CHAPTER 8

PROJECT COST ESTIMATION

CHAPTER 8. PROJECT COST ESTIMATION

8.1 Cost Estimation Method

8.1.1 Methodology

(1) Basic Conditions

The project costs will consist of the construction costs, preliminary costs, contingency costs, technical costs, and land acquisition costs. To estimate these costs, the basic conditions will be as follows:

1) All construction works will be performed by Omani contractors.

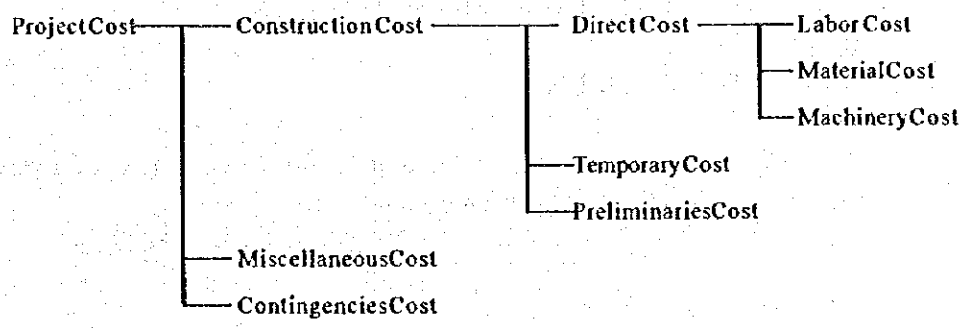
2) The project costs will be assessed at the economic values in 1996.

3) The construction costs will consist of the direct costs, temporary (preparatory) costs and miscellaneous costs. The project costs were calculated by obtaining quantities from the detailed design drawings and multiplying by the unit cost for construction operations of recent tender prices.

4) Land acquisition cost will be calculated from the road area required for road widening and for road alignment improvement, and the land acquisition unit costs obtained from related authorities.

(2) Project Cost Component

Project cost components are as shown below.



Project Cost: Project cost consists of construction cost, contingencies preliminaries.

Construction Cost: Construction cost consists of direct cost, indirect cost and temporary cost. This cost including all cost which will be paid in construction site.

Preliminary Cost: Preliminary cost is the cost which will be used for all common works; difficult to separate into job items.

8.1.2 Standard Bill of Quantities

Standard Bill of Quantities was established in April, 1994. Contents of this standard bill of quantities are listed below:

100 PRELIMINARIES
200 EARTHWORKS
300 GRANULAR AND STABILIZED SUBBASE, BASECOURSE AND STABILIZED SUBGRADE
400 BITUMINOUS PAVEMENT
500 CONCRETE AND CONCRETE STRUCTURES
600 STRUCTURAL STEEL AND OTHER METALWORK
700 PAINT
800 DRAINAGE AND SERVICE DUCTS
900 SLOPE PROTECTION AND STABILIZATION
1000 PILING
1100 BRIDGE BEARING, EXPANSION JOINTS, JOINT SEALS AND FILLERS
1200 SIDEWALKS, PAVED AREAS AND CURBS
1300 SAFETY BARRIERS, DELINEATORS AND FENCES
1400 HIGHWAY SIGNS AND ROAD MARKINGS
1500 ELECTRICAL INSTALLATIONS
1600 LANDSCAPE AND LANDSCAPE IRRIGATION
1700 UTILITIES
1800 PLANT AND EQUIPMENT

Following the above work items, Bill of Quantities for construction of fly over and pedestrian underpass was made and shown on tender documents.

8.1.3 Unit Cost

The unit cost of construction works are analyzed based on the labor cost, material cost, machinery cost, overhead and profit for major work items. The analyzed unit prices are compared with current tender prices and adjusted as required to obtain the most realistic prices.

(1) Unit Cost of Labor

Unit cost of labor is shown in Table 8-1. This unit cost includes air fare, medical care, transport food and accommodation.
Production hours per month is 283 hours, over 25 days.

Table 8.1 Unit Cost of Labour

(Unit :R.O)

Description	Unit Cost per Day
Supervisor	44.000
Site Surveyor	39.400
Foreman	35.800
1st class operator	12.452
2nd class operator	10.980
Mechanic	11.660
Driver	11.320
Skilled labor	7.018
Semi skilled labor	6.566
Ordinary labor	6.226
Driller	8.264
Miner	11.320
Mason	7.245
Painter	8.264
Carpenter	7.415
Steel fitter	6.894
Electrician	9.226
Scaffolders	7.315
Drainlayers	7.315
Plaster	7.315
Plumber	7.315
Plant operator	9.275

(2) Unit Cost of Materials

Unit Cost of Materials is shown in Table 8.2, showing unit costs of major construction materials. The cost of imported materials are based on the Omani commercial price which includes port handling, clearance and import duties. The cost of local materials is based on market and recent tender prices in Muscat area.

Table 8.2 Unit Cost of Materials

Description	Unit	Unit Cost
Fill Materials for Embankment	m3	0.800
Fill Materials for Subbase	m3	1.000
Fill Materials for Backfill	m3	0.800
Aggregate for Subbase	m3	1.000
Aggregate for Basecourse	m3	1.000
Ready Mixed Concrete Class 16	m3	17.000
Ready Mixed Concrete Class 24	m3	18.000
Ready Mixed Concrete Class 32	m3	19.000
Ready Mixed Concrete Class 40	m3	20.000
Prime Coat	ton	90.000
Bitumen	ton	40.000
Reinforcement Bar Highyield	ton	130.000
Reinforcement Bar Mild Steel	ton	165.000
Mesh Reinforcement	ton	175.000
Cement	ton	23.000
Sand	m3	2.500
Form for Superstructure	m2	1.500
Form for Substructure	m2	1.250
Steel Form	m2	2.500
Scaffolding	m2	2.000
Expansion Joint	lin.m	70.000
Bearing Shoe 400 x 200 x 52	No	30.000
Box Culvert 1 x 2m	lin.m	40.000
Pipe Culvert D=1.0 m	lin.m	20.000
Bridge Hand Rail	lin.m	20.000
PC Anchor	No	30.000
Sheath	lin.m	1.000
Drainage Pit for Bridge	No	200.000

(3) Unit Cost of Equipment

Table 8.3 shows the unit cost of main construction equipment. The unit cost of Equipment including fuel, oil and maintenance cost.

Table 8.3 Unit Cost of Equipment

(per month)

Equipment	Capacity	Unit Price
Bulldozer	15 ton	1990.000
	21 ton	3100.000
	32 ton	4430.000
Back Hoe	0.35 m3	936.000
	0.60 m3	1474.000
	1.00 m3	2048.000
Dump and Tipper Truck	4 ton	400.000
	10 ton	2007.000
Truck with Crane	2 ton	1350.000
	10 ton	1714.000
Crawler Crane	20 ton	1978.000
	50 ton	3373.000
	100 ton	3731.000
	150 ton	4500.000
Track Crane	20 ton	1978.000
	50 ton	3400.000
	80 ton	3500.000
Motor Grader	Blade width 2~3 m	1886.000
	Blade width 3~5 m	2752.000
Tire Roller	8~20 ton	1162.000
Vibrator Roller	1 ton	266.000
	2.5 ton	400 000
	3~4 ton	650.000
Tamper	60~80 kg	150.000
Agitating Truck	4.5 m3	1700.000
Concrete Pump	55 m3 / hour	2766.000
Asphalt Finisher	2.4~5.0 m	2120.000
Tensioning Device	for PC cable	1000.000
Generator	100 kva	1097.000
	200 kva	3026.000

8.1.4 Process Cost

(1) Basic Consideration for Process Cost Estimation

This project involves the construction of flyovers and pedestrian underpasses. Bridge type is prestressed concrete box girder type due to consideration of construction ability of Omani contractor, economical matters and aesthetics. At the time of cost estimation of fly over and pedestrian underpass, Omani standard bill of quantities and applicable tender process cost will be employed, however, in the case of process costs which are not covered in Omani standard bill of quantity, Japanese process costs will be applied. Most of all process costs are covered by recent tender process cost, and required process cost is only for PS concrete structure. Analysis of PS concrete structure, and work ability of Omani contractor was assumed as follows

Table 8.4 Comparison of Work Abilities

Item	Japan	Oman
Worker	1	1.5 times
Foreman, Skilled Labor (Foreigner)	1	1 time
Operator	1	1 time

The study team has reviewed the process of cost estimation practice in Japan and compared the mean estimate costs with those of Oman. The mean process costs are found to be about one-third of those in Japan. Considering the price differences of materials and labour between Japan and Oman, the process cost estimation practice in Japan is considered appropriate.

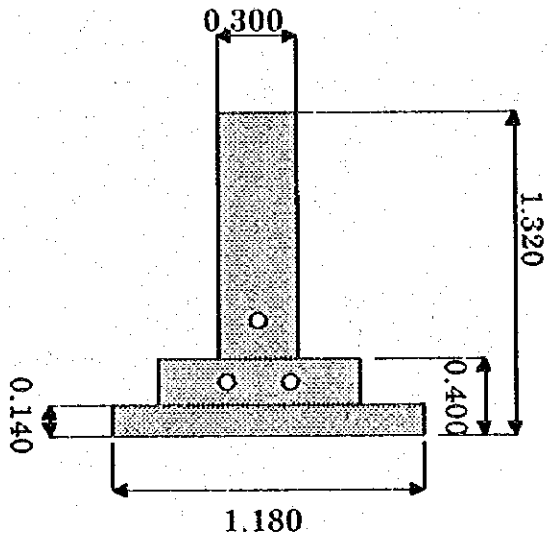
Calculation Example of Process Cost

Following the process cost estimation practice in Japan, an example of PS concrete T-beam process cost was calculated because there is unit cost data for PS concrete T-beam in recent tender price. It was calculated applying Omani cost to Japanese process cost practice.

