Facility (air conditioning, lighting, etc.)	132.1	132.1
Total Cost (million SP.)	308.9	525.4

Note; 1) Prices: Prices are estimated at the constant 1999 prices.
2) Exchange Rates: Syrian pound (SP) 46 are equivalent to US$ 1.

2) Project life

The project life is different depending upon the type of the project. In this study, the expected life for the project by component is assumed as follows.

i. Concrete structure: 50 years
ii. Mechanical and electrical works: 10 years

3) Operation and maintenance cost

The operation and maintenance (O&M) cost is different according to the type of project. In this case, operation hours of the parking facility are 12 hours a day from 9:00 to 21:00. Staffing will be in two shifts a day from 9:00 to 15:00 and from 15:00 to 21:00.

One shift needs 5 staffers consisting of 1 manager, 2 staffers for ticket service and collection of fee at the entrance, 1 inspector and 1 maintenance service, i.e. a total of 10 staffers will be required for operation. The average monthly salary is set at 7,000 SP. per staff. An administration cost for parking management of 30% of operation and maintenance cost shall be applied by the investor.

- O&M cost = 7,000 SP x 10 staff x 12 months
- Administration cost = O&M cost x 30 %

4) Depreciation

Depreciation is calculated by the fixed percentage method as per the Syrian accounting system and the durable years of capital are as follows:

i. Concrete structure or parking : 2% (50 years)
ii. Facility (Air conditioning, lighting, etc.) : 10% (10 years)

5) Borrowing capital

Max. 60% of the capital cost is possible to be borrowed from the Syrian Bank as long term

borrowing. The borrowing conditions of the capital are fixed as follows.

i. Repayment: 10 years (after completion of construction)
ii. Interest: 11% per annum

6) Tax

Tax is assumed to be 42% of operating profit (operating revenue - operating expense and interest). However all taxes are exempted for 7 years from beginning of operation according to "Act No.10" dated 4th May 1991. Thus, this Act is applied for this project.

7) Contract Period

The parking facility will be operated by the investor up to 2020 from the completion of construction. The royalty (concession) to Damascus Governorate will be exempted during contract period (up to 2020) in terms of magnitude of profits for the investor aiming at encouragement of investment.

8) Subsidy from Damascus Governorate

There is no need for any subsidy for both cases. However, in the Case-2, additional capital cost is required because of the building to be constructed on the parking facility. This additional capital cost is deemed as subsidy or payment by the owner of the building.

(3) Project implementation:

Selection of the investor, design and construction of the project and necessary approval for documents will be implemented within 12 months. The project construction is expected to be completed by the end of the year 2000. Operation of parking will start at the beginning of 2001.

24.8.2 Financial Cash Flow

The projected income statement for the project (Case-1) is made on the basis of the preconditions stated above (refer to Tables 24.8.3 ~ 5).

The projected profit and losses statement and the projected cash flow statement are also prepared respectively. The Financial Internal Rate of Return (FIRR) on the Project is 11.4% and FIRR on equity is 18.1%.

24.8.3 Profitability Analysis

Based upon the financial analysis results, profitability analysis is made for case-1. The factors and magnitude which affect the project profitability are assumed by the following conditions.

The result of the profitability analysis based on the several preconditions is shown in Table 24.8.1.

Table 24.8.2 Profitability Analysis

Option	Preconditions			FIRR On Equity	Refer to Projected Financial Statements
	Royalty To Damascus Governorate	Tax	Contract Period		
Base Case	Exemption for Contract period	Exemption for 7 Years only	20 years	18.1%	Table 24.8.3 Table 24.8.4 Table 24.8.5
Option-1	Exemption for 7 Years only	Exemption for 7 Years only	20 years	15.1%	Table 24.8.6 Table 24.8.7 Table 24.8.8
Option-2	Exemption for Contract period	Exemption for Contract period	20 years	22.0%	Table 24.8.9 Table 24.8.10 Table 24.8.11
Option-3	Exemption for Contract period	Exemption for Contract period	15 years	19.7%	Table 24.8.12 Table 24.8.13 Table 24.8.14

Option-1 is not attractive for private sector as a commercial business endeavor, and at least Options-2 or -3 should be considered for realization of the project. This means that the investor is exempted from royalty payment to Damascus Governorate and tax for the contract period.

