PART II

ROAD NETWORK PLANNING

CHAPTER 6

FUTURE SOCIOECONOMIC FRAMEWORK

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6.1 DEVELOPMENT POLICY OF SOCIOECONOMIC FRAMEWORK

6.1.1 Consideration on Development Policy of Oman Government

At present, the most important Oman Government's long-term development policy is "Oman Vision 2020". The primary aim of the Vision is to maintain at least the current (1995) level of per capita income in real terms, and strive to double it by 2020.

In order to move from an economy based on a mono depletable source continuously by external economic and political factors to an economy with varied and renewable sources, it is essential if economic diversification is to be achieved. Quantitative and qualitative indicators for economic diversification are shown in Table 6.1-1.

In order to improve the employment situation of Omanis, human resources development is important. The Vision shows the target percentages of employed Omanis in 2020; for the public sector 95%, and for the private sector 75%.

For the preparation of future socioeconomic framework, the above-mentioned targets are taken into consideration as much as possible.

6.1.2 Basic Policy and Methodology for Socioeconomic Framework

1) Target Years

Year 2000 is adopted as the base year. For future socioeconomic framework, years 2005, 2010, 2015, 2020, 2025 and 2030 are determined as target years. In addition, year 2003 (Census year) is used for the preparation of national level framework.

2) Basic Considerations

As the preliminary results of 2003 Census revealed a low growth rate of Omani population, the future sex-age structure of Omani population should be projected in the first place based on assumed future fertility rates. For expatriate population, the number of employed persons will be obtained first as supplement labor force for the total labor force demand depending on future economic growth. Total expatriate population will

be obtained applying assumed activity rates. Accordingly, future total population will vary depending on future economic growth.

Table 6.1-1 Quantitative and Qualitative Indicators for Economic Diversification

Sector	AAGR (%) 1995-2020	Relative Shares to GDP (%)			Remarks
		1995	2000	2020	
Oil	-2.2	33.5	25.9	9.0	1. Crude Oil Extraction Rate Decrease from 850,000 bpd to 426,000 bpd in 2020 2. Oil Reserves Gradual depletion, despite the expected increase 5 billion barrels
Gas	11.1	1.5	5.0	10.0	1. Natural Gas Reserves 16 trillion cubic feet, with expected discovery of additional reserves
Agriculture	4.5	3.0	3.5	3.1	1. Increase of cultivated consistent with available water resources 2. Raising of productivity with modern techniques 3. Development of agro-industries
Fisheries	5.6	1.1	1.0	2.0	1. Utilization of modern and high value added technologies 2. Development of necessary infrastructure, such as fishing ports
Mining	10.8	0.6	0.6	2.0	1. Proven Reserves of Main Minerals a. Copper: Additional reserves of around 15 million tons b. Chromite: More than 100,000 tons c. Coal: More than 100 million tons d. Silica: Around 5.6 million tons
Manufactur-ing	7.3	5.4	6.8	15.0	1. Expansion of the petrochemical industry, based on gas as a feed stock 2. Expansion of oil refining 3. Expansion of the production of agricultural, fisheries and mining sectors 4. Increase in the participation of foreign investment
Electricity & Water	4.5	1.7	4.3	2.0	1. Promoting privatization in order to increase in productivity 2. Providing water to areas that are not yet supplied
Const. & Real Estate		3.2	6.9	10.0	1. Development of the country's infrastructure
Trade & Tourism	3.9	14.1	17.8	18.0	1. Expansion of non-oil production for the increase in trade exchange 2. Utilizing Oman's location for export, re-export and transit operations 3. Raising tourism's share of GDP from 0.8% in 1995 to 3% by 2020
Transport & Telecomm.	5.9	7.0	8.6	8.0	1. Upgrading the efficiency of existing ports and development of a new port 2. Expanding and upgrading the existing telecommunications network
Finance	5.9	7.9	4.3	8.0	1. Meeting the increased funding needs and volume of savings resulting from the high growth of the national economy 2. Need to develop the export oriented services
Private Serv.	5.0	8.3	3.2	5.0	1. High rates of growth based on the following factors: a. A large population increase, with an annual average growth rate of 3.7% b. An income increase, with a per capita income of RO3,000 by 2020
Public Serv.	1.1	13.9	12.6	10.0	1. Expected decline of the public services, resulting from the following: a. Achieving economic stabilization and rationalizing public expenditures b. Enhancing the role of the private sector c. Enhancing economic diversification d. Human resources development
Custom D. & Imptd Serv.		-1.2	-5.0	-2.1	
GDP	**3.3**	**100.0**	**100.0**	**100.0**	

Source: "Vision for Oman's Economy - Oman: 2020"

For the future economic framework, future petroleum activities (crude oil and natural gas) should be projected in the first place. Then future non-petroleum activities will be forecast based on the assumed sectoral growth rates.

Sectoral labor force demand (number of employed persons) will be obtained by applying sectoral labor productivity. Accordingly, future number of employed persons will vary depending on the assumed future labor productivity, even with the same economic growth.

3) Development Scenarios

Three development scenarios are studied as follows:

a. Higher Omanization Development (Optimistic Case)
b. New Oman Vision Development (Strategic Case)
c. Steady Economic Development (Pessimistic Case)

Selecting one development scenario, future socioeconomic framework at the national level is fixed.

4) Future Gross Regional Domestic Product (GRDP)

The future projected GDP by economic activity at the national level is broken down into the regional level. The base is an estimate for the year 2000 by utilizing various kinds of regional data obtained.

5) Future Socioeconomic Indices by Zone

Available socioeconomic data for zone (Wilayat) are limited. Published data are only population and number of households based on the 1993 and 2003 Censuses. In addition by favor of Ministries, the Study Team obtained data about agriculture, fisheries and manufacturing at the Wilayat level.

Utilizing these data, zonal indices are estimated first for 2000. Future zonal indices are estimated by considering distribution patterns in 2000, location of development projects and location industrial estates.

6.2 DEMOGRAPHIC FRAMEWORK

6.2.1 Revision of Population Growth Trend

As described before, the 2003 Census showed a low growth trend of Omani population. Decline of fertility rate seems to be in progress at a faster pace than expected. According to the Ministry of Health (MOH), the changing trend of the total fertility rate (TFR), equivalent to the number of children born from one woman, is 6.87 in 1993, 5.99 in 1995, 4.74 in 2000, 4.19 in 2001 and 3.64 in 2002. However, the TFR might have already dropped to about 4.2 between 1995 and 2000, because an estimation of the change in sex-age structure of Omanis from 1995 to 2000 by applying the component method showed that the Age-Specific Fertility Rate (ASFR)

of 2001 fitted best. After various trials and errors, the population growth trend during ten years between 1993 and 2003 was estimated as shown in Table 6.2-1. For the expatriate population, no revision work was carried out.

Table 6.2-1 Revision of Population Trend, 1993-2003 (in thousand)

Year	MONE			Study Team		
	Oma.	Exp.	Total	Oma.	Exp.	Total
1993	1,465	535	2,000	1,465	535	2,000
Cens.1993	1,483	535	2,018	1,483	535	2,018
1994	1,512	538	2,050	1,498	538	2,036
1995	1,557	574	2,131	1,530	574	2,104
1996	1,602	612	2,214	1,563	612	2,175
1997	1,642	613	2,255	1,596	613	2,209
1998	1,685	602	2,287	1,629	602	2,231
1999	1,729	596	2,325	1,662	596	2,258
2000	1,778	624	2,402	1,693	624	2,317
2001	1,823	671	2,494	1,721	671	2,392
2002	1,872	712	2,584	1,749	712	2,461
2003	1,922	730	2,652	1,776	730	2,506
Cens.2003	1,779	552	2,331	1,779	552	2,331

Source: MONE (1993-1999), Statistical Yearbook
MONE (2000-2003), Sixth Five Year Development Plan (2001-2005)

6.2.2 Future Omani Population

Future projection of Omani population was carried out, by applying the component method. The reason is that it is necessary to estimate future labor force. Setting 2000 as the base year, populations by sex and age-group of 2005, 2010, 2015, 2020, 2025 and 2030 were forecast.

For the estimation of future fertility rates, United Nations' population projections for Oman and neighboring countries were studied. Table 6.2-2 shows the changing trends of total fertility rates assumed by the UN population projections for Oman and neighboring countries (Medium Variant). And Figure 6.2-1 shows the future population of small-scale countries (excluding Saudi Arabia and Yemen with estimated populations of 20,346 thousand and 18,349 thousand in 2000, respectively). The UN projection assumes considerably high future TFRs for Oman. On the contrary, lower rates are assumed for Bahrain, Kuwait, Qatar and UAE, setting TFR of 2.10 (net reproduction rate of 1.01) in the near future.

Table 6.2-2 Future Total Fertility Rates by Country in UN Population Projection

	2000-05	2005-10	2010-15	2015-20	2020-25	2025-30
Oman	5.46	5.06	4.67	4.27	3.88	3.48
Bahrain	2.28	2.10	2.10	2.10	2.10	2.10
Kuwait	2.66	2.44	2.21	2.10	2.10	2.10
Qatar	3.34	2.99	2.63	2.28	2.10	2.10
Saudi Arabia	5.54	5.01	4.51	4.05	3.61	3.20
UAE	2.86	2.56	2.25	2.10	2.10	2.10
Yemen	7.60	7.35	6.85	6.35	5.85	5.35

Source: World Population Prospects, the 2000 Revision (United Nations)

According to Figure 6.2-1, only Oman's population will increase steeply from about 2.5 million in 2000 to more than 6 million in 2030.

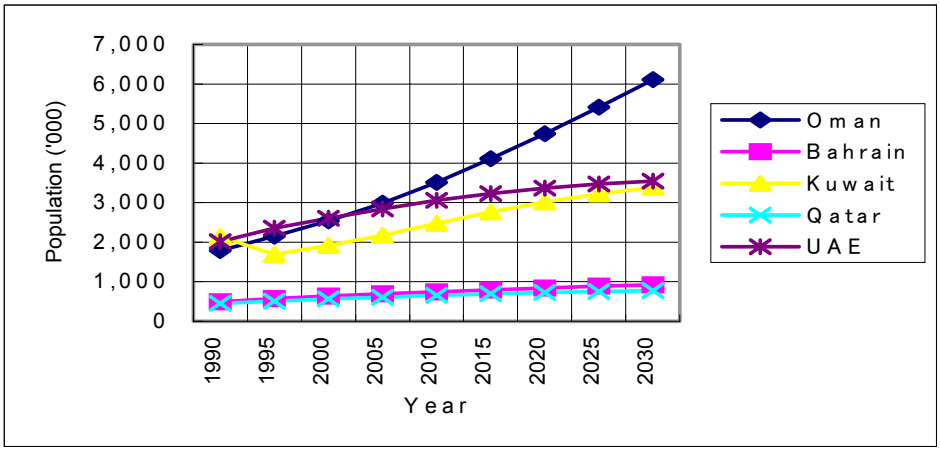


Figure 6.2-1 Future Population Projection by UN

Considering the present sharp declining trend of TFR in Oman, it will reach 2.10 in the near future like other small GCC countries. It was assumed that TFR would become 2.10 between 2020 and 2025. Future ASFRs were estimated based on the MOH's ASFR changing trend. Assumed future TFR and ASFRs are shown in Table 6.2-3.

The results of future projection of Omani population by use of the component method are shown in Table 6.2-4. Omani population will increase gradually from 1,693 thousand in 2000, to 1,846 thousand in 2005, 2,032 thousand in 2010, 2,433 thousand in 2020 and finally 2,746 thousand in 2030. Due to the assumed low fertility rates, the percentage of population aged 15 or more will increase from 58.6% in 2000 to 75.1% in 2030.

Table 6.2-3 Assumed Future TFR and ASFR

	2000-05	2005-10	2010-15	2015-20	2020-25	2025-30
15-19	0.0160	0.0151	0.0141	0.0132	0.0123	0.0123
20-24	0.1020	0.0957	0.0894	0.0831	0.0768	0.0768
25-29	0.1398	0.1309	0.1221	0.1132	0.1044	0.1044
30-34	0.1687	0.1531	0.1375	0.1219	0.1064	0.1064
35-39	0.1261	0.1145	0.1028	0.0912	0.0795	0.0795
40-44	0.0563	0.0507	0.0451	0.0395	0.0339	0.0339
45-49	0.0095	0.0088	0.0081	0.0074	0.0067	0.0067
TFR	3.09	2.84	2.60	2.35	2.10	2.10

Source: Study Team Estimates

Table 6.2-4 Future Omani Population by Sex and Age Group

Omani Population 2000

Age Group	Male	Female	Total
00-04	102,009	97,946	199,955
05-09	125,254	120,835	246,089
10-14	129,750	125,683	255,433
15-19	120,563	115,467	236,030
20-24	100,258	95,272	195,530
25-29	67,940	62,791	130,731
30-34	44,291	41,412	85,703
35-39	34,107	34,755	68,862
40-44	28,696	31,788	60,484
45-49	24,184	25,995	50,179
50-54	20,901	20,853	41,754
55-59	19,700	18,905	38,605
60-64	14,998	13,572	28,570
65+	28,470	26,608	55,078
Total	861,121	831,882	1,693,003
15+	504,108	487,418	991,526

Omani Population 2005

Age Group	Male	Female	Total
00-04	97,318	93,382	190,700
05-09	101,270	97,385	198,655
10-14	124,442	120,101	244,543
15-19	128,830	124,889	253,719
20-24	119,557	114,659	234,216
25-29	99,337	94,544	193,881
30-34	67,250	62,263	129,513
35-39	43,766	41,006	84,772
40-44	33,570	34,343	67,913
45-49	28,065	31,275	59,340
50-54	23,422	25,335	48,757
55-59	19,883	20,046	39,929
60-64	18,096	17,784	35,880
65+	33,097	31,350	64,447
Total	937,903	908,362	1,846,265
15+	614,873	597,494	1,212,367

Omani Population 2010

Age Group	Male	Female	Total
00-04	116,505	111,722	228,227
05-09	96,656	92,882	189,538
10-14	100,640	96,811	197,451
15-19	123,588	119,358	242,946
20-24	127,804	124,042	251,846
25-29	118,516	113,815	232,331
30-34	98,380	93,781	192,161
35-39	66,494	61,677	128,171
40-44	43,107	40,542	83,649
45-49	32,861	33,816	66,677
50-54	27,213	30,523	57,736
55-59	22,321	24,404	46,725
60-64	18,323	18,917	37,240
65+	39,172	38,611	77,783
Total	1,031,580	1,000,901	2,032,481
15+	717,779	699,486	1,417,265

Omani Population 2015

Age Group	Male	Female	Total
00-04	128,414	123,067	251,481
05-09	115,761	111,165	226,926
10-14	96,080	92,351	188,431
15-19	99,970	96,224	196,194
20-24	122,647	118,574	241,221
25-29	126,750	123,162	249,912
30-34	117,430	112,931	230,361
35-39	97,330	92,933	190,263
40-44	65,536	61,010	126,546
45-49	42,231	39,950	82,181
50-54	31,899	33,045	64,944
55-59	25,977	29,458	55,435
60-64	20,633	23,098	43,731
65+	44,191	45,510	89,701
Total	1,134,849	1,102,478	2,237,327
15+	794,594	775,895	1,570,489

Table 6.2-4 Future Omani Population by Sex and Age Group (Continued)

Omani Population 2020			
Age Group	Male	Female	Total
00-04	126,865	121,509	248,374
05-09	127,644	122,496	250,140
10-14	115,101	110,549	225,650
15-19	95,459	91,802	187,261
20-24	99,242	95,610	194,852
25-29	121,687	117,762	239,449
30-34	125,645	122,241	247,886
35-39	116,241	111,947	228,188
40-44	95,987	91,971	187,958
45-49	64,254	60,163	124,417
50-54	41,037	39,087	80,124
55-59	30,498	31,950	62,448
60-64	24,081	27,960	52,041
65+	50,028	54,613	104,641
Total	1,233,769	1,199,660	2,433,429
15+	864,159	845,106	1,709,265

Omani Population 2025			
Age Group	Male	Female	Total
00-04	113,629	108,769	222,398
05-09	126,151	120,986	247,137
10-14	126,950	121,841	248,791
15-19	114,379	109,904	224,283
20-24	94,795	91,234	186,029
25-29	98,506	94,979	193,485
30-34	120,678	116,914	237,592
35-39	124,440	121,215	245,655
40-44	114,704	110,839	225,543
45-49	94,177	90,755	184,932
50-54	62,499	58,931	121,430
55-59	39,293	37,855	77,148
60-64	28,349	30,404	58,753
65+	57,405	66,110	123,515
Total	1,315,955	1,280,736	2,596,691
15+	949,225	929,140	1,878,365

Omani Population 2030			
Age Group	Male	Female	Total
00-04	110,356	105,577	215,933
05-09	113,031	108,339	221,370
10-14	125,502	120,364	245,866
15-19	126,179	121,145	247,324
20-24	113,620	109,246	222,866
25-29	94,130	90,655	184,785
30-34	97,729	94,321	192,050
35-39	119,583	115,969	235,552
40-44	122,865	120,068	242,933
45-49	112,618	109,444	222,062
50-54	91,691	88,994	180,685
55-59	59,927	57,163	117,090
60-64	36,618	36,111	72,729
65+	66,646	77,687	144,333
Total	1,390,495	1,355,083	2,745,578
15+	1,041,606	1,020,803	2,062,409

6.2.3 Future Expatriate Population

Future expatriate population will vary depending on labor force demand due to economic growth, and on employment status of Omanis. The following is based on the adopted Strategic Case of development scenarios, which are discussed in Section 6.3.

In 2000, the Labor Force Participation Rate (LFPR) of Omani population aged 15 or more was 36.4% and unemployment rate was 22.9%. Such situation will not change until 2005. In future, the LFPR will rise due mainly to the increase in the percentage of women in labor force. The unemployment rate is expected to decline by the effect of human resources development and the Omanization policy.

The number of expatriate employed persons was determined as supplementary labor

force for the total labor force demand. Total expatriate population was obtained by applying a ratio of employed to total population of 0.84, which was used for the Sixth Five Year Development Plan (2001-2005).

Table 6.2-5 shows the procedure and results of the forecast of future expatriate population.

Table 6.2-5 Forecast of Future Expatriate Population

	2000	2005	2010	2015	2020	2025	2030
Labor Force Demand (Total No. of Employed)	801,700	822,877	895,637	983,093	1,066,460	1,160,377	1,265,344
Omanis Aged 15 +	991,500	1,212,367	1,417,265	1,570,489	1,709,265	1,878,365	2,062,409
LFPR (%)	36.4	36.4	40.0	45.0	50.0	52.5	52.5
Unemployment Rate (%)	22.9	22.9	20.0	15.0	10.0	10.0	5.0
No. of Employed Omanis	278,300	340,058	453,525	600,712	769,169	887,527	1,028,626
No. of Employed Expatriates	523,400	482,819	442,112	382,381	297,291	272,850	236,718
Ratio of Employed/Total Pop.	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Expatriate Population	623,600	574,785	526,324	455,215	353,918	324,821	281,807

Source: Study Team Estimates

6.2.4 Future Total Population

As shown in Figure 6.2-2 and Table 6.2-6, the total population of Oman is expected to increase from 2,317 thousand in 2000 to 3,027 thousand in 2030. The size of population will become 1.3 times during 30 years. Annual average growth rate (AAGR) is 0.9%. Omani population will increase at an AAGR of 1.62%, while expatriate population will decrease at an AAGR of -2.61%.

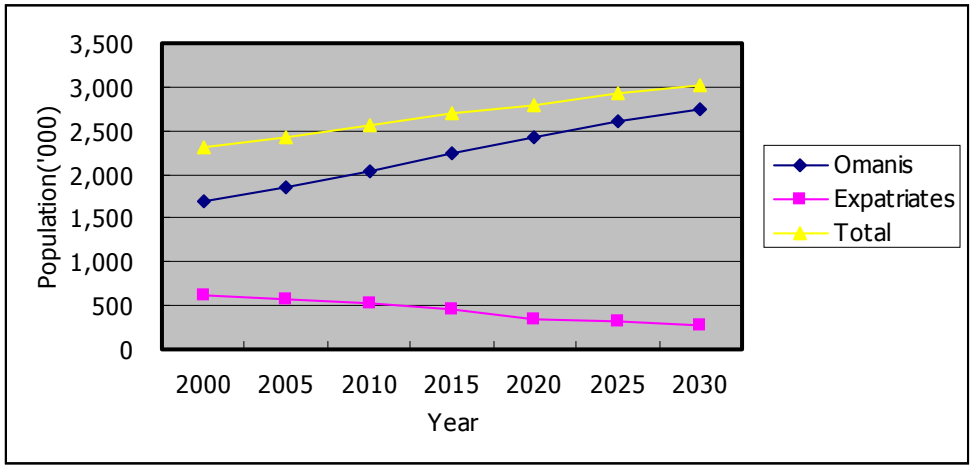


Figure 6.2-2 Future Population of Oman

Table 6.2-6 Future Population of Oman

	2000	2005	2010	2015	2020	2025	2030
Population							
Omanis	1,693,000	1,846,265	2,032,481	2,237,327	2,433,429	2,596,691	2,745,578
Expatriates	623,600	574,785	526,324	455,215	353,918	324,821	281,807
Total	2,316,600	2,421,050	2,558,805	2,692,542	2,787,347	2,921,512	3,027,385
	2000-05	2005-10	2010-15	2015-20	2020-25	2025-30	2000-30
Annual Average Growth Rate (%)							
Omanis	1.75	1.94	1.94	1.69	1.31	1.12	1.62
Expatriates	-1.62	-1.75	-2.86	-4.91	-1.70	-2.80	-2.61
Total	0.89	1.11	1.02	0.69	0.94	0.71	0.90

Source: Study Team Estimates

6.3 ECONOMIC FRAMEWORK AT NATIONAL LEVEL

6.3.1 Future Oil Production and Gross Value Added of Extraction of Crude Oil

Daily average crude oil production of Oman was 819.5 thousand barrels in 2003. In 2004 the production is anticipated to decrease 5%. After that the government plans to increase 50 thousand barrels every year. However, it is not sure until when such increase will be able to continue. Then it is assumed that the increase will continue to 2006 and that the same production level will be maintained until 2010. After 2010, the production will be decreased. The Oman Vision 2020 assumed a production level of 426 thousand barrels per day. This assumption is adopted in this Study, and it is assumed that the oil production will decrease at an annual rate of -6.98% from 2010 to 2030.

Annual average oil price was US$ 27.84 per barrel in 2003. High oil prices are maintained at present. Considering such situation, it is assumed that annual average oil price is US$ 27 per barrel in 2005 and US$ 25 per barrel after 2010.

In the national account of Oman, 38% of annual sales of crude oil is the gross value added (GVA) of extraction of crude oil. For the estimation of future GVA of this sector, this percentage is applied to be expected future annual sales of crude oil.

Future crude oil production and GVA are shown in Table 6.3-1.

Table 6.3-1 Future Oil Production and Gross Value Added of Extraction of Crude Oil

	2000	2003	2005	2010	2015	2020	2025	2030
Oil Production								
- Daily Average (thousand bbl)	955	819.5	828.5	878.5	611.8	426.0	296.6	206.6
- Annual (million bbl)	349.5	299.1	302.4	320.7	223.3	155.5	108.3	75.4
Annual Average Oil Price (US$/bbl)	26.71	27.84	27	25	25	25	25	25
Annual Sales of Crude Oil (RO m)	9,335.1	8,326.9	8,165.1	8,016.5	5,582.3	3,887.3	2,706.9	1,884.9
GVA/Annual Sales	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
GVA of Extraction of Crude Oil (RO m)	3,552.8	3,164.2	3,102.7	3,046.3	2,121.3	1,477.2	1,028.6	716.3

Source: 2000 and 2003: Actual; 2005-2030: Study Team Estimates

6.3.2 Estimation of 2000, 2003 and 2005 Framework

Economic framework at the national level includes GDP by economic activity, GDP per capita and number of employed persons by economic activity. Through the following procedure, the economic framework for 2000, 2003 and 2005 were estimated.

1) Estimation of employment for 2000
2) Estimation of employment and labor productivity for 2003
3) Estimation of labor productivity rising rates
4) Estimation of GDP by economic activity for 2005
5) Estimation of labor productivity and employment for 2005

1) Estimation of Employment for 2000

According to the 2000 Labor Force Survey, labor force participation rates (LFPR) of Omani males and females were 59.3% and 12.7%, respectively. As shown in Table 6.2-4, Omani population aged 15 or more is estimated at 991,500 (males 504,100 and females 487,400) for 2000. Then, labor force (economically active population) is estimated at 360,800 (males 298,900 and females 61,900) and LFPR for both sexes is 36.4%. Unemployment rates were 19.3% for males and 40.0% for females. Applying these rates, the number of employed persons is estimated at 278,300 (males 241,200 and females 37,100) and unemployment rate for both sexes is 22.9%.

For expatriates, the number of employed persons is 523,420 (28,720 for the public sector and 494,700 for the private sector) as shown in the Statistical Yearbook. Accordingly, the total number of employed persons is estimated at 801,700 in 2000.

Economic activity distribution is obtained from 2000 Labor Force Survey for Omanis and from the Statistical Yearbook for expatriates. Table 6.3-2 shows the estimation results.

Table 6.3-2 Number of Employed Persons by Economic Activity, 2000

Economic Activity	No. of Employed Persons
Agriculture & Fisheries	76,120
Mining	13,470
Manufacturing	82,780
LNG & Related	400
Others	82,380
Electricity, Water & Construction	127,000
Services	502,350
Total	801,720

Source: Study Team Estimates

2) Estimation of Employment and Labor Productivity for 2003

The sex-age structure of 2003 Census population is not yet published. Therefore, Omani population aged 15 or more by sex was obtained by interpolating 2000 and 2005 estimated sex-age structure. Assuming that employment status is the same as 2000, Omani employed population is estimated at 313,000 (males 271,100 and females 41,900).

Expatriate employed population is assumed to be 84% of the total expatriate Census population of 552,073. Estimated expatriate employed population is 463,700. The total number of employed persons is estimated at 776,700.

Economic sector distribution is assumed to be the same as 2000. Using the obtained number of employed persons by economic activity, labor productivity by economic activity is calculated. Table 6.3-3 shows the estimation results.

Table 6.3-3 Number of Employed Persons and Labor Productivity by Economic Activity, 2003

Economic Activity	No. of Employed Persons	Labor Productivity (RO/person)
Agriculture & Fisheries	71,610	2,304
Mining	14,020	248,531
Manufacturing	76,822	8,921
LNG & Related	500	724,800
Others	76,300	4,229
Electricity, Water & Construction	114,680	2,568
Services	499,590	7,353
Total	776,700	10,689

Source: Study Team Estimates

3) Estimation of Labor Productivity Rising Rates

As the base for assuming future rising rates of labor productivity, the past rising trend is studied. As 2003 GDP data is published only at current prices, 2003 GDP at 1988 constant prices is estimated, assuming that ratios of current to constant prices by economic activity is the same as 2002. After that, labor productivity by economic activity in real terms is calculated for 1993 and 2003.

Calculation results are shown in Table 6.3-4.

Table 6.3-4 Calculation Results of Labor Productivity Annual Rising Rates, 1993-2003

Economic Activity	No. of Employed Persons		GVA (const.) (RO m)		Productivity (RO/person)		Rising Rate (%)
	1993	2003	1993	2003	1993	2003	1993-2003
Agriculture & Fisheries	62,373	71,610	131.6	187.2	2,110	2,614	2.17
Mining	14,021	14,020	1600.3	1808.6	114,136	129,001	1.23
Manufacturing (excl. LNG)	60,099	76,300	203.5	285	3,386	3,735	0.99
Electricity, Water & Construction	112,121	114,680	210.7	339.4	1,879	2,960	4.65
Services	421,661	499,590	2248.8	3507.6	5,333	7,021	2.79

Source: Study Team Estimates

4) Estimation of GDP by Economic Activity for 2005

It is not expected that a large change will happen in economic structure of Oman until 2005. The GDP by economic activity of 2005 is estimated basically following the growth trend from 2000 to 2003, although for some activities longer- or shorter-term trends are applied.

Assumed annual average growth rates (AAGR) from 2003 and estimated gross value added by economic activity are shown in Table 6.3-5.

Table 6.3-5 Assumed AAGR and Estimated GDP by Economic Activity, 2005

Economic Activity	GDP (RO m)	Assumed AAGR from 2003
1. Industry	4,613.4	
1.1 Petroleum Activities	3,495.9	
- Crude Oil	3,223.7	
- Extraction of Crude Oil	3,102.7	See Section 6.3.1
- Incidental Services to Oil & Gas	121.0	13.83% (2000-03)
- Natural Gas	272.2	13.15% (1993-2003)
1.2 Non-petroleum Activities	1,117.5	
- Mining & Quarrying	15.1	3.06% (1993-2003)
- Manufacturing	747.4	
Refined Oil Production	39.9	2.38% (2000-2003)
LNG Production	395.9	4.53% (2001-2003)
Other Manufacturing	311.5	4.63% (2000-2003)
- Electricity & Construction	355.0	9.80% (2000-2003)
2. Agriculture & Fisheries	176.3	3.37% (2000-2003)
3. Services	4,098.6	5.63% (2000-2003)
GDP at Market Prices	8,888.3	
GDP per Capita (RO)	3,671.2	
GDP per Capita (US$)RO)	9,548.1	

Source: Study Team Estimates

5) Estimation of Labor Productivity and Employment for 2005

Principally employment is determined by applying labor productivity to GVA by economic activity. However, for LNG and related industries 500 persons, the same number as 2003, are allocated first. For the estimation of labor productivity in 2005, long-term rising rates (1993-2003) by economic activity are applied to the productivity in 2003.

The number of employed persons (labor force demand) by economic activity is calculated, by dividing the estimated GVA by labor productivity. Total labor force demand will be 822,877 persons. Assuming that the employment status of Omanis will be the same as present, Omani employed population will be 340,058, and remaining demand of 482,819 will be supplied by expatriate labor force.

Table 6.3-6 shows the calculation procedure of employment by economic activity for 2005.

Table 6.3-6 Estimation of Labor Productivity and Number of Employed Persons, 2005

Economic Activity	2003-2005 Productivity Rising Rate (%)	2005 Labor Productivity (RO/person)	2005 No. of Employed Persons
Agriculture & Fisheries	2.17	2,405	73,296
Mining	1.23	254,682	13,786
Manufacturing			81,982
LNG & Related*	4.52	791,803	500
Others	0.99	4,314	81,482
Electricity, Water & Construction	4.65	2,812	126,235
Services	2.79	7,769	527,578
Total			822,877

* No. of employed persons of 500 is determined first, then labor productivity and rising rate is calculated.

Source: Study Team Estimates

6) Economic Frameworks for 2000, 2003 and 2005

Table 6.3-7 shows the economic framework for 2000, 2003 and 2005. Although extraction of crude oil decreased from RO 3,552.8 million to RO 3,164.2 million during the period between 2000 and 2003, GDP total increased with an annual average growth rate (AAGR) of 2.81% owing to a considerable growth of other sectors. From 2003 to 2005, it is expected that AAGR of Oman economy will be 3.47% due to a minimal decrease in crude oil sector and a continuous growth of other sectors.

In principle GDP per capita should be calculated by dividing GDP by mid-year population. Although 2003 Census was carried out in the beginning of December, the 2003 GDP per capita of RO 3,561.1 (US$ 9,261.7) is nearly actual. Based on the results of 2003 Census, 2000 population was revised for Omanis but not for expatriates. Therefore 2000 expatriate population could be excessive. 2000 GDP per capita of RO 3,297.6 (US$ 8,576.3) seems to be too small in comparison with that of 2003.

2005 economy is projected based on the recent trend of each sector and employment (labor force demand) based on the long-term trend of labor productivity. The present Omani employment status (labor force participation and unemployment rate) is expected to continue until 2005. Under this condition, expatriate labor force is expected to increase from 463,700 in 2003 to 482,819 in 2005 and population from 552,073 in 2003 to 574,785 in 2005.

As a result, total population is expected to increase to 2,421,050 and GDP per capita will rise to RO 3,671.2 (US$ 9,548.1) in 2005.