Process cost calculation

Quantity take-off

Size of PS T beam :27.460 m long x 1.180 m wide x 1.320 m deep



Concrete (class 550/20) : 35 m3
Form (steel form): 90 m2
Reinforcement : 2.8 ton
Anchorage system : Freyssinet system
PC Strand : 12 T5 28.8 m
PC Anchor : 3 No/beam

Fabrication of Girder per Number							
No	Description	Size	Unit	Quantity	Unit Price	Amount	Remark
	Reinforcement Bar	High yield	ton ton	2.800	214.729	601.241	Sheet-12
	Assembling of PC strand		m	86.400	3.462	299.159	Sheet-13
	Assembling of Sheath for Diaphragm		m	2.700	0.564	1.523	Sheet-14
	Form for Girder		sq. m	90.000	2.445	220.039	Sheet-15
	Concrete		cu m	35.000	24.504	857.653	Sheet-16
	Tensioning		NR	3.000	43.406	130.217	Sheet-17
	Shifting of Girder		L.S	1.000	51.486	51.486	Sheet-18
	Sub-Total		L.S			2161.318	

Sheet-12	Reinforcement Bar (1ton)						
No	Description	Size	Unit	Quantity	Unit Price	Amount	Remark
	Foreman		m/d	0.7	35.800	25.060	
	Steel Fitter		m/d	4.6	6.894	31.712	
	Ordinary Labor		m/d	3.2	6.226	19.923	
	Reinforcement Bar		ton	1.05	130.000	136.500	
	Miscellaneous		L.S	1		1.534	Labor x 2%
	Sub-Total					214.729	

Sheet-13	Assembling of PC strand and Sheath (100m)						
No	Description	Size	Unit	Quantity	Unit Price	Amount	Remark
	Foreman		m/d	1.7	35.800	60.860	
	Skilled Labor		m/d	7.5	7.018	52.638	
	Ordinary Labor		m/d	6.3	6.226	39.224	
	PC Strand	12T15.2	m	100	1.070	107.000	
	Sheath	d=65mm	m	100	0.600	60.000	
	Grouting material		cu m	0.5	50.000	25.000	Quotation
	Miscellaneous		LS	1		1.527	Labor x 1%
	Sub-Total					346.249	
	per 1m					3.462	

Sheet-14	Assembling of Sheath(Audit)						
No	Description	Size	Unit	Quantity	Unit Price	Amount	Remark
	Foreman		m/d	0.4	35.800	14.320	
	Skilled Labour		m/d	0.8	7.018	5.615	
	Ordinary Labour		m/d	1	6.226	6.226	
	Sheath	d=35mm	m	100	0.300	30.000	
	Miscellaneous					0.262	Lobour x 1%
	Sub-Total					56.422	
	per 1m					0.564	

Sheet-15	Form for Girder (10sqm)						
No	Description	Size	Unit	Quantity	Unit Price	Amount	Remark
	Foreman		m/d	0.7	35.800	25.060	
	Form Carpenter		m/d	4.2	7.415	31.141	
	Ordinary Labour		m/d	2.8	6.226	17.433	
	Form		sq m	10	1.250	12.500	
	Sub-Total					86.134	
	1 sq. m					8.613	
	1 sq. m/No					0.431	Usage No 20
	Set and Remove		sq m	1	2.014	2.014	Sheet 15-1
	1 sq. m					2.445	

Sheet-15-1	Set and Remove of form (10sq m)						
No	Description	Size	Unit	Quantity	Unit Price	Amount	Remark
	Foreman		m/d	0.2	35.800	7.160	
	Form Carpenter		m/d	1	7.415	7.415	
	Labor		m/d	0.8	6.226	4.981	
	Miscellaneous		L.S	1		0.587	Labour x 3%
	Sub-Total					20.142	
	1 sq. m					2.014	

Sheet16	Concrete (10 cum) placed by Ridged Crane						
No	Description	Size	Unit	Quantity	Unit Price	Amount	Remark
	Foreman		m/d	0.3	35.800	10.740	
	Skilled Labor		m/d	2.1	7.018	14.739	
	Labor		m/d	2.5	6.226	15.565	
	Concrete	Class 40	cu m	10.2	20.000	204.000	
	Sub-Total					245.044	
	per 1qu m					24.504	

Sheet-17	Tensioning (10 cables) Type=195 ton						
No	Description	Size	Unit	Quantity	Unit Price	Amount	Remark
	Foreman		m/d	1.6	35.800	57.280	
	Skilled Labor		m/d	5.6	7.018	39.303	
	Labor		m/d	4.8	6.226	29.885	
	Anchorage	Type	nr	10	30.000	300.000	
	Miscellaneous					7.588	Labour x 6%
	Sub-Total					434.056	
	1 cable					43.406	

Sheet-18	Shifting of Girder (1 girder)						
No	Description	Size	Unit	Quantity	Unit Price	Amount	Remark
	Foreman		m/d	0.5	35.800	17.900	
	Skilled Labour		m/d	3.1	7.018	21.757	
	Ordinary Labour		m/d	1.9	6.226	11.829	
	Miscellaneous		L.S	1			
	Sub-Total					51.486	

Calculation Result

Following the Japanese process cost practice, the cost of PS concrete T-beam was estimated. As compared with Omani contractor's estimation cost, cost difference is only seven to twenty percent as shown below table. This difference does not significantly influence the priced bill of quantities and is within construction error of contractor's ability. Therefore, adequacy of Japanese process cost practice is verified.

(R.O.)

Japanese Process Cost	Contractor 1	Contractor 2
2161.318	1823.326	2021.700

Process cost calculation results are shown in the priced bill of quantities in appendix.

8.1.5 Indirect Cost

Preliminaries
An allowance of 10 % of the construction cost except day works is commonly set aside for preliminaries. Preliminaries are costs of bonds and insurance, facilities for the engineer, maintenance and protection of traffic and other items specified in the tender document.

Contingency
Contingency cost is assumed to be 10 % of the construction cost.

Temporary Cost
Temporary cost consists of temporary work for construction which is not included in each construction item.

Miscellaneous Cost (Supervision Cost)
Miscellaneous cost consists of supervision of the project and the cost other than the above items; assumed at 10 % of direct cost.

8.1.6 Land Acquisition

The land acquisition cost of each R/A is given in the Table 8.5. This cost is not applied to the pedestrian underpass, because the construction work will be executed in the right of way. For the construction of the flyovers, there is a need to acquire some land area in the vicinity of the roundabouts. Great efforts were made in the design stage to minimize the expropriate land area. Due to the limited right-of-way at some locations, some land area must be acquired for the construction of the proposed flyovers.

R/A No	Wilayat	Land Use	Unit Cost (R.O/m2)	Quantity (m2)	Total Cost (R.O)	Amount (R.O)
2	Barka	Agricultural Area	3~5	7430	37150	
		Resident Area	5~8			
		Commercial Area	10~15			3715
3	Barka	Agricultural Area	3~5			
		Resident Area	5~8			
		Commercial Area	10~15	260	3900	390
5	Al Musanaah	Agricultural Area	3~5	7170	35850	
		Resident Area	5~8			
		Commercial Area	7~12	780	9360	45210
12	Sohar	Agricultural Area	3~6	9620		57720
		Resident Area	5~10			
		Commercial Area	10~20	1070		21400
8	Al Khabrah	Agricultural Area	3~5	1002	5010	
		Resident Area	5~8			
		Commercial Area	7~12	859	10308	15318
10	Saham	Agricultural Area	3~6	710	4260	
		Resident Area	5~10			
		Commercial Area	10~20	983	19960	23920
14	Liwa	Agricultural Area	2~4			
		Resident Area	4~6			
		Commercial Area	7~10	1605	16050	16050
18	Shinas	Agricultural Area	3~5	50281	251405	
		Resident Area	5~8	448	3584	
		Commercial Area	10~16			254989

Notes: 1) Unit-cost is classifiedinto three categories (Town center, Outskirts, Other Areas). The adopted unit cost is of Outskirts, because roundabouts are almost always located in the outskirts.
2) To calculate the total cost, the upper unit cost is applied
3) The source of unit cost is MOC

8.1.7 Other Items

Maintenance Cost

The maintenance work is applied to the flyover. The work consists of routine maintenance, periodic maintenance, rehabilitation and reconstruction. The implementation years in the project life (25 years) and unit costs are given in Table 8.6. Additionally, the actual implementation dates of each R/A follow the "Implementation Plan" mentioned in Chapter 9.

Table 8.6 Type of Maintenance and Unit Cost

Type of Maintenance	Implementation Year	Unit Cost (R.O/m2)
Routine Maintenance	Every Year	0.10
Periodic Maintenance	5th and 15th year after opening to traffic	3.50
Rehabilitation	10th year after opening to traffic	5.50
Reconstruction	25th year after opening to traffic	7.00

The unit cost of maintenance is for the cost of the bituminous pavement and does not include the cost of the accessories. Estimated maintenance costs for each roundabout is as shown in Table 8.7.

Table 8.7 Maintenance Cost

Item	R/A-2	R/A-3	R/A-5	R/A-8	R/A-10	R/A-12	R/A-14	R/A-18
Objective Area	12000	17000	17000	15000	15000	18000	16000	10000
Routine Maintenance	1200	1700	1700	1500	1500	1800	1600	1000
Periodic Maintenance	42000	59500	59500	52500	52500	63000	56000	35000
Rehabilitation	66000	93500	93500	82500	82500	99000	88000	55000
Reconstruction	84000	119000	119000	105000	105000	126000	112000	70000

Protection of Traffic

Diversion of the existing road for the construction and reconstruction work is assumed 300 R.O/km based on a recent tender prices. Necessary materials for diversion other than including in diversion cost are granular materials and base course which will be estimated for the each project site.

8.2 Cost Estimation

8.2.1 Project Cost of Flyovers

The Project (Financial Cost) cost of a flyovers were calculated following the cost estimation method. Estimation results of each flyover are as shown Table 8.8.

Table 8.8 Project Cost of Flyover

(Cost Unit: R.O)

Type of Cost	A'Naseem Garden R/A	Barka R/A	Al Muladdah R/A	Sohar R/A
Construction Cost	2,875,251	2,860,400	2,919,043	4,083,781
Supervision	287,572	286,040	291,904	408,378
Land Acquisition	45,210	37,150	79,120	3,900
Project Cost	3,207,986	3,183,90	3,290,067	4,496,059

Type of Cost	Khaburah R/A	Saham R/A	Al Falaj Qabail R/A	Aqr R/A
Construction Cost	3,035,078	3,640,548	2,739,661	2,944,251
Supervision	303,508	364,055	273,966	294,425
Land Acquisition	23,920	15,318	16,050	254,989
Project Cost	3,362,506	4,019,921	3,029,677	3,493,665

8.2.2 Project Cost of Pedestrian Underpass

The project cost of pedestrian underpasses were calculated following the cost estimation method. Estimation results of each pedestrian underpass are as shown in Table 8.9.

Table 8.9 Project Cost of Pedestrian Underpass

(Cost Unit: R.O)

Type of Cost	Barka P/U	A'Tareef P/U	A'Tharmad P/U	A'Suweiq P/U	Al Billah P/U	Al Khabra P/U
Construction Cost	97,895	102,391	103,978	99,270	95,013	93,866
Supervision	9,790	10,239	10,398	9,927	9,501	9,387
Land Acquisition						
Project Cost	107,685	112,630	114,376	109,197	104,514	103,253

Type of Cost	Majaz A'Sughra P/U	Qarih P/U	Al Qarat P/U	Asrar Bani Sa'd P/U	Liwa P/U	Khor A'Siyabi P/U
Construction Cost	93,799	93,001	93,129	92,790	94,832	92,210
Supervision	9,380	9,300	9,303	9,279	9,483	9,221
Land Acquisition						
Project Cost	103,179	102,301	102,442	102,069	104,315	101,431

CHAPTER 9

PROJECT IMPLEMENTATION PROGRAM

CHAPTER 9 PROJECT IMPLEMENTATION PROGRAM

9.1 Description of the Project

9.1.1 Background and Necessity of the Project

The Batinah Highway (National Road No.1) is an expressway (speed limit : 120 km/hr) stretching 274 kilometers from the capital of Muscat along the Gulf of Oman all the way to Khatmat Malahah near the United Arab Emirates. The Batinah Highway is positioned as a vital road link connecting Muscat to agricultural regions in the interior and to the neighboring United Arab Emirates.