Table 24.8.3 Projected Income Statement for ARNOUS Square Underground Parking Area (Base case)

	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A.	Total Capacity		500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
	Monthly Base Users (%)		10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
B.	No. of Monthly Users		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Unit rate/Month (S.P),+7%up		2,290	2,450	2,622	2,805	3,001	3,212	3,436	3,677	3,934	4,210	4,504	4,820	5,157	5,518	5,904	6,318	6,760	7,233	7,739	8,281
C.	Sub Total (1000S.P.)		1,374	1,470	1,573	1,683	1,801	1,927	2,062	2,206	2,361	2,526	2,703	2,892	3,094	3,311	3,543	3,791	4,056	4,340	4,644	4,969
D.	Remaining Capacity		450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450
	Hourly Base Users(%)		60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
E.	No. of Hourly Users		270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270
	Operational Hours/day		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	Unit rate/Hour (S.P),+7%up		45.8	49.0	52.4	56.1	60.0	64.2	68.7	73.5	78.7	84.2	90.1	96.4	103.1	110.4	118.1	126.4	135.2	144.7	154.8	165.6
F.	Sub Total (1000S.P.)		43,623	46,677	49,944	53,441	57,181	61,184	65,467	70,050	74,953	80,200	85,814	91,821	98,248	105,126	112,485	120,358	128,784	137,798	147,444	157,765
G.	Total (C+F), 1000S.P.		44,997	48,147	51,517	55,124	58,982	63,111	67,529	72,256	77,314	82,726	88,517	94,713	101,343	108,437	116,027	124,149	132,839	142,138	152,088	162,734

Table 24.8.4 Projected Profit and Losses Statement (S.P.1000)

	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A.	Operational Income		44,997	48,147	51,517	55,124	58,982	63,111	67,529	72,256	77,314	82,726	88,517	94,713	101,343	108,437	116,027	124,149	132,839	142,138	152,088	162,734
B.	Operational Expenditure		19,173	19,261	19,354	19,455	19,562	19,676	19,799	19,931	20,071	20,221	6,242	6,414	6,599	6,796	7,007	7,232	7,474	7,732	8,009	8,304
	(O/M cost+7% up)		962	1,029	1,101	1,178	1,261	1,349	1,443	1,544	1,652	1,768	1,892	2,024	2,166	2,318	2,480	2,653	2,839	3,038	3,251	3,478
	(Administration Cost)		289	309	330	353	378	405	433	463	496	530	568	607	650	695	744	796	852	911	975	1,043
	(Deprociation)		17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783
C.	Operational Profit(A-B)		25,824	28,886	32,163	35,669	39,421	43,435	47,730	52,325	57,243	62,504	82,274	88,298	94,744	101,641	109,020	116,917	125,366	134,406	144,079	154,430
	Interest for Long Term(11%)		21,816	19,634	17,453	15,271	13,090	10,908	8,726	6,545	4,363	2,182	0	0	0	0	0	0	0	0	0	0
	Interest for Short Term(8%)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D.	Profit before Royalty Payment		4,008	9,252	14,710	20,398	26,331	32,527	39,003	45,781	52,880	60,323	82,274	88,298	94,744	101,641	109,020	116,917	125,366	134,406	144,079	154,430
	Royalty to Damascus Govt		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E.	Profit before Tax		4,008	9,252	14,710	20,398	26,331	32,527	39,003	45,781	52,880	60,323	82,274	88,298	94,744	101,641	109,020	116,917	125,366	134,406	144,079	154,430
	Tax(42%)		0	0	0	0	0	0	0	19,228	22,209	25,336	34,555	37,085	39,792	42,689	45,789	49,105	52,654	56,451	60,513	64,860
F	Net Profit after Tax		4,008	9,252	14,710	20,398	26,331	32,527	39,003	26,553	30,670	34,987	47,719	51,213	54,951	58,952	63,232	67,812	72,712	77,956	83,566	89,569

Table 24.8.5 Projected Fund Flow Statement (S.P.1000)