Table 6.3-7 Economic Frameworks for 2000, 2003 and 2005

	2000	2003	2005
Population			
Omanis	1,693,000	1,779,318	1,846,265
(Aged 15+)	991,500	1,115,900	1,212,367
Expatriates	623,600	552,073	574,785
Total	2,316,600	2,331,391	2,421,050
Employed Persons by Nationality			
Omanis	278,300	313,000	340,058
Expatriates	523,420	463,700	482,819
Total	801,720	776,700	822,877
% of Omanis Employed	34.7	40.3	41.3
Extraction of Crude Oil			
Oil Production			
- Daily Average (thousand bbl)	955	819.5	828.5
- Annual (million bbl)	349.5	299.1	302.4
Annual Average Oil Price (US$/bbl)	26.71	27.84	27
Annual Sales of Crude Oil (RO m)	9,335.1	8,326.9	8,165.1
GVA/Annual Sales	0.38	0.38	0.38
GVA of Extraction of Crude Oil (RO m)	3,552.8	3,164.2	3,102.7
Gross Domestic Product (RO m)			
1. Industry	4,373.1	4,464.1	4,613.4
1.1 Petroleum Activities	3,717.7	3,470.2	3,495.9
- Crude Oil	3,616.1	3,257.6	3,223.7
- Extraction of Crude Oil	3,552.8	3,164.2	3,102.7
- Incidental Services to Oil & Gas	63.3	93.4	121.0
- Natural Gas	101.6	212.6	272.2
1.2 Non-petroleum Activities	655.4	993.9	1,117.5
- Mining & Quarrying	18.2	14.2	15.1
- Manufacturing	414.7	685.1	747.4
- Refined Oil & Related	35.5	38.1	39.9
- LNG & Related	130.7	362.4	395.9
- Other Manufacturing	248.5	284.6	311.5
- Electricity & Construction	222.5	294.5	355.0
2. Agriculture & Fisheries	149.4	165.0	176.3
3. Services	3,116.7	3,673.3	4,098.6
GDP at Market Prices	7,639.2	8,302.4	8,888.3
GDP per Capita (RO)	3,297.6	3,561.1	3,671.2
GDP per Capita (US$)	8,576.3	9,261.7	9,548.1
GDP Growth Rate (%)		2.81	3.47
GDP per Capita Growth Rate (%)		2.60	1.53
Employed Persons by Economic Activity			
Agriculture & Fisheries	76,120	71,610	73,296
Mining	13,470	14,020	13,786
Manufacturing	82,780	76,800	81,982
LNG & Related	400	500	500
Others	82,380	76,300	81,482
Electricity & Construction	127,000	114,680	126,235
Services	502,350	499,590	527,578
Total	801,720	776,700	822,877

Source: Study Team Estimates

The percentage of Omani employed persons (Omanization ratio) is estimated at 40.3% in 2003. It is considered to be reasonable, comparing with the percentage of expatriate population in 2003 Census. In comparison with 40.3% in 2003, 34.7% in 2000 is too low. It is due to a large expatriate population of 623,600. In 2005, Omanization ratio is expected to rise to 41.3%.

6.3.3 Future Long-term Economic Frameworks

For the preparation of future long-term (2010, 2015, 2020, 2025 and 2030) economic frameworks, the same estimation procedure as used for the period of 2003-2005 is to be applied one after another to the periods of 2005-2010, 2010-2015, 2015-2020, 2020-2025 and 2025-2030. Future Omani population (by sex and age group) and future crude oil production are considered to be unchangeable.

As there are several large-scale industrial development projects, tourism projects and various government development policies, it is necessary to study more than one set of assumptions after 2005. Changeable assumptions are as follows:

a. Future growth rate of each economic activity
b. Future rising rate of labor productivity of each economic activity
c. Future employment status (labor force participation and unemployment rate) of Omanis

For the comparison of future economic conditions, the following three development scenarios are established:

1) Higher Omanization Development
2) New Oman Vision Development
3) Steady Economic Development

Each development scenario is based on one set of assumptions. And three future economic frameworks are prepared for respective development scenarios.

1) Higher Omanization Development

This development scenario aims to achieve Omanization policy as much as possible. For this purpose, high productivity services such as international banking and trade related activities and also high productivity urban development such as high quality housing and tourism development should be promoted. And these activities would give employment opportunities to training Omanis through human resources development.

Future assumptions for this development scenario are shown in Table 6.3-8.

Table 6.3-8 Future Growth Assumptions for Higher Omanization Development

	2005-10	2010-15	2015-20	2020-25	2025-30
AAGR of GVA by Sector (%)					
Extraction of Crude Oil	As assumed in Section 6.3.1				
Incidental Services to Oil & Gas	3.59% of GVA of Oil & Gas, the same ratio as 2005				
Natural Gas	11.1	11.1	11.1	9.5	7.0
Mining & Quarrying	10.8	10.8	10.8	10.8	10.8
Manufacturing					
Refined Oil & Related	2 times	2.5 times	5.0	5.0	5.0
LNG & Related	2 times	2.5 times	8.0	6.5	5.0
Other Manufacturing	6.0	6.5	7.0	7.0	7.0
Electricity, Water & Construction	3.7	3.7	3.7	3.7	3.7
Agriculture & Fisheries	4.5	4.5	4.5	4.5	4.5
Services	4.0	4.0	4.0	4.0	4.0
AARR of Labor Productivity (%)					
Agriculture & Fisheries	2.20	2.20	2.20	2.20	2.20
Mining & Quarrying	3.00	3.00	3.00	3.00	3.00
LNG & Related	4.50	5.00	3.00	3.00	3.00
Other Manufacturing	2.00	3.00	3.00	3.00	3.00
Electricity, Water & Construction	3.00	3.00	3.00	3.00	3.00
Services	2.80	3.00	3.00	3.00	3.00
Employment Status of Omanis	2010	2015	2020	2025	2030
LFPR (%)	40	45	50	52.5	52.5
Unemployment Rate (%)	15	10	7.5	5	5

Source: Study Team Estimates

The bases of assumptions for growth rates by sector are as follows:

a. Natural Gas

Until 2020, this sector will grow at AAGR of 11.1% as the Oman Vision 2020 assumed. After 2020, it will gradually slow down.

b. Mining & Quarrying

This sector will continue to grow at 10.8% as the Vision assumed.

c. Refined Oil & Related

It is assumed that Sohar refinery and related industries will contribute to enlarge the size of gross value added of the sector to five times until 2015. After 2015, it will grow at AAGR of 5%.

d. LNG & Related

It is assumed that Sur fertilizer and other projects will contribute to enlarge the size of gross value added of the sector to five times until 2015. After 2015, it will gradually slow down.

e. Other Manufacturing

Although the Vision expects this sector will grow at AAGR of 7.3% until 2020, it is assumed that the sector will accelerate its growth from 6.0% (the growth rate of the sector from 2002 to 2003) to 7.0%.

f. Electricity, Water & Construction

The Vision assumes 4.5% growth for electricity and water sector, and 3.3% for construction. Considering the composition of these sectors, the unified growth rate is 3.7%. It is assumed that the sector will continue to grow at AAGR of 3.7%.

g. Agriculture & Fisheries

The Vision expects 4.5% growth for agriculture and 5.6% for fisheries. A unified growth rate of 4.5% is adopted.

h. Services

This sector includes various sub-sectors. The Vision assumes 3.9% for wholesale and retail trade, 5.9% for transport and communications, 5.9% for finance, 5.0% for private sector services and 1.1% for public sector services. Considering the government intention to make Oman an international center for re-export and world trade related businesses, it is assumed that the sector will continue to grow at AAGR of 4.0%. It is also considered that a unified growth rate of services sector between 2002 and 2003 was 4.2%.

For labor productivity rising rates, the following was considered.

a. Agriculture & Fisheries

Based on AAGR of 2.17% from 1993 to 2003, it is assumed that the future AAGR of labor productivity of the sector will be 2.20%.

b. Mining (including oil and gas sectors)

Although the AAGR from 1993 to 2003 was 1.23%, a future AAGR of 3.00% is adopted, considering the future necessities for improving productivity of extraction of crude oil and natural gas.

c. LNG and Related

The AAGR of productivity of LNG sector between 2003 and 2005 was estimated at 4.52%. The LNG and related industries at Sur is expected to grow sharply until 2015 and continue to grow steadily in future. Considering this, it is assumed that AAGR of productivity of the sector will be 4.50% between 2005 and 2010 and 5.00% between 2010 and 2015 and 3.00% after 2015.

d. Other Manufacturing (including refined oil and related)

Although the AAGR of labor productivity of the sector was 0.99% from 1993 to 2003, capital intensive industries including refined oil and related industries will play an important role in future. Considering this, AAGR of productivity is assumed to be 2.00% from 2005 to 2010 and 3.00% after 2010.

e. Electricity, Water & Construction

Labor productivity of this sector registered a high AAGR of 4.65% from 1993 to 2003. This is mainly due to the development of electricity sector. It is considered that such high improvement in labor productivity of the sector will not continue in future. On the other hand, high quality housing development and tourism development will raise the labor productivity of construction sector. Considering these factors, a unified AAGR of labor productivity of this sector is assumed to be 3.00%.

f. Services

AAGR of labor productivity of this sector was 2.79% from 1993 to 2003. In future service activities related to international banking, trade and tourism will be developed. Public sector service activities should be carried out with smaller size of manpower. Considering these factors, an AAGR of labor productivity of this sector is assumed as 2.80% between 2005 and 2010, and 3.00% after 2010.

For employment status of Omanis, the following was considered:

a. Labor Force Participation of Omanis

Labor force participation rate (LFPR) of Omani total population aged 15 or more was 36.4%, and 59.3% for males and 12.7% for females in 2000. This situation is assumed to continue until 2005. In future, labor force participation of females will rise considerably. However, there is a limit in an Islamic society. So, it is assumed that the maximum LFPR is 52.5% for both sexes, 65% for males and 40% for females.

The LFPR is assumed to rise to 40% in 2010, 45% in 2015, 50% in 2020 and 52.5% after 2025.

b. Unemployment of Omanis

Unemployment rate was 22.9% for total Omani labor force, and 19.3% for males and 40.0% for females in 2000. This situation is assumed to continue until 2005. After 2005, it is expected that the "Human Resources Development and "Omanization" policies will gradually become effective and unemployment rate of Omanis will decrease.

For this case, an optimistic assumption is adopted that unemployment rate of Omani labor force will decline to 15% in 2010, 10% in 2015, 7.5% in 2020 and 5% after 2025.

2) New Oman Vision Development

This development scenario aims to attain the objectives of Oman Vision 2020 economically. Comparing with the "Higher Omanization Development", it assumes the same economic development, but for employment status of Omanis it assumes more realistic future targets. In addition, future AAGRs of labor productivity of construction and service sectors are assumed lower than the "Higher Omanization Development".

Table 6.3-9 shows future assumptions of this development scenario.

Table 6.3-9 Future Growth Assumptions for New Oman Vision Development

	2005-10	2010-15	2015-20	2020-25	2025-30
AAGR of GVA by Sector (%)					
Extraction of Crude Oil	As assumed in Section 6.3.1				
Incidental Services to Oil & Gas	3.59% of GVA of Oil & Gas, the same ratio as 2005				
Natural Gas	11.1	11.1	11.1	9.5	7.0
Mining & Quarrying	10.8	10.8	10.8	10.8	10.8
Manufacturing					
Refined Oil & Related	2 times	2.5 times	5.0	5.0	5.0
LNG & Related	2 times	2.5 times	8.0	6.5	5.0
Other Manufacturing	6.0	6.5	7.0	7.0	7.0
Electricity, Water & Construction	3.7	3.7	3.7	3.7	3.7
Agriculture & Fisheries	4.5	4.5	4.5	4.5	4.5
Services	4.0	4.0	4.0	4.0	4.0
AARR of Labor Productivity (%)					
Agriculture & Fisheries	2.20	2.20	2.20	2.20	2.20
Mining & Quarrying	3.00	3.00	3.00	3.00	3.00
LNG & Related	4.50	5.00	3.00	3.00	3.00
Other Manufacturing	2.00	3.00	3.00	3.00	3.00
Electricity, Water & Construction	2.00	2.00	2.00	2.00	2.00
Services	2.80	2.80	2.80	2.80	2.80
Employment Status of Omanis	2010	2015	2020	2025	2030
LFPR (%)	40	45	50	52.5	52.5
Unemployment Rate (%)	20	15	10	10	5

Source: Study Team Estimates

3) Steady Economic Development

This development scenario is rather a pessimistic future vision for Oman. It assumes that future unemployment rate of Omani cannot decline under 20%. It also assumes lower economic growth rates than other development scenarios.

Table 6.3-10 shows future assumptions for this development scenario.

Table 6.3-10 Future Growth Assumptions for Steady Economic Development

	2005-10	2010-15	2015-20	2020-25	2025-30
AAGR of GVA by Sector (%)					
Extraction of Crude Oil	As assumed in Section 6.3.1				
Incidental Services to Oil & Gas	3.59% of GVA of Oil & Gas, the same ratio as 2005				
Natural Gas	8.0	8.0	8.0	6.0	4.0
Mining & Quarrying	5.0	5.0	5.0	5.0	5.0
Manufacturing					
Refined Oil & Related	1.5 times	2 times	3.0	3.0	3.0
LNG & Related	1.5 times	2 times	5.0	4.5	4.0
Other Manufacturing	5.0	5.0	5.0	4.5	4.0
Electricity, Water & Construction	3.0	3.0	3.0	3.0	3.0
Agriculture & Fisheries	3.5	3.5	3.5	3.5	3.5
Services	4.0	4.0	4.0	3.5	3.5
AARR of Labor Productivity (%)					
Agriculture & Fisheries	2.20	2.20	2.20	2.20	2.20
Mining & Quarrying	3.00	3.00	3.00	3.00	3.00
LNG & Related	4.50	5.00	3.00	3.00	3.00
Other Manufacturing	2.00	3.00	3.00	3.00	3.00
Electricity, Water & Construction	2.00	2.00	2.00	2.00	2.00
Services	2.80	2.80	2.80	2.80	2.80
Employment Status of Omanis	2010	2015	2020	2025	2030
LFPR (%)	40	45	50	52.5	52.5
Unemployment Rate (%)	20	20	20	20	20

Source: Study Team Estimates

4) Selection of Development Scenario

Economic frameworks of the three scenarios are shown in Tables 6.3-11, 6.3-12 and 6.3-13. The following outlines characteristics of Case 1 (Higher Omanization Development), Case 2 (New Oman Vision Development) and Case 3 (Steady Economic Development).

1. Future populations vary depending on labor force demand for expatriates. In Case 2, expatriate population will be about 282 thousand and total population about 3,027 thousand in 2030. On the other hand, 2030 total populations in the other two cases will be smaller than 3 million.
2. In Case 3 future unemployment rate of Omanis is assumed to be 20%, but labor force demand for expatriates is not great due to low economic growth.
3. In Case 1 higher labor productivity rising rates are assumed for construction and service sectors. Accordingly, labor force demand is smaller than that of Case 2 despite the same economic growth assumptions.
4. In addition, assumed rapid improvement in unemployment of Omanis in Case 1 requires the smallest expatriate population among the three cases.
5. The percentages of Omanis in total number of employed persons (Omanization ratio) are shown in Table 6.3-14. The highest Omanization is seen in Case 1. The

second is Case 2. Omanization ratio of 76.6% in 2020 in Case 1 is near to the target of Oman Vision 2020 (public sector 95% and private sector 75%).

Table 6.3-11 Economic Framework of Higher Omanization Development

	2005	2010	2015	2020	2025	2030
Population						
Omanis	1,846,265	2,032,481	2,237,327	2,433,429	2,596,691	2,745,578
(Aged 15+)	1,212,367	1,417,265	1,570,489	1,709,265	1,878,365	2,062,409
Expatriates	574,785	484,808	389,848	287,879	206,282	200,630
Total	2,421,050	2,517,289	2,627,175	2,721,308	2,802,973	2,946,208
Employed Persons by Nationality						
Omanis	340,058	481,870	636,048	790,535	936,835	1,028,626
Expatriates	482,819	407,239	327,472	241,818	173,277	168,529
Total	822,877	889,109	963,520	1,032,353	1,110,112	1,197,155
% of Omanis Employed	41.3	54.2	66.0	76.6	84.4	85.9
Extraction of Crude Oil						
Oil Production						
- Daily Average (thousand bbl)	828.5	878.5	611.8	426	296.6	206.6
- Annual (million bbl)	302.4	320.7	223.3	155.5	108.3	75.4
Annual Average Oil Price (US$/bbl)	27	25	25	25	25	25
Annual Sales of Crude Oil (RO m)	8,165.1	8,016.5	5,582.3	3,887.3	2,706.9	1,884.9
GVA/Annual Sales	0.38	0.38	0.38	0.38	0.38	0.38
GVA of Extraction of Crude Oil (RO m)	3,102.7	3,046.3	2,121.3	1,477.2	1,028.6	716.3
Gross Domestic Product (RO m)						
1. Industry	4,613.4	5,372.5	6,308.5	7,545.0	9,504.0	11,915.1
1.1 Petroleum Activities	3,495.9	3,632.9	3,005.3	2,897.6	3,218.2	3,761.2
- Crude Oil	3,223.7	3,172.2	2,225.4	1,577.6	1,140.1	846.6
- Extraction of Crude Oil	3,102.7	3,046.3	2,121.3	1,477.2	1,028.6	716.3
- Incidental Services to Oil & Gas	121.0	125.9	104.2	100.4	111.5	130.3
- Natural Gas	272.2	460.7	779.9	1,320.0	2,078.1	2,914.6
1.2 Non-petroleum Activities	1,117.5	1,739.6	3,303.2	4,647.3	6,285.8	8,153.9
- Mining & Quarrying	15.1	25.2	42.1	70.2	117.3	195.9
- Manufacturing	747.4	1,288.7	2,750.6	3,964.8	5,434.3	7,077.5
- Refined Oil & Related	39.9	79.9	199.7	254.9	325.3	415.1
- LNG & Related	395.9	791.9	1,979.7	2,908.8	3,985.4	5,086.4
- Other Manufacturing	311.5	416.9	571.2	801.1	1,123.6	1,575.9
- Electricity & Construction	355.0	425.7	510.6	612.3	734.2	880.5
2. Agriculture & Fisheries	176.3	219.7	273.8	341.2	425.2	529.8
3. Services	4,098.6	4,986.5	6,066.9	7,381.3	8,980.4	10,926.1
GDP at Market Prices	8,888.3	10,578.7	12,649.2	15,267.4	18,909.6	23,371.0
GDP per Capita (RO)	3,671.2	4,202.4	4,814.7	5,610.3	6,746.3	7,932.6
GDP per Capita (US$)	9,548.1	10,929.6	12,522.1	14,591.2	17,545.6	20,630.9
GDP Growth Rate (%)	3.47	3.54	3.64	3.83	4.37	4.33
GDP per Capita Growth Rate (%)	1.53	2.74	2.76	3.11	3.76	3.29
Employed Persons by Economic Activity						
Agriculture & Fisheries	73,296	81,924	91,566	102,344	114,391	127,855
Mining	13,786	12,390	8,903	7,480	7,251	7,421
Manufacturing	81,982	105,115	141,200	166,982	197,631	234,072
LNG & Related	500	803	1,572	1,992	2,355	2,592
Others	81,482	104,312	139,628	164,990	195,276	231,480
Electricity & Construction	126,235	130,583	135,081	139,734	144,547	149,526
Services	527,578	559,097	586,770	615,813	646,292	678,281
Total	822,877	889,109	963,520	1,032,353	1,110,112	1,197,155

Source: Study Team Estimates

Table 6.3-12 Economic Framework of New Oman Vision Development

	2005	2010	2015	2020	2025	2030
Population						
Omanis	1,846,265	2,032,481	2,237,327	2,433,429	2,596,691	2,745,578
(Aged 15+)	1,212,367	1,417,265	1,570,489	1,709,265	1,878,365	2,062,409
Expatriates	574,785	526,324	455,215	353,918	324,821	281,807
Total	2,421,050	2,558,805	2,692,542	2,787,347	2,921,512	3,027,385
Employed Persons by Nationality						
Omanis	340,058	453,525	600,712	769,169	887,527	1,028,626
Expatriates	482,819	442,112	382,381	297,291	272,850	236,718
Total	822,877	895,637	983,093	1,066,460	1,160,377	1,265,344
% of Omanis Employed	41.3	50.6	61.1	72.1	76.5	81.3
Extraction of Crude Oil						
Oil Production						
- Daily Average (thousand bbl)	828.5	878.5	611.8	426	296.6	206.6
- Annual (million bbl)	302.4	320.7	223.3	155.5	108.3	75.4
Annual Average Oil Price (US$/bbl)	27	25	25	25	25	25
Annual Sales of Crude Oil (RO m)	8,165.1	8,016.5	5,582.3	3,887.3	2,706.9	1,884.9
GVA/Annual Sales	0.38	0.38	0.38	0.38	0.38	0.38
GVA of Extraction of Crude Oil (RO m)	3,102.7	3,046.3	2,121.3	1,477.2	1,028.6	716.3
Gross Domestic Product (RO m)						
1. Industry	4,613.4	5,372.5	6,308.5	7,545.0	9,504.0	11,915.1
1.1 Petroleum Activities	3,495.9	3,632.9	3,005.3	2,897.6	3,218.2	3,761.2
- Crude Oil	3,223.7	3,172.2	2,225.4	1,577.6	1,140.1	846.6
- Extraction of Crude Oil	3,102.7	3,046.3	2,121.3	1,477.2	1,028.6	716.3
- Incidental Services to Oil & Gas	121.0	125.9	104.2	100.4	111.5	130.3
- Natural Gas	272.2	460.7	779.9	1,320.0	2,078.1	2,914.6
1.2 Non-petroleum Activities	1,117.5	1,739.6	3,303.2	4,647.3	6,285.8	8,153.9
- Mining & Quarrying	15.1	25.2	42.1	70.2	117.3	195.9
- Manufacturing	747.4	1,288.7	2,750.6	3,964.8	5,434.3	7,077.5
- Refined Oil & Related	39.9	79.9	199.7	254.9	325.3	415.1
- LNG & Related	395.9	791.9	1,979.7	2,908.8	3,985.4	5,086.4
- Other Manufacturing	311.5	416.9	571.2	801.1	1,123.6	1,575.9
- Electricity & Construction	355.0	425.7	510.6	612.3	734.2	880.5
2. Agriculture & Fisheries	176.3	219.7	273.8	341.2	425.2	529.8
3. Services	4,098.6	4,986.5	6,066.9	7,381.3	8,980.4	10,926.1
GDP at Market Prices	8,888.3	10,578.7	12,649.2	15,267.4	18,909.6	23,371.0
GDP per Capita (RO)	3,671.2	4,134.2	4,697.8	5,477.4	6,472.5	7,719.9
GDP per Capita (US$)	9,548.1	10,752.3	12,218.1	14,245.5	16,833.7	20,077.7
GDP Growth Rate (%)	3.47	3.54	3.64	3.83	4.37	4.33
GDP per Capita Growth Rate (%)	1.53	2.40	2.59	3.12	3.40	3.59
Employed Persons by Economic Activity						
Agriculture & Fisheries	73,296	81,924	91,566	102,344	114,391	127,855
Mining	13,786	12,390	8,903	7,480	7,251	7,421
Manufacturing	81,982	105,115	141,200	166,982	197,631	234,072
LNG & Related	500	803	1,572	1,992	2,355	2,592
Others	81,482	104,312	139,628	164,990	195,276	231,480
Electricity & Construction	126,235	137,111	148,924	161,755	175,692	190,829
Services	527,578	559,097	592,500	627,899	665,412	705,167
Total	822,877	895,637	983,093	1,066,460	1,160,377	1,265,344

Source: Study Team Estimates

Table 6.3-13 Economic Framework of Steady Economic Development

	2005	2010	2015	2020	2025	2030
Population						
Omanis	1,846,265	2,032,481	2,237,327	2,433,429	2,596,691	2,745,578
(Aged 15+)	1,212,367	1,417,265	1,570,489	1,709,265	1,878,365	2,062,409
Expatriates	574,785	505,977	443,210	367,906	291,750	248,415
Total	2,421,050	2,538,458	2,680,537	2,801,335	2,888,441	2,993,993
Employed Persons by Nationality						
Omanis	340,058	453,525	565,376	683,706	788,913	866,212
Expatriates	482,819	425,021	372,296	309,041	245,070	208,669
Total	822,877	878,546	937,672	992,747	1,033,983	1,074,881
% of Omanis Employed	41.3	51.6	60.3	68.9	76.3	80.6
Extraction of Crude Oil						
Oil Production						
- Daily Average (thousand bbl)	828.5	878.5	611.8	426	296.6	206.6
- Annual (million bbl)	302.4	320.7	223.3	155.5	108.3	75.4
Annual Average Oil Price (US$/bbl)	27	25	25	25	25	25
Annual Sales of Crude Oil (RO m)	8,165.1	8,016.5	5,582.3	3,887.3	2,706.9	1,884.9
GVA/Annual Sales	0.38	0.38	0.38	0.38	0.38	0.38
GVA of Extraction of Crude Oil (RO m	3,102.7	3,046.3	2,121.3	1,477.2	1,028.6	716.3
Gross Domestic Product (RO m)						
1. Industry	4,613.4	5,052.2	5,123.0	5,311.7	5,801.1	6,459.8
1.1 Petroleum Activities	3,495.9	3,569.9	2,806.2	2,424.6	2,262.5	2,198.3
- Crude Oil	3,223.7	3,170.0	2,218.5	1,561.2	1,107.0	792.5
- Extraction of Crude Oil	3,102.7	3,046.3	2,121.3	1,477.2	1,028.6	716.3
- Incidental Services to Oil & Gas	121.0	123.7	97.3	84.0	78.4	76.2
- Natural Gas	272.2	399.9	587.6	863.4	1,155.5	1,405.8
1.2 Non-petroleum Activities	1,117.5	1,482.2	2,316.8	2,887.0	3,538.6	4,261.6
- Mining & Quarrying	15.1	19.3	24.6	31.4	40.0	51.1
- Manufacturing	747.4	1,051.4	1,815.1	2,302.6	2,857.3	3,467.1
- Refined Oil & Related	39.9	59.9	119.8	138.9	161.0	186.7
- LNG & Related	395.9	593.9	1,187.8	1,516.0	1,889.2	2,298.5
- Other Manufacturing	311.5	397.6	507.5	647.7	807.1	982.0
- Electricity & Construction	355.0	411.6	477.1	553.1	641.2	743.3
2. Agriculture & Fisheries	176.3	209.4	248.7	295.4	350.8	416.6
3. Services	4,098.6	4,986.5	6,066.9	7,381.3	8,766.6	10,412.0
GDP at Market Prices	8,888.3	10,248.1	11,438.5	12,988.3	14,918.5	17,288.5
GDP per Capita (RO)	3,671.2	4,037.1	4,267.2	4,636.5	5,164.9	5,774.4
GDP per Capita (US$)	9,548.1	10,499.7	11,098.2	12,058.4	13,432.8	15,017.9
GDP Growth Rate (%)	3.47	2.89	2.22	2.57	2.81	2.99
GDP per Capita Growth Rate (%)	1.53	1.92	1.11	1.67	2.18	2.26
Employed Persons by Economic Activity						
Agriculture & Fisheries	73,296	78,078	83,172	88,598	94,378	100,535
Mining	13,786	12,157	8,270	6,190	5,006	4,218
Manufacturing	81,982	96,669	114,559	123,931	131,595	137,035
LNG & Related	500	602	943	1,038	1,116	1,172
Others	81,482	96,067	113,616	122,893	130,479	135,863
Electricity & Construction	126,235	132,545	139,171	146,129	153,434	161,104
Services	527,578	559,097	592,500	627,899	649,570	671,989
Total	822,877	878,546	937,672	992,747	1,033,983	1,074,881

Source: Study Team Estimates

Table 6.3-14 Future Omanization Ratios by Development Scenarios

	2020	2030
Case 1: Higher Omnization Development	76.6%	85.9%
Case 2: New Oman Vision Development	72.1%	81.3%
Case 3: Steady Economic Development	68.9%	80.6%

Source: Study Team Estimates

6. Future Omani population will be smaller than that Oman Vision 2020 projected. If assumed rapid improvement in unemployment of Omanis will not be realized, expatriate labor force will increase and Omanization ratio will decline. It seems that targeted Omanization ratio of 75% in private sector is too high in view of labor force demand and supply.
7. Future GDP per Capita is shown in Table 6.3-15. GDP per Capita in 1995 was RO 2,522 (US$ 6,559) based on the revised population of 2,104 thousand. Comparing this with 2020 estimates, Cases 1 and 2 are more than two times, and Case 3 is 1.84 times. The Oman Vision 2020 targeted to double 1995 GDP per Capita until 2020.
8. 2020 estimates of Cases 1 and 2 are near to the present level of Bahrain (US$ 15,100). 2030 estimates are near to the present level of Qatar (US$ 20,100).

Table 6.3-15 Future GDP per Capita by Development Scenario

	2020	2020/1995	2030
Case 1: Higher Omnization Development	RO 5,610.3 (US$ 14,591.2)	2.22	RO 7,932.6 (US$ 20,630.9)
Case 2: New Oman Vision Development	RO 5,477.4 (US$ 14,245.5)	2.17	RO 7,719.9 (US$ 20,077.7)
Case 3: Steady Economic Development	RO 4,636.5 (US$ 12,058.4)	1.84	RO 5,774.4 (US$ 15,017.9)

Source: Study Team Estimates

Comparing the three cases, assumptions about improvement in unemployment of Omanis in Case 1 seem to be too optimistic and those of Case 3 too pessimistic. Economic growth assumptions of Case 3 are steady but hopeless. Assumptions about rising of labor productivity for construction and service sectors in Case 1 seem to be too high.

Finally Case 2 is selected. Economic growth assumptions of this case are challenging but succeed to the quantitative targets of Oman Vision 2020.

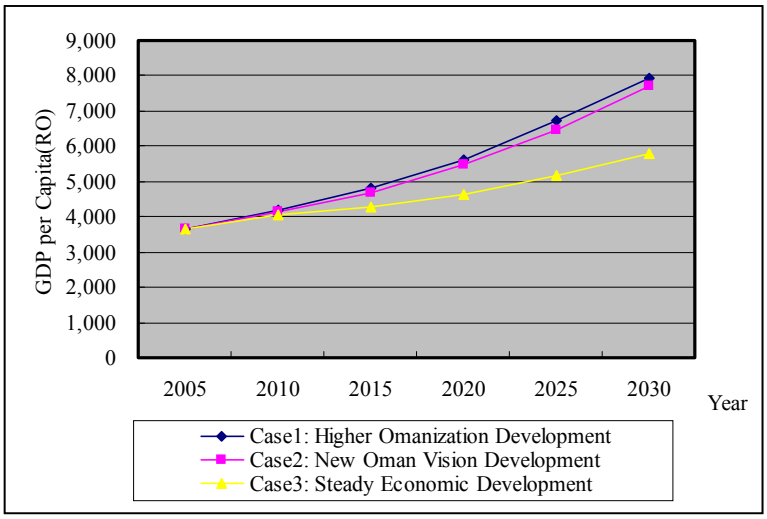


Figure 6.3-1 Future GDP per Capita by Development Scenario

6.4 GROSS REGIONAL DOMESTIC PRODUCT (GRDP)

6.4.1 GRDP in 2000

As the base for the preparation of future GRDP, GRDP in 2000 is estimated by utilizing the following data:

a. GDP by economic activity, 2000 (Ministry of National Economy: MONE)
b. Agricultural production by crop and region, 1999 (Ministry of Agriculture and Fisheries: MOAF)
c. Fish landing by species and region, 2001 (MOAF)
d. Gross value added by industrial category and region, 2000 (Ministry of Commerce and Industry: MOCI)
e. Employed population by economic activity and region, 2000 (MONE)

For 2000, GRDP is estimated for detailed classification of economic activity almost same as used for the national account (GDP). The following is the outline of estimation methods by economic activity.

1) Petroleum Activities

Gross value added (GVA) of extraction of crude oil and natural gas (including incidental services to oil and gas) is totally allocated to Muscat where main offices of companies engaged in these activities are located. It is also due to unavailability of data about oil and gas fields. In addition, crude oil and natural gas are transported through pipelines and do not generate heavy truck traffic.

2) Agriculture

GVA of agriculture is distributed to regions proportionally to estimated crop production (ton) by region in 2000 based on 1999 regional production data.

3) Fisheries

GVA of fisheries is distributed to regions proportionally to estimated sales value (RO million) of traditional fisheries by region in 2000 based on 2001 Fisheries Statistics

4) Mining & Quarrying (excluding oil and gas)

GVA of mining and quarrying is distributed to regions proportionally to estimated

number of employed persons by region in 2000 based on 2000 Labor Force Survey for Omanis and regional data about expatriate labor force published in the Statistical Yearbook.

5) Manufacturing of Refined Oil Products

GVA of this sector is totally allocated to Muscat where Oman Refinery is located (Bausher).