The Batinah Highway has rotary-type at-grade intersections (roundabouts and junctions) in 18 locations. Monuments and others are positioned within the rotaries for scenic effect for the benefit of vehicle occupants and local residents. Nevertheless, while the highway is designed for a maximum speed of 120 km/hr, an almost complete absence of grade separations forces local residents to walk across the road. As a result, there are constant pedestrian accidents involving vehicles traveling at more than 100 km/hr. For the residents of villages divided by the highway, crossing over to the other side can be a dangerous undertaking. The construction of flyovers and pedestrian underpasses along the Batinah Highway is an urgent task for the Sultanate of Oman in the interests of public safety and smooth traffic flow.

To resolve these problems, the Sultanate of Oman, Believing that the development of roadways as an important infrastructure element for conveyance and transport is a basic requirement for domestic economic growth, has required that the Government of Japan perform the following:

- Feasibility Study on the Construction of Flyovers and Pedestrian Underpasses along the Batinah Highway
- Maintenance and Rehabilitation Plan for Bridges
- Detailed Design Study on the Construction of Flyovers and Pedestrian Underpasses based on the Feasibility Study

In response, the Japanese Government dispatched a study team for the Feasibility Study to Oman in February 1994 and that for the Detailed Design in December 1995. The Sultanate of Oman studied results of the Feasibility Study with the intent of incorporating them in the 5th Five Year Plan to be implemented in 1996 and has carried out the maintenance and rehabilitation program for bridges. Furthermore, the Sultanate of Oman intends to construct flyovers and pedestrian underpasses based on the Detailed Design Study in and after the 6th Five Year Plan.

9.1.2 Scope of the Project

This road development project will include the following construction matters.

- Construction of 8 flyovers on roundabouts and junctions
- Construction of 12 pedestrian underpasses
- Improvement of roundabouts
- Construction of ramp way to access flyovers
- Road improvement of connection around roundabouts
- Other related construction and improvement

9.2 Result of the Feasibility Study

9.2.1 Future Traffic Volume and Socio-economic Framework

Traffic volume in the Batinah district is high at about 2,000 vehicles per day. This demonstrates the attracting power of Muscat, that capital. An analysis of the socio-economic framework of this area leads to forecast that, by 2010, the population of Batinah area will reach 808,000 and the number of registered vehicles will increase 3.6 times to 975,000. Traffic volume is also forecast to increase by about three times from the present 69,700 vehicles to 210,000 vehicles by that time. Considering the likely apportionment of this traffic onto the Batinah Highway, it becomes apparent that, in areas with much traffic influx from roundabouts and junctions, traffic volume will become excessive and traffic demand will exceed the level at which it can be efficiently handled.

9.2.2 Economic Evaluation

As for the economic analysis, benefits resulting from a change in traffic flow which are brought about by the construction of flyovers, the cash flow method was used to calculate the economic internal rate of return, the net present value and the cost-benefit ratio. The economic internal rate of return (EIRR) was found to equal 12.9 ; the net present value (NPV), RO 2,146,000 ; and the cost-benefit ratio (B/C), 1.09. This shows that project is economically feasible.

Table 9.1 Result of Economic Evaluation on Construction of Flyovers

Economic Cost*	Benefit*	EIRR(%)	B/C	NPV*
23,848	25,994	12.9	1.09	2,146

*x 1000 R.O

(Source : Final Report on the Feasibility Study Conducted 1994)

As for the construction of pedestrian underpasses, an analysis of construction costs and traffic functions showed that this aspect would not be entirely economically feasible. However, in consideration of pedestrian safety, the implementation of this part of the project will certainly prove beneficial for those living along the Batinah Highway.

Table 9.2 Result of Economic Evaluation on Construction of Pedestrian Underpasses

Economic Cost*	Benefit*	EIRR(%)	B/C	NPV*
1,055	915	10.4	0.87	-140

*x 1000 R.O

(Source: Final Report on the Feasibility Study conducted 1994)

9.2.3 Environmental Impact and Aesthetics

Environmentally speaking, while there will be some impact on the environment during the construction of the facilities, there will be no fundamental, lasting impact. As for aesthetics, there are already a variety of monuments placed alongside the road and the construction of flyovers at crossings will produce some visual obstructions. For this reason a type judged to be the most aesthetically pleasing was selected for each roundabout. In the detailed design stage, work is required to assure the visual attractiveness of the superstructure, substructure, retaining walls and pedestrian underpasses.

9.3 Outline of the Detailed Design Study

9.3.1 Design Process

In the Detailed Design Study which follows on the Feasibility Study, eight flyovers and twelve pedestrian underpasses have been designed through the following 3 steps.

Step 1	Review of the Feasibility Study Confirmation of 8 flyovers and 12 pedestrian underpasses to be designed
Step 2	Detailed design work of 4 flyovers and 6 pedestrian underpasses of higher priority
Step 3	Detailed design work of remaining 4 flyovers and 6 pedestrian underpasses

Names of flyovers and pedestrian underpasses in each design step and their priority ranking are shown in Tables 9.3 and 9.4.

Table 9.3 Flyovers and Pedestrian Underpass to be designed in Step 2

Priority Ranking	Name of Roundabout	Priority Ranking	Name of Pedestrian Underpass
1	R/A-3 Barka	1	P/U-1 Barka
2	R/A-12 Sohar	2	P/U-3 A'Tareef
3	R/A-2 A'Naseem Garden	3	P/U-5 A'Tharmad
4	R/A-5 Al Muladdah	4	P/U-6 A'Suweiq
		5	P/U-2 Al Billah
		6	P/U-7 Al Khadra

Table 9.4 Flyovers and Pedestrian Underpass to be designed in Step 3

Priority Ranking	Name of Roundabout	Priority Ranking	Name of Pedestrian Underpass
5	R/A-10 Saham	7	P/U-9 Majaz A'Sughra
6	R/A-8 Al Khaburah	8	P/U-8 Qarih
7	R/A-14 Falaj Al Qabail	9	P/U-4 Al Qarat
8	R/A-18 Aqr	10	P/U-12 Asrar Bani Sa'd
		11	P/U-11 Liwa
		12	P/U-10 Khor A'Siyabi

9.3.2 Summary of Design Conditions

Design conditions for the detailed design of flyovers, road and pedestrian underpasses are described in Chapter 3. Therefore in this clause, the summary of such is shown below:

Highway design speed	:	120 km/hr
Rampway design speed	:	60 km/hr
Design live load	:	HS20-44 (AASHTO) increased 100% Special Truck TypeA, B1, B2
Type of superstructure	:	Simple beam, Continuous beam Post-tensioned prestressed concrete box girder
Span length	:	26m, 30m, 32m, 35m
Type of substructure	:	Abutment: Reinforced concrete inverted-T type
	:	Pier : Reinforced concrete rigid frame type Reinforced concrete T-shape type
Foundation type	:	Spread foundation Pile foundation (Cast-in-place concrete pile ϕ 600, 1000 mm)

9.4 Estimated Project Cost

Project cost for eight flyovers and twelve pedestrian underpasses are summarized as follows:

Table 9.5 Project Cost for 8 Flyovers with the Higher Priority

(Unit: R.O)

Name of Roundabout	Construction Cost	Land Acquisition	Supervision	Total
R/A-3 Barka	2,860,400	37,150	286,040	3,183,590
R/A-12 Sohar	4,083,781	3,900	408,378	4,496,059
R/A-2 A'Naseem Garden	2,875,251	45,210	287,525	3,207,986
R/A-5 Al Muladdah	2,919,043	79,120	291,904	3,290,067
R/A-10 Saham	3,640,548	15,318	364,055	4,019,921
R/A-8 Al Khaburah	3,035,078	23,920	303,508	3,362,506
R/A-14 Falaj Al Qabail	2,739,661	16,050	273,966	3,029,677
R/A-18 Aqr	2,944,251	254,989	294,425	3,493,665
Total	25,098,013	475,657	2,509,801	28,083,471

Table 9.6 Construction Cost for 12 Pedestrian Underpasses with the Higher Priority

(Unit: thousands R.O)

Name of Roundabout	Construction Cost	Supervision	Total
P/U-1 Barka	97,895	9,790	107,685
P/U-3 A'Tareef	102,391	10,239	112,630
P/U-5 A'Tharmad	103,978	10,398	114,376
P/U-6 A'Suweiq	99,270	9,927	109,197
P/U-2 Al Billah	95,013	9,501	104,514
P/U-7 Al Khadra	93,866	9,387	103,253
P/U-9 Majaz A'Sughrar	93,799	9,380	103,179
P/U-8 Qarih	93,001	9,300	102,301
P/U-4 Al Qarat	93,129	9,313	102,442
P/U-12 Asrar Bani Sa'd	92,790	9,279	102,069
P/U-11 Liwa	94,832	9,483	104,315
P/U-10 Khor A'Siyabi	92,210	9,221	101,431
Total	1,152,174	115,217	1,267,391

*Flyovers and pedestrian underpasses in the above table are listed in order of priority.

9.5 Project Implementation Program

9.5.1 Construction Time Schedule

The construction schedule of eight flyovers and twelve pedestrian underpasses for this project, assuming that they are to be executed in the 5th and 6th Five-Year Plans from 1996 to 2005, is shown in this draft final report.

Based on the conditions of working day and work efficiency in the Sultanate of Oman, the construction time schedule for this project is calculated the construction period as shown in Chapter 6.6.

The construction schedule of the typical flyovers and pedestrian underpasses is shown below Table 9.7 according to the results of the calculation for construction time schedule.

Table 9.7 Construction Schedule of Typical flyovers and Pedestrian Underpasses

Type of Construction	Construction Period
Flyover with Spread Foundation	20 months
Flyover with Pile Foundation	24 months
Aqr Flyover	24 months
Pedestrian Underpasses	8 months

9.5.2 Project Implementation Programme

Implementation programme for this road development project, which was based on the following conditions, is shown in Figure 9.8.

- Assumed project period is 10 years, corresponding to the combined periods of the 5th and 6th Five-year Plans.
- Flyovers and pedestrian underpasses are to be constructed in order of their priority.
- Maximum simultaneous construction of flyovers and pedestrian underpasses should be two locations since only two contractors are capable of completing the construction.
- Time schedule is estimated on the basis of typical construction time which is described in Chapter 6.6.

Table 9.8 Implementation Programme of Batinah Highway Project

			Fifth Five Year Plan					Sixth Five Year Plan				
			1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Final Engineering Design			12months									
(1) Flyover												
Preparation for documents				4		6		3	3	3	3	
Construction	Priority	Name of R/A										
	1	R/A- 3 Barka				20						
	2	R/A-12 Sohar						24				
	3	R/A- 2 A'Naseem Garden					20					
	4	R/A- 5 Al Muladdah						20				
	5	R/A-10 Saham							20			
	6	R/A- 8 Al Khaburah								20		
	7	R/A-14 Falaj Al Qabail									20	
	8	R/A-18 Aqr								24		
(2)Pedestrian Underpass												
Preparation for documents				2	2	2	2	4	4	4	4	
Construction	Priority	Name of P/U										
	1	P/U- 1 Barka		8								
	2	P/U- 3 A'Tareef			8							
	3	P/U- 5 A'Tharmad				8						
	4	P/U- 6 A'Suweiq						8				
	5	P/U- 2 Al Billah							8			
	6	P/U- 7 Al Khadra							8			
	7	P/U- 9 Majaz A'Sughra								8		
	8	P/U- 8 Qarih								8		
	9	P/U- 4 Al Qarat									8	
	10	P/U-12 Asrar Bani Sa'd									8	
	11	P/U-11 Liwa										8
	12	P/U-10 Khor A'Siyabi										8

9.5.3 Execution of the Project

(1) Executing and Management Agencies

The Directorate General of Roads (DGR), Ministry of Communications is the government agency responsible for the execution of the project and for the management, operation and maintenance of the Highway.