	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A.	SOURCE																					
	Net Profit after Tax		4,008	9,252	14,710	20,398	26,331	32,527	39,003	26,553	30,670	34,987	47,719	51,213	54,951	58,952	63,232	67,812	72,712	77,956	83,566	89,569
	Depreciation		17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783
	Self-Equity (Min. 40%)	132218																				
	Balance Brought Forward		0	0	0	0	0	0	0	0	0	0	33,077	84,579	139,575	198,310	261,044	328,059	399,654	476,148	557,887	645,236
	Long Term Borrowing (Max.60%)	198327																				
	Short Term Borrowing		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
B.	Sub Total	330544	21,931	27,175	32,633	38,321	44,254	50,450	56,926	44,476	48,593	52,910	84,579	139,575	198,310	261,044	328,059	399,654	476,148	557,887	645,236	738,588
C.	APPLICATION																					
	Construction	330544																				
	Investment (Land cost)	0																				
	Repayment of Long Term		19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833										
	Repayment of ShortTerm			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D.	Sub Total	330544	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	0	0	0	0	0	0	0	0	0	0
E.	Balance(B-D)	0	2,098	7,342	12,801	18,488	24,421	30,617	37,094	24,643	28,760	33,077	84,579	139,575	198,310	261,044	328,059	399,654	476,148	557,887	645,236	738,588
	DSCR		2.01	2.38	2.87	3.51	4.38	5.63	7.52	7.80	12.14	25.25										
				IRR on Equity		18.1%																

Table 24.8.6 Projected Income Statement for ARNOUS Square Underground Parking Area (Option-1)

	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A.	Total Capacity		500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
	Monthly Base Users (%)		10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
B.	No. of Monthly Users		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Unit rate/Month (S.P),+7%up		2,290	2,450	2,622	2,805	3,001	3,212	3,436	3,677	3,934	4,210	4,504	4,820	5,157	5,518	5,904	6,318	6,760	7,233	7,739	8,281
C.	Sub Total (1000S.P.)		1,374	1,470	1,573	1,683	1,801	1,927	2,062	2,206	2,361	2,526	2,703	2,892	3,094	3,311	3,543	3,791	4,056	4,340	4,644	4,969
D.	Remaining Capacity		450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450
	Hourly Base Users(%)		60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
E.	No. of Hourly Users		270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270
	Operational Hours/day		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	Unit rate/Hour (S.P),+7%up		45.8	49.0	52.4	56.1	60.0	64.2	68.7	73.5	78.7	84.2	90.1	96.4	103.1	110.4	118.1	126.4	135.2	144.7	154.8	165.6
F.	Sub Total (1000S.P.)		43,623	46,677	49,944	53,441	57,181	61,184	65,467	70,050	74,953	80,200	85,814	91,821	98,248	105,126	112,485	120,358	128,784	137,798	147,444	157,765
G.	Total (C+F), 1000S.P.		44,997	48,147	51,517	55,124	58,982	63,111	67,529	72,256	77,314	82,726	88,517	94,713	101,343	108,437	116,027	124,149	132,839	142,138	152,088	162,734

Table 24.8.7 Projected Profit and Losses Statement (S.P.1000)

	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A.	Operational Income		44,997	48,147	51,517	55,124	58,982	63,111	67,529	72,256	77,314	82,726	88,517	94,713	101,343	108,437	116,027	124,149	132,839	142,138	152,088	162,734
B.	Operational Expenditure		19,173	19,261	19,354	19,455	19,562	19,676	19,799	19,931	20,071	20,221	6,242	6,414	6,599	6,796	7,007	7,232	7,474	7,732	8,009	8,304
	(O/M cost,+7%up)		962	1,029	1,101	1,178	1,261	1,349	1,443	1,544	1,652	1,768	1,892	2,024	2,166	2,318	2,480	2,653	2,839	3,038	3,251	3,478
	(Administration Cost, +7%up)		289	309	330	353	378	405	433	463	496	530	568	607	650	695	744	796	852	911	975	1,043
	(Depreciation)		17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783
C.	Operational Profit(A-B)		25,824	28,886	32,163	35,669	39,421	43,435	47,730	52,325	57,243	62,504	82,274	88,298	94,744	101,641	109,020	116,917	125,366	134,406	144,079	154,430
	Interest for Long Term(11%)		21,816	19,634	17,453	15,271	13,090	10,908	8,726	6,545	4,363	2,182	0	0	0	0	0	0	0	0	0	0
	Interest for Short Term(8%)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D.	Profit before Royalty Payment		4,008	9,252	14,710	20,398	26,331	32,527	39,003	45,781	52,880	60,323	82,274	88,298	94,744	101,641	109,020	116,917	125,366	134,406	144,079	154,430
	Royalty to Damascus Govt		0	0	0	0	0	0	0	16,806	19,412	22,144	30,203	32,414	34,781	37,312	40,021	42,920	46,022	49,340	52,892	56,691
E.	Profit before Tax		4,008	9,252	14,710	20,398	26,331	32,527	39,003	28,975	33,467	38,178	52,071	55,884	59,963	64,328	68,999	73,997	79,344	85,066	91,188	97,739
	Tax(42%)		0	0	0	0	0	0	0	12,169	14,056	16,035	21,870	23,471	25,185	27,018	28,980	31,079	33,324	35,728	38,299	41,050
F	Net Profit after Tax		4,008	9,252	14,710	20,398	26,331	32,527	39,003	16,805	19,411	22,143	30,201	32,413	34,779	37,311	40,019	42,918	46,019	49,338	52,889	56,688