6) Manufacturing of Basic Chemicals (LNG)

GVA of this sector is totally allocated to Sharqiyah where Oman LNG is located (Sur).

7) Other Manufacturing

For medium- to large-scale establishments, regional GVA of 2000 Industrial Census is used. For small-scale establishments, GVA is distributed proportionally to estimated number of employed persons by region.

8) Electricity, Water and Construction

Respective GVAs are distributed proportionally to estimated number of employed persons by region.

9) Service Activities

Each sub-sectoral GVA is distributed proportionally to estimated number of employed persons by region.

10) Financial Intermediation Services Indirectly Measured and Import Taxes

These are totally allocated to Muscat

Estimation results are shown in Table 6.4-1.

Table 6.4-1 Estimated GRDP by Region in 2000 (at Current Prices, RO million)

Economic Activity	Muscat	Batinah	Musandam	Dhahirah	Dakhliyah	Sharqiyah	Wusta	Dhofar	Total
1. Total Petroleum Activities	3,717.7								
1.1 Crude Petroleum	3,616.1								
1.2 Natural Gas	101.6								
2. Total Non Petroleum Activities	2,152.7	675.8	35.0	218.8	223.0	415.5	15.8	342.8	4,079.4
2.1 Agriculture & Fishing	14.1	69.6	4.7	13.0	7.1	20.1	6.6	14.2	149.4
A. Agriculture	3.8	58.9	0.8	13.0	7.1	9.6	0.1	7.4	100.7
B. Fishing	10.3	10.7	3.9	0.0	0.0	10.5	6.5	6.8	48.7
2.2 Industry Activities	302.4	68.3	3.2	40.9	28.4	161.4	1.8	49.0	655.4
C. Mining & Quarrying	7.2	1.1	0.0	6.2	1.1	1.9	0.0	0.7	18.2
D. Manufacturing	205.5	36.2	0.3	13.6	9.9	136.0	0.0	13.2	414.7
- Manufacturing of Refined Petroleum Products	35.5								35.5
- Manufacturing of Basic Chemicals (LNG)						130.7			130.7
- Other Manufacturing	170.0	36.2	0.3	13.6	9.9	5.3	0.0	13.2	248.5
Medium- to Large-scale	165.9	32.2		12.2	8.3	3.4		13.2	235.2
Small-scale	4.1	4.0	0.3	1.4	1.6	1.9	0.0	0.0	13.3
E. Electricity & Water Supply	26.1	19.7	2.7	5.8	6.4	5.8	1.4	9.8	77.7
F. Building & Construction	63.6	11.3	0.2	15.3	11.0	17.7	0.4	25.3	144.8
2.3 Services Activities	1,836.2	537.9	27.1	164.9	187.5	234.0	7.4	279.6	3,274.6
G. Wholesale & Retail Trade	580.2	56.2	6.9	31.1	30.6	45.8	0.4	64.7	815.9
H. Hotels & Restaurants	32.1	3.8	0.6	2.1	2.9	2.7	0.1	9.7	54.0
I. Transport, Storage and Communication	152.8	214.9	5.2	16.7	18.7	8.2	0.0	34.4	450.9
J. Financial Intermediation	185.9	16.9	1.4	8.9	9.2	13.9	0.0	20.1	256.3
K. Real Estate & Business Activities	326.3	29.2	0.0	15.4	16.5	24.4	0.0	10.1	421.9
L. Public Administration & Defence	314.4	123.2	7.9	45.3	63.3	76.5	3.8	81.4	715.8
M. Education	139.8	54.9	3.5	20.2	28.2	34.1	1.7	36.2	318.6
N. Health	54.0	21.2	1.4	7.8	10.9	13.2	0.6	14.0	123.1
O. Other Community, Social and Personal Services	42.9	14.7	0.0	16.0	6.3	14.0	0.7	7.0	101.6
P. Private Household with Employed Persons	7.8	2.9	0.2	1.4	0.9	1.2	0.1	2.0	16.5
Financial Intermediation Services Indirectly Measured	-204.0								-204.0
GRDP at Producers Prices	5,666.4	675.8	35.0	218.8	223.0	415.5	15.8	342.8	7,593.1
Plus: Import Taxes	46.1								46.1
GRDP at Market Prices	5,712.5	675.8	35.0	218.8	223.0	415.5	15.8	342.8	7,639.2
Population									
Omanis	353,300	537,500	21,300	145,300	225,100	251,000	16,000	143,500	1,693,000
Expatriates	294,900	108,300	7,300	53,800	35,500	45,700	4,000	74,100	623,570
Total	648,200	645,800	28,600	199,100	260,600	296,700	20,000	217,600	2,316,570
GRDP per Capita (RO)	8,813	1,046	1,224	1,099	856	1,400	790	1,575	3,298

Source: Study Team Estimates

6.4.2 Future GRDP

For the estimation of future GRDP, the following facts are taken into consideration:

1) GRDP in 2000
2) Large-scale industrial development projects
3) Distribution of industrial estates
4) Tourism development projects
5) Assumed distribution of employed population by economic activity (workplace base)

Economic activities are integrated for future GRDP. Estimation results are shown in Table 6.4-2.

Table 6.4-2 Future GRDP by Region and Year (RO million)

2005

	Petroleum Activities	Crude Oil	Natural Gas	Non-oil Activities	Agriculture & Fisheries	Mining & Quarrying	Manufac-turing	Electricity/ Construction	Services	Total	GRDP per Capita
Oman Total	3,495.9	3,223.7	272.2	5,392.4	176.3	15.1	747.4	355.0	4,098.6	8,888.3	3,671
Muscat	3,495.9	3,223.7	272.2	2,624.0	16.6	6.0	251.2	143.1	2,207.0	6,119.9	9,334
Batinah				885.0	82.1	0.9	45.1	49.5	707.4	885.0	1,306
Musandam				46.1	5.5	0.0	0.3	4.6	35.6	46.1	1,571
Dhahirah				287.9	15.3	5.1	16.9	33.7	216.9	287.9	1,357
Dakhiliyah				295.8	8.4	0.9	12.2	27.8	246.6	295.8	1,075
Sharqiyah				774.9	23.7	1.6	404.4	37.5	307.7	774.9	2,387
Wusta				20.6	7.8	0.0	0.2	2.9	9.7	20.6	860
Dhofar				458.1	16.8	0.6	17.1	56.0	367.7	458.1	2,058

2010

	Petroleum Activities	Crude Oil	Natural Gas	Non-oil Activities	Agriculture & Fisheries	Mining & Quarrying	Manufac-turing	Electricity/ Construction	Services	Total	GRDP per Capita
Oman Total	3632.9	3172.2	460.7	6,945.8	219.7	25.2	1,288.7	425.7	4,986.5	10,578.7	4,134
Muscat	3632.9	3172.2	460.7	3,213.0	20.7	10.0	325.5	171.6	2,685.2	6,845.9	9,915
Batinah				1,123.8	102.4	1.5	100.0	59.3	860.6	1,123.8	1,571
Musandam				56.2	6.9	0.0	0.4	5.5	43.4	56.2	1,832
Dhahirah				357.1	19.1	8.6	25.2	40.4	263.8	357.1	1,608
Dakhiliyah				364.7	10.4	1.5	19.5	33.3	300.0	364.7	1,255
Sharqiyah				1,243.1	29.6	2.6	791.6	45.0	374.4	1,243.1	3,559
Wusta				25.2	9.7	0.0	0.2	3.4	11.8	25.2	937
Dhofar				562.6	20.9	1.0	26.3	67.2	447.3	562.6	2,409

2015

	Petroleum Activities	Crude Oil	Natural Gas	Non-oil Activities	Agriculture & Fisheries	Mining & Quarrying	Manufac-turing	Electricity/ Construction	Services	Total	GRDP per Capita
Oman Total	3005.3	2225.4	779.9	9,644.0	273.8	42.1	2,750.6	510.6	6,066.9	12,649.3	4,698
Muscat	3005.3	2225.4	779.9	3,938.2	25.8	16.7	422.9	205.8	3,266.9	6,943.5	9,598
Batinah				1,486.7	127.6	2.5	238.4	71.1	1,047.1	1,486.7	1,981
Musandam				68.5	8.6	0.0	0.5	6.7	52.8	68.5	2,138
Dhahirah				442.9	23.8	14.3	35.3	48.4	321.0	442.9	1,903
Dakhiliyah				448.7	13.0	2.5	28.2	39.9	365.0	448.7	1,467
Sharqiyah				2,537.4	36.8	4.4	1,986.7	53.9	455.5	2,537.4	6,799
Wusta				30.9	12.1	0.0	0.3	4.1	14.4	30.9	1,045
Dhofar				690.8	26.0	1.6	38.3	80.5	544.3	690.8	2,818

2020

	Petroleum Activities	Crude Oil	Natural Gas	Non-oil Activities	Agriculture & Fisheries	Mining & Quarrying	Manufac-turing	Electricity/ Construction	Services	Total	GRDP per Capita
Oman Total	2,897.6	1,577.6	1,320.0	12,369.8	341.2	70.2	3,964.8	612.3	7,381.3	15,267.4	5,477
Muscat	2,897.6	1,577.6	1,320.0	4,850.1	32.2	27.8	568.6	246.8	3,974.7	7,747.7	10,386
Batinah				1,845.5	159.0	4.2	323.1	85.3	1,273.9	1,845.5	2,382
Musandam				83.6	10.7	0.0	0.7	8.0	64.2	83.6	2,520
Dhahirah				552.4	29.7	23.9	50.2	58.1	390.5	552.4	2,291
Dakhiliyah				552.9	16.2	4.2	40.5	47.9	444.1	552.9	1,743
Sharqiyah				3,598.1	45.9	7.3	2,926.0	64.7	554.2	3,598.1	9,233
Wusta				38.2	15.1	0.0	0.6	5.0	17.5	38.2	1,215
Dhofar				849.0	32.4	2.7	55.1	96.6	662.2	849.0	3,340

2025

	Petroleum Activities	Crude Oil	Natural Gas	Non-oil Activities	Agriculture & Fisheries	Mining & Quarrying	Manufac-turing	Electricity/ Construction	Services	Total	GRDP per Capita
Oman Total	3,218.2	1,140.1	2,078.1	15,691.4	425.2	117.3	5,434.3	734.2	8,980.4	18,909.6	6,473
Muscat	3,218.2	1,140.1	2,078.1	5,900.6	40.1	46.4	682.3	296.0	4,835.8	9,118.8	11,743
Batinah				2,300.4	198.1	7.1	443.0	102.3	1,549.9	2,300.4	2,849
Musandam				104.5	13.4	0.0	3.5	9.6	78.1	104.5	2,986
Dhahirah				702.3	37.0	40.0	80.6	69.6	475.1	702.3	2,764
Dakhiliyah				700.1	20.2	7.1	75.1	57.4	540.3	700.1	2,096
Sharqiyah				4,872.6	57.2	12.2	4,051.4	77.5	674.2	4,872.6	11,819
Wusta				49.3	18.8	0.0	3.3	5.9	21.3	49.3	1,465
Dhofar				1,061.5	40.4	4.5	95.1	115.8	805.6	1,061.5	3,956

2030

	Petroleum Activities	Crude Oil	Natural Gas	Non-oil Activities	Agriculture & Fisheries	Mining & Quarrying	Manufac-turing	Electricity/ Construction	Services	Total	GRDP per Capita
Oman Total	3,761.2	846.6	2,914.6	19,609.8	529.8	195.9	7,077.5	880.5	10,926.1	23,371.0	7,720
Muscat	3,761.2	846.6	2,914.6	7,232.5	50.0	77.5	866.5	355.0	5,883.6	10,993.7	13,749
Batinah				2,869.4	246.8	11.8	602.4	122.7	1,885.7	2,869.4	3,447
Musandam				129.8	16.7	0.0	6.7	11.5	95.0	129.8	3,541
Dhahirah				894.7	46.1	66.7	120.3	83.5	578.1	894.7	3,371
Dakhiliyah				881.5	25.2	11.8	118.3	68.9	657.3	881.5	2,533
Sharqiyah				6,215.9	71.3	20.5	5,210.8	93.0	820.3	6,215.9	14,472
Wusta				62.9	23.4	0.0	6.4	7.1	25.9	62.9	1,783
Dhofar				1,323.1	50.4	7.5	146.1	138.9	980.2	1,323.1	4,716

Source: Study Team Estimates

6.5 VEHICLE OWNERSHIP

6.5.1 Relation between Vehicle Ownership and Household Income

Based on the regional number of private vehicles estimated by MONE, relation between vehicle ownership and per capita income is analyzed. The total number of samples is 16, Omani households and expatriate household of eight regions. Using selected samples, the following logistic curve is obtained.

$$Y = 490/(1+4.5495e^{(-0.005269x)})$$

Where y: private vehicle ownership (vehicles/1,000 persons)
x: per capita monthly income (RO)
e: base of natural logarithm (2.7182818)
$R^2 = 0.914903$

The limiting value of vehicle ownership of 490 is the present value of the United States.

This formula is used for theoretical future ownership of each zone (Wilayat).

6.5.2 Future Vehicle Ownership and Number of Private Vehicles

After revision of number of private vehicles and ownership due to the revision of 2000 Omani population, estimation for 2003 is carried out. Then, future vehicle ownership and number of private vehicles are projected. Future per capita income growth is assumed to be parallel to per capita GDP growth.

Calculation of number of vehicles is carried out at the zone (Wilayat) level by use of the above-mentioned logistic curve and summed up to the regional and national level. If theoretical ownership of 2005 is lower than that of 2003, or ownership of 2010 is lower than that of 2005 for some zones, the ownership of previous years is adopted. Accordingly, the vehicle ownership at the regional and national level does not correspond to the theoretical value.

Table 6.5-1 shows the estimation results. In 2000, as the composition of expatriates was higher than 2003, monthly per capita income was higher and the number of vehicles was larger. It seems that 2003 values are more credible. Comparing 2003 and 2030, per capita income will become more than 2 times and vehicle ownership will increase from one vehicle for 8 persons to one vehicle for 5 persons. The number of

private vehicles will increase from 285 thousand to 578 thousand.

Table 6.5-1 Future Vehicle Ownership and Number of Private Vehicles

	2000	2003	2005	2010	2015	2020	2025	2030
Monthly per capita Income (RO)	96.72	93.68	96.59	108.76	123.55	144.11	170.34	203.13
Vehicles/1000 Persons	123.2	122.0	126.3	139.0	146.3	157.4	172.1	191.4
Number of Private Vehicles	285,428	284,529	305,736	355,581	393,822	438,687	502,748	577,759

Source: Study Team Estimates

6.6 FUTURE SOCIOECONOMIC INDICES BY ZONE

Available socioeconomic data for zone (Wilayat) are limited. Published data are only population and number of households based on the 1993 and 2003 Censuses. In addition by favor of Ministries, the Study Team obtained the following data at the Wilayat level.

a. Area of plantation, 1993 (MOAF)
b. Number of fishermen, 2001 (MOAF)
c. Number of employed persons by manufacturing establishment by industrial classification, 2000 (MOCI)

In addition, data included in Muscat Area Structure Plan document are usable for Muscat. Future socioeconomic indices are as follows:

a. Population
b. Number of Employed Persons by Sector (Residence Base and Workplace Base)
c. Number of Private Vehicles
d. Gross Value Added and Finished Goods Manufactured by ISIC (International Standard Industrial Classification)

Estimation for 2000 was carried out first as the base, by utilizing the above-mentioned data. As the second step, estimation for 2005 was carried out by use of 2000 results and 2003 Census data. The third step was to establish the final image of 2030, considering the regional development balance. Finally, the intermediate years' estimation was carried out.

6.6.1 Population

Table 6.6-1 shows estimation results of future population by zone. Until 2005 population by nationality is estimated but after 2010 only total population is estimated. For future distribution of population, it is considered that the share of Muscat and

Batinah will gradually decline due to constraints of land use and government development policy for regional balance.

6.6.2 Number of Employed Persons

Number of employed persons by zone is estimated on residence base and on workplace base. Residence based employed persons are determined by labor force participation rate and unemployment rate of zone population. On the other hand, workplace based employed persons are determined by the degree of existence of workplace such as factories, shopping centers, farms and so on.

For the primary sector (agriculture and fisheries), it is assumed that workplace is existent within the zone of living place. For other sectors, many people are commuting from neighboring regions to Muscat, and in the region, from rural zones to the capital city. Such situation is estimated quantitatively for 2000 as the base, by utilizing various data such as number of employees in manufacturing establishments, commercial floor area by Wilayat in Muscat and assumed urban/rural ratios.

Based on the 2000 pattern and planned large-scale development projects, future estimation is carried out. Tables 6.6-2 and 6.6-3 show the estimation results.

6.6.3 Number of Private Vehicles

As described in Section 6.5, future vehicle ownership by zone is estimated by use of a logistic curve formula. And allying the determined vehicle ownership to estimated population, number of private vehicle by zone is estimated. The results are shown in Table 6.6-4.

6.6.4 Gross Value Added and Finished Goods Manufactured

In order to estimate future truck traffic, finished goods manufactured by ISIC and zone is required. Gross value added (GVA) by ISIC and zone is an intermediate product of the work. As an economic framework at the national level, GVA of manufacturing industries is obtained. This GVA is broken down to the zone level, by considering large-scale industrial projects and planned industrial estates. Finished goods manufactured are obtained by multiplying respective coefficients to GVA by ISIC. Table 6.6-5 shows the results.

Table 6.6-1 Future Population by Zone

	2000	2005	2010	2015	2020	2025	2030
Oman Total	2,316,600	2,421,050	2,558,805	2,692,542	2,787,347	2,921,512	3,027,385
Muscat	648,200	655,654	690,461	723,461	745,962	776,534	799,612
Muttrah	190,300	151,433	149,673	146,558	140,529	135,267	127,937
Baushar	137,000	161,311	173,599	185,798	195,600	207,805	218,294
A'Seeb	203,600	237,780	254,562	270,883	283,162	298,950	311,849
Al-Amrat	42,600	42,424	46,788	51,238	55,113	59,747	63,969
Muscat	35,800	22,949	22,678	22,406	22,134	21,862	21,590
Quriyat	38,900	39,757	43,161	46,578	49,424	52,903	55,973
Al-Batinah	645,800	677,537	715,143	750,484	774,642	807,548	832,455
Sohar	103,300	108,042	115,545	122,838	128,424	135,580	141,517
Al-Rustaq	72,200	76,936	80,698	84,153	86,311	89,404	91,570
Shinas	48,300	49,048	51,428	53,611	54,966	56,915	58,272
Liwa	25,700	26,469	27,357	28,098	28,373	28,921	29,136
Saham	84,500	87,670	92,623	97,291	100,516	104,884	108,219
Al-Khabourah	46,700	48,268	50,055	51,591	52,285	53,499	54,110
Al-Suwaiq	97,600	104,922	111,052	116,861	120,955	126,439	130,695
Nakhal	15,600	16,929	18,586	20,257	21,686	23,417	24,974
W. Al-Maawil	11,400	11,685	12,012	12,269	12,316	12,476	12,487
Al-Awabi	10,200	10,922	11,797	12,662	13,361	14,232	14,984
Al-Musana'a	54,600	58,560	60,891	62,934	63,964	65,642	66,596
Barka	75,700	78,086	83,099	87,919	91,485	96,139	99,895
Musandam	28,600	29,354	30,684	32,043	33,171	35,012	36,669
Khasab	17,300	18,361	19,282	20,229	21,037	22,307	23,468
Bukha	3,400	2,949	3,037	3,123	3,184	3,308	3,410
Daba Al-baiya	5,500	5,711	6,003	6,304	6,562	6,964	7,334
Madhaa	2,400	2,333	2,362	2,387	2,388	2,433	2,457
A'Dhahirah	199,100	212,132	222,084	232,745	241,106	254,133	265,404
Al-Buraimi	53,800	66,132	70,267	74,724	78,527	83,953	88,910
Ibri	102,500	102,347	106,151	110,200	113,076	118,043	122,086
Mahdhah	9,000	9,356	9,790	10,255	10,619	11,187	11,678
Yanqul	16,700	17,040	17,869	18,758	19,465	20,551	21,498
Dhank	17,100	17,257	18,007	18,808	19,419	20,399	21,232
A'Dakhliyah	260,600	275,162	290,657	305,848	317,163	333,988	347,937
Nizwa	67,000	72,248	76,750	81,216	84,690	89,680	93,944
Samail	43,700	46,441	49,418	52,381	54,714	58,032	60,889
Bahla	51,000	53,184	55,697	58,102	59,726	62,341	64,368
Adam	14,700	14,211	14,916	15,594	16,067	16,809	17,397
Al-Hamra	16,500	17,776	18,509	19,195	19,614	20,347	20,876
Manah	12,100	13,124	13,706	14,258	14,614	15,210	15,657
Izki	34,800	36,730	38,886	41,011	42,625	44,987	46,971
Bidbid	20,800	21,448	22,775	24,091	25,113	26,582	27,835
A'Sharqiyah	296,700	324,645	349,324	373,205	389,688	412,282	429,501
Sur	59,900	69,156	75,597	82,034	86,983	93,425	98,784
Ibra	23,600	25,563	27,944	30,321	32,148	34,528	36,508
Biddiyah	17,500	18,461	19,385	20,198	20,555	21,180	21,475
Al-Qabil	13,400	14,079	14,565	14,936	14,943	15,120	15,033
Al-Mudhaibi	57,400	61,416	65,653	69,680	72,276	75,957	78,599
D. W. Tayeen	16,500	17,657	18,693	19,643	20,168	20,976	21,475
A. K. W. Alwafi	19,400	20,937	22,215	23,398	24,081	25,107	25,770
J. B. B. Ali	47,200	52,853	57,374	61,833	65,125	69,494	73,015
J. B. B. Hassan	25,200	26,693	28,567	30,354	31,521	33,166	34,360
W. B. Khalid	7,300	8,241	9,190	10,163	10,971	11,988	12,885
Massirah	9,300	9,589	10,141	10,645	10,917	11,341	11,597
Al-Wusta	20,000	23,947	26,881	29,600	31,389	33,677	35,270
Haima	2,700	3,314	3,756	4,174	4,468	4,838	5,115
Mahut	8,900	10,131	11,275	12,309	12,939	13,761	14,284
A'Duqum	4,000	4,440	5,089	5,720	6,189	6,772	7,230
Al-Jazir	4,400	6,062	6,761	7,397	7,793	8,306	8,641
Dhofar	217,600	222,619	233,571	245,156	254,226	268,338	280,537
Salalah	156,800	162,663	171,101	180,044	187,178	198,070	207,597
Thumrait	8,500	7,469	7,904	8,367	8,751	9,314	9,819
Taqah	17,800	17,927	18,551	19,200	19,629	20,422	21,040
Marbat	13,800	15,457	16,244	17,077	17,738	18,753	19,638
Sadah	5,000	5,627	5,984	6,366	6,689	7,153	7,574
Rakhiyout	4,600	4,617	4,716	4,816	4,855	4,977	5,050
Dhalkout	3,100	2,994	3,074	3,155	3,198	3,298	3,366
Maqshan	1,900	556	607	662	712	778	842
S. W. Halaniyyat	6,100	5,309	5,390	5,469	5,476	5,573	5,611

Source: Study Team Estimates

Table 6.6-2 Future Number of Employed Persons by Zone (Residence Base)

	2000	2005	2010	2015	2020	2025	2030
Oman Total	801,720	822,877	895,637	983,093	1,066,460	1,160,377	1,265,344
Muscat	320,570	320,477	346,675	378,559	408,865	442,648	480,630
Muttrah	94,110	78,433	78,028	78,890	79,419	80,485	82,319
Baushar	67,750	75,957	84,842	95,123	105,009	115,799	127,694
A'Seeb	100,690	113,342	125,445	139,610	153,195	168,141	184,666
Al-Amrat	21,070	20,734	23,925	27,512	30,984	34,746	38,839
Muscat	17,710	12,572	12,486	12,603	12,668	12,829	13,113
Quriyat	19,240	19,439	21,949	24,821	27,590	30,648	33,999
Al-Batinah	178,840	185,439	201,147	220,154	238,246	258,980	282,186
Sohar	28,610	29,594	32,695	36,330	39,812	43,702	48,009
Al-Rustaq	19,990	21,049	22,653	24,629	26,502	28,628	31,028
Shinas	13,380	13,428	14,429	15,667	16,840	18,212	19,758
Liwa	7,120	7,243	7,633	8,148	8,630	9,208	9,874
Saham	23,400	23,995	26,051	28,535	30,900	33,631	36,684
Al-Khabourah	12,930	13,204	13,978	14,981	15,922	17,046	18,333
Al-Suwaiq	27,030	28,720	31,266	34,325	37,242	40,581	44,307
Nakhal	4,320	4,637	5,304	6,059	6,788	7,594	8,472
W. Al-Maawil	3,160	3,197	3,345	3,548	3,737	3,965	4,231
Al-Awabi	2,820	2,986	3,342	3,753	4,149	4,590	5,074
Al-Musana'a	15,120	16,023	17,028	18,312	19,520	20,944	22,568
Barka	20,960	21,363	23,423	25,867	28,204	30,879	33,848
Musandam	8,960	9,090	9,915	10,903	11,846	12,893	14,064
Khasab	5,420	5,678	6,236	6,895	7,527	8,219	8,990
Bukha	1,070	922	985	1,065	1,140	1,224	1,320
Daba Al-baiya	1,720	1,770	1,943	2,148	2,344	2,567	2,815
Madhaa	750	720	751	795	835	883	939
A'Dhahirah	63,690	67,065	73,088	80,310	87,199	95,107	103,922
Al-Buraimi	17,210	20,908	23,265	26,005	28,637	31,575	34,814
Ibri	32,790	32,355	34,805	37,825	40,687	44,034	47,802
Mahdhah	2,880	2,958	3,217	3,529	3,827	4,180	4,573
Yanqul	5,340	5,389	5,885	6,477	7,042	7,695	8,421
Dhank	5,470	5,455	5,916	6,474	7,006	7,623	8,312
A'Dakhliyah	65,980	68,860	75,323	83,022	90,377	98,639	107,841
Nizwa	16,970	18,089	19,945	22,127	24,220	26,550	29,133
Samail	11,060	11,615	12,832	14,260	15,629	17,163	18,861
Bahla	12,910	13,309	14,387	15,701	16,949	18,362	19,950
Adam	3,720	3,558	3,858	4,221	4,566	4,956	5,394
Al-Hamra	4,180	4,447	4,767	5,166	5,543	5,977	6,468
Manah	3,060	3,283	3,534	3,843	4,136	4,472	4,850
Izki	8,810	9,190	10,085	11,145	12,159	13,294	14,555
Bidbid	5,270	5,369	5,915	6,559	7,175	7,865	8,630
A'Sharqiyah	76,930	83,199	92,148	102,612	112,649	123,896	136,327
Sur	15,540	17,726	20,087	22,781	25,381	28,236	31,361
Ibra	6,120	6,556	7,427	8,420	9,378	10,437	11,596
Biddiyah	4,540	4,733	5,060	5,470	5,858	6,308	6,819
Al-Qabil	3,470	3,600	3,767	3,995	4,207	4,463	4,761
Al-Mudhaibi	14,880	15,735	17,258	19,064	20,791	22,757	24,941
D. W. Tayeen	4,280	4,531	4,899	5,347	5,772	6,269	6,825
A. K. W. Alwafi	5,030	5,370	5,830	6,385	6,914	7,514	8,186
J. B. B. Ali	12,240	13,544	15,194	17,094	18,922	20,948	23,174
J. B. B. Hassan	6,530	6,840	7,516	8,315	9,079	9,944	10,904
W. B. Khalid	1,890	2,107	2,455	2,844	3,221	3,633	4,080
Massirah	2,410	2,457	2,655	2,897	3,126	3,387	3,680
Al-Wusta	5,970	7,066	8,074	9,215	10,317	11,548	12,890
Haima	810	986	1,144	1,321	1,492	1,680	1,884
Mahut	2,660	2,996	3,378	3,816	4,238	4,713	5,233
A'Duqum	1,190	1,303	1,537	1,796	2,047	2,326	2,628
Al-Jazir	1,310	1,781	2,015	2,282	2,540	2,829	3,145
Dhofar	80,780	81,681	89,267	98,318	106,961	116,666	127,484
Salalah	58,210	59,691	65,463	72,309	78,856	86,192	94,351
Thumrait	3,160	2,745	3,034	3,373	3,698	4,065	4,470
Taqah	6,610	6,576	7,052	7,644	8,204	8,839	9,559
Marbat	5,120	5,666	6,207	6,850	7,465	8,151	8,915
Sadah	1,860	2,066	2,300	2,572	2,833	3,124	3,444
Rakhiyout	1,710	1,694	1,784	1,903	2,015	2,144	2,294
Dhalkout	1,150	1,102	1,169	1,255	1,335	1,428	1,535
Maqshan	710	201	232	267	300	337	377
S. W. Halaniyyat	2,260	1,940	2,026	2,145	2,255	2,386	2,539

Source: Study Team Estimates

Table 6.6-3 Future Number of Employed Persons by Zone (Workplace Base)

	2000	2005	2010	2015	2020	2025	2030
Oman Total	801,720	822,877	895,637	983,093	1,066,460	1,160,377	1,265,344
Muscat	379,070	381,222	402,263	429,880	455,708	485,245	519,390
Muttrah	139,070	117,074	117,269	119,369	120,969	123,339	126,886
Baushar	118,700	134,415	141,091	150,072	158,430	167,850	178,850
A'Seeb	84,920	96,927	108,679	122,220	135,254	149,673	165,519
Al-Amrat	11,000	11,015	12,579	14,351	16,063	17,962	20,032
Muscat	13,720	9,893	9,630	9,523	9,376	9,335	9,383
Quriyat	11,660	11,898	13,015	14,345	15,616	17,086	18,720
Al-Batinah	144,050	148,999	167,484	188,727	209,186	232,166	257,361
Sohar	41,960	43,511	50,022	57,363	64,464	72,160	80,545
Al-Rustaq	10,420	10,998	12,088	13,376	14,609	16,010	17,563
Shinas	9,170	9,168	10,234	11,468	12,655	14,018	15,515
Liwa	4,490	4,549	4,967	5,466	5,942	6,500	7,121
Saham	16,630	16,975	18,861	21,057	23,165	25,589	28,257
Al-Khabourah	8,860	9,011	9,712	10,571	11,387	12,359	13,449
Al-Suwaiq	18,780	19,898	22,450	25,371	28,187	31,376	34,865
Nakhal	2,570	2,751	3,345	3,994	4,627	5,318	6,059
W. Al-Maawil	1,970	1,987	2,164	2,377	2,580	2,819	3,084
Al-Awabi	1,660	1,756	2,078	2,434	2,780	3,161	3,573
Al-Musana'a	10,000	10,564	11,447	12,518	13,537	14,736	16,075
Barka	17,540	17,831	20,116	22,732	25,253	28,120	31,256
Musandam	8,960	9,090	9,915	10,903	11,846	12,893	14,064
Khasab	5,670	5,920	6,532	7,252	7,941	8,694	9,529
Bukha	900	774	819	877	932	995	1,068
Daba Al-baiya	1,780	1,814	1,953	2,125	2,288	2,476	2,690
Madhaa	610	582	611	649	685	728	777
A'Dhahirah	59,040	62,520	68,716	76,041	83,049	91,059	99,938
Al-Buraimi	20,470	24,558	28,010	31,926	35,708	39,827	44,326
Ibri	24,900	24,297	25,817	27,759	29,585	31,805	34,329
Mahdhah	3,620	3,656	4,255	4,925	5,574	6,312	7,110
Yanqul	5,980	6,003	6,312	6,723	7,107	7,603	8,172
Dhank	4,070	4,006	4,322	4,708	5,075	5,512	6,001
A'Dakhliyah	53,780	56,447	63,573	71,746	79,620	88,319	97,860
Nizwa	21,240	22,681	26,290	30,335	34,253	38,487	43,089
Samail	7,620	8,008	8,952	10,043	11,092	12,267	13,560
Bahla	8,300	8,587	9,348	10,262	11,133	12,125	13,232
Adam	2,590	2,483	2,736	3,034	3,319	3,644	4,003
Al-Hamra	2,630	2,800	3,043	3,336	3,615	3,937	4,296
Manah	1,960	2,111	2,317	2,560	2,793	3,059	3,354
Izki	5,790	6,054	6,715	7,487	8,228	9,057	9,972
Bidbid	3,650	3,723	4,172	4,689	5,187	5,743	6,354
A'Sharqiyah	72,520	78,797	89,187	101,047	112,487	125,153	139,012
Sur	23,420	26,624	31,813	37,529	43,090	49,046	55,470
Ibra	5,150	5,500	6,200	7,002	7,774	8,634	9,577
Biddiyah	3,600	3,741	3,986	4,296	4,588	4,936	5,332
Al-Qabil	2,760	2,851	2,970	3,137	3,291	3,486	3,714
Al-Mudhaibi	12,790	13,463	14,668	16,114	17,493	19,090	20,868
D. W. Tayeen	3,640	3,832	4,167	4,570	4,955	5,406	5,908
A. K. W. Alwafi	3,900	4,159	4,492	4,899	5,286	5,733	6,235
J. B. B. Ali	8,920	9,868	11,102	12,519	13,883	15,401	17,065
J. B. B. Hassan	5,100	5,330	5,885	6,537	7,162	7,876	8,665
W. B. Khalid	1,360	1,517	1,830	2,173	2,507	2,870	3,260
Massirah	1,880	1,912	2,074	2,271	2,458	2,675	2,917
Al-Wusta	3,520	4,121	5,232	6,431	7,603	8,876	10,235
Haima	640	778	942	1,122	1,296	1,483	1,685
Mahut	1,370	1,520	1,924	2,361	2,789	3,256	3,754
A'Duqum	750	812	1,085	1,376	1,661	1,970	2,298
Al-Jazir	760	1,011	1,281	1,572	1,857	2,167	2,498
Dhofar	80,780	81,681	89,267	98,318	106,961	116,666	127,484
Salalah	64,000	65,480	72,001	79,705	87,077	95,305	104,441
Thumrait	3,000	2,604	2,841	3,124	3,394	3,705	4,051
Taqah	4,530	4,522	4,723	5,002	5,260	5,571	5,936
Marbat	3,490	3,870	4,132	4,461	4,772	5,128	5,532
Sadah	1,370	1,528	1,695	1,889	2,076	2,284	2,513
Rakhiyout	1,180	1,171	1,233	1,316	1,393	1,485	1,591
Dhalkout	790	754	822	903	980	1,068	1,167
Maqshan	580	169	203	240	277	316	359
S. W. Halaniyyat	1,840	1,583	1,617	1,678	1,732	1,804	1,894