(2) Procurement Method

(a) Selection of Contractor(s)

The construction of the flyovers and the pedestrian underpasses will be performed along heavily traveled roads in the sultanate and it will be necessary for the contractor to be highly qualified, well organized and to have had previous experience of similar projects in the Sultanate of Oman.

- Pre-qualification of contractors; and
- Formal selective tendering.

(b) Selection of Consultant

With regard to the selection of the consultant for the supervisory services, it is desirable that the government contracts the consultant who has had previous experience of similar projects in the Sultanate of Oman to properly arrange the project proceedings.

(3) Attention to Construction Method

For the construction method, the following items will be fully considered:

- Existing smooth traffic flow will be maintained as far as possible during construction period, by provision of proper traffic diversions and control signs;
- A safety precaution system shall be fully applied to prevent construction accidents, since the construction will be performed in high speed traffic roads and the stoppage of traffic flow will result in vast economic loss.
- Price escalation for the project shall be considered in terms of 10 years construction period.

CHAPTER 10

TENDER AND CONTRACT DOCUMENTS

CHAPTER 10 TENDER AND CONTRACT DOCUMENTS

10.1 General

In preparing the tender documents for the construction of the proposed flyovers and pedestrian underpasses, the prevailing tendering practice of civil works in the Sultanate of Oman is considered as basic conditions. In general, for the tendering the documents shown in Table 10-1 are commonly used. The necessary documents of this projects were decided by the negotiation with DGR.

Table 10.1 Documents of Tender and Contract

Documents	Common	Particular
Pre Qualification	o	
Instruction to Tenderers	o	
Forms of Tender 1) Form of Tender 2) Form of Agreement 3) Form of Tender Bond 4) Form of Advance Payment Bond 5) Form of Performance Bond	o	
General Condition of Contract Special Condition of Contract	o	o
Bill of Quantities		o
General Specification Special Specification	o	o
Drawings		o

10.2 Pre Qualification

In the Sultanate of Oman, Pre Qualification process is usually applied for the construction of few experience, large scale construction and in case to invite foreign companies. But, whether its process is actually applied will be decided by the Tender Board.

First, an invitation to Pre Qualification will be published in journal or informed to Embassies for foreign companies. All the contractors which deemed have an ability to accomplish the project are requested to apply this invitation. It is advantageous for the Employer to include capable contractor to the coming tender and also for the contractors who are not capable to do so from wasteful efforts to prepare tender.
The Pre Qualification Documents consist of the following chapters

(1) Introduction
(2) Submission of Pre Qualification Documents
(3) General Information

(4) Contract Information
(5) Pre Qualification Data Instruction

10.3 Instruction and Form of Tender

Instruction and Form of Tender are common in all the projects. In the Sultanate of Oman they are stipulated in one document as Prime Document. The prime Document is prepared for each of the project location specifying the site and Scope of Work. The contents of the Prime Document are:

(1) Invitation to Tender
This comprises of an official letter by the Tender Board to the pre qualified firms, inviting them to tender for the project. The letter shall specify the manner to prepare the tender that are to be submitted, date of submission, etc.

(2) Instruction to Tenderers
A list of instructions of how to submit the tender, specifying the required supporting documents or particulars of the firm(s), the possibility of joint ventures etc.

(3) Scope of Work
This prescribes the work which shall be accomplished by the Contractor.

(4) Condition of Contract
This prescribes the documents which shall govern the contract.

(5) Condition of Particular Application
This defines the Employer, the Engineer and the Contractor

(6) Specification
This prescribes the Specification and Design Standard which shall specifies the engineering matters.

(7) Measurement of Work
This stipulate Bill of Quantities contains estimated quantities only.

(8) List of Equipment
The list of equipment that shall be used in the project.

(9) List of Personnel
The list of Personnel who shall be employed in the project Omani and Expatriate separately.

(10) Form of Tender
A standard Form specified by the executing agency, to be filled in by the tenderer, which contain the quoted price for the intended works. It becomes a binding document for the contractor for the intended works at the quoted price for a specified time period stipulated in the form, before the completion of

evaluation and selection of the best tender .

(11) Appendix to the Form of Tender
This prescribes the amount of bonds, third party insurance and interest. Also the day of commencement, maintenance period and so on.

(12) Form of Agreement
This is a standard form by the executing body, which duly signed by the successful contractor and the representative of the Government of the Sultanate of Oman, will constitute a legal and binding document for the execution of the project.

(13) Appendix "A" to Form of Agreement
This prescribes constitution of company

(14) Appendix "B" to Form of Agreement
The tender form is accompanied by a Summary of the Tender Price, in a format specified by the employer. The summary is a breakdown of the total tender price into various packages, or by the types of works, such as preliminaries, permanent works, sub-contracted works, dayworks, etc.

(15) Form of Tender Bond
This is also a standard form by the executing body to be filled in by a bank upon the deposit of a certain percent of the tender price by the contractor, as a guarantee bond against any withdrawal of his tender within the stipulated tender period.

(16) Form of Performance Bond
This is a standard form designated by the executing agency for the successful tenderer to secure a bond equivalent to a specified percent value of the contract price from an authorized bank against any dissatisfactory performance of the contract.

(17) Note to Contractor
Note to Contractor about effect of the Performance Bond.

(18) Form of Advance Payment Bond
Another standard form for the successful tenderer to secure a bond against the advance payment given to the contractor by the employer.

(19) List of Drawing
A list of Drawing that will be attached.

(21) Tenderer's Enclose

10.4 Condition of Contract

1) General Condition

General Condition of Contract are stipulated in "Standard Documents for Building and Civil Engineering Works" 3rd Edition July, 1981 and is published. It was agreed not to duplicate it for the project. The conditions contained in the document shown below are in accordance with "Condition of Contract for Works of Civil Engineering Construction" by "Federation Internationale Des Ingenieurs-Conseils "(FIDIC) modified considering local conditions.

(1) Definitions and Interpretation
(2) Engineer and Engineer's Representative
(3) Assignment and Sub-Letting
(4) Contract Documents
(5) General Obligations
(6) Labour
(7) Materials and Workmanship
(8) Commencement Time, Procedures and Delays
(9) Maintenance and Defects
(10) Alterations, Additions and Omissions
(11) Plant, Temporary Works and Materials
(12) Quantities
(13) Provisional Sums
(14) Nominated Sub-contractors
(15) Certificates and Payment
(16) Remedies and Powers
(17) Special Risks
(18) Frustration
(19) Settlement of Disputes
(20) Notices
(21) Default of Employer
(22) Changes in Cost and Legislation
(23) Miscellaneous

2) Special Condition

In general, the special conditions of Contract shall contain further provisions of a legal binding between the Employer and the Contractor, that are not specified nor covered in the General Conditions of Contract, or that are needed further details or clarifications, to suit the requirements and conditions of the said project.

But, according to the present practice in the Sultanate of Oman, those matters which need further prescription are contained in the "Appendix to the Form of Tender" in the Prime Document. So, the Special Condition is not prepared separately from it.

10.5 Bills of Quantity

The bills of quantity (BOQ) shall be prepared for tender. The BOQ to be included in the tender document for the estimated of the proposed project costs will basically follow the BOQ prepared and reported for the project.

10.6 Specification

1) General Specifications of Works

The detailed design of the proposed flyovers and pedestrian underpasses has been based chiefly on the specifications contained in the General Specifications for Roads April 1994 by the Ministry of Communications, it shall be General Specifications in the Tender Document for this project. It specifies the following items.

(1) General
(2) Earthworks
(3) Granular and Stabilised Subbase, Basecourse and Stabilised Subgrade
(4) Bituminous Pavement
(5) Concrete and Concrete Structure
(6) Structural Steel and Other Metal Works
(7) Paint
(8) Drainage and Service Ducts
(9) Slope Protection and Stabilisation
(10) Piling
(11) Bridge bearings, Expansion Joints, Joint Seals and Fillers
(12) Sidewalks, Paved areas and Curbs
(13) Safety Barriers, Delineators and Fences
(14) Highway Signs and Road Markings
(15) Electrical Installations
(16) Landscape and Irrigation
(17) Utilities
(18) Plant and Equipment

2) Special Specifications of Works

Specifications on design, materials proposed by this Study that are not covered in the General Specifications of Works shall be specified in the special specifications of works. Items to be covered in supplementing the General Specifications shall cover the following items.

(1) Engineer's Office
(2) Surveying Instruments
(3) Engineer's Accommodation
(4) Laboratory and its Furnishings
(5) Contractors Compound
(6) Maintenance and Protection of Traffic
(7) Progress Photographs

(8) Sign Boards
(9) Commemorative Plaque and Opening Ceremony
(10) As Built Drawings
(11) Clearing and Grubbing
(12) Concrete Mixes
(13) Utilities
(14) Preamble to the Bill of Quantities

Engineer's Accommodation, however, is not applicable for the sites located in the Capital region and Sohar.

10.7 Drawings

This Drawings based on the detailed design of the project consist part of the Tender Document. Tenderers are requested to estimate their quotation based on the design shown in the Drawings.

CHAPTER 11

ENVIRONMENTAL IMPACT ASSESSMENT

CHAPTER 11. Environmental Impact Assessment

11.1 Description

Sultanate of Oman has set an example to the world by maintaining a judicious balance between the needs of the development and the environment. So that the environmental consideration of any development project is required. Oman has licensing system in which an Environmental Impact Statement (EIS) is for a statement on impact on the environment caused by the project and this statement requires by the Ministry of Environment and regional Municipality. Meanwhile JICA projects intend to attain environmental conservation aspects in simultaneously going with aspects of economical development and technical consideration.

The required EIS is stated those of general description of the project and identification consideration of presumed environmental impacts caused by the development activities. The study on this project intend to consider more details of environmental conditions and aspects than EIS level for which presume to the year of 2010 and this environmental study is described in following section.

In May 1996, the JICA Study Team contracted a local consulting firm to conduct an EIA as a part of the Detail Design Study on the Road Development Project in the Sultanate of Oman in accordance with the relevant laws and regulation in force in the Sultanate of Oman and JICA Guideline. The time frame for the EIA was estimated for the three months, from May 1996 to August 1996.

11.2 Procedure of the Environmental survey

11.2.1 Environmental Survey Method

(1) Requirement of Environmental Impact Assessment

The Environmental Impact Assessment(EIA) works required for the detailed design study on road development project in the Batinah Highway Sultanate of Oman are as follows.

1) Environmental survey on the present conditions
2) Extracting environmental Impacts factors
3) Environmental impact forecast
4) Environmental Impact assessment
5) Reporting

(2) Environmental Survey on the Present Condition

The environmental survey has being carried out in May 1996 at selected locations of the study 8 Roundabouts and 12 Pedestrian underpasses. The investigation area as follows:

Flyover Section

R/A-2 A' Naseem Garden, R/A-3 Barka, R/A-5 Al Muladdah, R/A-8 Khaburah ,R/A-10 Saham, R/A-12 Sohar, R/A-14 Falaj Al Qabail, R/A-18 Aqr.