Table 24.8.8 Projected Fund Flow Statement (S.P.1000)

	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A.	SOURCE																					
	Net Profit after Tax		4,008	9,252	14,710	20,398	26,331	32,527	39,003	16,805	19,411	22,143	30,201	32,413	34,779	37,311	40,019	42,918	46,019	49,338	52,889	56,688
	Depreciation		17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783
	Self-Equity (Min. 40%)	132,218																				
	Balance Brought Forward		0	0	0	0	0	0	0	0	0	0	20234	54218	90414	128975	170069	213871	260572	310374	363495	420167
	Long Term Borrowing (Max.60%)	198,327																				
	Short Term Borrowing		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
B.	Sub Total	330,544	21,931	27,175	32,633	38,321	44,254	50,450	56,926	34,728	37,334	40,066	54,218	90,414	128,975	170,069	213,871	260,572	310,374	363,495	420,167	480,638
C.	APPLICATION																					
	Construction	330,544																				
	Investment (Land cost)	0																				
	Repayment of Long Term		19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833										
	Repayment of ShortTerm			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D.	Sub Total	330,544	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	0	0	0	0	0	0	0	0	0	0
E.	Balance(B-D)	0	2,098	7,342	12,801	18,488	24,421	30,617	37,094	14,895	17,501	20,234	54,218	90,414	128,975	170,069	213,871	260,572	310,374	363,495	420,167	480,638
	DSCR		2.01	2.38	2.87	3.51	4.38	5.63	7.52	6.31	9.56	19.37										
				IRR on Equity		15.1%																

Table 24.8.9 Projected Income Statement for ARNOUS Square Underground Parking Area (Option-2)

	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A.	Total Capacity		500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
	Monthly Base Users (%)		10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
B.	No. of Monthly Users		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Unit rate/Month (S.P),+7%up		2,290	2,450	2,622	2,805	3,001	3,212	3,436	3,677	3,934	4,210	4,504	4,820	5,157	5,518	5,904	6,318	6,760	7,233	7,739	8,281
C.	Sub Total (1000S.P.)		1,374	1,470	1,573	1,683	1,801	1,927	2,062	2,206	2,361	2,526	2,703	2,892	3,094	3,311	3,543	3,791	4,056	4,340	4,644	4,969
D.	Remaining Capacity		450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450	450
	Hourly Base Users(%)		60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
E.	No. of Hourly Users		270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270	270
	Operational Hours/day		12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
	Unit rate/Hour (S.P),+7%up		45.8	49.0	52.4	56.1	60.0	64.2	68.7	73.5	78.7	84.2	90.1	96.4	103.1	110.4	118.1	126.4	135.2	144.7	154.8	165.6
F.	Sub Total (1000S.P.)		43,623	46,677	49,944	53,441	57,181	61,184	65,467	70,050	74,953	80,200	85,814	91,821	98,248	105,126	112,485	120,358	128,784	137,798	147,444	157,765
G.	Total (C+F), 1000S.P.		44,997	48,147	51,517	55,124	58,982	63,111	67,529	72,256	77,314	82,726	88,517	94,713	101,343	108,437	116,027	124,149	132,839	142,138	152,088	162,734