Source: Study Team Estimates

Table 6.6-4 Future Number of Private Vehicles by Zone

	2000	2005	2010	2015	2020	2025	2030
Oman Total	285,428	305,736	355,581	393,822	438,687	502,748	577,759
Muscat	113,012	112,722	121,330	136,938	155,988	182,328	213,182
Muttrah	36,735	28,895	30,112	32,244	34,659	37,937	41,035
Baushar	25,745	30,086	33,366	38,936	45,821	55,281	66,500
A'Seeb	32,764	37,977	41,118	47,024	54,087	63,994	75,977
Al-Amrat	6,015	5,899	6,754	7,860	9,174	10,986	13,214
Muscat	6,368	4,408	3,887	3,903	4,244	4,700	5,284
Quriyat	5,385	5,457	6,093	6,971	8,003	9,430	11,172
Al-Batinah	62,446	70,937	85,852	93,771	102,228	114,091	127,747
Sohar	8,588	12,296	14,522	16,153	17,961	20,469	23,425
Al-Rustaq	6,367	7,342	9,280	10,017	10,771	11,838	13,033
Shinas	4,213	4,635	5,979	6,460	6,957	7,660	8,452
Liwa	2,250	2,515	3,160	3,361	3,561	3,855	4,178
Saham	8,219	9,241	11,036	12,051	13,130	14,639	16,371
Al-Khabourah	4,542	5,100	5,944	6,366	6,800	7,430	8,139
Al-Suwaiq	9,473	10,982	13,349	14,619	15,979	17,879	20,069
Nakhal	1,382	1,622	2,128	2,399	2,691	3,080	3,527
W. Al-Maawil	1,006	1,118	1,377	1,456	1,531	1,645	1,768
Al-Awabi	905	1,049	1,345	1,493	1,649	1,860	2,101
Al-Musana'a	5,309	6,142	7,300	7,850	8,422	9,247	10,182
Barka	7,916	8,895	10,432	11,546	12,776	14,489	16,502
Musandam	3,046	3,342	3,859	4,218	4,645	5,296	6,085
Khasab	1,965	2,219	2,459	2,704	2,997	3,440	3,980
Bukha	301	286	366	392	422	470	526
Daba Al-baiya	559	611	750	823	910	1,042	1,201
Madhaa	221	226	284	299	316	344	378
A'Dhahirah	26,383	28,277	29,684	31,361	34,313	39,169	45,013
Al-Buraimi	7,796	9,581	10,180	10,826	12,241	14,339	16,920
Ibri	13,510	13,491	13,993	14,526	15,498	17,413	19,680
Mahdhah	1,068	1,138	1,237	1,356	1,495	1,702	1,950
Yanqul	1,981	2,021	2,122	2,315	2,531	2,854	3,233
Dhank	2,028	2,046	2,153	2,338	2,548	2,861	3,230
A'Dakhliyah	24,720	28,609	35,674	39,170	43,048	48,729	55,396
Nizwa	6,733	7,860	9,766	10,828	12,031	13,783	15,870
Samail	4,200	4,878	6,021	6,652	7,354	8,370	9,566
Bahla	4,871	5,557	6,793	7,387	8,038	9,006	10,130
Adam	1,169	1,274	1,779	1,934	2,102	2,350	2,636
Al-Hamra	1,470	1,725	2,177	2,343	2,519	2,785	3,088
Manah	1,048	1,223	1,622	1,753	1,893	2,102	2,342
Izki	3,293	3,854	4,739	5,210	5,731	6,492	7,383
Bidbid	1,936	2,238	2,778	3,063	3,380	3,841	4,381
A'Sharqiyah	25,189	29,621	43,508	48,597	53,923	61,517	70,185
Sur	5,593	6,714	10,077	11,518	13,106	15,354	18,003
Ibra	1,981	2,332	3,548	4,032	4,554	5,289	6,144
Biddiyah	1,373	1,588	2,336	2,534	2,725	3,007	3,313
Al-Qabil	1,189	1,361	1,804	1,932	2,051	2,234	2,428
Al-Mudhaibi	5,104	5,912	8,147	9,033	9,945	11,255	12,736
D. W. Tayeen	1,349	1,563	2,226	2,431	2,632	2,925	3,245
A. K. W. Alwafi	1,508	1,763	2,698	2,961	3,224	3,605	4,027
J. B. B. Ali	3,793	4,558	6,905	7,745	8,617	9,844	11,235
J. B. B. Hassan	2,013	2,328	3,423	3,783	4,147	4,667	5,247
W. B. Khalid	602	733	1,091	1,254	1,427	1,665	1,939
Massirah	684	769	1,254	1,374	1,495	1,672	1,868
Al-Wusta	2,129	2,601	3,598	4,176	4,756	5,571	6,473
Haima	288	364	566	672	785	945	1,129
Mahut	1,061	1,243	1,439	1,646	1,845	2,124	2,424
A'Duqum	401	472	646	761	877	1,038	1,217
Al-Jazir	379	522	947	1,097	1,249	1,464	1,703
Dhofar	28,503	29,627	32,076	35,591	39,786	46,047	53,678
Salalah	21,581	22,354	23,987	26,738	30,045	34,964	40,989
Thumrait	1,066	963	1,066	1,190	1,338	1,557	1,824
Taqah	1,989	2,150	2,382	2,586	2,821	3,181	3,608
Marbat	1,541	1,856	2,088	2,303	2,553	2,925	3,373
Sadah	560	678	772	862	967	1,122	1,309
Rakhiyout	514	554	606	649	698	776	867
Dhalkout	347	359	395	425	460	514	578
Maqshan	215	67	79	90	103	123	146
S. W. Halaniyyat	690	646	702	748	801	885	984

Source: Study Team Estimates

Table 6.6-5 Future Finished Goods Manufactured by Zone (RO 1000)

	2000	2005	2010	2015	2020	2025	2030
Oman Total	1,150,998	2,157,817	3,780,494	8,272,411	11,938,279	16,346,709	21,217,698
Muscat	538,984	655,953	845,638	1,092,945	1,460,917	1,759,472	2,235,247
Muttrah	73,510	91,609	122,485	163,442	225,948	279,781	365,910
Baushar	220,246	262,110	326,092	407,554	524,563	630,071	788,415
A'Seeb	230,366	283,793	372,179	488,667	664,325	793,321	1,007,893
Al-Amrat	9,493	11,796	16,133	21,746	30,239	36,264	46,484
Muscat	2,836	3,510	4,548	5,947	8,128	9,570	12,118
Quriyat	2,537	3,136	4,203	5,589	7,714	10,464	14,423
Al-Batinah	99,481	123,570	287,844	712,108	963,182	1,305,849	1,762,358
Sohar	62,373	77,883	226,925	631,465	852,208	1,160,048	1,564,849
Al-Rustaq	2,362	2,849	3,903	5,191	7,157	10,283	14,604
Shinas	875	1,024	1,454	1,936	2,669	4,857	7,610
Liwa	526	623	867	1,147	1,576	3,292	5,390
Saham	2,575	3,114	4,276	5,694	7,856	11,270	15,989
Al-Khabourah	806	938	1,329	1,765	2,430	4,551	7,202
Al-Suwaiq	11,927	14,770	19,527	25,808	35,491	42,622	54,690
Nakhal	278	313	478	651	906	2,435	4,249
W. Al-Maawil	662	826	1,087	1,440	1,983	3,556	5,535
Al-Awabi	167	209	297	411	581	1,974	3,598
Al-Musana'a	2,240	2,731	3,688	4,888	6,728	9,532	13,437
Barka	14,688	18,291	24,013	31,712	43,597	51,430	65,207
Musandam	695	834	1,118	1,462	1,999	7,397	13,657
Khasab	417	521	687	912	1,257	2,899	4,881
Bukha	83	104	133	172	234	1,476	2,893
Daba Al-baiya	139	139	209	261	350	1,646	3,132
Madhaa	56	70	89	117	158	1,376	2,752
A'Dhahirah	31,552	39,160	58,285	81,772	116,085	189,125	284,050
Al-Buraimi	15,959	19,915	32,908	48,345	70,193	130,542	205,995
Ibri	6,939	8,501	11,281	14,851	20,375	25,693	33,982
Mahdhah	7,340	9,174	11,961	15,767	21,659	25,704	32,722
Yanqul	734	882	1,193	1,571	2,158	3,853	5,996
Dhank	579	688	941	1,239	1,700	3,333	5,357
A'Dakhliyah	23,467	28,993	45,914	66,042	94,867	179,118	284,054
Nizwa	13,297	16,489	29,132	43,762	64,147	133,477	218,204
Samail	1,546	1,897	2,591	3,467	4,803	7,250	10,537
Bahla	3,561	4,381	5,837	7,722	10,623	13,880	18,745
Adam	689	861	1,140	1,516	2,093	3,730	5,800
Al-Hamra	619	773	1,032	1,382	1,914	3,562	5,620
Manah	475	559	775	1,018	1,398	2,911	4,761
Izki	1,912	2,355	3,161	4,199	5,787	8,216	11,597
Bidbid	1,369	1,677	2,250	2,976	4,103	6,091	8,788
A'Sharqiyah	424,760	1,266,854	2,476,705	6,223,215	9,164,198	12,665,608	16,267,524
Sur	396,177	1,192,620	2,391,050	6,124,401	9,049,043	12,520,759	16,086,963
Ibra	22,735	67,134	75,812	85,613	96,860	110,498	126,170
Biddiyah	420	525	707	951	1,319	2,910	4,835
Al-Qabil	231	290	393	527	733	2,172	3,861
Al-Mudhaibi	1,683	2,033	2,816	3,768	5,211	7,916	11,535
D. W. Tayeen	278	348	484	659	920	2,443	4,254
A. K. W. Alwafi	548	684	929	1,249	1,733	3,412	5,486
J. B. B. Ali	1,827	2,215	3,069	4,106	5,683	8,336	11,956
J. B. B. Hassan	542	643	912	1,222	1,696	3,455	5,620
W. B. Khalid	152	155	251	336	466	1,807	3,357
Massirah	167	209	284	384	534	1,901	3,492
Al-Wusta	0	591	461	942	1,546	6,783	12,815
Haima	0	70	58	120	197	1,431	2,836
Mahut	0	278	209	425	695	2,124	3,802
A'Duqum	0	104	86	175	286	1,559	3,013
Al-Jazir	0	139	108	222	367	1,669	3,165
Dhofar	32,064	41,862	64,530	93,925	135,480	233,357	357,987
Salalah	31,593	40,717	63,158	91,684	132,078	219,654	332,392
Thumrait	241	370	470	675	970	2,331	3,963
Taqah	0	139	164	334	545	1,940	3,560
Marbat	61	215	256	452	702	2,110	3,764
Sadah	67	118	159	245	366	1,623	3,070
Rakhiyout	0	35	39	81	133	1,348	2,720
Dhalkout	0	35	33	67	108	1,312	2,667
Maqshan	0	35	22	44	72	1,256	2,586
S. W. Halaniyyat	103	198	229	344	506	1,784	3,269

Source: Study Team Estimates

CHAPTER 7

PRESENT AND FUTURE TRANSPORT DEMAND

CHAPTER 7

PRESENT AND FUTURE TRAFFIC DEMAND

7.1 IMPLEMENTATION METHODOLOGY AND RELATED DATA

7.1.1 General

The workflow for the demand forecast practice is divided into four tasks, which are subsequently divided into 13 sub-tasks as shown in Figure 7.1-1.

Task-1: Confirmation of Present OD Tables

To establish the present Origin-Destination (OD) tables, traffic surveys were conducted and zoning systems were adopted. Methodology and result analysis of the traffic surveys are presented in Appendix 7.1.

There are two zoning systems; large zones which confirm to the administrative governorates boundaries (Region/Governorate), and small zones which confirm to Wilayat. OD Tables are established for the trips of both passengers and commodities as well as vehicular base. The passenger OD has been prepared based on the traffic survey results. On the other side, commodity OD based on the traffic survey has been adjusted by yearly production/consumption data to remove the seasonal fluctuation.

Task-2: Preparation of Traffic Demand Forecast

Various models are developed based on present OD tables and socioeconomic indicators.

- Production Model to predict trip amount of passenger/commodity based on socioeconomic indicators of each zone.
- Generation/Attraction Model to predict the generation and attraction volumes of passenger/commodity based on socioeconomic indicators of each zone
- Trip distribution followed the present pattern because the amount changes of passenger trips and commodity are reflected in the generation and attraction models.
- Based on the results of passenger OD by vehicle type, the passenger transport modal split was projected in the generation and attraction models.

Task-3: Traffic Demand Forecast

Trip Generation/Attraction of each zone in terms of number of passengers and commodity tonnage is estimated based on the future socioeconomic indicators of the zone applying the Generation/Attraction Model.

The future indicators were prepared in the socioeconomic framework that is presented in Chapter 6.

Task-4: Traffic Assignment Work

The OD traffic tables are assigned to the road network to obtain the traffic volume on each link of the network.

7.1.2 Zoning

1) Large Zones

The boundaries of the large zones correspond to the regional boundaries in order to facilitate data collection. Outer zones are UAE, Saudi Arabia, Yemen, Qatar and the Arabian Sea. Each of these outer zones represents the traffic from other countries passing through them as well as the traffic generated from them. There are 13 large zones in total.

2) Small Zones

The small zones correspond to the wilayats, ports and outer zones. Outer zones consist of Dubai, Abu Dhabi, As Sila, Mina Jabel Ali, Sharajah, Alman, Ras Al Khaymah, Al Fujayrah, Al Ain, Yemen, Saudi Arabia and Qatar. The total number of small zones is 76.

Large and Small zones are shown in Figure 7.1-2 and Table 7.1-1.

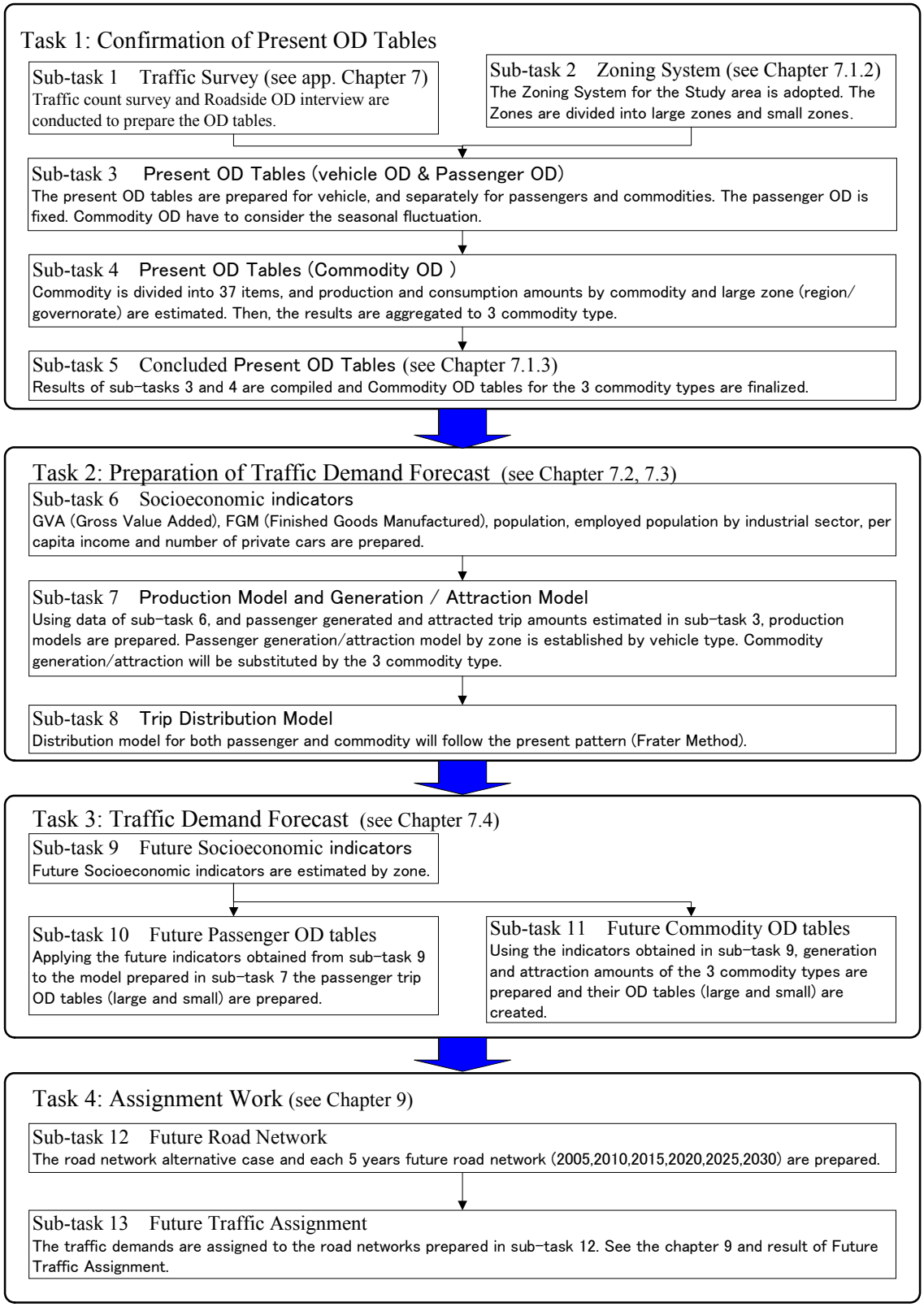


Figure 7.1-1 Workflow for the Future Traffic Demand

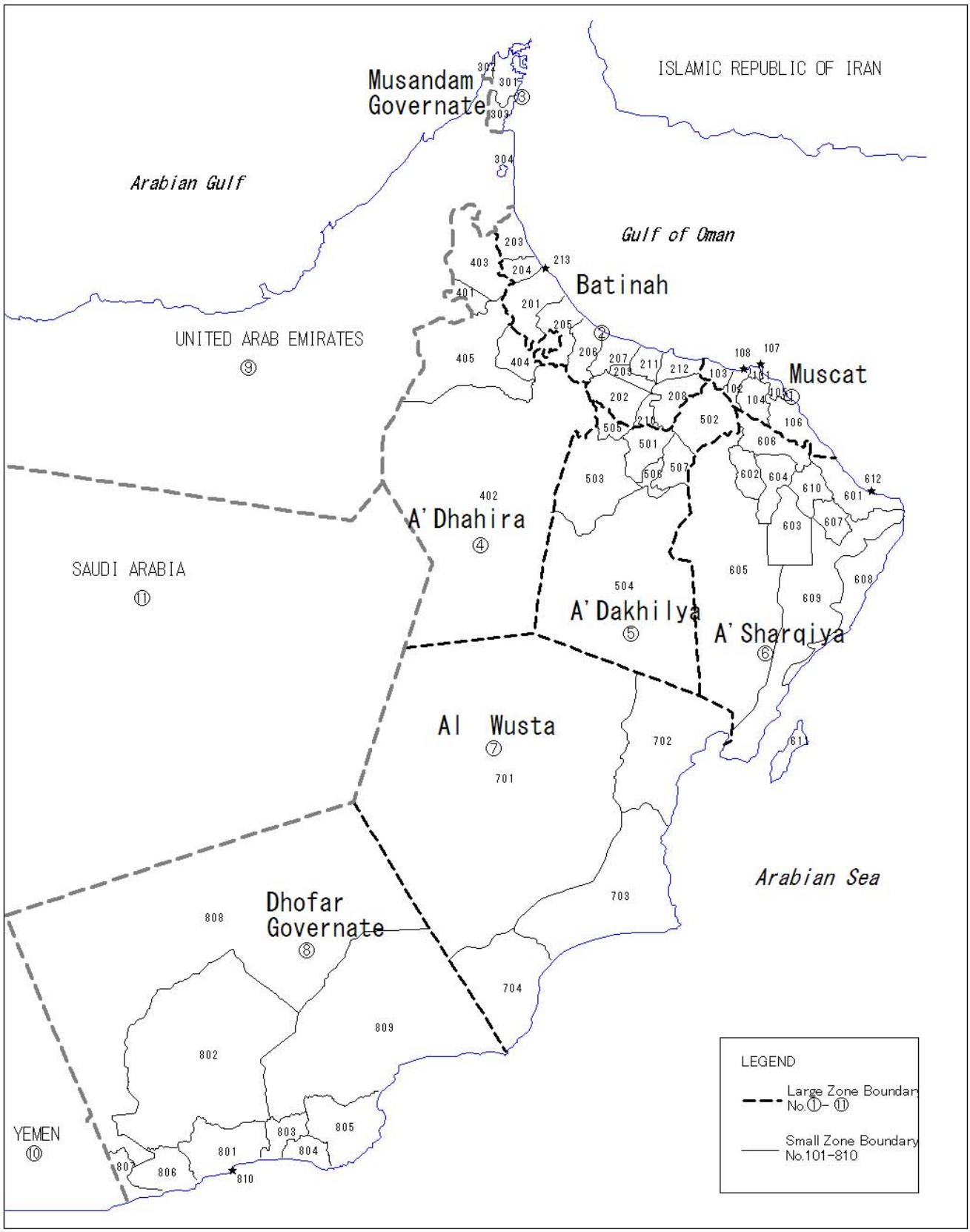


Figure 7.1-2 Zoning Map

Table 7.1-1 Large and Small Zones (1/2)

Small Zoning System			Large Zoning System	
No.	Zone Code	Name	Zone Code	Name
1	101	Mutrah	1	Muscat
2	102	Bawshar		
3	103	As Seeb		
4	104	Al Amrat		
5	105	Muscat		
6	106	Qurayyat		
7	201	Sohar	2	Al Batinah
8	202	Al Rustaq		
9	203	Shinas		
10	204	Liwa		
11	205	Saham		
12	206	Al khaburah		
13	207	As Suwayq		
14	208	Nakhal		
15	209	Wadi Al maawil		
16	210	Al Awabi		
17	211	Al Musanah		
18	212	Barka		
19	301	Khasab	3	Musandam
20	302	Bukha		
21	303	Daba		
22	304	Madha		
23	401	Al Buraymi	4	Adh - Dhahirah
24	402	Ibri		
25	403	Mahdah		
26	404	Yanqul		
27	405	Dank		
28	501	Nizwa	5	Ad - Dakhliyah
29	502	Samail		
30	503	Bahla		
31	504	Adam		
32	505	Al Hamra		
33	506	Manah		
34	507	Izki		
35	508	BidBid		
36	601	Sur	6	Ash - Sharqiyah
37	602	Ibra		
38	603	Bidiyah		
39	604	Al Qabil		
40	605	Al Mudaybi		
41	606	Dima wa at Taiyyin		
42	607	Al Kamil wa al Wafi		
43	608	Jaalan bani bu Ali		
44	609	Jaalan bani bu Hasan		
45	610	Wadi bani Khalid		
46	611	Masirah		

Table 7.1-1 Large and Small Zones (2/2)

Small Zoning System			Large Zoning System	
No.	Zone Code	Name	Zone Code	Name
47	701	Hayma	7	Al - Wusta
48	702	Muhut		
49	703	Ad Duqm		
50	704	Al Jazer		
51	801	Salalah	8	Dhofar
52	802	Thumrayt		
53	803	Taqah		
54	804	Mirbat		
55	805	Sadh		
56	806	Rakhyut		
57	807	Dalkut		
58	808	Muqshin		
59	809	Shalim wa juzur al Hallaniyat		
60	1001	Dubai	9	U.A.E
61	1002	Abu Dhabi		
62	1003	As sila		
63	1004	Mina Jebel Ali		
64	1005	Sharjah(Ash Shariqah)		
65	1006	Ajman		
66	1007	Ras Al Khaymah		
67	1008	Al Fujayrah		
68	1009	Al Ain		
69	1101	Yemen	10	Yemen
70	1201	Saudi Arabia	11	Saudi Arabia
71	1301	Qatar	12	Qatar
72	107	MINA Qaboos	13	Arabian Sea
73	108	MINA Al Fahal		
74	213	MINA Sohar		
75	612	MINA Sur(Qalhat)		
76	810	MINA Salalah		

7.1.3 Present OD Tables

The concluded OD trips are presented in tables in the form of matrices. All of the OD tables are obtained first on small zoning base, and aggregated to large zoning base. OD trips of all vehicles, Passenger Car, Truck, Passengers, and Commodities are prepared. All OD tables of large zone are shown in Tables 7.1-2 through 7.1-6.

Table 7.1-2 All Vehicles OD of Large Zones (2004) (Vehicle)

	1. Muscat	2. Al Batinah	3. Musandam	4. Adh Dhahirah	5. Ad Dakhliyah	6. Ash Sharqiyah	7. Al Wusta	8. Dhofar	9. UAE	10. Yemen	11. Saudi	12. Qatar	13. Arabian Sea	Total
1.Muscat	28,026	7,268	122	1,820	2,889	2,291	24	136	701	9	24	22	35	43,367
2.Al Batinah	7,268	9,462	230	1,813	1,037	935	73	121	2,827	0	14	9	17	23,806
3.Musandam	122	230	1,290	26	0	0	0	0	626	0	0	0	0	2,294
4.Adh Dhahirah	1,820	1,813	26	2,086	376	505	24	50	206	0	5	0	16	6,927
5.Ad Dakhliyah	2,889	1,037	0	376	1,046	1,145	52	53	44	0	1	0	8	6,651
6.Ash Sharqiyah	2,291	935	0	505	1,145	3,122	81	102	71	0	9	0	13	8,274
7.Al Wusta	24	73	0	24	52	81	82	196	6	0	0	0	3	541
8.Dhofar	136	121	0	50	53	102	196	5,222	7	24	2	2	38	5,953
9.UAE	701	2,827	626	206	44	71	6	7	0	0	0	0	2	4,490
10.Yemen	9	0	0	0	0	0	0	24	0	0	0	0	0	33
11.Saudi	24	14	0	5	1	9	0	2	0	0	0	0	0	55
12.Qatar	22	9	0	0	0	0	0	2	0	0	0	0	0	33
13.Arabian Sea	35	17	0	16	8	13	3	38	2	0	0	0	0	132
Total	43,367	23,806	2,294	6,927	6,651	8,274	541	5,953	4,490	33	55	33	132	102,556

Table 7.1-3 Passenger Car OD of Large Zones (2004) (Vehicle)

	1. Muscat	2. Al Batinah	3. Musandam	4. Adh Dhahirah	5. Ad Dakhliyah	6. Ash Sharqiyah	7. Al Wusta	8. Dhofar	9. UAE	10. Yemen	11. Saudi	12. Qatar	13. Arabian Sea	Total
1.Muscat	18,018	5,560	62	1,309	2,455	1,710	12	63	416	3	9	10	0	29,627
2.Al Batinah	5,560	7,040	182	1,067	808	686	38	65	1,865	0	5	0	0	17,316
3.Musandam	62	182	622	17	0	0	0	0	255	0	0	0	0	1,138
4.Adh Dhahirah	1,309	1,067	17	1,346	215	324	11	16	135	0	0	0	0	4,440
5.Ad Dakhliyah	2,455	808	0	215	594	647	14	7	25	0	1	0	0	4,766
6.Ash Sharqiyah	1,710	686	0	324	647	1,856	11	29	38	0	2	0	0	5,303
7.Al Wusta	12	38	0	11	14	11	14	41	2	0	0	0	0	143
8.Dhofar	63	65	0	16	7	29	41	3,210	2	10	0	0	0	3,443
9.UAE	416	1,865	255	135	25	38	2	2	0	0	0	0	0	2,738
10.Yemen	3	0	0	0	0	0	0	10	0	0	0	0	0	13
11.Saudi	9	5	0	0	1	2	0	0	0	0	0	0	0	17
12.Qatar	10	0	0	0	0	0	0	0	0	0	0	0	0	10
13.Arabian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	29,627	17,316	1,138	4,440	4,766	5,303	143	3,443	2,738	13	17	10	0	68,954

Table 7.1-4 Truck OD of Large Zones (2004) (Vehicle)

	1. Muscat	2. Al Batinah	3. Musandam	4. Adh Dhahirah	5. Ad Dakhliyah	6. Ash Sharqiyah	7. Al Wusta	8. Dhofar	9. UAE	10. Yemen	11. Saudi	12. Qatar	13. Arabian Sea	Total
1.Muscat	8,486	1,588	60	495	433	566	12	69	276	6	15	12	35	12,053
2.Al Batinah	1,588	1,804	48	704	219	238	35	56	928	0	9	9	17	5,655
3.Musandam	60	48	668	9	0	0	0	0	315	0	0	0	0	1,100
4.Adh Dhahirah	495	704	9	708	160	179	13	33	71	0	5	0	16	2,393
5.Ad Dakhliyah	433	219	0	160	378	488	36	44	19	0	0	0	8	1,785
6.Ash Sharqiyah	566	238	0	179	488	1,082	70	73	33	0	7	0	13	2,749
7.Al Wusta	12	35	0	13	36	70	66	137	4	0	0	0	3	376
8.Dhofar	69	56	0	33	44	73	137	1,910	5	14	2	2	38	2,383
9.UAE	276	928	315	71	19	33	4	5	0	0	0	0	2	1,653
10.Yemen	6	0	0	0	0	0	0	14	0	0	0	0	0	20
11.Saudi	15	9	0	5	0	7	0	2	0	0	0	0	0	38
12.Qatar	12	9	0	0	0	0	0	2	0	0	0	0	0	23
13.Arabian Sea	35	17	0	16	8	13	3	38	2	0	0	0	0	132
Total	12,053	5,655	1,100	2,393	1,785	2,749	376	2,383	1,653	20	38	23	132	30,360

Table 7.1-5 Passenger OD of Large Zones (2004) (Person)

	1. Muscat	2. Al Batinah	3. Musandam	4. Adh Dhahirah	5. Ad Dakhliyah	6. Ash Sharqiyah	7. Al Wusta	8. Dhofar	9. UAE	10. Yemen	11. Saudi	12. Qatar	13. Arabian Sea	Total
1.Muscat	58,360	13,708	136	3,077	5,413	3,947	26	188	1,026	7	20	22	0	85,930
2.Al Batinah	13,708	23,089	400	2,864	1,901	1,645	84	143	4,521	0	11	0	0	48,366
3.Musandam	136	400	1,368	37	0	0	0	0	1,250	0	0	0	0	3,191
4.Adh Dhahirah	3,077	2,864	37	3,355	485	737	24	48	297	0	0	0	0	10,924
5.Ad Dakhliyah	5,413	1,901	0	485	2,217	1,546	55	40	55	0	2	0	0	11,714
6.Ash Sharqiyah	3,947	1,645	0	737	1,546	6,346	24	64	84	0	4	0	0	14,397
7.Al Wusta	26	84	0	24	55	24	55	312	4	0	0	0	0	584
8.Dhofar	188	143	0	48	40	64	312	8,317	4	22	0	0	0	9,138
9.UAE	1,026	4,521	1,250	297	55	84	4	4	0	0	0	0	0	7,241
10.Yemen	7	0	0	0	0	0	0	22	0	0	0	0	0	29
11.Saudi	20	11	0	0	2	4	0	0	0	0	0	0	0	37
12.Qatar	22	0	0	0	0	0	0	0	0	0	0	0	0	22
13.Arabian Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	85,930	48,366	3,191	10,924	11,714	14,397	584	9,138	7,241	29	37	22	0	191,573

Table 7.1-6 Commodity OD of Large Zones (2004) (Tons)

	1. Muscat	2. Al Batinah	3. Musandam	4. Adh Dhahirah	5. Ad Dakhliyah	6. Ash Sharqiyah	7. Al Wusta	8. Dhofar	9. UAE	10. Yemen	11. Saudi	12. Qatar	13. Arabian Sea	Total
1.Muscat	69,585	13,022	492	4,059	3,551	4,641	98	566	2,263	49	123	98	287	98,834
2.Al Batinah	13,022	14,793	394	5,773	1,796	1,952	287	459	7,610	0	74	74	139	46,373
3.Musandam	492	394	5,478	74	0	0	0	0	2,583	0	0	0	0	9,021
4.Adh Dhahirah	4,059	5,773	74	5,806	1,312	1,468	107	271	582	0	41	0	131	19,624
5.Ad Dakhliyah	3,551	1,796	0	1,312	3,100	4,002	295	361	156	0	0	0	66	14,639
6.Ash Sharqiyah	4,641	1,952	0	1,468	4,002	8,872	574	599	271	0	57	0	107	22,543
7.Al Wusta	98	287	0	107	295	574	541	1,123	33	0	0	0	25	3,083
8.Dhofar	566	459	0	271	361	599	1,123	15,662	41	115	16	16	312	19,541
9.UAE	2,263	7,610	2,583	582	156	271	33	41	0	0	0	0	16	13,555
10.Yemen	49	0	0	0	0	0	0	115	0	0	0	0	0	164
11.Saudi	123	74	0	41	0	57	0	16	0	0	0	0	0	311
12.Qatar	98	74	0	0	0	0	0	16	0	0	0	0	0	188
13.Arabian Sea	287	139	0	131	66	107	25	312	16	0	0	0	0	1,083
Total	98,834	46,373	9,021	19,624	14,639	22,543	3,083	19,541	13,555	164	311	188	1,083	248,959

7.1.4 Future Socioeconomic Indicators of Region/Wilayat Characteristics

Socioeconomic indicators are concluded for each zone based on the established socioeconomic framework.