Pedestrian Under Pass Section

P/U-1 Barka, P/U-2 Al Billah, P/U-3 A' Tareef, P/U-4 Al Qarat, P/U-5 A' Tharmad, P/U-6 A' Suweiq, P/U-7 Al Khadra, P/U-8 Qarih, P/U-9 Majaz A' Sughra, P/U-10 Khor A' Siyabi, P/U-11 Liwa, P/U-12 Asrar Bani Sa'd.

The survey is covering an area measuring 100 m on each side of the center line of Batinah Highway.

- Collection of existing data on social and natural environment, environmental pollution.
- Field reconnaissance, Hearing with relevant authorities and residents
- Measurement of exhaust and traffic noise

The items to be surveyed are as follows:

- Social environment:
  Resettlement/ land acquisition, Traffic and community facilities,
  Historical remains and cultural properties, Grave yards, Disasters and risk areas,
  Economic activities, Construction waste
- Natural environment:
  Topographic and geological conditions, Existing trees, shrubs and vegetation, Soil erosion
- Pollution:
  Noise and vibration, Atmospheric quality, Water and soil pollution

Above detailed survey items are shown Appendices IV, Table IV-1 Detailed Survey item. Regarding with the pollution, total number of locations and duration for noise level and atmospheric pollution survey are as follows:

1) Noise Level: 5 locations
   (1 day, 6:00-22:00, 18 times/days (2 hours interval), 1 time-10 min.)

2) Atmospheric quality: 5 locations
   (SO_X, NO_X, CO, Pb: 1 day, 12 times/day, 1 time-30 min.)
   (SPM: 1 day (same with SO_X, NO_X, CO, Pb), 12 times/day, 1 time-30 min.)

The location for the survey in particular are as follows;
Flyover section: R/A-3 Barka, R/A-8 Khaburah, R/A-12 Sohar,
Pedestrian Under Pass Section: P/U-3 A'Tareef, P/U-9 Majaz A' Sughra

11.2.2 Procedure for Identification of Environmental Impact Factors, Forecast and Assessment

Based on the results of the above surveys, possible environmental factors are to be examined for the each items, and important impact factors are to be identified. According to the surveyed results, the measured level of environment impact factors are to be forecasted to the year 2010. The environmental impact caused by the project are to be examined and assessed for any adverse impact. Mitigation measures again the assessed adverse effects are to be proposed.

11.3 Environmental Impact Statement

Based on the requirement by Directorate General of Environment Affairs, the Ministry of Regional Municipality and Environment, The JICA Study team has cooperated together with Directorate General of Road (DGR) and made an application form of Environmental Impact Statement (EIS-Form L) for the Project and then this EIS application Form had been submitted to the Department of Environment and Permission (DEP), Directorate General of Environmental Affairs on February 1996. (See Appendices IV, Table IV-2 EIS Application Form submitted to the DEP, Ministry of Regional Municipalitiesand Environment).

11.4. Environmental Condition of Batinah Region

11.4.1 The topography and geology

The Batinah area is located in the northern part of the Sultanate of Oman and ranges from Musandam Peninsula southeasterly to the Sharqtya region, and forms an arc to the eastern Hajar mountain range. The topological and geological characteristics follow the pattern of this range, and the fertile and populous coastal plain known as the Batinah coast slopes gradually from the northeast side of the foothills. The region is divided into the high tablelands and the coastal plains. The fluvial wadi plains, and the coastal plains which from the four principal areas of the project area. From the foothills to the coast line there are many pediments and a wide plain with many wadis. Further north is the alluvial plain

which forms a fertile coastal plain washed by rivers with sand-gravel beds, detritus layers, and alluvialbeds.

11.4.2 Climate

Oman has an arid subtropical climate. The weather in the project area consists of summer type (June - September) and winter type (November - April); and the seasons in between are mostly dry and change constantly. In the summer months due to the dominating high pressure cell prevailing over the Indian Ocean there is a low pressure cell which blows from northwest India, and the southwest trade wind dominates.

The average annual rainfall in Batinah region is 121 mm. The maximum average winds are 6.6m/s from April to June, and the minimum winds from November to January are 1.8m/s. The Maximum temperature is 47 - 48℃ in June, and the minimum is 19 - 25℃ in January. The relative humidity is 64%. the average monthly relative humidity is 70 - 80% and occurs in August and from November to January. The minimum is 40 - 50% during April to June, and 50 - 60% from September to November.

11.4.3 Fauna of northern region

The flora of northern region is said that in many ways unique, providing important links between the basically African flora of southern Arabia and the Asiatic plant communities across the Gulf to the east. The isolated mountains of Oman had also seen the evolution of plant species which were not to be found elsewhere.

Oman is considerably more arid than most of East Africa, however, and this has inhibited development of the true savanna grasslands. Many of the Oman desert plants are short-lived annuals, which evade the extreme temperatures and desiccation of the desert environment by assuming the form of drought-resistant seeds for most of the year. In the mountain valleys, some of the larger lowland trees, such as *Acacia*, *Ziziphus* and *Prosopis*, *Nerium mascatense*, wild fig trees, while other woody shrubs with showy flowers, such as *Acridocarpus*, begin to be seen.

11.4.4 Social environment

(1) Population of Oman

The world Bank estimated the population as 1,600,000 in the year 1989. According to the Initial Results of Census - December 1993 - The population of the Sultanate was 2,017,591 out of which more than half were living in the capital area and Batinah regions the population of Muscat and Batinah were found to be 622,506 and 538,763 respectively. (Source: Statistical Yearbook 1994, Ministry of Development. JICA FeasibilityStudy 1994)

(2) Population in Batinah region

According to the Annual Average Growth Rate (AAGR) of population data basis, the total population of Batinah region in 1993 was 538,763 out of which 458,084 (85%) were Omani and 80,679 (15%) were Non-Omani. Population by Wiray at and average household size in Batinah region shows in the Table 11-1 and Table 11-2.

Table 11-1 Population by Wilayat in Batinah Region, 1993

Wilayat	1993 Census population	Initial estimated population
Shohar	90,809	85,857
A'Suweiq	85,025	81,165
Saham	74,904	71,671
Barka	64,526	61,164
Al Masnaah	47,560	45,414
Shinas	44,313	42,533
Al Khaburah	40,760	38,429
Liwa	22,667	21,463
Others (4 Wilayat)	94,113	91,067
Total	564,677	538,763

Table 11-2 Average household size in Batinah Region, 1993

	Total population	Number of households	Average House hold (persons)
Al-Batinah	564,677	89,259	6.3

(3) Land and Urban development along the Batinah region

Industrial developments at Majees and A'Naseem Garden were noted and taken into account in estimating future trip generations from these two areas. Inquiries with the various ministries concerned on land development in the Batinah region revealed that development plans are being implemented to meet the expected increase in population in the various Wilayats.

(4) Towns and villages distribution along the Batinah Highway

Towns and villages along the highway are mainly distributed sea side area adjacent old highway with long historical background, and new portion of towns and villages settlement along the highway have been developed recent two decades after development of the Batinah highway. Therefore settlements at round about along the highway are mainly commercial type facing to the road, and some residential use areas are located behind of these commercial area and others are agricultural use and vacant area.

11.5. Environmental Impact Assessment

11.5.1 Social Environment

(1) Survey Method

In order to determine probable socio-economic impacts of the Round about (R/A) and Pedestrian Underpass (P/U) through the Batinah Highway, areas of 8 R/A and 12 P/U were surveyed. The areas on each side of roads within 100 m far from centerline of existing road are surveyed. Using 1:10,000 scale topographic maps combined with information gathered during survey field visit. Along each project areas, total 52 samples were randomly selected to be interviewed. A questionnaire was prepared and through visiting hearing survey regarding information on household numbers, nationality, property ownership, employment status, owners employment and general opinion to the project had been made. The questionnaire were tabulated for statistical analysis of data.

(2) Land use condition, public facilities distribution and settlement condition

Land use along the Batinah highway is used for different purposes such as commercial, residential, agricultural. Roadside facade of R/A and P/U are mainly commercial use and adjacent to this commercial area residential is situated behind. Agricultural use area often situated next to commercial use area. Existing land use, public facilities distribution at R/A,P/U areas are shown in the Table 11-3 and Table 11-4.

Table 11-3 Existing land use, public facilities distribution and settlement condition of R/A area

R/A	Land use	Numbers of Facility within 1 km radius area				Condition of Settled Area		
						1 km radius circle area		Building
		Mosque	School	Clinic, hospital	Gov. office	Area (km2)	Ratio (%)	(Nr / 10ha)
R/A-2 A'Naseem garden	Agr. /Res.	2	0	0	0	0.019	0.5	3
R/A-3 Barka	Comm./Res.	2	0	1	1	0.130	4.2	86
R/A-5 Al Muladdah	Comm./Res.	7	0	0	0	0.835	26.6	63
R/A-8 Khaburah	Comm. /Agr.	8	2	2	4	0.360	11.5	68
R/A-10 Saham	Comm./Res.	8	2	2	5	0.985	31.4	75
R/A-12 Sohar	Comm./Res.	16	1	1	12	0.825	26.3	108
R/A-14 Falaj Al Qabail	Comm./Res.	3	0	0	0	1.085	34.6	83
R/A-18 Aqr	Comm./Res.	6	0	0	0	0.280	8.9	43

Note: Agr.: Agriculture, Comm.: Commercial, Res.: residential

Table 11-4 Existing land use, public facilities distribution and settlement condition of P/U area

P/U	Land use	Numbers of Facility within 500 m radius circle area								Condition of Area	
		Mosque		School		Clinic, hospital		Govern't office		500 m radius circle area	
		In	Out	In	Out	In	Out	In	Out	Area (km2)	Ratio(%)
P/U 1 Barka	Comm./ Res.	0	(2)	0	(0)	0	(0)	1	(0)	0.33	41.9
P/U 2 Al Billah	Agr./Res.	1	(1)	1	(0)	0	(0)	0	(0)	0.12	15.2
P/U 3 A' Tareef	Comm./ Res.	1	(3)	0	(1)	1	(0)	0	(3)	0.48	61.1
P/U 4 Al Qarat	Comm./ Res.	0	(1)	0	(1)	0	(0)	0	(0)	0.39	49.7
P/U 5 A' Tharmad	Comm./ Res.	2	(2)	0	(0)	0	(0)	0	(0)	0.39	49.7
P/U 6 A' Suweiq	Comm./ Agr.	0	(3)	2	(1)	0	(0)	0	(4)	0.24	30.6
P/U 7 Al Khadra	Comm./ Agr.	0	(2)	0	(2)	0	(0)	0	(0)	0.18	23.6
P/U 8 Qarih	Comm./ Res.	1	(3)	0	(1)	0	(0)	0	(0)	0.1	12.7
P/U 9 Majaz A' Sughra	Comm./ Res.	3	(3)	0	(0)	0	(0)	0	(0)	0.31	39.5
P/U10 Khor A' Siyabi	Res.	1	(0)	0	(1)	0	(0)	0	(0)	0.25	31.8
P/U 11 Liwa	Comm./ Res.	0	(0)	0	(0)	0	(0)	0	(0)	0	0.0
P/U12 Asrar Bani Sa'd	Agr./Res.	2	(3)	1	(0)	0	(0)	0	(0)	0.41	52.2

Note: Agr.: Agriculture, Comm.: Commercial, Res.: residential

In :Facilities within 500 m of radius area, Out: Facilities outside of 500 m radius area.