Table 24.8.10 Projected Profit and Losses Statement (S.P.1000)

	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A.	Operational Income		44,997	48,147	51,517	55,124	58,982	63,111	67,529	72,256	77,314	82,726	88,517	94,713	101,343	108,437	116,027	124,149	132,839	142,138	152,088	162,734
B.	Operational Expenditure		19,173	19,261	19,354	19,455	19,562	19,676	19,799	19,931	20,071	20,221	6,242	6,414	6,599	6,796	7,007	7,232	7,474	7,732	8,009	8,304
	(O/M cost,+7%up)		962	1,029	1,101	1,178	1,261	1,349	1,443	1,544	1,652	1,768	1,892	2,024	2,166	2,318	2,480	2,653	2,839	3,038	3,251	3,478
	(Administration Cost, +7%up)		289	309	330	353	378	405	433	463	496	530	568	607	650	695	744	796	852	911	975	1,043
	(Depreciation)		17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783
C.	Operational Profit(A-B)		25,824	28,886	32,163	35,669	39,421	43,435	47,730	52,325	57,243	62,504	82,274	88,298	94,744	101,641	109,020	116,917	125,366	134,406	144,079	154,430
	Interest for Long Term(11%)		21,816	19,634	17,453	15,271	13,090	10,908	8,726	6,545	4,363	2,182	0	0	0	0	0	0	0	0	0	0
	Interest for Short Term(8%)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D.	Profit before Royalty Payment		4,008	9,252	14,710	20,398	26,331	32,527	39,003	45,781	52,880	60,323	82,274	88,298	94,744	101,641	109,020	116,917	125,366	134,406	144,079	154,430
	Royalty to Damascus Govt		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E.	Profit before Tax		4,008	9,252	14,710	20,398	26,331	32,527	39,003	45,781	52,880	60,323	82,274	88,298	94,744	101,641	109,020	116,917	125,366	134,406	144,079	154,430
	Tax(42%)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F	Net Profit after Tax		4,008	9,252	14,710	20,398	26,331	32,527	39,003	45,781	52,880	60,323	82,274	88,298	94,744	101,641	109,020	116,917	125,366	134,406	144,079	154,430

Table 24.8.11 Projected Fund Flow Statement (S.P.1000)

	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A.	SOURCE																					
	Net Profit after Tax		4,008	9,252	14,710	20,398	26,331	32,527	39,003	45,781	52,880	60,323	82,274	88,298	94,744	101,641	109,020	116,917	125,366	134,406	144,079	154,430
	Depreciation		17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783	3,783
	Self-Equity (Min. 40%)	132,218																				
	Balance Brought Forward		0	0	0	0	0	0	0	0	0	0	58,413	144,470	236,551	335,078	440,502	553,305	674,005	803,153	941,342	1,089,204
	Long Term Borrowing (Max.60%)	198,327																				
	Short Term Borrowing		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
B.	Sub Total	330,544	21,931	27,175	32,633	38,321	44,254	50,450	56,926	63,703	70,802	78,246	144,470	236,551	335,078	440,502	553,305	674,005	803,153	941,342	1,089,204	1,247,417
C.	APPLICATION																					
	Construction	330,544																				
	Investment (Land cost)	0																				
	Repayment of Long Term		19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833										
	Repayment of ShortTerm			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
D.	Sub Total	330,544	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	0	0	0	0	0	0	0	0	0	0
E.	Balance(B-D)	0	2,098	7,342	12,801	18,488	24,421	30,617	37,094	43,871	50,970	58,413	144,470	236,551	335,078	440,502	553,305	674,005	803,153	941,342	1,089,204	1,247,417
	DSCR		2	2	3	4	4	6	8	11	17	37										

IRR on Equity 22.0%

Table 24.8.12 Projected Income Statement for ARNOUS Square Underground Parking Area (Option-3)