Indicators of Wilayat characteristics are used for projection of passenger trips, and their generation and attraction. Indicators of Wilayat characteristics are shown in Appendix 7.2. And in spite of Wilayat characteristics, indicators of Region/Governorate that are used as control-total are shown in Table 7.1-7. Details of each of these indicators are presented in Chapter 3.

7.1.5 Occupancy Rate and Average Loadings

1) Average Number of Passengers by Vehicle Category

Vehicle OD is linked to passenger OD through the vehicle occupancy, which is the average number of passengers on board by vehicle type. Table 7.1-8 shows the average number of passengers on board by vehicle types that are concluded from data collected through the OD survey. It is noteworthy that vehicle category "Bus" consists of large bus of 45-49 seats and medium size bus of 25-35 seats, and the majority of running buses are medium size..

Table 7.1-8 Occupancy Rates of Passenger Vehicles

Vehicle Category	Type of Vehicle (8 types)	(Person/Vehicle)
Passenger Car	Private Car, Taxi & 4WD	2.2
Bus	Bus	12.3
Truck	Light Truck, Heavy Truck, Trailer & Oil Tanker	2.0

2) Average Loading[1] by Truck Type

Vehicle OD is linked to commodity OD through the average loading by truck type. Table 7.1-9 shows the average loading by commodity type and by truck type, based on data of the OD survey.

[1] The word "loading" represents actual weight loaded, while the word "load" represents the load capacity.

Table 7.1-7 Indices of Region/Governorate Characteristics

2005	Oman	Muscat	Batinah	Musandam	Adh Dhahirah	Ad Dakhiliyah	Ash Sharqiyah	Al Wusta	Dhofar
Population	2,421,050	655,654	677,537	29,354	212,132	275,162	324,645	23,947	222,619
Employed Population by Economic Activity (Workplace Base)									
Primary Sector	73,296	4,718	38,751	1,320	7,206	4,606	8,639	1,853	6,203
Secomndary Sector	222,003	102,024	29,903	1,134	23,410	17,350	24,156	367	23,659
Tertiary Sector	527,578	274,480	80,345	6,636	31,904	34,491	46,002	1,901	51,819
Per Cap. Income (RO/m)	94	153	64	73	76	68	71	88	93
No. of Private Cars	305,736	112,722	70,937	3,342	28,277	28,609	29,621	2,601	29,627
Gross Value Added (RO'000)	730,876	246,378	40,336	0	15,255	10,337	402,159	0	16,411
Finished Goods Manufact. (RO'000)	2,111,599	642,505	110,365	0	34,538	23,606	1,260,609	0	39,916
2020									
Population	2,787,347	745,962	774,642	33,171	241,106	317,163	389,688	31,389	254,226
Employed Population by Economic Activity (Workplace Base)									
Primary Sector	102,344	5,920	54,403	2,025	10,017	6,358	12,481	2,853	8,287
Secomndary Sector	336,217	145,437	51,885	2,250	32,543	27,968	38,725	1,423	35,986
Tertiary Sector	627,899	304,351	102,898	7,571	40,489	45,294	61,281	3,327	62,688
Per Cap. Income (RO/m)	144	235	98	113	116	105	110	135	143
No. of Private Cars	438,687	155,988	102,228	4,645	34,313	43,048	53,923	4,756	39,786
Gross Value Added (RO'000)	3,919,914	555,939	310,489	0	45,884	35,299	2,919,834	0	52,467
Finished Goods Manufact. (RO'000)	11,813,497	1,425,752	927,990	0	104,134	80,395	9,147,156	0	128,063
2030									
Population	3,027,385	799,612	832,455	36,669	265,404	347,937	429,501	35,270	280,537
Employed Population by Economic Activity (Workplace Base)									
Primary Sector	127,855	7,076	68,105	2,616	12,492	7,908	15,793	3,691	10,174
Secomndary Sector	432,322	183,014	69,620	3,128	40,564	36,706	50,738	2,212	46,340
Tertiary Sector	705,167	329,300	119,636	8,320	46,882	53,246	72,481	4,332	70,970
Per Cap. Income (RO/m)	203	331	138	159	164	148	155	190	202
No. of Private Cars	577,759	213,182	127,747	6,085	45,013	55,396	70,185	6,473	53,678
Gross Value Added (RO'000)	6,989,199	841,716	577,507	5,292	111,906	108,095	5,198,740	5,289	140,654
Finished Goods Manufact. (RO'000)	20,972,213	2,166,361	1,693,239	9,790	260,671	255,597	16,233,907	9,785	342,858

Table 7.1-9 Average Loadings considering Empty Load Trucks (kg)

Commodity	Light Truck	Heavy Truck	Trailer	Oil Tanker	Weighted Mean
Food	900	2,821	17,315	0	5,573
Ore, Construction Material	0	5,925	19,078	0	7,151
Industrial Products	478	4,293	14,633	18,377	5,954
Share by Truck Type	0.284	0.459	0.232	0.025	1.000

Note: Roadside OD survey results.

Assuming that the same commodity type will be transported by the same composition of truck fleet as it is; the weighted mean of present truck composition is applied as conversion factor of commodity flow to truck flow without changes during the planning period.

3) Passenger Car Equivalents (PCE)

PCE is used to convert each vehicle to passenger car unit (PCU). PCE of the Sultanate of Oman Highway Design Manual for truck is 1.7 for flat terrain, 4.0 for rolling terrain and 8.0 for mountainous terrain. Based on the road inventory survey, 84% of roads is facilitated in flat terrain, 6% in rolling terrain, and 10% in mountainous terrain.

Incidentally, traffic assignment results on the present network shows 11,350,041 veh-km in flat terrain and 2,235,718 veh-km in rolling and/or mountainous terrain. Assume average PCE in rolling and/or mountainous terrain is 6.0; the weighted mean of PCE of truck is estimated as 2.4.

Weighted mean of PCE

= (11350041*1.7 + 2235718*6.0) / (11350041+2235718) 2.4

This figure is applied to truck PCE. As there is no PCE included for buses in the manual, the same PCE of trucks is applied for buses as shown in Table 7.1-10.

Table 7.1-10 Passenger Car Equivalents

Vehicle Category	Vehicle type (8 types)	PCE
Passenger Car	Private Car, Taxi & 4WD	1.0
Bus	Bus	2.4
Truck	Light Truck	2.0
	Heavy Truck, Trailer & Oil Tanker	2.4

7.2 PASSENGER TRANSPORT

7.2.1 Production Model

Production models are formulated based on the OD tables and Wilayat socioeconomic characteristics, prepared in the section 7.1.4. Because OD tables are produced by vehicle type, production model by vehicle type can be obtained.

The daily trips used for this model as input are inter-small zonal trips induced from the maximum entropy model[2]. Intra-zonal trips of small zones are not included in this production model output. Hereafter, trips without any specific definition are trips between zones excluding intra-zonal trip.

The Sultanate of Oman consists of regions that have very different local characteristics. The production model reflects, therefore, the regional characteristics.

Based on the regional characteristics, factor analysis was done for number of trips in 2004 by region applying the number of primary, secondary and tertiary workers (work place base) separately, average income, number of private own cars, gross value added (summing up of all items and that excluding Industrial Clarification Code (ICC) 23, Refined Petro. Products), and yields of finished goods manufactured (including ICC 23 and also excluding ICC 23). On the analysis process, the standardized data on person base are used.

Applying the factor analysis, the following equations of the production model were obtained:

$$TP = \sum (T_i \times P_i)$$
$$T_i = a \times FFTP_i + (b + LF_i) \times SFTP_i$$
$$FFTP_i = \sum (c_x \times V_{i\,x})$$
$$SFTP_i = \sum (d_x \times V_{i\,x})$$

Where,

TP : Total Trip Production
T_i : Trip per person on i large zone (Region Base)

[2] The Maximum entropy model is OD matrix estimation model, which utilizes the available link traffic volumes and collected initial OD table information for estimating the current trip OD matrix. The maximum entropy model attempts to cover maximum degree of disorder or random exchange between zones to define trip OD tables.

P_i : Population on i large zone

$FFTP_i$: First Factor Total Point on i large zone

$SFTP_i$: Second Factor Total Point on i large zone

LF_i : Local Factors on i large zone (see table 7.2-1)

a = 0.0004, b = 0.0004

c_x , d_x : Coefficient on Variable (x) (see Table 7.2-2)

V : Variable (see Table 7.2-2)

Local Factor is introduced to adjust local difference and it is considered as a coefficient as shown in Table 7.2-1.

To estimate the trip production, applied variables and factor coefficients are estimated as shown in Table 7.2-2.

The amount of estimated trip production by utilizing these equations and future socioeconomic indicators is illustrated in Figure 7.2-1.

Table 7.2-1 Local Factors of Production Model

	Regional Factors
Muscat	0.00085
Al Batinah	0.00150
Musandam	0.00250
Adh Dhahirah	0.00050
Ad Dakhliyah	0
Ash Sharqiyah	0.00020
Al Wusta	0
Dhofar	-0.00020

Table 7.2-2 Coefficients and Variables of Production Model

x	Coefficient for first factor (c_x)	Coefficient for second Factor (d_x)	Variable ($V_{i\,x}$)
1	0.4063047	0.84867167	Secondary workers per population
2	0.7043647	0.57605976	Tertiary workers per population
3	0.9094918	0.39613396	Average income
4	0.7020148	0.62623587	Number of private own cars
5	0.7074133	0.63678638	GVA+FGM per population (RO'000)

GVA: Gross Value Added, FGM :Finished Goods Manufactured

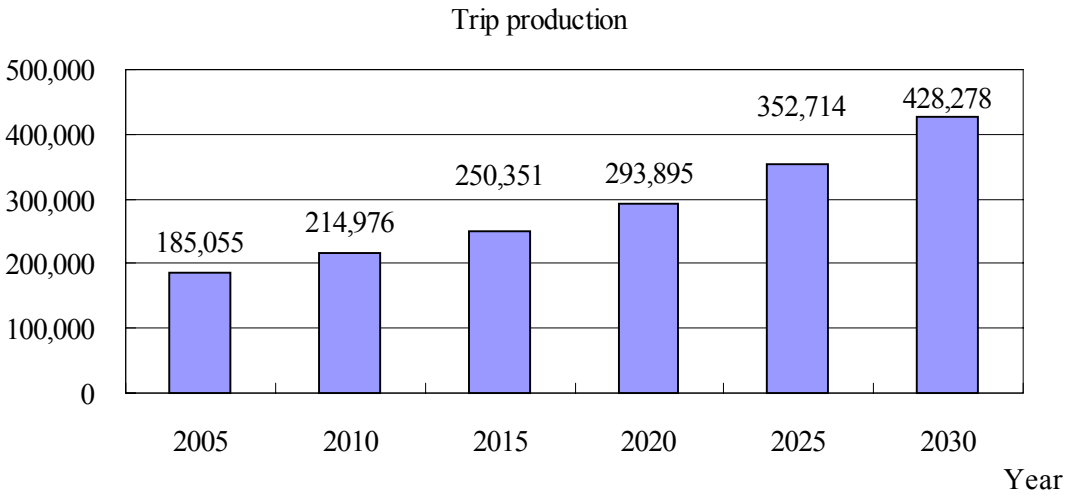


Figure 7.2-1 Future Daily Trips (Production Model Result)

Incidentally, trip production elasticity of GDP is around 0.9. Table 7.2-3 shows the growth in trips in relation to GDP.

Table 7.2-3 Trip Production Elasticity of GDP

	2020/2005	2030/2005
Trip Production (a)	1.59	2.31
GDP (b)	1.72	2.63
Trip Production Elasticity of GDP (a/b)	0.92	0.88

7.2.2 Generation/Attraction Model

The models are formulated directly for small (Wilayat base) zones. Applied parameters for the small zone generation and attraction models are shown in the Appendix 7.2.

Data of traffic counts by vehicle type are used to project generation/attraction vehicle volume and passenger trips by vehicle type. In addition, trips/volume of movement by air and marine are excluded from the beginning because of the nature of observation (road side counts), and there is no specific data for modal split model formulation purpose.

In this study, considering the reasons described above, Generation/Attraction Model by vehicle type was explored directly. The amount of generated and attracted trips for each OD zone pair is the same in terms of going and return traffic. Due to this, there is only one model considered for both generation and attraction of trips.

Generation/Attraction Model by vehicle type was obtained by applying the step wise

multi regression analysis method. In this analysis, the objective variable is generation/attraction trips by small zone by vehicle type, and explanatory variables are the number of primary, secondary and tertiary workers of residence base and also work place base separately, average income, number of private own cars, gross value added (summing up of all items and that of excluding ICC 23, Refined Petro. Products), and yields of finished goods manufactured (including ICC 23 and also excluding ICC 23). On the process of analysis, data are standardized per person base. After step wise elimination of weak explainable variables, the following equations are obtained.

Private Car+4WD Trips	= 242.87+0.0456STW+0.2297Cars	R^2=0.941
Taxi Trips	= 50.80+0.4243STW+0.8023Cars	R^2=0.967
Bus Trips	= 47.06+0.6290STW+0.1307Cars	R^2=0.966

Where,

STW : Number of secondary and tertiary workers (work place base)

Cars : Number of private cars owned

All passenger car and bus trips are explained by number of secondary and tertiary workers (work place base) which represent personal attribute, and number of private-owned cars which represents convenience of transport.

An interview survey was done at the Ruwi Bus Terminal, and result show the tendency of choosing bus for long trips, but it is not clear from the statistical analysis because bus passengers of shorter trip length were majority. Generation/attraction trips by transport mode (aggregation of vehicle type) in 2005 are shown in Table 7.2-4.

Table 7.2-4 Estimated Generation/Attraction Trips in 2005

	Passenger Car*	Bus	Total**
Muscat	79,554	20,629	100,183
Al Batinah	19,400	5,057	24,456
Musandam	2,957	980	3,938
Adh Dhahirah	11,271	2,979	14,250
Ad Dakhliyah	11,976	3,289	15,265
Ash Sharqiyah	14,256	4,477	18,732
Al Wusta	554	192	746
Dhofar	6,029	1,456	7,485
Total	145,996	39,059	185,055

Note: * Private Car + 4WD + Taxi, ** Trips transported by trucks are excluded.

7.2.3 Trip Distribution Model

The Generation/Attraction model estimates the number of trips originating and terminating in zones, while trip distribution is the process of computing the number of trips between one zone and all others. The trip distribution procedure provides a full matrix of trips between all zones in the given zoning system.

The present pattern method was adopted for distribution of trips between zones, because changes in the land use in Oman are taken into consideration in Generation/Attraction models.

This procedure is based on the Frator Method which is widely used in future traffic demand studies. The basic premise of this model is that the distribution of future trips from a zone is proportional to the present trip-distribution pattern modified by the growth factors of all the zones under consideration. Because of the special nature of the computation, successive iteration procedures are used as adjusting steps in the trip distribution stage.

The method uses the following formulas to synthesize the future trip-interchange magnitudes and to overcome imbalances in the trip distribution so that interchange ultimately balances by direction.

$$T_{ij} = (T_{ij}(i) + T_{ij}(j)) / 2$$
$$T_{ij}(i) = t_{ij} * F_i * F_j * L_i$$
$$T_{ij}(j) = t_{ij} * F_i * F_j * L_j$$
$$L_i = \Sigma t_{ix} / \Sigma t_{ix} * F_x$$
$$L_j = \Sigma t_{jx} / \Sigma t_{jx} * F_x$$

Where,

T_{ij} : Future trips from zone i to zone j
$T_{ij}(i)$: Future trips from zone i to zone j considering growth of zone i
$T_{ij}(j)$: Future trips from zone i to zone j considering growth of zone j
t_{ij} : Present trips from zone i to zone j
F_i, F_j : Growth factors of trips for zone i and j
L_i, L_j : Locational factors
t_{ix}, t_{jx} : Present trips from zone i to zone j to another zone x
F_x : Growth factor of trips for zone x

The iteration process continues until the trips generated through the Generation/Attractions Model for each zone equal to the trips distributed to that zone from all other zones.

The distributed passenger trip is converted to number of vehicles by type and also to PCE base, using figures of Tables 7.1-9 and 7.1-10.

7.3 COMMODITY TRANSPORT

7.3.1 Generation/Attraction Model

The generation and attraction of commodity trips composes of three phases of production/consumption such as import and production of raw materials, production of finished goods, and export and final consumption. Herein, generation consists of import, production of raw materials, and production of finished goods. Attraction consists of export, final consumption and raw materials consumed for finished goods production.

The data applicable for the preparation of prototype of production/consumption table of commodities is only the year 2000. The table is prepared by region base due to the data limitation.

Commodity flow produced from the present OD tables includes seasonal effect. Therefore, commodity flow has to be obtained in different way to avoid seasonal effect, as presented in the following sections.

1) Agricultural/Fishery Goods

Three layers were considered to induce the production/consumption table of agricultural goods of 2000; those are family expenditure vs. domestic production including necessary domestic goods movement, food industry production vs. input including necessary domestic goods movement, and export vs. import. The said three layers are briefly summarized as follows.

- The first step is to estimate Household (HH) consumption (as the final consumption) of food based on “The Household Expenditure & Income Survey, 1999/2000”.

- The second step is to estimate domestic import and shipment using HH consumption and data of domestic agricultural production and domestic fishery

production derived from Annual Survey of Agricultural Production 1993 and Fisheries Statistical Year Book 2001.

– The third step is to establish food industrial production and materials for that production, using "Yearly Industrial Statistical Yearbook 2000". In this step, material weight for production is assumed as same amount of production including loss.

Table 7.3-1 shows the result of agricultural and fishery goods movement in 2000 by applying the above procedure. Agricultural and fishery goods movement in 2005, which is the starting table of future projection, is induced from this table using socioeconomic forecast data.

2) Mineral and Industrial Goods

Domestic production and consumption (P/C) table was provided from the socioeconomic framework in Chapter 3 based on the Yearly Industrial Statistical Book 2000. The table, however, included various kinds of commodity units. The first step for exploring the present P/C table for mineral and industrial commodities was to unify the units of that table to ton under reasonable assumptions.

Production/consumption estimates must include export/import volumes because these are considered as generation/attraction volumes. Export/import items in the Statistical Year Book, however, are slightly different from consumption/production data categories shown in the Yearly Industrial Statistical Yearbook. The second step is to integrate categories of both sources to the same category items, and categories were integrated to 15 items.

Export /import statistics are available in weight (and also in value) by commodity category or by export/import zone, but not by category by zone. The third step of exploring the present P/C table is to establish P/C table by category by zone.

Production (final products) and consumption (raw materials or inter-mediate products) are hard to balance because of many different production units are used. The fourth step is to establish amount of consumption by category from the formula: consumption = production + import – export.

The fifth step is to divide consumption into consumption as production materials and direct consumption. Amount of production materials are assumed as the same amount

Table 7.3-1 Agricultural and Fishery Goods Movement (2000) (ton)

Item	Oman	Muscat	Batinah	Musandam	Adh Dhahirah	Ad Dakhiliyah	Ash Sharqiyah	Al Wusta	Qaboos
Layer 1									
Monthly HH Expenditure (RO)	581.731	370.631	409.425	460.013	375.147	349.907	321.23	444.352	
Monthly HH Expenditure for Food (RO)	23.620	35.900	30.600	34.690	37.920	35.630	49.050	35.660	
No. of HH	103,426	61,975	5,993	21,866	26,356	42,721	3,482	23,520	
Annual Total Exp. for Food (RO)	170,534,823	98,954,141	9,009,928	41,872,124	44,991,508	63,913,280	6,583,626	44,722,600	
HH Consumption Total (ton) *	769,528	446,525	40,657	188,945	203,021	288,405	29,708	201,808	
Domestic Agricultural Production	48,242	754,382	9,615	165,561	90,896	122,575	1,407	93,957	
Domestic Fishery Production	26,388	26,702	5,868	0	0	35,357	14,522	16,437	
Domestic Import/Shipment	694,898	-334,559	25,174	23,384	112,125	130,473	13,779	91,414	
Layer 2									
Food Industrial Production	864,373	67,574	0	6,617	17,067	10,660	0	131,676	
Domestic Import	864,373	67,574	0	6,617	17,067	10,660	0	131,676	
Layer 3									
Import	0	0	0	0	0	0	0	0	550,948
Export	14,010	146,626	2,906	31,079	17,063	29,647	2,990	20,723	
Total of Three Layers (GA)									
Production+Dom. Shipment+Import	1,633,901	514,098	40,657	195,563	220,089	299,065	29,708	333,484	1,392,114
Consumption+Export	783,538	593,150	43,563	220,025	220,085	318,052	32,698	222,531	0

* Conversion Rate (Value to Weight): 0.0045124 ton/RO

of production. Domestic production and retail data of refined petro products relied on data of the Statistical Yearbook.

These 15 items are aggregated into 3 major items of; agricultural/fishery, mineral, and industrial as presented in Table 7.3-2, and then unfolded on small zone base using forecast of the first industry workers (work place base) by small zone for agricultural/fishery industry item and using secondary industry workers (work place base) by small zone for mineral and industrial industry items. The results of the year 2005 are summarized in the Appendix 7.2.

Table 7.3-2 Generation/Attraction by Major Item Category by Region (2005)

(ton)

Region	Agricultural/Fishery		Mineral		Industry	
	Generation	Attraction	Generation	Attraction	Generation	Attraction
Muscat	2,071,991	1,509,804	13,907,986	13,907,986	17,759,666	17,055,354
Al Batinah	828,385	728,587	2,973,491	2,973,491	1,313,508	1,537,793
Musandam	15,483	50,245	4,663	4,663	4,951	19,050
Adh Dhahirah	170,193	257,970	2,353,743	2,353,743	137,180	210,848
Ad Dakhliyah	102,843	265,727	2,101,599	2,101,599	73,877	195,698
Ash Sharqiyah	165,394	374,076	605,343	605,343	97,532	231,885
Al Wusta	15,929	37,693	0	0	0	18,905
Dhofar	202,567	348,683	5,484,640	5,484,640	215,867	333,049
Total	3,572,786	3,572,786	27,431,466	27,431,466	19,602,582	19,602,582

7.3.2 Trip Distribution and Modal Split Models

Present pattern method is applied here due to the same reasons described in section 7.2.3. Trucks are considered as one transport mode mixed with various sizes. Average loadings as presented in Table 7.1-9, are estimated by applying these models under that assumption.

7.4 FUTURE OD TABLES

7.4.1 Unification of Passenger Trips and Commodity Trips

1) Generation/Attraction of the year 2005

Future OD projection started from the aggregation of 2005 generation/attraction of passenger trips and commodity trips, by applying the following steps.

a. To adjust trips of private cars and buses separately to meet output of the production model.

b. To convert passenger trips and commodity tons to number of vehicles using Tables 7.1-8 and 7.1-9.
c. To obtain adjustment parameter by vehicle type in comparing with generation/ attraction figures of 2004 OD (vehicle base) in order to adjust vehicle type composition, and to apply them to each vehicle trips.

Generation/attraction by vehicle type by region of 2005 is estimated as shown in Table 7.4-1.

Table 7.4-1 Generation/Attraction by Vehicle Type by Region（2005）

Region	Private Car , 4WD, Taxi	Bus	Truck	Total
Muscat	36,161	1,677	25,011	62,850
Al Batinah	8,817	411	2,457	11,687
Musandam	1,060	80	21	1,445
Adh Dhahirah	5,123	242	1,352	6,716
Ad Dakhliyah	5,443	267	1,428	7,138
Ads Sharqiyah	6,480	364	1,269	8,113
Al Wusta	252	16	4	272
Dhofar	2,740	118	958	3,817
Total	66,362	3,175	32,502	102,040

7.4.2 Future OD Tables

The future OD tables of large zones for vehicular trips of passenger cars, buses and trucks in 2010, 2020 and 2030 are presented in Tables 7.4-2, 7.4-3 and 7.4–4. Other OD tables of small (Wilayat base) zones are included in the Appendix 7.3.

Table 7.4-2 All Vehicle of Large Zone (2010) (Vehicle/day)

	1. Muscat	2. Al Batinah	3. Musandam	4. Adh Dhahirah	5. Ad Dhakhliyah	6. Ash Sharqiyah	7. Al Wusta	8. Dhofar	9. UAE	10. Yemen	11. Saudi	12. Qatar	13. Arabian Sea	Total
1.Muscat	46,130	9,547	95	2,455	3,336	3,118	32	236	1,303	10	35	32	456	66,785
2.Al Batinah	9,547	10,622	370	1,783	1,173	1,171	103	252	3,606	0	20	3	32	28,682
3.Musandam	95	370	480	52	0	0	0	0	439	0	0	0	0	1,436
4.Adh Dhahirah	2,455	1,783	52	1,962	398	603	30	50	304	0	5	0	23	7,665
5.Ad Dhakhliyah	3,336	1,173	0	398	1,346	1,028	46	33	42	0	1	0	17	7,420
6.Ash Sharqiyah	3,118	1,171	0	603	1,028	3,533	49	88	64	0	3	0	18	9,675
7.Al Wusta	32	103	0	30	46	49	120	155	5	0	0	0	0	540
8.Dhofar	236	252	0	50	33	88	155	3,693	21	32	3	6	23	4,592
9.UAE	1,303	3,606	439	304	42	64	5	21	1	0	0	0	14	5,799
10.Yemen	10	0	0	0	0	0	0	32	0	0	0	0	1	43
11.Saudi	35	20	0	5	1	3	0	3	0	0	0	0	1	68
12.Qatar	32	3	0	0	0	0	0	6	0	0	0	0	0	41
13.Arabian Sea	456	32	0	23	17	18	0	23	14	1	1	0	0	585
Total	66,785	28,682	1,436	7,665	7,420	9,675	540	4,592	5,799	43	68	41	585	133,331

Table 7.4-3 All Vehicle of Large Zone (2020) (Vehicle/day)

	1. Muscat	2. Al Batinah	3. Musandam	4. Adh Dhahirah	5. Ad Dhakhliyah	6. Ash Sharqiyah	7. Al Wusta	8. Dhofar	9. UAE	10. Yemen	11. Saudi	12. Qatar	13. Arabian Sea	Total
1.Muscat	60,554	13,883	123	3,435	4,663	4,535	45	390	1,442	10	40	41	756	89,917
2.Al Batinah	13,883	14,956	504	2,646	1,734	1,747	155	348	5,262	0	37	4	73	41,349
3.Musandam	123	504	660	69	0	0	0	0	601	0	0	0	0	1,957
4.Adh Dhahirah	3,435	2,646	69	2,746	595	876	43	84	378	0	5	0	28	10,905
5.Ad Dhakhliyah	4,663	1,734	0	595	1,949	1,531	68	60	55	0	1	0	23	10,679
6.Ash Sharqiyah	4,535	1,747	0	876	1,531	5,331	82	160	91	0	3	0	29	14,385
7.Al Wusta	45	155	0	43	68	82	206	194	8	0	0	0	0	801
8.Dhofar	390	348	0	84	60	160	194	4,851	33	47	6	11	37	6,221
9.UAE	1,442	5,262	601	378	55	91	8	33	1	0	0	0	17	7,888
10.Yemen	10	0	0	0	0	0	0	47	0	0	0	0	2	59
11.Saudi	40	37	0	5	1	3	0	6	0	0	0	0	1	93
12.Qatar	41	4	0	0	0	0	0	11	0	0	0	0	2	58
13.Arabian Sea	756	73	0	28	23	29	0	37	17	2	1	2	0	968
Total	89,917	41,349	1,957	10,905	10,679	14,385	801	6,221	7,888	59	93	58	968	185,280

Table 7.4-4 All Vehicle of Large Zone (2030) (Vehicle/day)

	1. Muscat	2. Al Batinah	3. Musandam	4. Adh Dhahirah	5. Ad Dhakhliyah	6. Ash Sharqiyah	7. Al Wusta	8. Dhofar	9. UAE	10. Yemen	11. Saudi	12. Qatar	13. Arabian Sea	Total
1.Muscat	81,508	19,971	173	5,258	7,174	8,057	64	753	1,948	11	56	62	1,309	126,344
2.Al Batinah	19,971	20,494	688	4,220	2,785	2,995	214	593	8,286	0	67	7	133	60,453
3.Musandam	173	688	952	93	0	1	0	1	842	0	0	0	0	2,750
4.Adh Dhahirah	5,258	4,220	93	4,344	1,132	1,599	61	197	538	0	9	0	47	17,498
5.Ad Dhakhliyah	7,174	2,785	0	1,132	3,542	3,149	96	177	90	0	2	0	53	18,200
6.Ash Sharqiyah	8,057	2,995	1	1,599	3,149	10,094	132	521	170	0	10	0	90	26,818
7.Al Wusta	64	214	0	61	96	132	330	242	12	0	0	0	0	1,151
8.Dhofar	753	593	1	197	177	521	242	7,914	72	83	13	27	65	10,658
9.UAE	1,948	8,286	842	538	90	170	12	72	5	0	0	0	30	11,993
10.Yemen	11	0	0	0	0	0	0	83	0	0	0	0	2	96
11.Saudi	56	67	0	9	2	10	0	13	0	0	0	0	1	158
12.Qatar	62	7	0	0	0	0	0	27	0	0	0	0	2	98
13.Arabian Sea	1,309	133	0	47	53	90	0	65	30	2	1	2	0	1,732
Total	126,344	60,453	2,750	17,498	18,200	26,818	1,151	10,658	11,993	96	158	98	1,732	277,949

7.4.3 Growth of Generation and Attraction

Future generation and attraction trips of all vehicles are illustrated on zonal base in Figure 7.4.1. The highlight growth in generation and attraction trips belongs to the Governorate of Muscat. It will keep its role as the core of the Sultanate of Oman in the future too. Other cities with remarkable increased trips are Sohar, in which a large industrial area is located, and Sur sited beside on LNG plant. They are followed by zones in Al Batinah Region and Salalah.

7.4.4 Desire Line

The future desire line of all vehicles is illustrated in Figure 7.4-2. Generally traffic distribution will not change and the concentration of traffic trips to Muscat is very clear in the future as well as the present. The desire lines among Muscat, costal cities in Al

Batinah and Sur are greatly strong. The desire lines between the northern cities and Salalah also grow larger in 2030.