- **Grave yard**

Grave yards are locating near by vicinity of R/A 5, Al Muladdah and R/A 14, Al Qabail. There grave yards will effect to the right of way of Batinah Highway.

(3) Affected Area, buildings, houses and shops

On the basis of new arranged alignment of service roads in connection with R/A, there are 4 shops , 2 garages are partially affected and lands adjacent to the service roads. The numbers of those existing shops and land to be acquired are shown in Table 11-5.

Table 11-5 Affected area and buildings at Round About

Items	Objects	Unit	Quantities							
			R/A 2 A'Naseem Garden	R/A 3 Barka	R/A 5 Al Muladdah	R/A 8 Khaburah	R/A 10 Saham	R/A12 Sohar	R/A 14 Falaj Al Qabail	R/A 18 Aqr
Land	Commercial	m2	-	260	780	-	983	-	1,605	-
	Residential	m2	-	-	-	1,070	-	1,070	-	448
	Agricultural	m2	7,430	-	7,170	9,620	710	9,620	-	-
	Vacant land	m2	-	-	-	-	-	-	-	50,281
Buildings	Residential	Nr	-	-	-	-	-	-	-	-
	Commercial	Nr	1	1	-	-	1	-	1	-
	Others	Nr	-	-	-	1 (garage)	-	-	-	1 (garage)

Considering above situation, various service road alignments has been studied for minimizingof affection to the shops as well as land.

- **Resettlement, land acquisition and compensation**

The service road arrangement will require the acquisition of land (mainly agriculture land and vacant land) near the R/A. According current regulations, transfer of land to construct highway project must be based on the following;

The Ministry of Communication (MOC) submits its plans to the Ministry of Communication (MOC).

The plans are the submitted to the office of the Ministry of State for Legal Affairs which prepares a Royal Decree. On the basis of the Royal Decree, the amount of compensation the land owner will receive is fixed in accordance with standard scale.

(4) Social and Economic condition based on hearing survey

The hearing survey had been carried total 52 samples selected randomly among community settlements for 20 numbers of R/A and P/U project areas, each project area had 2 to 4 samples. As for most general land use pattern along the highway, commercial area is mainly expanded along the highway and residential area is located behind of this commercial area. Property condition of the houses, shops and registered condition of these buildings, households condition of residents and employment condition of the shops are shown following Table 11-6.

Table 11-6 Property condition, household condition

Ownership		Tenant		Total sample	
14	27 %	38	73 %	52	100 %

House, shop & building				Total sample	
Registered		Non registered			
23	44.2 %	29	55.8 %	52	100 %

Household condition (12 houses)	
Persons lived	Av. per household
8 - 32 persons	14.8 person / Hh

Employment (39 shops / 93 employee)					
Omani		Egyptian		Asian	
3	3 %	1	1 %	89	96 %

Also hearing survey asking to headmen or owners of houses and shops had been carried. Regarding with an opinion to the project, They have totally positive opinion to the project. Following Table 11-7 shows situation of property owner's employment and their opinion to the project.

Table 11-7 Employment of property owner and opinion to the project

Property owner's employment (52 samples)							
Business man		Officials		Farmer		No disclosed	
	(%)		(%)		(%)		(%)
24	46.2	3	5.8	1	2	28	53.8

Opinion to the Project			
Positive		Negative	
	(%)		(%)
52	100	0	0

Most of residents are expecting an improvement of existing condition of R/A for safety and smooth traffic circulation and safety road crossing system of P/U.

(5) Social and Economic activities

1) Effect of traffic to the residence and public facilities

Project areas of R/A are tending to be important traffic and transportation nodes for these districts and communities. Smooth grade separated traffic flow will be given much safety condition to the community peoples. Since public facility such as mosques, schools, clinics and hospitals well as market and shops are distributed both side along the highway, so that projection of pedestrian underpass will be secured daily activities of community residents with safety crossing of the highway.

2) Industry and industrial land to be influenced

Implementation of flyover will be largely contributed to fast and safety transportation of industrial materials and products, these flyover system will encourage more increase of industrial opportunity to the highway vicinity areas.

3) Agriculture areas to be influenced

Agriculture land area is expanded along the Batina highway, flyover sections are quite limited points comparing to all way of Batina highway. Construction of flyover and pedestrian underpass will not be given any damage to the agricultural activities, but much more benefit given to smooth transportation for agricultural products.

(6) Construction waste

According to the construction of flyover and it's related road arrangement, removal of existing structures and obstructions are to be generated. Major removal items are 1) Concrete, 2) Asphalt concrete and 3) Others. These generated construction wastes are mostly non-hazardous solid wastes, and these concrete and asphalt concrete are crashed into small segment from original form, then those are to be dumped at the disposal yard. It is commonly practiced in Oman that reuse of the removed asphalt concrete is to be utilized for base course materials to the other road improvement, and 90 % of removed asphalt concrete volume come to be re-utilized, therefore 10 % of removed one is to become object of disposal material. Following Table 11-8 shows construction waste volumes at each project sites.

Table 11-8 Generated Construction Waste volume at each project site

Location of the Project		Concrete m3	Asphalt conc. m3			Note
			Generated vol.	Reusable portion	waste portion	
A' Naseem Garden	R/A-2	245	5,771	5,194	577	324m(block fence incl.)
Barka	P/U-1		68	61	7	
	R/A-3	341	6,884	6,196	688	
Al Billah	P/U-2		100	90	10	
A' Tareef	P/U-3		109	98	11	
Al Muladdah	R/A-5	51	4,831	4,348	483	
Al Qarat	P/U-4		88	79	9	
A' Tharmad	P/U-5		105	95	10	
A' Suweiq	P/U-6		103	93	10	
Al Khadra	P/U-7		99	89	10	
Qarih	P/U-8		100	90	10	
Al Khaburah	R/A-8	423	5,159	4,643	516	370m(block fence incl.)
Saham	R/A-10	668	4,562	4,106	456	
Majas A'Sughra	P/U9		88	79	9	
Khor A' Siyabi	P/U-10		119	107	12	
Sohar	R/A-12	445	6,079	5,471	608	
Falaj Al Qabail	R/A-14	125	3,978	3,580	398	
Liwa	P/U-11		85	77	8	
Asrar Bani Sa'd	P/U-12		79	71	8	
Aqr	R/A-18	41	4,680	4,212	468	
Total		2,339	43,087	38,779	4,308	

- Waste disposal site

Regarding to the waste disposal, each municipality has management system of waste disposal and prepares proper waste disposal yards where locally generated wastes and building rubbles to be dump. These disposal yards are located 3 to 20 km (mostly 5 to 10 km) towards mountain side from the each project sites. (See Appendix IV, Table IV-4 Waste disposal site). For the large scale of construction waste from development project, proper site for those project originated solid waste shall be considered by contractor under official guidance of local municipality and permission of Ministry of Regional Municipalitiesand Environment through application.

- Waste regulation

Sewerage and discharge water generated from temporally construction camp site may be affected to the ground water of Wadi if these sewerage water will discharge without any treatment. Proper regulation and guidance will be applied for setting a location of construction camp site and treatment of discharge water. These are guided by Regional Municipality and Ministry of Regional Municipality and Environmental.

Contractor shall be submitted necessary applications to the authority concerned.

(7) Borrow pit

Borrow pits for earth materials for the construction of road is commonly established by the contractor. A borrow pit can be secured at the foot of the Hajar Al Gharbi mountain range within a distance of 20 km from each project area. Existing borrow pits along Batinah highway from Seeb international airport to Shinas, there about 9 locations are used currently. So that at the construction stage, there is a necessity to carefully survey for an appropriate site for borrow pit for earth materials. Following Table 11-9 shows borrow earth and aggregate volume for each project.

Table 11-9 Borrow earth and aggregate volume

Location of the Project		Borrowed earth volume (m3)			Aggregate volume (m3)			
		Road work	Retaing wall	Sub Total	Fly over	Road work	P/U	Sub Total
A' Naseem Garden	R/A-2	62,000	5,834	67,834	364	12,470		12,834
Barka	P/U-1						128	128
	R/A-3	37,772	4,543	42,315	338	15,798		16,136
Al Billah	P/U-2						114	114
A' Tareef	P/U-3						115	115
Al Muladdah	R/A-5	42,727	11,687	54,414	343	13,933		14,276
Al Qarat	P/U-4						114	114
A' Thanmad	P/U-5						116	116
A' Suweiq	P/U-6						112	112
Al Khadra	P/U-7						112	112
Qarih	P/U-8						112	112
Al Khaburah	R/A-8	62,112	581	62,693	348	11,115		11,463
Saham	R/A-10	62,207	591	62,798	338	13,084		13,422
Majas A'Sughra	P/U9						114	114
Khor A' Siyabi	P/U-10						115	115
Sohar	R/A-12	91,430	390	91,820	452	13,990		14,442
Falaj Al Qabail	R/A-14	93,628	7,499	101,127	339	12,320		12,659
Liwa	P/U-11						114	114
Asrar Bani Sa'd	P/U-12						110	110
Aqr	R/A-18	171,159	0	171,159	307	10,038		10,345
Total		623,035	31,125	654,160	2829	102,748	1,376	106,953

(8) Historical remains and Cultural properties

There are no Historical remain and cultural property within the R/A and P/U project areas. Most of the project areas are located within the right of way of Batinah highway. Historical remains and Cultural properties managed by the Ministry of Cultural Heritage are situated

at old town area such as Barka and Sohar and these are far distance from the highway.

- **Aesthetic condition**

Major R/A has landscaped monument for the identification of the each district. Some are consisted with artificial symbolic object with plantings of trees and shrubs and some are composed of plantings. All of these monuments have functional role to the each district's representative landmarks and look quite good. So that flyover alignment and design shall be considered in harmony with these aesthetic landscape resources.

(9) Disaster and Risk: Wadi and flash flood

There are distributed numbers of wadis along the Batinah highway originated from the Hajar Al Gharbi mountain range to Batinah plain. However there are few and small scale wadis located nearby the R/A and P/U. At the bypass route of Aqr R/A there is small wadi catchment located, and this area requires drainage system and box culvert to lead surface water flow along this bypass route. Nearby R/A-8 Al Khaburah, R/A-14 Falaj Al Qabail and R/A Aqr, wadis at R/A and P/U areas are crossing under the highway by box culvert system and drainage water is flowing to seaside when it is rains.

11.5.2 Natural Environment

(1) Characteristics of vegetation and ecological condition

Much of northern Oman's plant life at lower and 'middle altitudes is largely African in character and origin. Oman is considerably more arid and it has inhibited development of the true savanna grasslands. Many of the desert plants are short-lived annuals, which evade the extreme temperatures and desiccation of the desert environment by assuming the form of drought-resistant seeds for most of the year. They grow quickly, flowering and fruiting within a few weeks after the infrequent rains. Those plants which do live year-round have developed means of reducing their water losses by shedding leaves or other parts and by suspending their growth until the rains again bring moisture. In the mountain valleys, some of the larger lowland trees, such as *Acacia*, *Ziziphus* and *Prosopis*, *Nerium mascatense*, while other woody shrubs with showy flowers, such as *Acridocarpus*, begin to be seen.