	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
A. Total Capacity			500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
Monthly Base Users (%)			10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
B. No. of Monthly Users			50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Unit rate/Month (S.P),+7%up			2290	2450	2622	2805	3001	3212	3436	3677	3934	4210	4504	4820	5157	5518	5904
C. Sub Total (1000S.P.)			1374	1470	1573	1683	1801	1927	2062	2206	2361	2526	2703	2892	3094	3311	3543
D. Remaining Capacity			450	450	450	450	450	450	450	450	450	450	450	450	450	450	450
Hourly Base Users(%)			60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%	60%
E. No. of Hourly Users			270	270	270	270	270	270	270	270	270	270	270	270	270	270	270
Operational Hours/day			12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Unit rate/Hour (S.P),+7%up			45.8	49.0	52.4	56.1	60.0	64.2	68.7	73.5	78.7	84.2	90.1	96.4	103.1	110.4	118.1
F. Sub Total (1000S.P.)			43,623	46,677	49,944	53,441	57,181	61,184	65,467	70,050	74,953	80,200	85,814	91,821	98,248	105,126	112,485
G. Total (C+F), 1000S.P.			44,997	48,147	51,517	55,124	58,982	63,111	67,529	72,256	77,314	82,726	88,517	94,713	101,343	108,437	116,027

Table 24.8.13 Projected Profit and Losses Statement (S.P.1000)

	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
A. Operational Income			44,997	48,147	51,517	55,124	58,982	63,111	67,529	72,256	77,314	82,726	88,517	94,713	101,343	108,437	116,027
B. Operational Expenditure			19,173	19,261	19,354	19,455	19,562	19,676	19,799	19,931	20,071	20,221	6,242	6,414	6,599	6,796	7,007
(O/M cost,+7%up)			962	1,029	1,101	1,178	1,261	1,349	1,443	1,544	1,652	1,768	1,892	2,024	2,166	2,318	2,480
(Administration Cost, +7%up)			289	309	330	353	378	405	433	463	496	530	568	607	650	695	744
(Depreciation)			17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	3,783	3,783	3,783	3,783	3,783
C. Operational Profit(A-B)			25,824	28,886	32,163	35,669	39,421	43,435	47,730	52,325	57,243	62,504	82,274	88,298	94,744	101,641	109,020
Interest for Long Term(11%)			21,816	19,634	17,453	15,271	13,090	10,908	8,726	6,545	4,363	2,182	0	0	0	0	0
Interest for Short Term(8%)				0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. Profit before Royalty Payment			4,008	9,252	14,710	20,398	26,331	32,527	39,003	45,781	52,880	60,323	82,274	88,298	94,744	101,641	109,020
Royalty to Damascus Govt			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E. Profit before Tax			4,008	9,252	14,710	20,398	26,331	32,527	39,003	45,781	52,880	60,323	82,274	88,298	94,744	101,641	109,020
Tax(42%)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F Net Profit after Tax			4,008	9,252	14,710	20,398	26,331	32,527	39,003	45,781	52,880	60,323	82,274	88,298	94,744	101,641	109,020

Table 24.8.14 Projected Fund Flow Statement (S.P.1000)

	Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
A. SOURCE																	
Net Profit after Tax			4,008	9,252	14,710	20,398	26,331	32,527	39,003	45,781	52,880	60,323	82,274	88,298	94,744	101,641	109,020
Depreciation			17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	17,923	3,783	3,783	3,783	3,783	3,783
Self-Equity (Min. 40%)		132,218															
Balance Brought Forward			0	0	0	0	0	0	0	0	0	0	58,413	144,470	236,551	335,078	440,502
Long Term Borrowing (Max.60%)		198,327															
Short Term Borrowing			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. Sub Total		330,544	21,931	27,175	32,633	38,321	44,254	50,450	56,926	63,703	70,802	78,246	144,470	236,551	335,078	440,502	553,305
C. APPLICATION																	
Construction		330,544															
Investment (Land cost)		0															
Repayment of Long Term			19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833					
Repayment of ShortTerm				0	0	0	0	0	0	0	0	0	0	0	0	0	0
D. Sub Total		330,544	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	19,833	0	0	0	0	0
E. Balance(B-D)		0	2,098	7,342	12,801	18,488	24,421	30,617	37,094	43,871	50,970	58,413	144,470	236,551	335,078	440,502	553,305
DSCR			2.01	2.38	2.87	3.51	4.38	5.63	7.52	10.73	17.23	36.87					

IRR on Equity 19.7%

24.9 Conclusion

Parking facilities have two functions, one as a public infrastructure from the viewpoint of relief of traffic congestion, the other as a commercial business because tariff can be collected from users as beneficiaries. Thus development of parking facilities should be harmonized with public infrastructure and commercial business aiming at improvement of traffic flow.