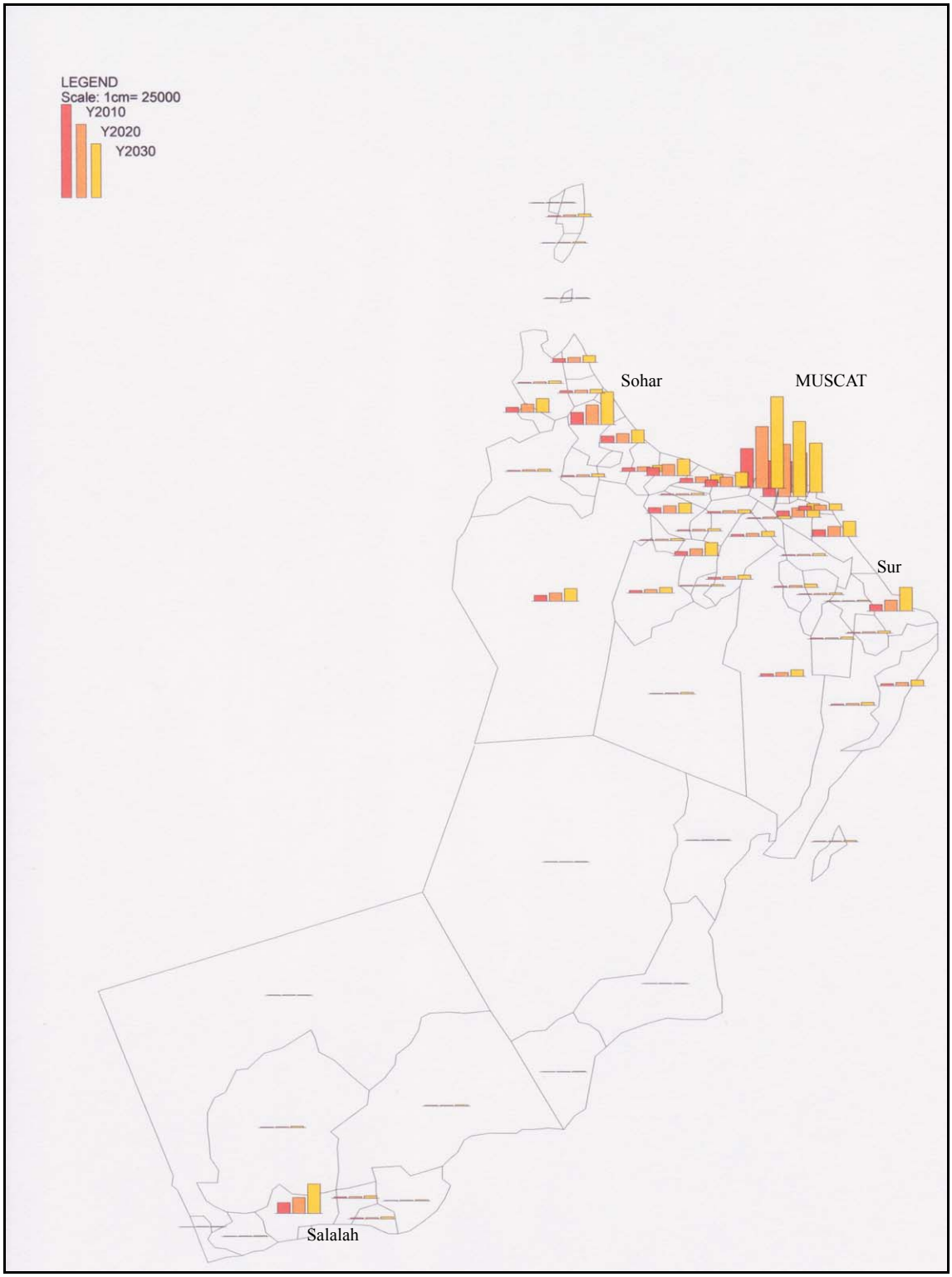
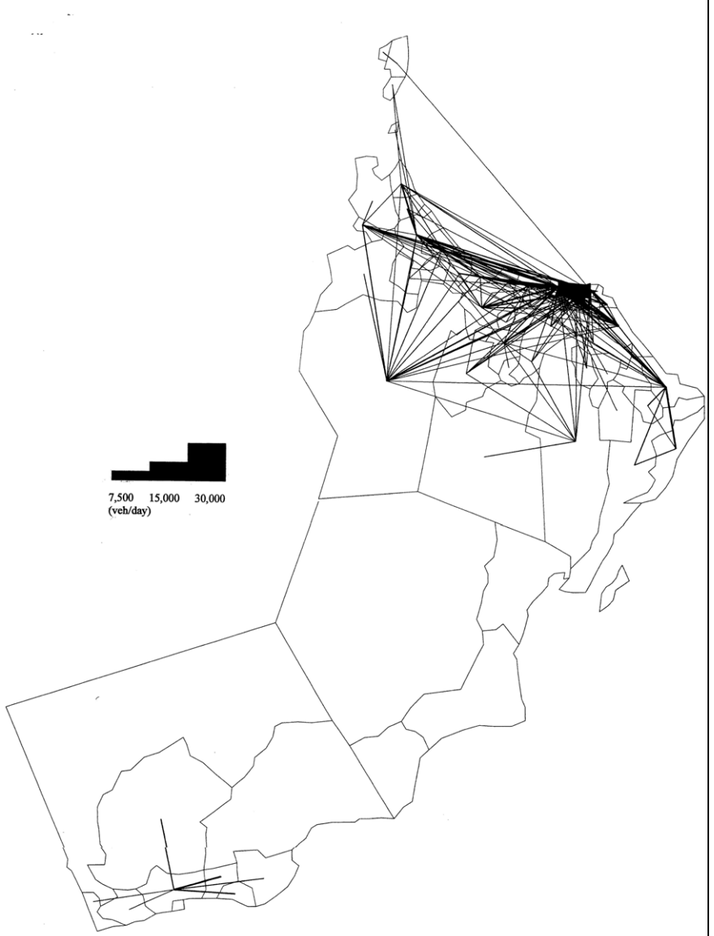


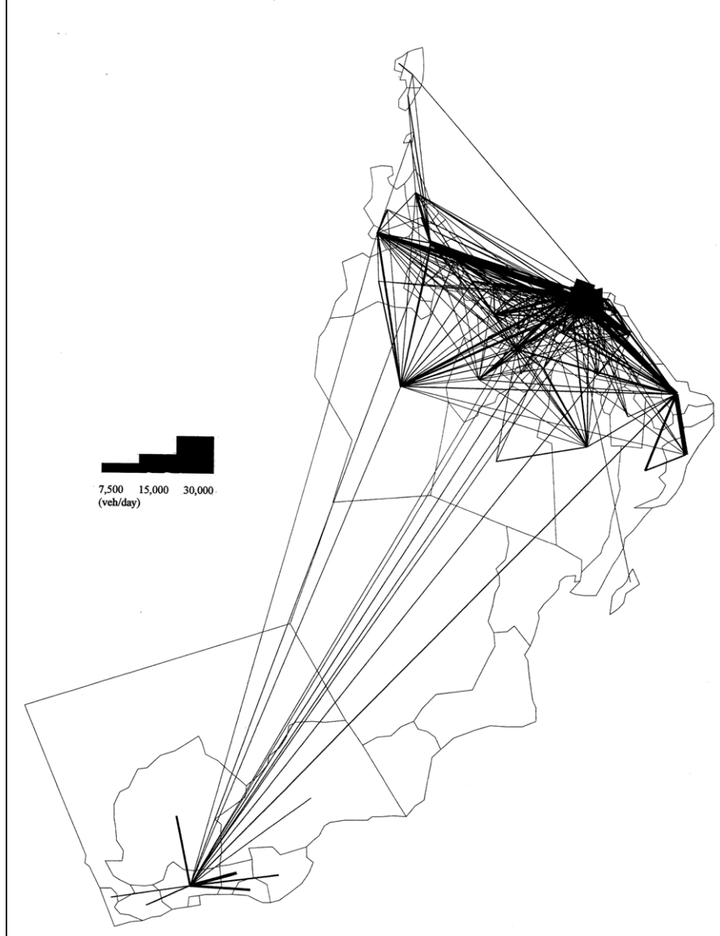
Figure 7.4-1 Future Trip Generation and Attraction by Wilayat (vehicle/day)

2010



2020

2030



Note: Desire line shows more than 100 vehicles

Figure 7.4-2 Future Traffic Desire Line (2010, 2020, 2030)

7.5 FUTURE TRAFFIC VOLUME

Estimated traffic volumes of the years 2010, 2020 and 2030 are assigned on the present road network. The results are shown in Figures 7.5-1, 7.5-2 and 7.5-3, respectively.

As a pattern of traffic the following things are found out.

a) Heavy traffic along Batinah Highway exists through the study period but keenly increases. In 2030 the traffic will be over capacity of the Batinah Highway.
b) In accordance of growth of Sur and Nizwa, Sur – Nizwa – Muscat traffic grows especially after 2020.
c) South – North connection becomes distinct in 2030. It shows Salalah economy growth needs stronger connection to North.
d) Due to the traffic congestion of Batinah Highway, Muscat – Nizwa – Ibri – Buraimi road is used as bypass road in 2030.

Regarding "overcapacity" roads:

- in 2010 there is no "overcapacity" road section,
- in 2020 few sections on Road 23 shows "overcapacity", and
- in 2030 eight roads show "overcapacity" in section described below (Table 7.5-1).

All of these congested sections are located northern area and mostly consisting links of Sur – Muscat – Al Khaburah (extension to Sohar).

Table 7.5-1 Road Sections of Overcapacity

Route No.	Road Name	Section
Route 1	Batinah Highway	Muscat – Al Khaburah
Route 7	Wadi Hattah Road	As Sihaylah – Az Zurub
Route 15	Muscat – Nizwa Road	Muscat – Bidbid
Route 17		Muscat – Qurayyat
Route 21	Nizwa – Hafeet Road	Nizwa – Bahla
Route 23	Bidbid – Sur Road	All Sections
Route 31	Nizwa – Thumrayt Road	Nizwa – Adam
Route 33		Izki – Al Mudaibi

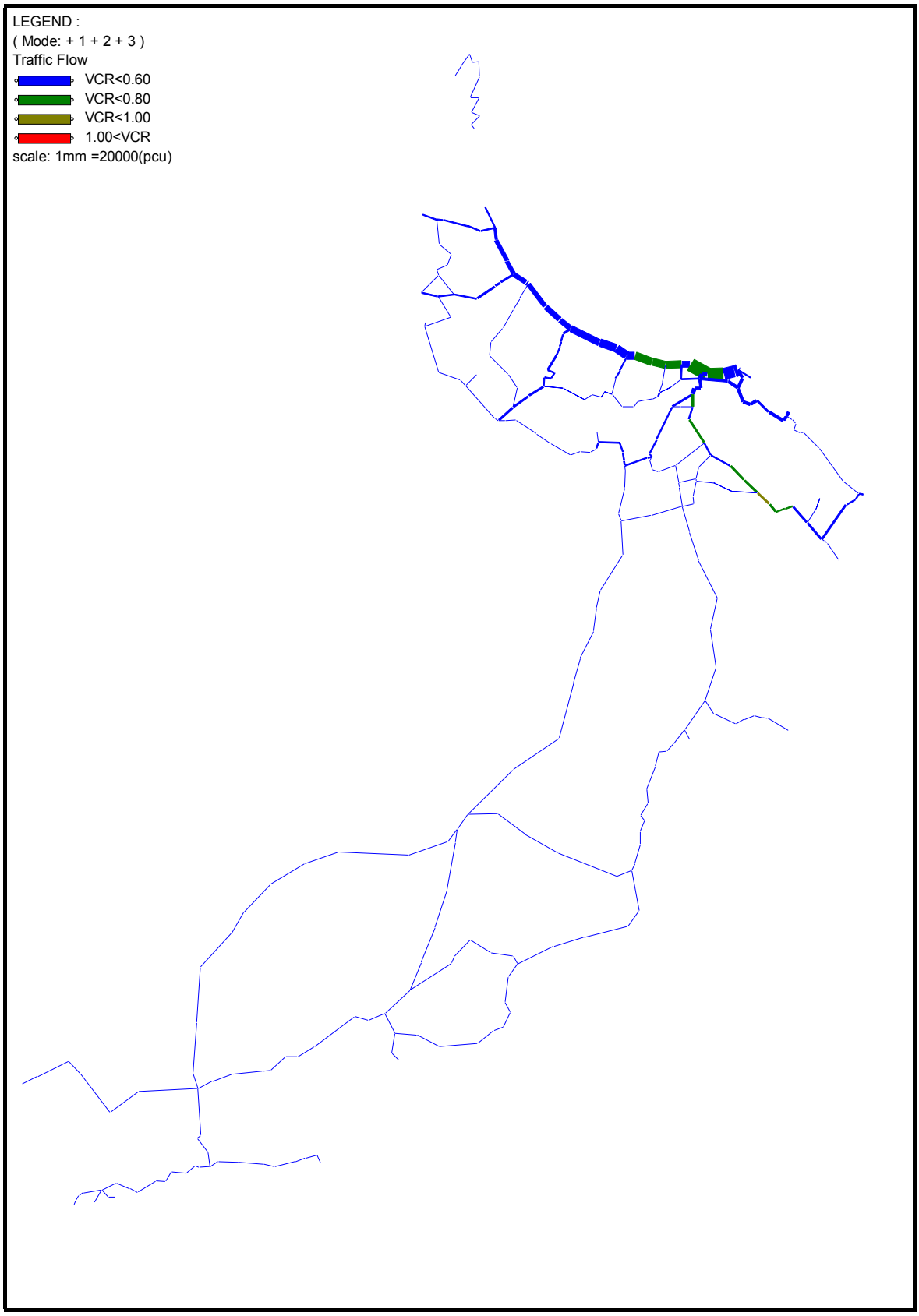


Figure 7.5-1 Future Traffic Volume (Without MP Projects) in 2010

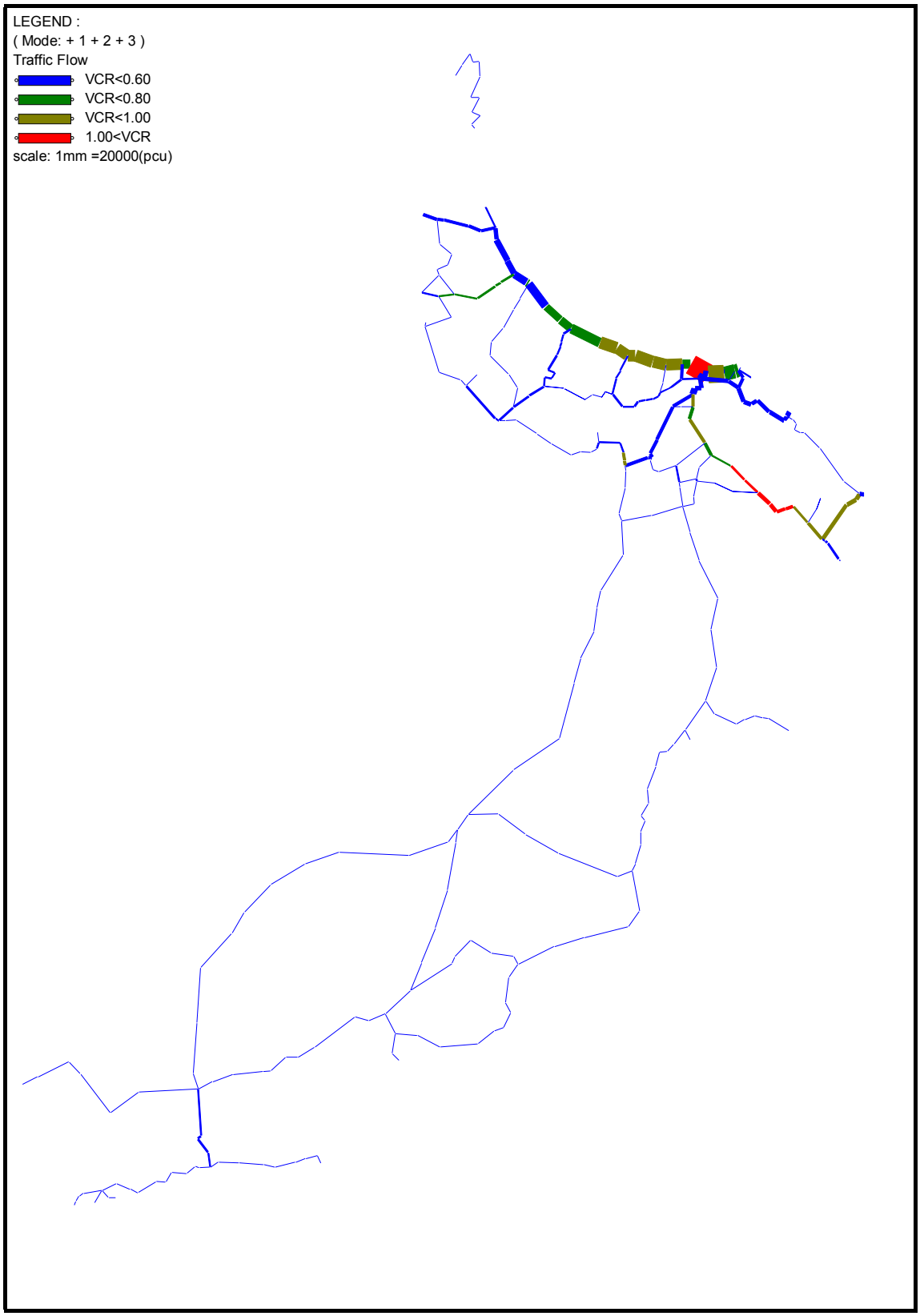


Figure 7.5-2 Future Traffic Volume (Without MP Projects) in 2020

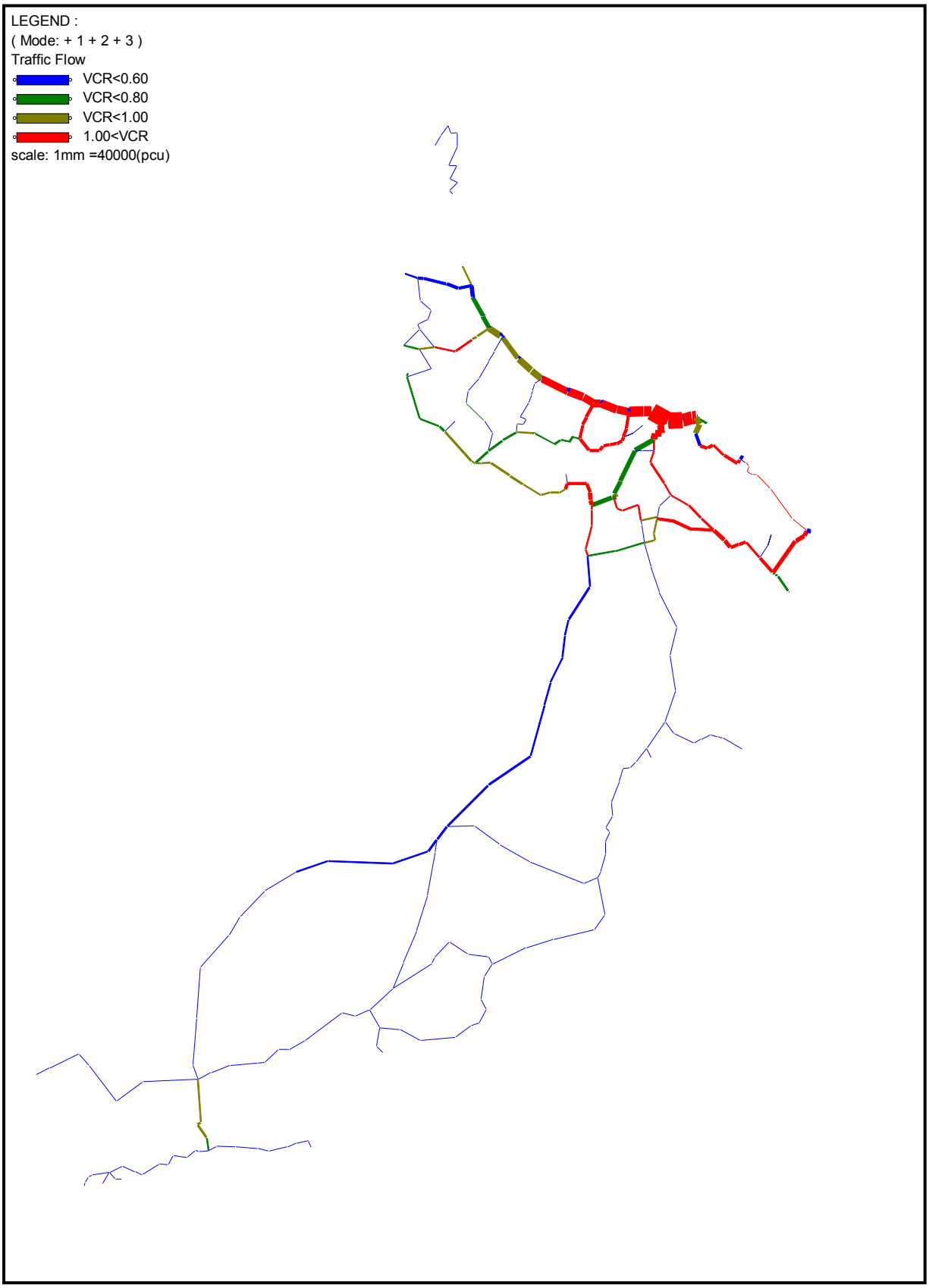


Figure 7.5-3 Future Traffic Volume (Without MP Projects) in 2030

CHAPTER 8

ROAD NETWORK DEVELOPMENT

CHAPTER 8

ROAD NETWORK DEVELOPMENT

The ultimate goal of this Master Plan is to establish a road network that supports the targets and future requirements of socioeconomic development in Oman. The present road network can be assessed as “fairly completed” that connects major cities and centers, and what is required is to develop this network based on the future vision of Oman. This Chapter discusses policies and strategies to establish such network.

8.1 FUTURE DEVELOPMENT IN OMAN

Oman Vision 2020, which gives the most important long-term development policy in the Sultanate, adopted the "Achievement of Economic Balance and Sustainable Growth" as the basic target, with the main strategies of:

1. Human Resources Development
2. Economic Diversification
3. Private Sector development

The Sixth Five Year Development Plan is the second phase within the framework of Oman Vision 2020. The overall objectives of the Plan, in which many items clarify the importance of developing the road network and transport sector, are as follows:

1. To ensure stability of the real average per capita income at its current level and its improvement of a target of achieving an annual growth in the GDP at constant prices at the minimum rate of not less than 3%.
2. To adopt sustainable fiscal policies through rationalizing the government spending, increasing the government revenues, particularly the non-oil revenue, and building up the government financial reserves.
3. To maintain the current low levels of inflation.
4. To raise the rate of enrollment ratio in higher education institutions and to upgrade and spread basic education.
5. To support the programs that aim at promoting the activities of the youth sector.
6. To give attention to culture and heritage.
7. To upgrade the scientific standard in the judicial field.
8. To provide suitable employment opportunities to the Omani citizens through the implementation of economically feasible and labor intensive production projects.
9. To accelerate the growth rates of targeted activities for diversification as well as raising their share in GDP.

10. To develop non-oil goods and services exports through increasing their share, quality standard, and structure
11. To develop the natural gas based industries
12. To upgrade tourism
13. To adopt transparent population policies consistent with the directives aiming at sustainability of development
14. To give special attention to the privatization program, so as to reduce the National Economy's dependence on public spending, encourage private sector investment, provide competitive environment and improve the efficiency of the National Economy.
15. To increase the private Sector share in GDP through its participation in the Industrial Program of Natural Gas based Projects in addition to strengthening its activities in its traditional fields of investment and raising its productivity.
16. To increase private savings, encourage local and foreign investment through creation of a suitable investment climate, and expand the sector's activities.
17. To realize comparable levels of development in the different regions of the country.

Developing the road network on technical base will realize the above national objectives of rationalizing the government spending (Objective 2), promoting culture and heritage (Objective 6), providing employment opportunities (Objective 8), accelerating economic diversification (Objective 9), developing non-oil industries (Objective 10), developing natural gas based industries (Objective 11), Upgrading and promoting tourism (Objective 12), encouraging private investments (Objective 14) as well as local and foreign investments (Objective 16) and realizing regional development (Objective 17).

Based on the above strategies and objectives, as well as the major objective of moving the country from an economy based on a mono depletable source continuously affected by external and unforeseen factors to an economy with a varied and renewable sources, Figure 8.1-1 presents the future development potential in Oman through major socioeconomic activities as established in the future socioeconomic framework, as well as major ports, airports, border points and development centers.

The map shows concentration of population and activities in the northern areas along the northern coast and south of the mountainous ranges. This concentration is a continuation for historical and present socioeconomic distribution patterns. The national plan is promoting comparable levels of development in the different regions of the country. In addition, diversification of the economy to new sub-sectors and the establishment of new development centers and activities through regional development is a major target of the government’s vision toward the future. As such efforts by the government are expected to continue for the short-, medium- and long-term planning periods, development of the road network should proceed towards both present and future requirements.

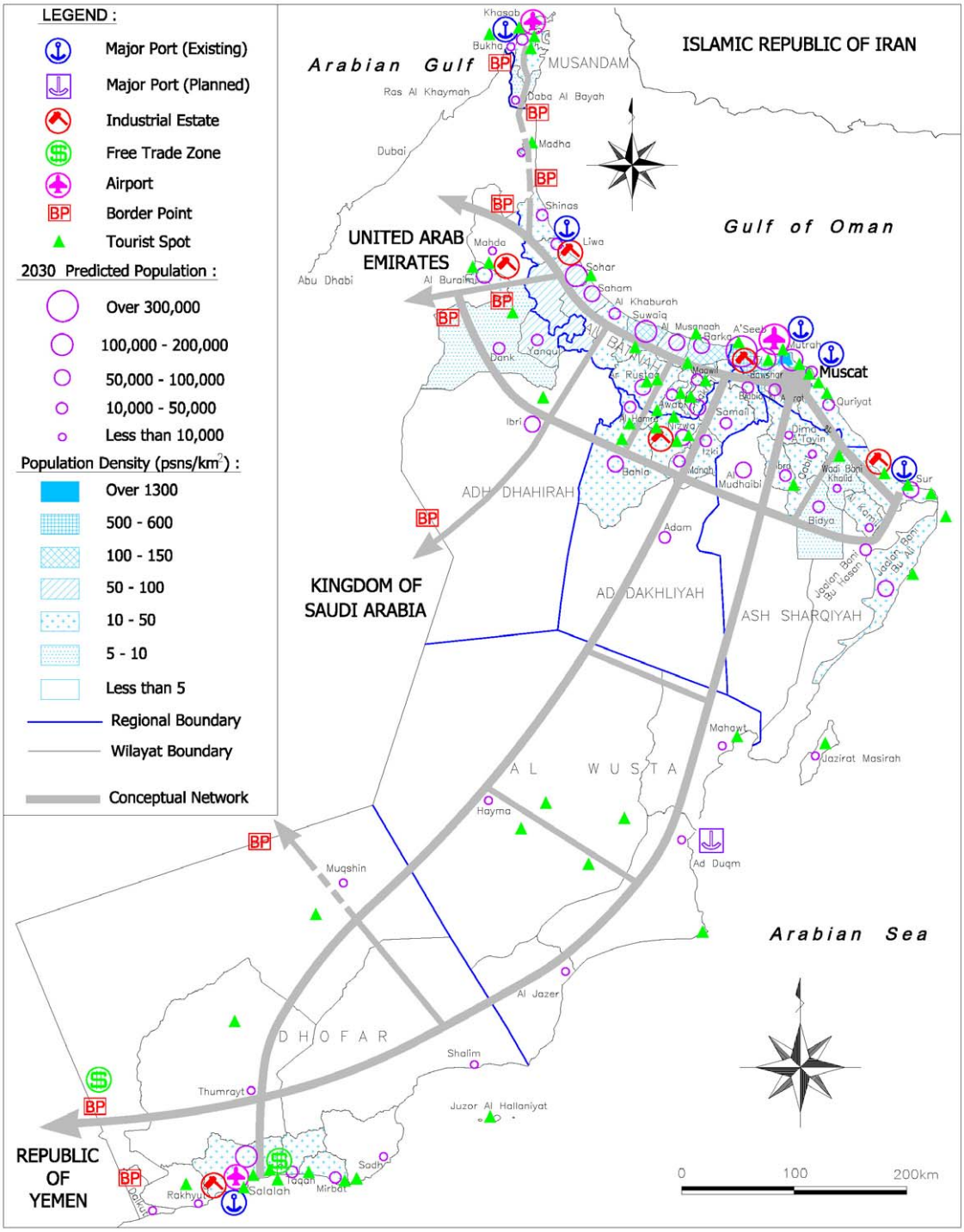


Figure 8.1-1 Future Development Potential in Oman and Conceptual Road Network

8.2 ASSESSMENT OF EXISTING ROAD NETWORK

A comprehensive inventory survey was conducted on the primary and secondary road network in Oman under this Study. Concluded present problems and expected future problems are presented here with an assessment of the networks.

8.2.1 Assessment of Road Network

Based on the collected information and field survey results, it can be stated that the existing primary and secondary road networks can be assessed as "fairly complete" in view of the following tasks:

Coverage: Major cities are connected and access to airports, major ports, industrial estates, etc., are provided.
Density: Density of roads is comparable to, or better than, other Gulf countries.

8.2.2 Road Network Problems

While the existing network of primary and secondary roads in the Sultanate has relatively little problems with regard to coverage, density and physical conditions including geometry and pavement, the result of road inventory survey revealed the following "Road Network Problems", which are pointed from a wider point of view regarding the existing road network as a whole, as thoroughly explained in Chapter 4:

i. Weak connection across the mountain ranges
ii. Primary road network not suitable for high-speed, long-distance trips
iii. Vulnerability to flash flood
iv. Lack of an alternative route to Batinah Highway
v. Low pavement ratio of lower-class roads
vi. Missing links
vii. Insufficient capacity at some sections

In addition, "Road Link Problems" can be summarized as follows:

viii. Poor pavement conditions (unpaved or deteriorated pavement) on some sections
ix. Insufficient shoulder width along some sections
x. Substandard alignment (steep grade and small radius of horizontal curvature) at some sections
xi. Defective bridges and culverts

[1] The primary roads that form the main corridors of the road network as schematically illustrated in Subsection 8.3.1.

xii. Low capacity roundabouts on heavy traffic roads
xiii. Traffic accident black spots.

In addition to the present problems, the following problems are anticipated in the future, based on the forecast of future traffic demand, if the road development plan will not be materialized and the present road network will not be improved.

(i) Traffic congestion on some important road sections
(ii) Increase in travel time between major cities
(iii) Increase in degree of severity of the problems (ii) to (v) of the existing road network, which are:
- Primary road network not suitable for high-speed, long-distance trips
- Vulnerability to flash flood
- Lack of a detour route, or alternative, to Batinah Highway
- Low pavement ratio of lower-class roads

As the traffic volume increases, the problems of existing road network will become more severe in future if appropriate measures will not be applied.

8.3 ROAD NETWORK DEVELOPMENT POLICY

The road network development planning and process depends on the socioeconomic and other regional characteristics that differ to a very large extent around the country. Based on the network planning objectives, the policy for road network development is established based on the requirements of each homogenous part of the country rather than administrative regions.

8.3.1 Network Development Objectives

The Government aims toward the enlargement and diversification of the economy to support the overall development growth. A well developed road network is required for the enhancement of the transport system in the country to cope with the diversification of industries and economic sectors to transfer the country's economy from oil-oriented to non-oil-oriented. Toward this goal, the following objectives of road network development are established:

- Road Network that contributes to national and regional economic development; by providing access to important facilities, industrial estates and tourism activities.
- Road Network that supports international and GCC settings; by enhancing the international transport facilities, especially those related to ESCWA road network for more cooperation with other Gulf countries.

- Road Network that provides welfare and improve living standards; by providing access from small and remote communities to public services, markets and job opportunity locations.
- Road Network that supports national and economic integration; by providing reliable and safe road network with better transport conditions especially to areas faraway from the capital region, such as the two governorates of Dhofar and Musandam.
- Road network development based on environmental considerations; by taking into consideration measures to protect the rich natural environment of the Sultanate.

8.3.2 Basic Concept of Future Network

In line with the Road Network Development objectives as described above, a basic concept for the future road network is designed as shown in Figure 8.3-1.