(2) Vegetation at R/A and P/U area

Landscaping at the R/A areas and road side areas has been developed along Batinah highway . Most of R/A and road side areas have been planted with rows of trees. Trees, shrubs and ground cover plants have been well grown and establishing good landscape conditions, Following are major tree and shrub species planted at R/A and P/U area along the highway.

Pithecellobium Dulce, Zizyphus Spina-Christi, Ficus Benjamina, Pongamia Glabra, Phoenix Dactylifera, Azadirachta Indica, Prosopis Cineraria, Carissa Grandiflora, Tecoma Stan, Ficus religiosa, Casuarina Equisentifolia, Delonix Elata, Bougainvillae sp., Hibiscus Rosa-Sinensis, Peltophorum Inerme. (See Appendices IV, Table IV-5 Planted major trees at R/A, P/U area and road side)

(3) Affected trees by construction

Due to implementation of flyover at the R/A, some of the existing trees and shrubs are affected and to be transplanted the other area of the R/A site. Following Table 11-10 show numbers of trees affected by the flyover construction project.

Table 11-10 Affected trees at Round About area

Location		R/A 2 A'Naseem Garden	R/A 3 Barka	R/A 5 Al Muladdah	R/A 8 Khaburah	R/A 10 Saham	R/A 12 Sohar	R/A 14 Falaj Al Qabail	R/A 18 Aqr
	Trunk diameter								
Quantity	Dia. over 30 cm	2	3	7	43	58	83	112	7
	Dia. under 30cm	67	75	104	44	1	176	1	54
	Total	69	78	111	87	59	261	113	83

(4) Fauna

Most of variety of fauna species are inhabited in the higher mountain range. In the low land plain of Batinah coast, as for mammalian species, there are rats and mice, bats and hedgehog (Paraechinus aethiopicus) commonly inhabited. In the mountain area there are more than 70 species of avifauna are reported to inhabit and near 60 % of them are migrant birds. Since area along the Batinah highway have been developed mainly agricultural area, there is less wild fauna inhabited and no variable species within the project areas of R/A vicinity.

- Regulation of protection for Natural Environment

Ministry of Regional Municipalities and Environment, Ministerial Decision no.207/93. pursuant to the law for conservation of environment and prevention of pollution, issued by Royal Decree no. 10/82 and its amendments. And Ministerial Decision no. 4/76. It is described that the hunting, catching and shooting of animals and birds is prohibited throughout the territory of Oman.

11.5.3 Pollution

(1) Air Quality

The assessment of air quality impacts involved monitoring existing air quality to obtain basic information, and air quality modeling to reduct future pollution levels resulting from vehicle emissions. The result were then compared with the criteria.

1) Existing ambient air monitoring and monitoring location

Ambient air quality was monitored from May. 1996 along the Batina highway. The monitoring period for every location was one day continuously. The pollutants monitored were carbon monoxide (CO), nitrogen dioxide (NO2), sulfur dioxide (SO2), and total suspended particulate matter (SPM).

Monitoring points were established on the coastal side of the dual carriageway at each location. At the 3 existing roundabout locations, Barka, Al Khaburah, Sohar, the monitoring location was established on the coastal side of the dual carriageway on the Muscat side of the roundabout. At the two locations where pedestrian underpasses are to be developed, A'Tareef and A'Sughra, the monitoring location was established on the coastal side of the dual carriageway on the Muscat side of the existing round about. Table 11-11 shows the location and deployment of monitoring equipment.

Table 11-11 Location and deployment of monitoring equipment

Locality	Distance of Air Monitor from dual carriageway	Distance from Noise Monitor from edge of dual carriageway	Distance of trailer from Generator
Barka	5.9 m	4.3 m	84.25 m
A' Tareef	4.8 m	6.1 m	32.2 m
Al Khaburah	5.5 m	5.8 m	51.8 m
A' Sughra	6.4 m	6.7 m	78.2 m
Sohar	6.4 m	5.7 m	80.6 m

2) Gaseous monitoring equipment

The selection of equipment for use in this project was made on the basis of criteria described below. The air pollutant monitoring equipment was established in an air conditioned trailer where ambient temperatures were maintained below 20 degrees Celsius.

Sulphur dioxide: Sulphur dioxide was determined using a Thermo Environmental (Model 36A) pulsed fluorescence ambient air analyser.

Nitrogen Oxides (NOx): Nitrogen oxides were determined using a Horiba NOx chemiluminescenceambient air analyser (Model No. APMA-350-E). This instrument measures nitric oxide and NOx (nitrogen oxides expressed as the equivalent volume concentration of nitric oxide). Nitrogen dioxide concentration is determined as the difference between NOx and nitric oxide concentrations. Data were recorded on a data logger.

Carbon Monoxide: Carbon monoxide was determined using a Horiba non-dispersive infra-red ambient air analyser (Model No. APNA-350-E). Data were recorded on a data logger.

3) Data logger

Data from the 3 ambient air monitoring instruments was recorded at 10 minute intervals on a multi-channel data logger. The data logger used was a Fluke Databucket 2635A with data recorded on a memory card. Data were recorded as 0-10 V output from the instruments. The values recorded are the instantaneous readings of the analysers not the average reading for the ten minute interval between readings. In addition to the time of monitoring the following parameters were recorded: nitric oxide concentration; NOx concentration, nitrogen dioxide concentration, sulphur dioxide concentration and carbon monoxide concentration.

4) Dust monitoring equipment

Total suspended particulate matter (SPM) was measured using the Grimm Particulate Analyser model 1.105. This monitor also collected a sample of the dust passing through the instrument.

Applied monitoring eqipments for this survey are shown in following Table 11-12

Table 11-12: Monitoring equipments

Monitoring item	Monitoring Eqipment	
Particulates	Grimm dust monitor	Model 1.104
Carbon monoxide	Carbon monoxide analyser	Horiba APMA-350E
Nitrogen oxides	Nitrogen oxider analyser	Horiba APMA-350E
Sulphur dioxide	Thermo environmental instruments	Model 45A
Noise level	Bruel and Kjaer	Type 2231 Modular precision sound level meter Statistical module BZ7110, Microphone type 4155

Basis of interpretation

The ambient air monitoring data and the chemical analysis data have been compared with WHO guidelines to assess the current state of the environment at the 5 locations monitored during this study. A summary of relevant WHO guidelines is given in Table 11-13. For the purposes of this evaluation the reported parameter NOx (nitrogen dioxide plus nitric oxide expressed as nitrogen dioxide) has been compared with the WHO guideline value for nitrogen dioxide.

Table 11-13 WHO Guidelines values and limits for air quality

PARAMETER	WHO LIMIT - guidelines	
SO2 Sulphur dioxide	500 mg/m3 Averaging time 10 mins	350 mg/m3 Averaging time 1 hour
NO2 Nitrogen dioxide	400 mg/m3 Averaging time 1 hour	150 mg/m3 Averaging time 24 hours
CO Carbon monoxide	60 mg/m3 Averaging time 30 mins 10 mg/m3 Averaging time 8 hours	30 mg/m3 Averaging time 1 hour
Particulates	120 mg/m3 Averaging time 24 hours	(Total suspended particulates)
Pb Lead	0.5-1.0 mg/m3 Averaging time 1 yr	

1) Summary and evaluation of chemical monitoring data

Monitoring data were collected for 5 sites of the Batinah dual carriageway over a five day period in May 1996. Below is a summary of salient features of the monitoring data obtained as these relate to the 5 sites as a group.

Nitrogen oxides (NOx): Hourly average values for NOx (the combined amounts of nitrogen dioxide and nitric oxide expressed as the equivalent concentration of nitrogen dioxide) measured between 06:00 and 22:00 on the dates from 25th to 29th May 1996 fell in the range 0 to 225 micrograms per m^3. None of the recorded hourly averages exceeded the WHO hourly average limit of 400 micrograms per m^3.

Carbon monoxide: Hourly average values for carbon monoxide measured between 06:00 and 22:00 on the dates from 25th to 29th May 1996 fell in the range 0 to 2.8 milligramsper m^3. None of the recorded hourly averages exceeded the WHO hourly average limit of 30 milligramsper m^3.

Sulphur dioxide: Hourly average values for sulphur dioxide measured between 06:00

Sulphur dioxide: Hourly average values for sulphur dioxide measured between 06:00 and 22:00 on the dates from 25th to 29th May 1996 fell in the range 0 to 53 micrograms per m^3. None of the recorded hourly averages measured at any of the 5 locations exceeded the WHO hourly average limit of 350 micrograms per m^3.

Particulates: Hourly average values for particulates (SPM - suspended particulate matter) in air measured between 06:00 and 22:00 on the dates from 25th to 29th May 1996 fell in the range 179 to 2442 micrograms per m^3. All the recorded hourly averages and the 16-hour average exceeded the WHO 24-hour average limit for particulates in air. At Barka the highest concentrations of particulates were recorded during the afternoon. At Sohar the concentrations of particulates were generally lower than at the other 4 sites.

Lead: Lead was determined in a sample of particulates collected on a filter over the 16 hour period between 06:00 and 22:00 on consecutive days for each of the 5 monitoring sites (the dates being from 25th to 29th May 1996). The concentration of lead was shown to be below <0.43 micrograms per m^3 in all 5 samples collected. The WHO annual limit for lead in air 0.5 to 1.0 micrograms per m^3 was not exceeded by any of the 16 hour average determinations made in this study.

The air monitoring results for 5 locations are shown in Appendices IV, Table IV-6 to IV-10, Figure IV-1.1 to Figure IV 5.2, and the summary results are shown in Table 11-14. and Predicted pollutant concentrations at points 5 m from the carriageway in Table 11-15.

Table 11-14 Hourly average value range of air quality for 5 locations

Parameter		Range of hourly average value (Micrograms per m3)	WHO hourly limit (Micrograms per m3)
NOx	Nitrogen Oxides	0 - 225	400
CO	Carbon Monoxide	0 - 2.8	30
SO2	Sulphur Dioxide	0 - 53	350
SPM	Suspended particulates	179 - 2442 (24 hours)	120 (24 hours)
Pb	Lead	<0.43	0.5 - 1.0

Table 11-15 Predicted pollutant concentrations at points 5 m from the Carriageway

Locality	Traffic flow veh/hr	CO Concentration*	NOx Concentration*
Barka	1200	0.6	0.24
A'Tareef	1100	0.55	0.22
Al Khaburah	1500	0.75	0.3
A'Sughra	900	0.45	0.18
Sohar	2000	1	0.4

*concentrations in milligramsper cubic metre

(3) Noise

1) Noise monitoring equipment

Noise data were recorded using the Bruel and Kjaer Model 2231 precision sound level monitor fitted with a BZ4155 microphone and with the BZ7110 model integrating statistical analyser module. Data were recorded on the internal memory of the noise monitor. At the end of each 16 hour recording period data a hand written record of the results was made in a log book.