(1) Development method

Investment cost for the related road sector is very limited based on the past performance of Damascus Governorate. It is difficult to find out financial resource to develop parking facilities in the public sector, therefore, utilization of private sector should be considered for that purpose. BOT (build, operate and transfer) system is commonly applied for development of infrastructure in other countries in recent years, and in Syria development of power station by BOT system has already started. This BOT system shall be applied for development of parking facilities. The following advantageous and disadvantageous of BOT system are considered.

Advantages:

- Large investment cost can be financed by the private sector and official budgeting for the project is not required as other infrastructure development.
- Operation and management of the parking facility will be by the private sector
- Ownership of the project shall belong to the Governorate.

Disadvantages:

- Profit from the users should be shared with the investor, thus profit will be smaller than of the project was to be developed by the Governorate itself.
- Implementation method should be studied before starting the project because the Governorate has no experience of BOT system.
- New tax regulation (tax exemption) should be formulated for BOT project

(2) Preparatory work for implementation

The Governorate has already committed management of two parking facilities to the private sector. This experience may be applied to the BOT system only to a certain extent because the BOT system is largely different in some aspects, for instance; design and construction of parking facility will be made by the investor, handing over parking facility to the Governorate from the investor, etc. Thus it is recommended that a Implementation Committee will be established for the smooth implementation of the parking facility.

(3) Selection of investor

The investor for parking facility may be selected by tendering through open invitation to pre-qualified bidders. Selection criteria should be formulated before tendering by the Committee. The most important factor is the proposed parking tariff for users. The investor wants to recover the investment cost as soon as possible, but if the investor sets a high tariff rate for parking, the number of users will be reduced and the number of on-street parking in the surrounding area will not change. As a result the parking facility will becomes meaningless.

So the tenders showing the highest price is not necessarily the best potential investor for the parking facility project. The investor does not need to be one company only but may be a consortium of companies specialized in design, construction and financing. In this case, the Governorate shall agree with the consortium members on the designation of one of the member companies as the prime contractor of the consortium for ease of communication and management

control of the project.

(4) Taking over the parking facility

Option-2 shows the highest FIRR on equity. In this financial planning, the investor shall be exempted from royalty payment to the Governorate and tax during the contract period and the Governorate will take over the parking facility in 2021 in terms of profitability. Normally these subjects shall be discussed with the investor and the related authorities, and mutual understanding for the incentives to investment will be formulated before starting the project.

(5) Coordination of building project

In this financial analysis, discrepancy of construction costs between Cases-1 and -2 is assumed to be the cost belonging to the building project. Therefore, the investor is not required to pay this amount (discrepancy). In this financial plan, the excess capital cost beyond Case-1 will be borne by the Governorate. Detailed information on the building project which will affect cost and implementation schedule should be given to the investor to estimate construction cost of parking facility at the bidding.

(6) Tender documents

In order to receive accurate offers from the tenders, the Governorate should provide detailed information such as traffic volume, on-street parking conditions and prohibition of on-street parking near Arnous Square, geological conditions, design document of parking facility, etc. Tender documents should comprise the following documents.

- Price breakdown of tender price schedule for construction of parking facility
- Implementation schedule
- Cash flow and financial resources
- Organization chart to execute the Project (design, construction and operation for parking facility)
- Procedures for project execution, project schedule control, quality control, correspondence and documentation, etc.
- Detailed specifications, drawings and catalogues of facilities

(7) Model case study

The master plan study recommends development of 5 parking facilities by BOT system. For smooth implementation of these projects, this project should be realized as a model case for parking facilities as soon as possible. The experiences gained through the project should then be reflected to the following projects.

(8) Improvement of traffic congestion

The number of parking users greatly depend on the traffic regulation on prohibition of on-street parking. In order to relieve traffic congestion, the main objective of the project, prohibition of on-street parking should be strictly controlled after construction of the parking facility. For instance the present regulations prohibiting on-street parking on both sides on the streets of Ibn Abdul Aziz, Al Malek and Jamal Abdel Nasser and prohibition on one side on Al Hamra street and the pedestrian only Sathiyeh street and some other streets should be strictly enforced.