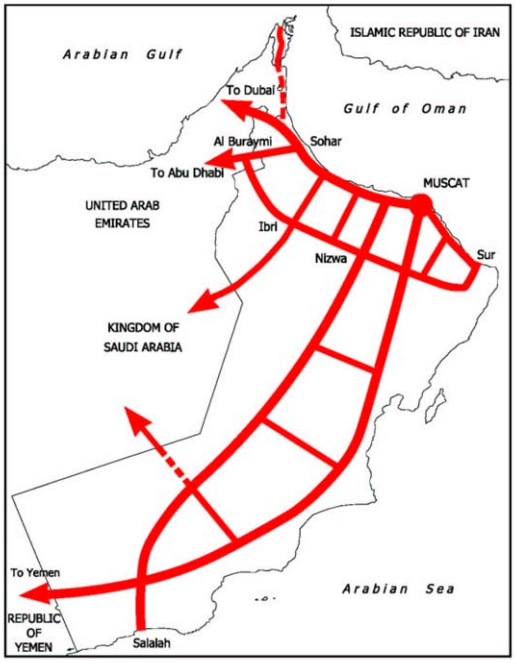


Figure 8.3-1 Basic Concept of Future Road Network Development

The road network is developed to strategically and basically consist of two major corridors in the East-West and North-South directions that have the function of the backbone for the whole road network, with other roads branching off. Each of the East-West and North-South Corridors consists of two routes that are interconnected with each other at strategic intervals. Under this basic concept, the road network secures strong connections and integration among all regions in the Sultanate with alternative routes that support balanced national and regional development.

Main features of these corridors are as follows:

East-West Corridor

(i) This corridor connects Sur – Muscat – Sohar along the northern coast and Sur – Ibra – Izki – Nizwa – Ibri – Buraymi along the southern side of the northern mountain ranges.

(ii) The western part of this corridor extends towards UAE and Saudi Arabia and forms a part of ESCWA Road Network.
(iii) The coastal route and the route in the south of mountain ranges are interconnected and communication of people and goods are encouraged to support socioeconomic development.

North-South Corridor

(i) This corridor connects the capital region with Al Wusta Region and Dhofar Governorate, and enhances the unity of the nation.
(ii) The central route of this corridor traverses the middle part of the nation while another route traverses coastal areas.
(iii) The southern end of this corridor extends to Yemen, and the Central Route constitutes a part of ESCWA Road Network.

8.3.3 Regional Framework and Road Development Strategy

Regional Characteristics:

The Sultanate has wide variety of geographic and topographic conditions that will affect the planning policy and process of the road network. From this view point, the country is divided into three major parts as follows:

1. Northern Part: The areas of this part include the well developed coastline north of the country, northern mountainous ranges of Al Hajar Al Gharbi and Ash Sharqi and the developed land south of the ranges. Administratively, it is composed mainly of Batinah Region and northern parts of Adh Dhahirah, Ad Dakhilyah and Ash Sharaqah. These areas are characterized with:

    - High density of population
    - Nationwide engine of economic growth (along Batinah coastal areas)
    - Industrial estates, agriculture areas and farm lands
    - Four major seaports
    - Tourism attractions

2. Central Part: This part of the country is topographically flat deserts that are administratively composed of the southern parts of Adh Dhahira, Ad Dakhilyah and Ash Shariqiya regions, Al Wusta Region and northern Dhofar Government. These areas are characterized with:

    - Low population density
    - Low development projects

- Low infrastructure facilities
- High oil and gas productivity
- High fishery production
- High potential of desert and marine tourism activities

3. Southern Part: This part includes Dhofar mountainous chain with its northern developed land and southern coastline that extends from Yemen border to the central areas. These areas are characterized with:
    - Moderate population density
    - Some industrial and agricultural activities
    - Tourism attractions
    - The deep seaport of Salalah

Figure 8.3-2 clarifies the major planning parts that are taken into consideration in the planning process of the future road network.

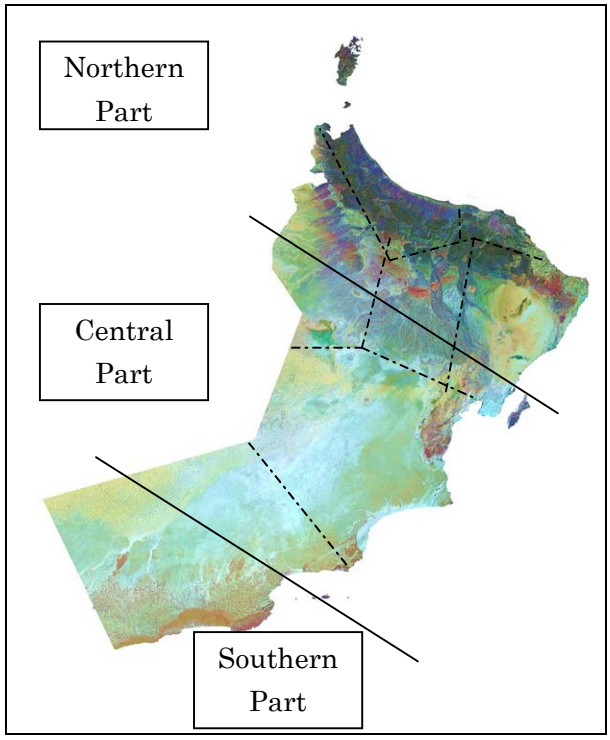


Figure 8.3-2 Major Planning Parts of Oman

Development Strategy:

With the different characteristics and requirements of each part in the Sultanate, the basic policy in the road network developments will differ also as follows:

1. Nationwide Network Development
   - Promoting national development
   - Improving international transport corridors that serve ESCWA
   - Improving transport conditions
   - Connecting major cities and new development centers
   - Providing strategic road alternatives
   - Increasing road safety on the network
   - Consideration of environmental aspects that may be affected.

2. Northern Part
   - Promoting national and regional development
   - Strengthening east-west corridor to support industrial and tourism activities
   - Providing connections across mountainous ranges to promote socioeconomic activities
   - Improving international links to UAE and Saudi Arabia to attract trade and tourism

3. Central Part
   - Promoting regional development for future potential sectors of fishery and tourism
   - Connecting north and south with two corridors to promote socioeconomic integration
   - Providing lateral connections between N-S corridors

4. Southern Part
   - Promoting regional development, especially in the sectors of tourism and trade
   - Strengthening north-south socioeconomic integration
   - Enhancing regional social welfare
   - Supporting free zone areas and international trade with Yemen

Overall Time Framework:

For the purpose of setting steps to establish nationwide and regional road networks, The master plan period is divided into the following three terms:

Term	Year	Major Objective
Short Term	2006 ~ 2010	To solve urgent problems/requirements
Medium Term	2011 ~ 2020	To develop the road network
Long Term	2021 ~ 2030	To strengthen and complete the network function

Based on the above mentioned considerations and the basic development concept, the overall scheme for regional development of the nationwide road network can be schematically presented as in Figure 8.3-3.

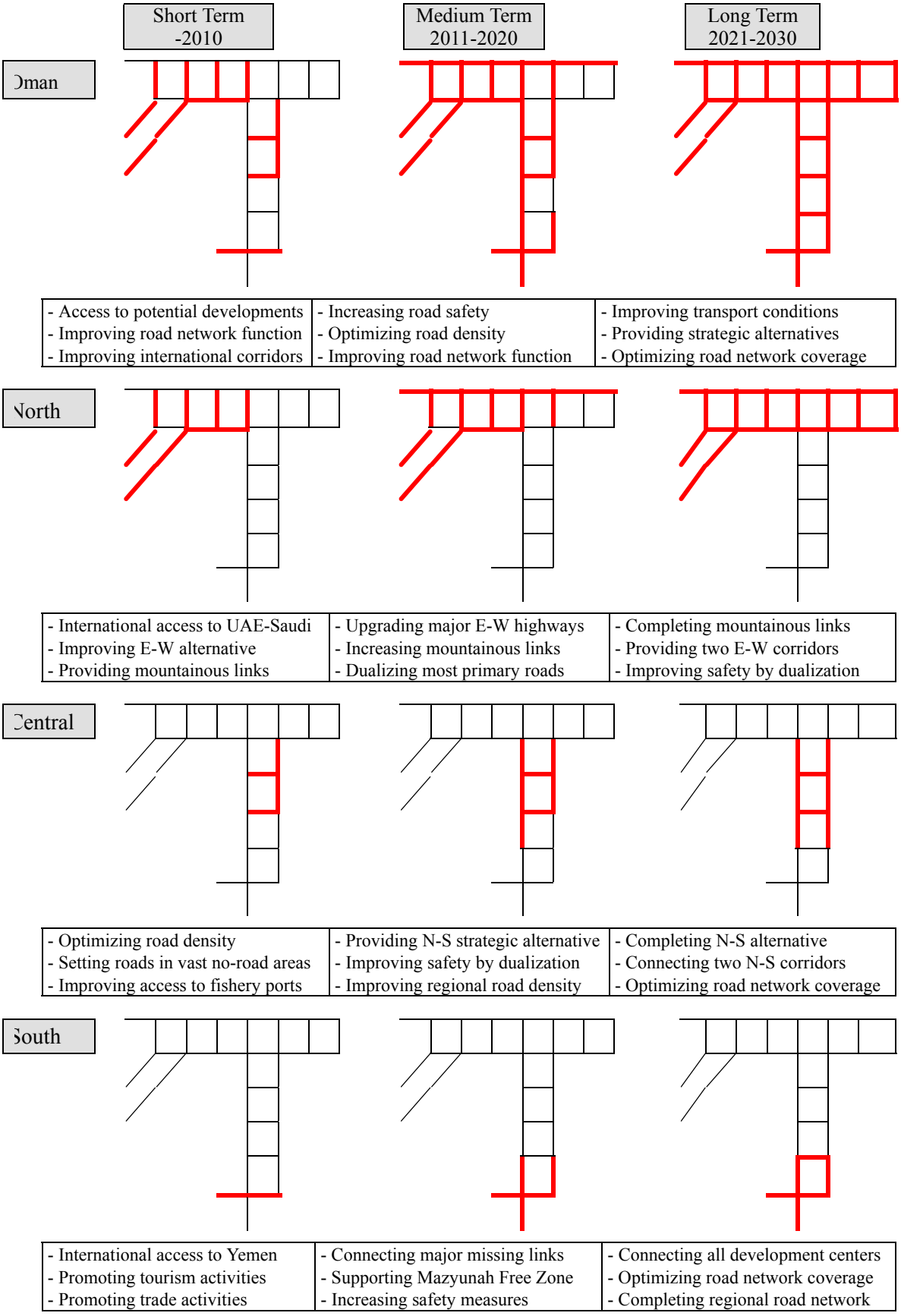


Figure 8.3-3 Conceptual Development Program of Road Network

8.3.4 Network Improvement Measures

The future road network needs to incorporate countermeasures for identified road and network problems as well as measures to support future socioeconomic development. Improvement measures are designed to meet the requirements of developing the road network based on its objectives and the established strategies. Table 8.3-1 shows the designed countermeasures for both network and link problems.

Table 8.3-1 Countermeasures for Road Problems

No.	Problem	Countermeasure
Road Network Problems		
i	Weak connection across the mountain ranges	- Construction of roads across mountain ranges
ii	Primary road network not suitable for high-speed, long-distance trips	- Dualization - Providing grade separation at major intersections - Construction of bypasses
iii	Vulnerability to flash flood	- Construction of detour routes - Convert Irish crossing into culverts (Batinah Highway)
iv	Lack of an alternative route to Batinah Highway	- Construction of New Batinah Expressway
v	Missing links	- Construction of missing link roads
vi	Insufficient capacity at some sections	- Widening of congested sections - Provision of alternate route
vii	Low pavement ratio of lower-class roads	- Paving local and access roads
Road Link Problems		
viii	Poor pavement conditions on some sections	- Paving unpaved roads - rehabilitation of deteriorated pavement
ix	Insufficient shoulder width along some sections	- Widening of shoulders
x	Substandard alignment at some sections	- Improvement works for substandard sections
xi	Defective bridges and culverts	- Repair defects
xii	Low capacity roundabouts on heavy traffic roads	- Provide grade-separation structures
xiii	Traffic accident black spots	- Physical improvement - Enforcement - Road-user education

Table 8.3-2 presents the major objectives and strategies applied in developing the road network in addition to the improvement measures to be applied.

Table 8.3-2 Network Development Objectives, Strategies and Improvement Measures

Development Objectives	Development Strategies	Network Improvement Measures
Road Network that contributes to national and regional economic development	Improving road transport conditions	Road upgrading
Road Network that supports international and GCC settings	Improving international transport corridors that serve ESCWA	Road widening
Road Network that provides welfare and improve living standards	Connecting major cities and new development centers	Road dualization
Road Network that supports national and economic integration	Increasing road safety on the network	New construction of roads
Road network development based on environmental considerations	Providing strategic road alternatives	New construction of bypass
Road Network that can cope with future transport demand	Optimizing road density	New construction of grade separation
	Strengthening road network function	Road structure improvement
	Consideration of environmental aspects	Proper route-location planning

8.3.5 Targets of Network Development

Based on the policy described above, the following targets are proposed to be accomplished by developing the road network to the year 2030:

- Rehabilitate and improve the network of major primary roads into dual-carriageway all-weather condition, including converting feasible Irish-crossings into culverts or Irish bridges.
- Provide paved Secondary Road Network with a minimum of 2-lane single-carriageway.
- Increase the percentage of paved roads from 40% at present to 80%.
- Decrease the travel time between any two Wilayats to less than 12 hours.
- Optimum utilization of financial resources on high priority projects that provide remarkable growth in socioeconomic development.

CHAPTER 9

ESTABLISHMENT AND EVALUATION OF ALTERNATIVES

CHAPTER 9

ESTABLISHMENT AND EVALUATION OF ALTERNATIVES

9.1 ESTABLISHMENT OF ALTERNATIVES OF FUTURE ROAD NETWORK

The future road network, as a matter of course, needs to fulfill the requirements to achieve the objectives as described in Chapter 8. More than one road network plan may be possible to achieve the objectives. To select the road network plan which achieve the objectives of future road network most efficiently and effectively (Optimum Network Plan), possible alternatives are established and compared.

Figure 9.1-1 shows the flow of applied selection procedure of the Optimum Network Plan. Based on the existing and future problems, as well as the measures to achieve the network objectives, several alternatives are established and compared.

9.1.1 Basic Future Road Network

Figure 9.1-2 shows the future road network to be used as the base for preparing the alternatives. This road network is assumed to satisfy the conditions required to attain the objectives as described in Section 8.3. The required conditions are:

- Strengthened connection across mountain ranges,
- Dualization of primary roads with grade separation at major intersections,
- Provision of detour routes for strategic routes/sections,
- Completion of missing links, and
- Widening of congested sections.

Therefore, the Basic Future Road Network is assumed to have incorporated all the countermeasures summarized in Table 8.3-1. However, some important measures crucial to efficiency and effectiveness of the future road network will be re-examined and used in preparing alternatives as discussed in the following subsection.

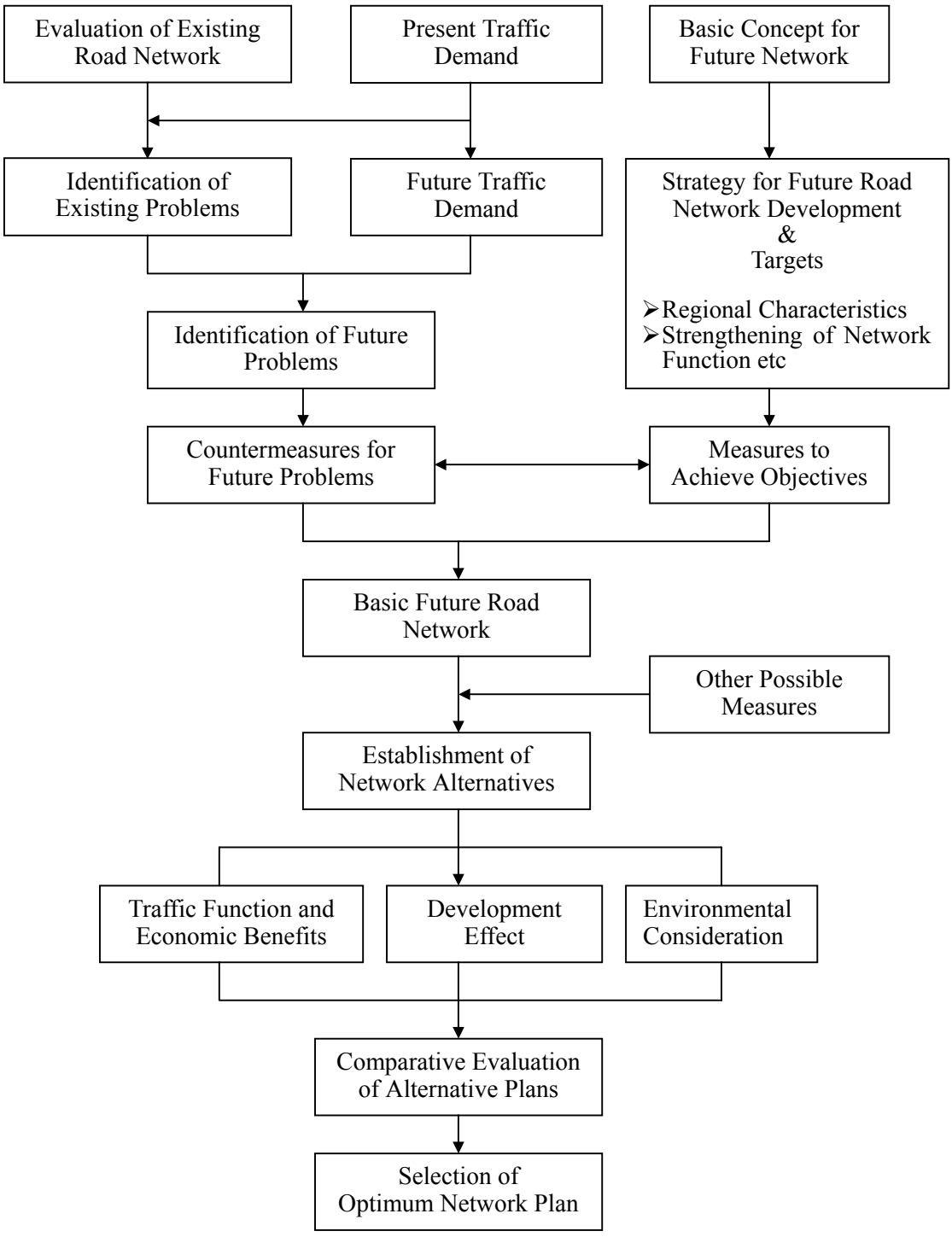


Figure 9.1-1 Flow Chart of Selection of Optimum Network

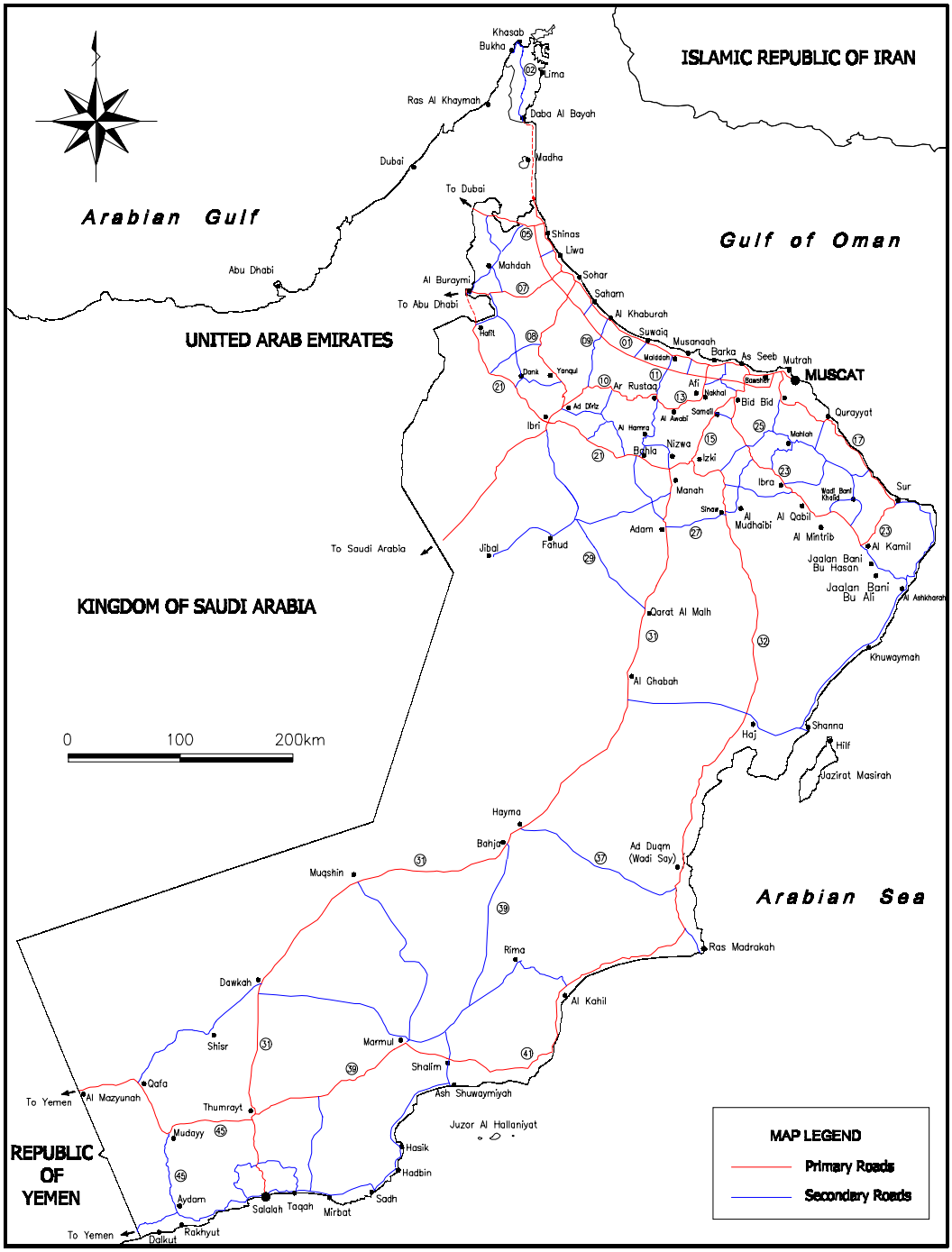


Figure 9.1-2 Basic Future Road Network

9.1.2 Establishment of Alternatives

As stated before, the existing road network of the Sultanate is fairly complete. Major cities are connected with each other, all existing international airports, and existing and planned major ports are connected directly, or via very short access roads, to the primary road network. Therefore, discussion of alternatives of future road network plan focuses mainly on strengthening the function of the existing road network to support future socio-economic development of the Sultanate.

Geographically, two basic strategies are proposed for the Northern part, and Central and Southern part of the country as discussed in Chapter 8. These strategies can be summarized as follows:

(i) Northern Part: Establish dense strategic network along both sides of, and across, the mountain ranges of Al Hajar Al Gharbi and Al Hajar Ash Sharqi to support development and diversification of industries.
(ii) Central and Southern Part: Establish reliable and safe high-speed road network that connects and integrates the Central (Al Wusta) and Southern (Dhofar) Part with the Northern Part (the Capital Region).

The basic strategies/policies for road network development in these two geographical areas are considerably different from each other. Therefore, alternatives are separately established and discussed for the two areas.

1) Northern Part

The Northern part of the Sultanate (the areas along the coast in the north of Al Hajar Al Ghabri and Al Hajar Ash Sharqi and the area in the south of Al Hajar Al Ghabri and Al Hajar Ash Sharqi) is expected to be the engine of economic development of the entire Sultanate. To support industrial activities, as well as social activities of relatively dense population, a reliable and strategic road network is proposed for this area. The main features of the proposed network in this area are as follows:

(i) Dualized major primary roads connecting important cities such as Sohar, Sur, Ibri, Nizwa, Ibra and Muscat in East-West direction.
(ii) Strategically positioned primary and secondary roads across the mountain ranges.
(iii) Provision of detour routes for strategically important road sections.

Basic concepts of these features can be summarized as follows:

a. Dualization of Major Primary Roads

Primary roads forming the East-West Corridor and North-South Corridor, as conceptually illustrated in Figure 8.2 –1, play important role in the network and it is ideal that all these primary roads are dualized (widened from single (2-lane) carriageway to double carriageway (divided 4-lane)). In the Northern Sultanate, all primary roads forming the East-West Corridor are proposed for dualization.

Primary roads which form East-West Corridor are as summarized in Table 9.1-1:

Table 9.1-1 Primary Road Forming East-West Corridor

Route	Roads Constituting the Route
Mountain-North (Coastal) Route	- NR No. 01 (Batinah Highway) - NR No. 17 (Mascut-Qurayyat-Sur Road) - New Batinah Expressway
Mountain-South Route	- NR No. 21 (Nizwa-Ibri-Buraymi Road) - NR No. 15 (Rusayl-Nizwa Road) - NR No. 23 (Bid Bid-Sur Road)

b. Roads Across the Mountain Ranges

Several roads are proposed across the mountain ranges as discussed in Section 8.3. These roads are proposed to promote the communication between the most developed coastal area and the area south of the mountain range, which is also developed but separated from the coastal area.

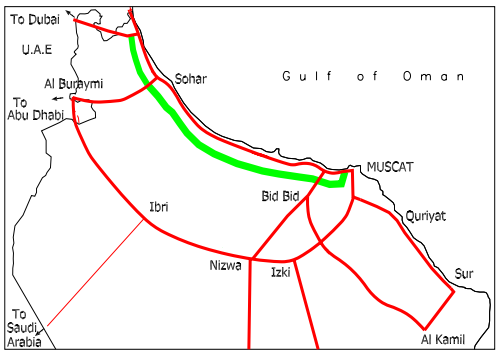
c. Provision of Detour Routes For Strategic Sections

Several detour routes for strategically important road sections are proposed in Section 8.3. These detour routes are proposed for two different objectives: (i) detour routes for road sections vulnerable to wadi floods and (ii) a detour route for the existing Batinah Highway which is the most important road in the road network of the Sultanate.

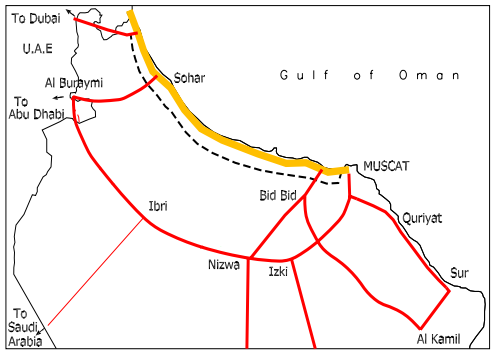
d. Establishment of alternatives

As for Items (i) and (ii) above, there are no substantial rooms for designing alternatives due to geographical constraints and locations of major cities. On the other hand, there are some possibilities for detour routes for important road sections. Especially, the proposed New Batinah Expressway requires large amount of investment and impact of its construction on the traffic flow of entire network is large. Therefore, the alternatives for the Northern Sultanate are centered at construction of

New Batinah Expressway or widening of the existing highway to accommodate future transport demand. Figure 9.1-3 schematically shows the alternatives for Northern Part as presented in Table 9.1-2.



Alternative N-1 With New Batinah Expressway



Alternative N-2 Without New Batinah Expressway (Existing Batinah Highway widened)

Figure 9.1-3 Schematic Illustration of Alternatives for Northern Part

Table 9.1-2 Alternatives of Road Network Plan for Northern Sultanate

Alternatives	Outline of Alternative
Alternative N-1 (Construction of New Batinah Expressway Plan)	Construct New Batinah Expressway and only upgrading (improvement of R/A intersections to grade-separated intersections etc.) is implemented on the existing Batinah Highway
Alternative N-2 (Widening of Exiting Batinah Highway Plan)	New Batinah Expressway is not constructed and the existing Batinah Highway is widened from current 4-lane to 8-lane to accommodate increased traffic in the future

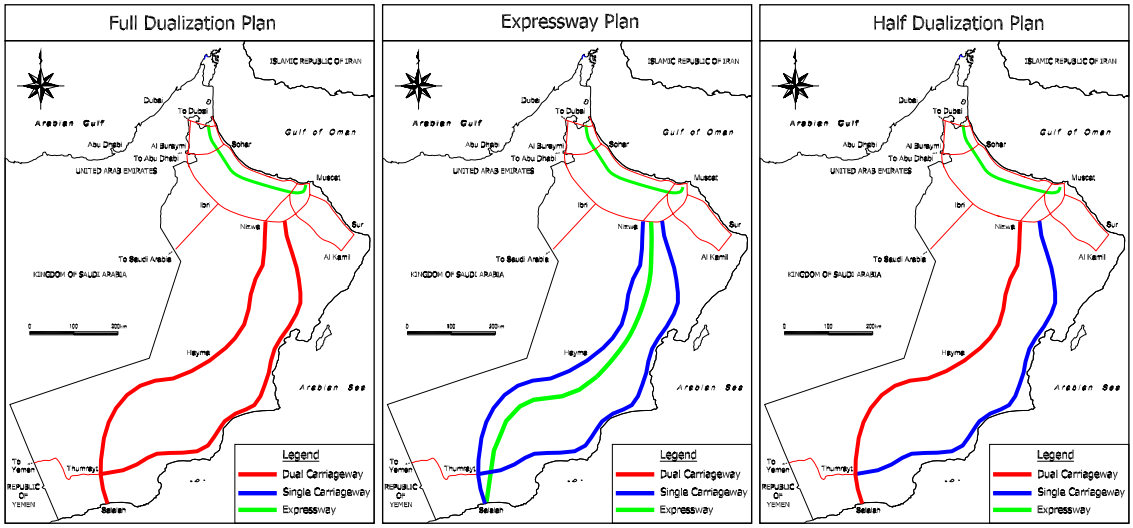
2) Central and Southern Part

Here, the word “Central Sultanate” refers Al Wusta Region combined with southern parts of Adh Dhahirah and Ad Dakhliyah Regions, as well as northern part of Dhofar Governorate, while “Southern Part” refers to the southern part of Dhofar Governorate. The basic strategy for the road network of these areas is to strengthen the connection among these areas and the Northern Sultanate. For this purpose, dualization of primary roads which form the North-South Corridor as listed in Table 9.1-3 is proposed:

Table 9.1-3 Primary Road Forming North-South Corridor

Route	Roads Constituting the Route
Central Route	- NR No.31 (Nizwa-Thmrayt-Salalh Road)
Coastal Route	- NR No. 33 (Nizwa-Sinaw Road) - NR No. 32 (Sinaw-Ras Madrakah Road) NR No. 41 (Ras Madrakah – Sawqrah – Shalim - Marmul Road)

Considering the above, alternatives for Central and Southern Part are established as schematically shown in Figure 9.1-4 and explained in Table 9.1-4.



Alternative S-1 Alternative S-2 Alternative S-3

Figure 9.1-4 Schematic Illustrations of Alternatives for Central and Southern Part

Table 9.1-4 Alternatives of Road Network Plan for Central and Southern Part of Sultanate

Alternatives	Outline of Alternative
Alternative S-1 (Full Dualization Plan)	Both the Central and Coastal Routes are dualized. Together with dualization, main intersections are improved into grade-separated intersections. Fundamentally, the alignments of both routes follow the existing ones.
Alternative S-2 (Expressway Plan)	Instead of dualizing the existing two primary roads, a new expressway is constructed. Accordingly, existing primary roads are basically maintained as single-carriageway. The alignment of the new expressway is tentatively assumed between the Central and Coastal Routes.
Alternative S-3 (Half-Dualization Plan)	Only the Central Route (NR 31) is dualized and the Coastal Route is maintained as a single-carriageway in view of high cost of dualization.

9.1.3 Preliminary Screening of Alternatives

Before conducting detailed evaluation, alternatives described above are preliminarily examined and cases which are judged to be evidently unviable are eliminated based on the following assessment.

1) Alternatives for Northern Part

Major impacts on traffic and regional development, major problems and cost of Alternatives N-1 and N-2 are compared in Table 9.1-5.

Table 9.1-5 Major Impacts and Problems of Alternatives for Northern Sultanate

	Alternative N-1	Alternative N-2
Outline of Alternative	Construct New Batinah Expressway (NBE)	Widen existing Batinah Highway (EBH) without constructing New Batinah Expressway
Impact on Regional Development	New development is expected in new areas along NBE	More concentration of development along EBH is expected
Impact on Regional Traffic	Safer and higher-speed alternative route is provided	Basically same as the present condition
Major Problem	No grave problem anticipated	-No detour route is provided for EBH: NR 21 which can function as the detour route for long–trip traffic is too distant from Batinah Highway and cannot become detour route for the vehicles traveling on the section between Muscat and Khatmat Milahah (UAE border). - Acquisition of ROW for widening in some built-up areas
Total Cost of Network for Northern Part	Approximately RO 542 million	Approximately RO 450 million

From Table 9.1-5, the following can be concluded:

- Impacts on Regional Development and Regional Traffic: There are comparative advantages in Alternative N-1, but Alternative S-2 does not have serious problems on these impacts which make Alternative S-2 evidently unqualified.