2) Basis of interpretation

Noise data have been evaluated by using the noise measurements made at each location and correcting these data to a standard baseline condition. In order to perform the calculations necessary on-site monitoring data have been used in association with measurements and descriptions of the monitoring locations and surroundings.

3) Summary and evaluation of noise monitoring data

In general variation of the hourly Leq values at each site are small although there is a general tendency for Leq values to be fairly constant through the day and then to fall during the late evening In order to provide data on the effects of road noise at a location 40 m from the edge of the carriageway the following procedure has been followed.

(1) Monitoring data for Leq have been converted to the parameter L_{A10} using a standard conversation applicable to road traffic noise (Leq + 3 dB(A) = L_{A10}).

(2) The value of L_{A10} is adjusted to a baseline condition such that the data are converted to values they would have had if the monitoring point had been located 10 m from the edge of the carriageway.

(3) The noise level (L_{A10}) is calculated for a location situated 40 m from the edge of the carriageway as if the sound was experiences 1 m in front of a facade at a height of 3.5m (1st story level). Correction is made for the absorption of sound by the ground and other local

features as appropriate. The value of noise 1 m in front of a vertical facade is calculated.

(4) The final L_{A10} value is converted back to the equivalent Leq value.

This procedure has been applied to the Leq value for the 16 hour period of monitoring at each location. The noise monitoring results for 5 locations are shown in Appendices IV, Table IV-11 to IV-15, Figure IV 1.1 to Figure IV 5.2, and following Table 11-16 shows the predicted noise levels at points 40 m from the carriageway.

Table 11-16 Predicted Noise Levels (Leq) at points 40 m from the carriageway

Locality	Leq Measured dB(A)	Leq Predicted dB(A)
Barka	66.3	61.3
A'Tareef	66.6	62.5
Al Khaburah	64.9	60.7
A'Sughra	70.1	66.3
Sohar	61.2	55.5

Omani Regulation criteria
Commercial/ Industrial district Leq dB(A) = 70

In the above examples non-absorbing ground is assumed for all the monitoring sites except Sohar where 80% rough grass has been assumed. No correction for the presence of trees at Sohar roundabout has been made as it is presumed that the status of these is uncertain given the nature of the proposed road development. The assumptions made in performing these calculations are conservative in that they underestimate screening and attenuation effects. Therefore the predicted values given here may be regarded as maxima. The values obtained for noise exposure levels at the facades of buildings located 40 m from the roadside are generally acceptable for commercial area buildings along the highway. Following Table 11-17 shows the Regulations for external noise (Road traffic) pollution control in public environment.

Table 11-17 Regulations for noise pollution control (Ministrial Division 79/93, Sultanate of Oman)

Type of district	Leq, T, dB(A)		
	Over Time Period		
	A (Work days-daytime) 7:00 AM to 6:00 PM	B (Workdays-Evening) 6:00 PM to 11:00 PM	C (Holidays & Nights) 11:00 PM to 7:00 AM
Rural residential recreational	45	40	35
Suburban residential	50	45	40
Urban residential	55	50	45
Urban residential with some workshops or business; city hub.	60	55	50
Industrial and commercial	70	70	70

(4) Future impact

In order to predict the future environmental impact of traffic increases between 1996 and the forecast year of 2010 calculations of future pollutant and noise levels have been made.

1) Noise

Noise impact for the year 2010 has been calculated by using traffic flow data and predictions made by JICA study. The relative proportions of vehicles of differing types (cars, buses, lorries, etc.) is assumed to be the same in 1996 and 2010. It has been assumed that the competing factors will be effectively neutral in terms of the noise impacting on a receptor located 40 m away from the edge of the current carriageway. Therefore it is concluded that the main effect on noise will be traffic volume. Tabulated below are the calculated values of Leq based on 1996 monitoring data and traffic flow predictions. The Leq values reported are for a location situated 1 m in front of a facade at first storey level. (See Table 11-18)

Table 11-18 Predicted noise levels (Leq) at points 40 m from the carriage way in the year 2010

Locality	Leq Predicted dB(A)
Barka	66.1
A'Tareef	66
Al Khaburah	66.1
A'Sughra	71
Sohar	61

Omani Regulation criteria
Commercial/ Industrial district Leq dB(A) = 70 (Note: Areas at facade of the road are commercial use at R/A)

The predicted values obtained for noise exposure levels at the facades of buildings located 40 m from the roadside have been compared with Omani regulations for acceptable noise exposure for commercial type district. This comparison shows that the predicted noise levels calculated for Barkha, A'Tareef, Al Khaburah and A'Sughra fall within Category C noise exposure classification where noise needs to be considered as part of the planning process and noise insulation measures would be required for any new residential development.

2) Pollutants

Based upon peak hourly traffic flows calculated taken traffic flow prediction data for the year 2010 calculations of pollutants concentrations have been made for points located 40 m from the edge of the carriageway at the relevant points of interest and 40m from the edge of the joining road at roundabout junctions. These predicted concentrations are listed in Table 11-19. The model assumes there will be no improvements in vehicle efficiency between 1996 and 2010.

Table 11-19 Predicted pollutant concentrations at points 40 m from the carriageway calculated for peak hour traffic flows in 2010

Locality	CO Concentration* Year 2010	NOx Concentration* Year 2010
Barka	3.1	0.909
A'Tareef	0.3	0.308
Al Khaburah	1.5	0.439
A'Sughra	0.3	0.308
Sohar	2.9	0.745

*concentration in milligramsper cubic metre

These data show that the calculated NOx one hour average concentrations, predicted from flow data, will exceed the WHO air quality guideline for nitrogen dioxide under peak traffic flow conditions at the 3 existing roundabout locations (Al Khaburah, Barkha, Sohar).

However, if a correction factor is applied to these calculated values to allow for the observation that the concentration of nitrogen dioxide is typically less than 0.3 of the value of NOx in the present study when elevated values of NOx are observed then none of the calculated nitrogen dioxide concentrations would exceed the current WHO guideline values for nitrogen dioxide.

3) Noise level of construction machines

Vicinity land use or activities which may be affected by the construction noise will be identified during development of the project, and measures to minimize or eliminate the impacts should be determined.

The A-weighted sound level ranges of construction equipments are 99-103 dB(A) for craweler crane, 104- 116 dB(A) for bulldozer, 107-113 dB(A) for track, 102-106 dB(A) for roller and so on. (See Appendices IV, Table IV-16 Noise level of construction machines). These sound levels are at nearest distance (1 m) from each origin of sounds. These sound level generally may reduce 15 to 20 dB(A) at 10 m from the origin of sounds, and 5 to 6 dB(A) may reduce each double distance from the origin of sounds. Generally noise level originated from construction machines may be lower than 70 dB(A) at the road side building facade area (40 m from the road margin).

4) Vibration

Regulation of vibration for public space have not been set yet, but government may consider the regulation in future. Vibration impact from this project may be negligible.

5) Water and soil pollution

Water resources of the project areas mainly obtain from open wells and tanker delivered from mountain foot hill sites. Ground water is usually used agricultural irrigation purpose at this Batinah region, and ground water levels of the each project site are range of 20 to 25 m depth from the ground level. Some areas are containing salinity because it is said that increase of ground water use for irrigation purpose recently. Referring to the boring survey and laboratory test done by JICA study results, soils of the project areas are generally sandy gravel to silty sand, chemical character of soil of the project areas are generally 10.2 to 27.2 % in moisture content range, 7.8 to 9.1 in pH value range, 55 to 276 mg/l in SO3 value range and 0.00 to 0.25 % in Cl content range. Also chemical character of water samples near the project areas are 7.14 to 8.25 in pH value range, 0.05 to 0.151 g/l in SO3 content range and 53.9 to 238.6 mg/l in Cl content range. There are any of pollution to be observed (See Appendices IV, Table IV-17 Ground water and soil condition, Table IV-18 Chemicalcharacter of soil, Table IV-19 Chemicalcharacter of water).

(5) Mitigation measures

1) Social environment:

- Affected area, buildings and compensation

Affected area, buildings are mainly generated by rearrangement of service road to the flyover section. Alignment of these service road have been studied to minimize affected portion to the adjacent area.

Land acquisition and compensation to be carried is following procedure.

1) The scheme has to be approved first by the Ministry of Communication (MOC)

2) "Land reference " drawings showing land acquisition including buildings are prepared with coordinating efforts from all the concerned Ministries, particularly the Ministry of Housing (MOH), the Ministry of Interior, Muscat Municipality, the Ministry of Regional Municipalities and Environment and so on.

3) MOC submits its plans to the MOH

4) MOH reviews and issues a no objection letter, if the plans are acceptable.

5) The plans are the submitted to the office of the Ministry of State for Legal Affairs which prepares a Royal Decree.

6) When the Royal Decree is made, the amount of compensation the land owner will receive is fixed in accordance with standard scale. The details are agreed between the owner and the compensation committee of either Muscat Municipality or the Ministry of Regional Municipalities and Environment. The scales of compensation to be followed are set by the Supreme Committee for Town Planning (SCTP).

- Construction waste

Major construction waste originated by this project will be segnents of concrete and asphalt concrete, and theses are non-hazardous solid wastes. Contractor shall be considered of environmental impact regarding distance to community settlement and Wadi area, and made application form to the Regional Municipality, the Directorate General of Environment for selected location of waste disposal yard, area wise, volume and quality of waste as well as way of disposal treatment.

- Borrow pit

Available existing borrow pit are counted 9 locations along the Batinah highway and these are distributed at foothill of Hajar Al Gharbi mountain range. They are approximately 10 to 20 km from the construction site. Generally activities at borrow pit are easily caused dusty air pollution to vicinity environment especially if borrow pit is selected near by community settlement. So that the contractor shall be considered of environmental impact regarding distance to community settlement and Wadi area, and made application form

to the Regional Municipality, the Directorate General of Environment for selected location of borrow pit, area wise and volume of borrow materials, dust control of activities and necessary environmental protection measures.

- Construction camp site

Construction camp site is temporally situation according to the procedure of project implementation and often it has lack of environmental management for generated wastes and sewerage from it's site, So that the contractor shall be considered of environmental impact regarding distance to community settlement and Wadi area, and made application form to the Regional Municipality, the Directorate General of Environment for selected location of camp site, numbers of labor and equipment, treatment system for sewerage and discharge water as well as it's management system.

2) Natural environment

- Roadside trees

Existing roadside trees and trees within the Round about are affected by the flyover construction, and these trees have been artificially planted and maintained for long time. These trees including shrubs are to be transplanted to other place during construction and replanted after flyover construction. Some of trees of large stem and crown which are difficult to transplant are to be replaced with new yang trees of same species shall be compensated.

3) Pollution

- Particulates

Most of the surveyed areas for air quality are showing high level of suspended particulates level or dusty conditions. This high level of suspended particulate is originated bare ground conditions of the surveyed points. In case of Sohar the level of particulate, surveyed points are rather ground covered area with plants, there is lower level than others. For future consideration it is recommended to provide ground cover planting at road side strip along settled area near by roundabout and pedestrian underpass in order to stabilize soil dust to fly into atmosphere.

(6) Specialists participated the study work for EIA

Consultant firm and major specialist participated of the environmental survey and environmental impact assessment are shown in Table IV-20, Appendices IV.

JICA