- Cost: Cost of Alternative N-1 is larger than that of Alternative N-2 by about 20 %, this difference of total cost is not considered as large to judge Alternative N-1 to be unrealistic.
- Major problem: While no grave problems is anticipated with Alternative N-1, Alternative S-2 imposes a grave problem that detour route is not provided for EBH.

Provision of detour route to the existing Batinah Highway is one of the main countermeasures of the Master Plan because securing reliable traffic on Batinah Highway is essential. However, whether or not New Batinah Highway should be constructed is very important issues in the Road Network. Therefore, these two alternatives are studied more in detail.

2) Alternatives for Central and Southern Part

Major impacts on traffic and regional development, major problems and cost of Alternatives S-1 through S-3 are compared in Table 9.1-6.

Table 9.1-6 Comparison of Alternatives

	Alternative S-1	Alternative S-2	Alternative S-3
Outline of Alternative	Both Central & Coastal Route are dualized.	A new expressway is constructed and both Central and Coastal Route are basically maintained as single-carriageway.	Only Central Route is dualized and Coastal Route is maintained as single-carriageway.
Impact on Regional Development	Development along Coastal Route may be promoted.	New development may be promoted along the new expressway.	Development may occur along Coastal Route but to less extent than Alternative S-1
Impact on Regional Traffic	Better access to Salalah and Muscat	Same as Alternative S-1 (Design speed and speed regulation by ROP for dulaized highway is 120 km/hr and there is no substantial difference in travel time)	Same as Alternative S-1
Major Problem	None in particular	Discarding the project of dualization of Central Route (NR 31) (See explanation below.)	None in particular
Total Cost of Network for Southern Part	Approximately RO 410 million	Approximately RO 402 million	Approximately RO 300 million

As can be seen in the above table, Alternative S-1 and S-3 do not indicate grave

problem. In case of Alternative S-2 (a new expressway is constructed and existing two routes are maintained as single-carriageway) has serious problem as explained below:

Project of dualization of NR 31 is in a very advanced stage and ready for implementation as soon as the fund becomes available. Tender documents for dualization works for all the sections (contract packages) between Izki and Thumrayt have been prepared. This means that project of dualization of NR 31 has been committed by concerned parties. Therefore, it is practically not possible to discard the dualization of NR 31. Accordingly, Alternative S-2 which includes discarding dualization of NR 31 is considered to be unviable, as there is not strong justification to select this alternative with relatively higher costs.

3) Nationwide Alternatives for Whole Sultanate

After the preliminary screening as described above, Alternative S-2 for Central and Southern Part is discarded. Accordingly, the following 4 cases are established as alternatives for the road network for the whole Sultanate by combining the two alternatives for Northern Part with those for Central and Southern Part as shown in Table 9.1-7.

Table 9.1-7 Combination of Alternatives for Each Part

Alternatives for Northern Part	Alternatives for Central and Southern Part	
	Alternative S-1	Alternative S-3
Alternative N-1	Case 1 [N-1 + S-1]	Case 2 [N-1 + S-3]
Alternative N-2	Case 3 [N-2 + S-1]	Case 4 [N-2 + S-2]

Case 1 through 4 in the above table are renamed as Alternative-1, Alternative-2, Alternative-3 and Alternative-4 respectively, for the purpose of discussion on the Optimum Network that are described hereinafter in this Chapter. Alternative-1 through Alternative-4 are summarized in Table 9.1-8 and illustrated in Figure 9.1-5.

Table 9.1-8 Summary of Alternatives for Whole Sultanate

Alternative	Main Features
Alternative 1 (Case 1)	NBE* constructed – Both Central and Coastal Route connecting Central and Southern Part dualized.
Alternative 2 (Case 2)	NBE* constructed – Only Central Route (NR31) dualized.
Alternative 3 (Case 3)	NBE not constructed, EBH widened – Both Central and Coastal Route connecting Central and Southern Part dualized.
Alternative 4 (Case 4)	NBE not constructed, EBH widened–Only Central Route (NR31) dualized.

Notes: *NBE: New Batinah Expressway
**EBH: Existing Batinah Highway (NR 01)

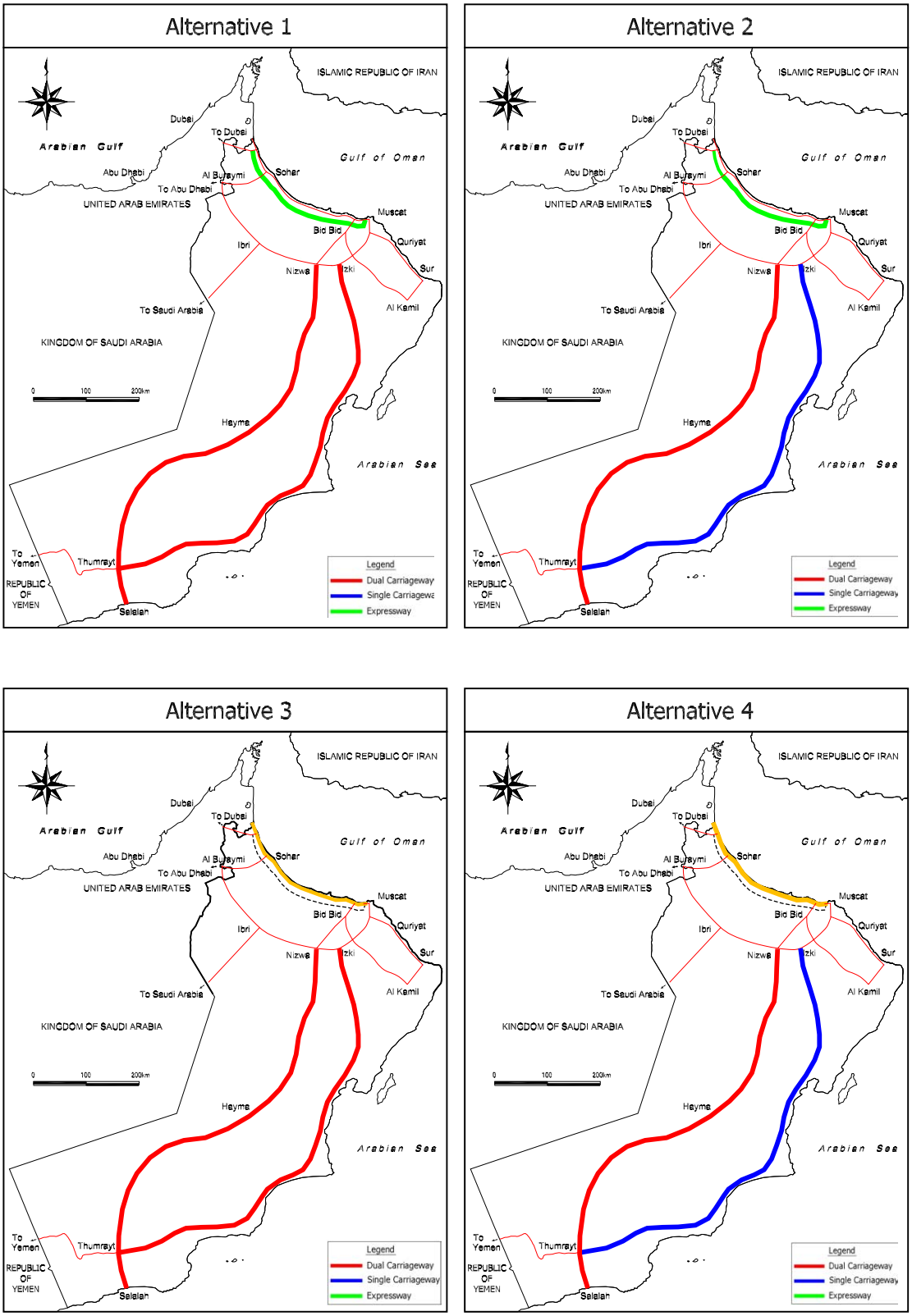


Figure 9.1-5 Alternatives for Nationwide Road Network

9.2 COMPARATIVE EVALUATION OF ALTERNATIVES

9.2.1 Basic Policy for Evaluation Factors

The objectives of the road network development were set in Section 8.3 as the following:

a) Road Network that contributes to national and regional economic development.
b) Road Network that supports international and GCC settings.
c) Road Network that provides welfare and improve living standards.
d) Road Network that supports national and economic integration
e) Road Network development based on environmental consideration.

As stated in the previous section, it is assumed here that all the necessary measures for achieving the above objectives, except those under discussion for establishing alternatives, are incorporated in all the four alternatives and the above-listed objectives are achieved on general basis in all the alternatives. Therefore, factors for evaluating the alternatives need to be set to examine efficiency and effectiveness of each alternative in achieving the objectives. Based on this consideration, the evaluation factors are set as follows:

a) Magnitude of Cost
b) Traffic efficiency
c) Economic efficiency
d) Reliability and flexibility of road network (Availability of detour/alternate routes)
e) Development effects

The indicators and their measuring methods are proposed as listed in Table 9.2-1:

Although a social and natural environmental impact to areas affected by the alternatives is very important factor, a presumption to formulate the alternatives is to avoid social and natural impacts to the areas. Therefore, it is not considered as the factor for evaluating and comparing the alternatives.

Table 9.2-1 Evaluation Factors and Indicators

	Evaluation Factor	Indicators	Method for Measurement
1	Magnitude of Cost	・Costs for road improvement consisting of widening, construction or upgrading costs	・Preliminary cost estimates
2	Traffic efficiency	・ Average congestion degree ・ Road length by Level of Service (LOS) ・ Average travel speed ・ Matching of traffic demand and capacity	・ Traffic assignment with JICA STRADA ・ Comparison between traffic demand and capacity of corridor
3	Economic efficiency	・ Saving of vehicle operating costs (VOC) ・ Benefit/Cost ratio	・ Benefit calculation ・ Economic analysis
4	Reliability/ flexibility of road network	Availability of alternative road network in transport corridor	Examine availability of alternative routes in transport corridor
5	Development effects	Matching road network with the development plan	Matching between network and the development plans

9.2.2 Traffic Efficiency

1) Traffic Assignment For Alternative Plans

Forecasted vehicular OD matrix by three (3) types of vehicles (passenger car, bus and truck) are converted to PCU and assigned to the alternative road network plans by applying JICA STRADA models as presented in Figures 9.2-1 (1) to (5). Assignment results give the traffic indicators of PCU-km, PCU-hr, average travel speed, road length by level of service (LOS). Table 9.2-2 shows the traffic indicators for each alternative plan as well as the 'Do Nothing' case in which no improvements are assumed to be implemented to the existing roads.

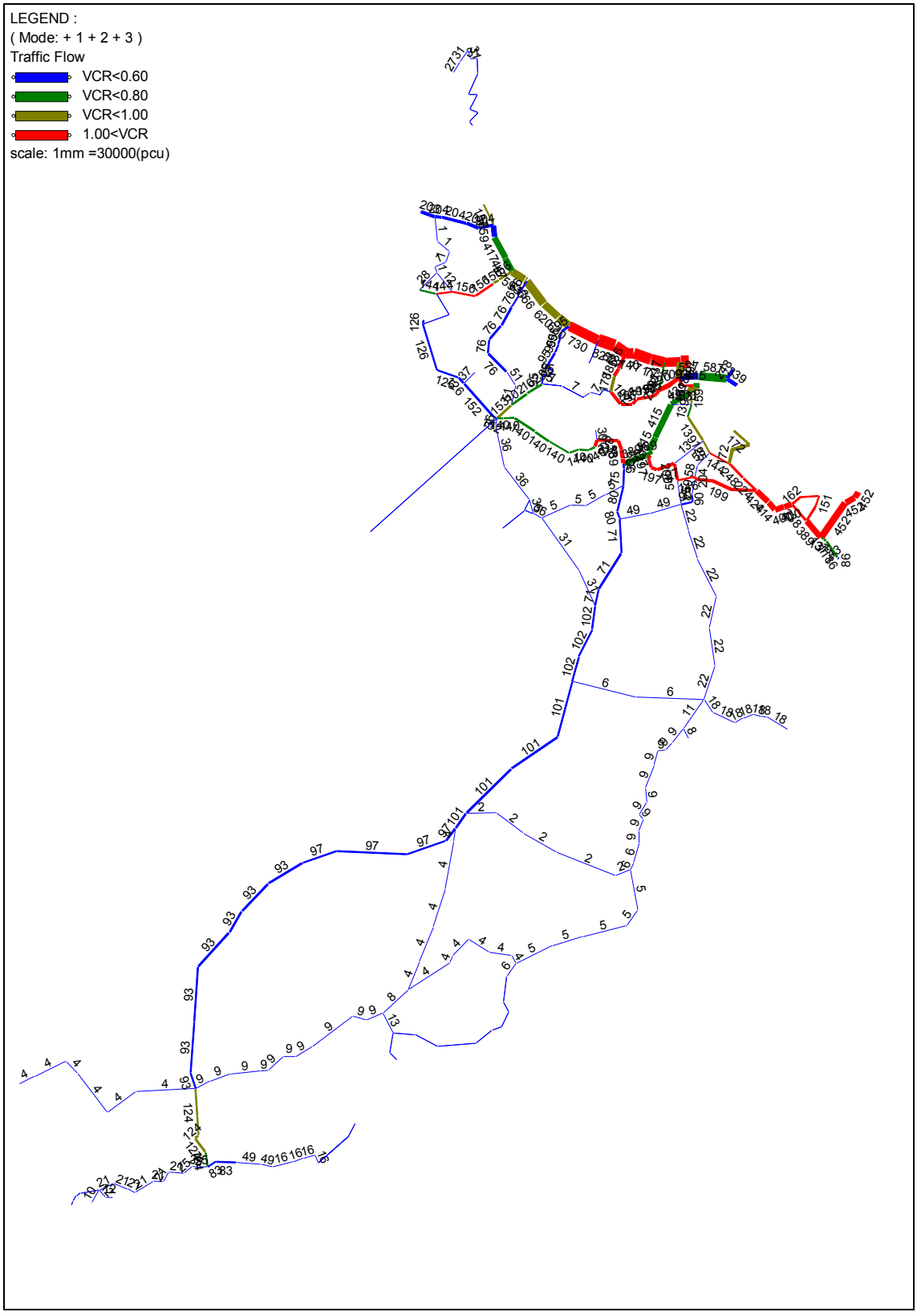


Figure 9.2-1 (1) Traffic Assignment to “Do-Nothing” Road Network - 2030

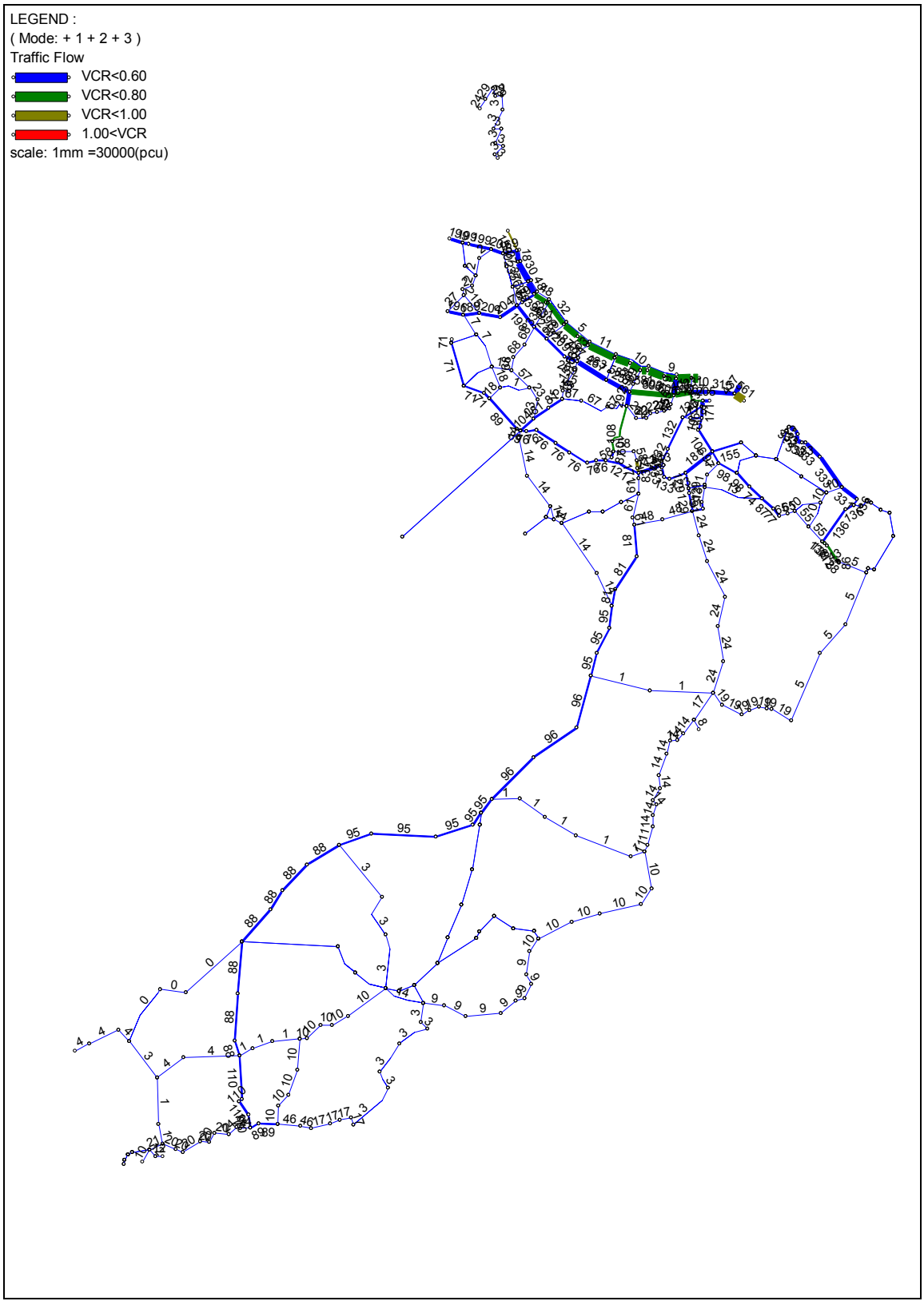


Figure 9.2-1 (2) Traffic Assignment to Alternative 1 Network - 2030

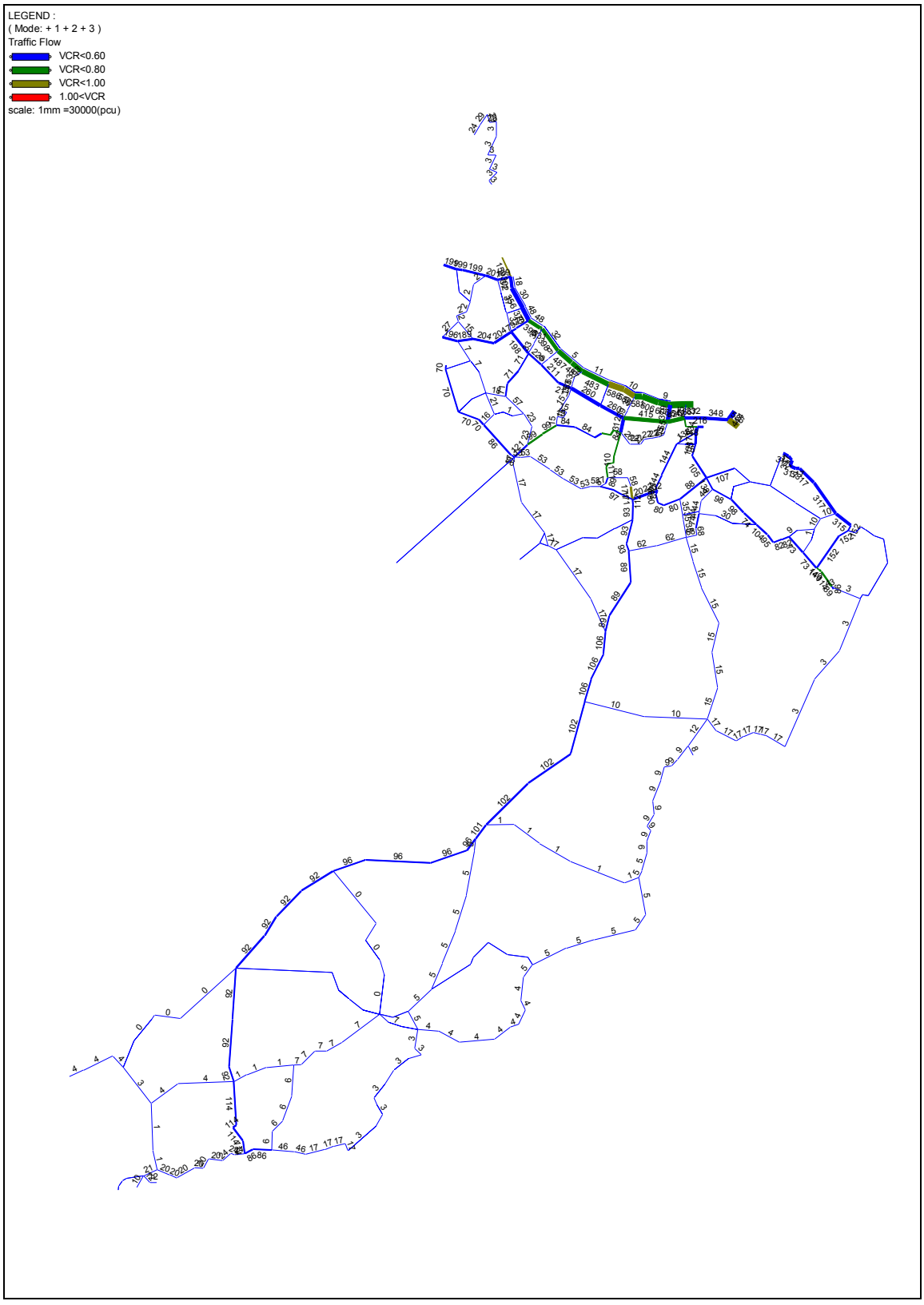


Figure 9.2-1 (3) Traffic Assignment to Alternative 2 Network - 2030

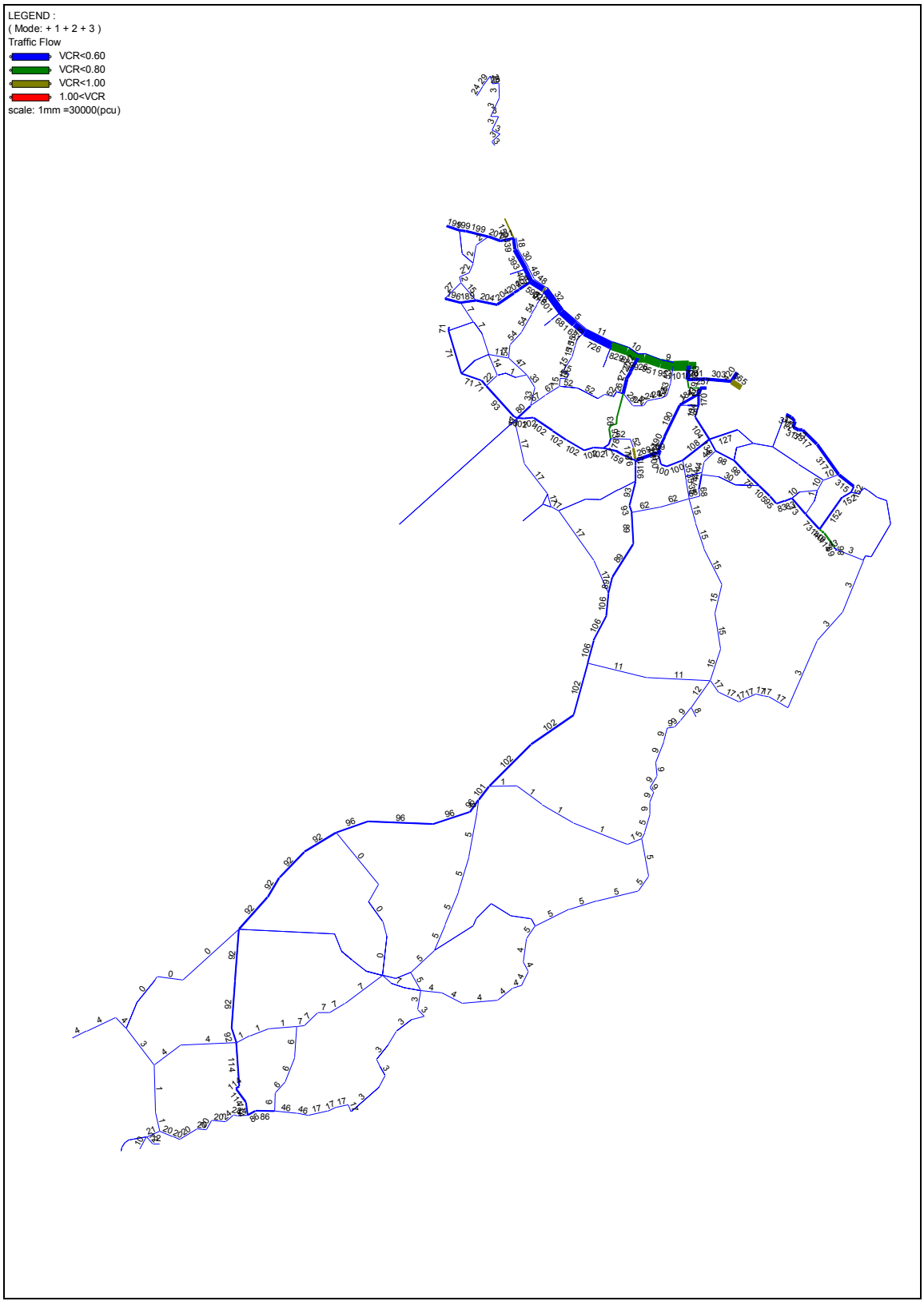


Figure 9.2-1 (4) Traffic Assignment to Alternative 3 Network - 2030

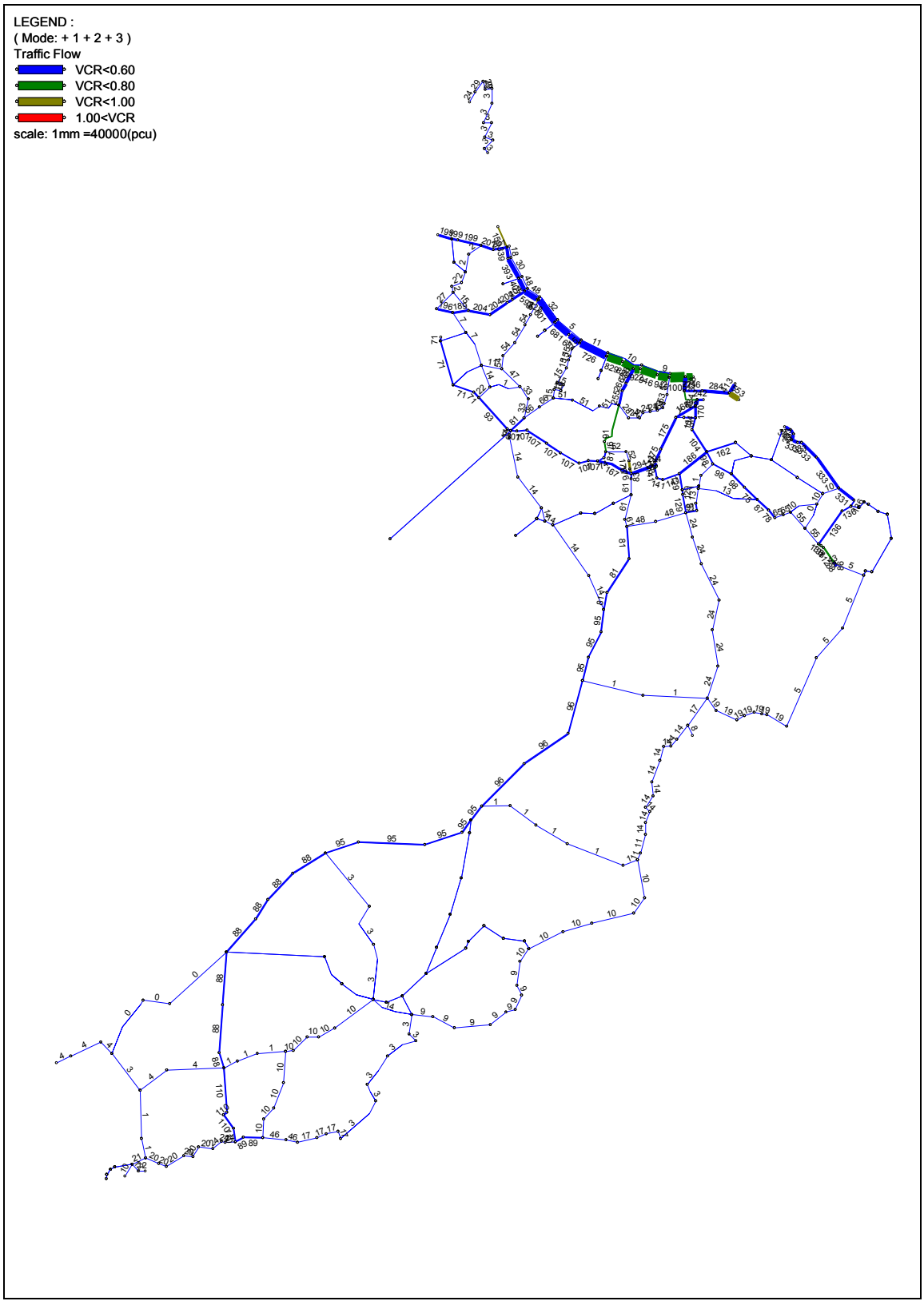


Figure 9.2-1 (5) Traffic Assignment to Alternative 4 Network - 2030

Table 9.2-2 Traffic Indicators by Alternative Plans in 2030

Indicator	Do Nothing Case	Alt-1	Alt-2	Alt-3	Alt-4
PCU -Kilometer ('000)	60,975	51,332	51,343	51,830	51,648
PCU –Hour	1,009,779	611,844	618,388	622,776	628,872
Capacity-Kilometer ('000)	131,637	303,077	257,592	297,658	253,102
Average Congestion Degree	0.463	0.169	0.199	0.174	0.204
Average Travel Speed (km/hour)	60.4	83.9	83.0	83.2	82.1

Table 9.2-3 presents road length by level of service (LOS). In this study, it is assumed that cases with traffic congestion rate, or traffic volume/capacity ratio (v/c), less than 0.6 is defined as LOS A-C and that v/c between 0.6 and 0.8 as LOS D, that v/c between 0.8 and 1.0 as LOS E and that v/c over 1.0 as LOS F. This table indicates that all roads under each plan are within LOS D. (In road planning, LOS C or better is used as the criteria for desirable traffic conditions while LOS D is considered as the criteria for lowest acceptable level. Further, LOS E and LOS F represent traffic conditions close to traffic jam and condition of traffic jam, respectively.)

Table 9.2-3 Road Length by Level of Service - 2030

LOS (V/C)	Road Length by LOS									
	Do Nothing Case		Alt-1		Alt-2		Alt-3		Alt-4	
	km	%	km	%	km	%	km	%	km	%
A-C (<0.6)	4,516	76	7,581	95	7,599	95	7,497	97	7,427	97
D (0.6-0.8)	351	6	413	5	380	5	224	3	268	3
E (0.8-1.0)	338	6	0	0	0	0	0	0	0	0
F (1.0 <)	720	12	0	0	0	0	0	0	0	0
Total	5,924	100	7,995	100	7,979	100	7,721	100	7,695	100

2) Traffic Demand and Corridor Capacity

Traffic capacity and traffic volume for main traffic corridors are compared in Table 9.2-4. Where the ratio of capacity against forecasted traffic volume is large, capacity is in excess or the investment is not efficient.

As shown in Table 9.2-4 (a), There are no substantial differences among the four alternatives as for Northern Part. On the other hand, as for Central and Southern Part, the capacities of Alternative 2 and 4 are substantially in excess of the demand (traffic volume) and those of Alternative 1 and 3 are further in excess of the demand.

It should be noted that as for Central and Southern Part, forecasted traffic volume in year 2030 is below the capacity of the Coastal Route (NR 33, 32, 41, 39) and traffic can be accommodated by the Coastal Route if the Central Route (NR 31) is closed for some reason.

9.2.3 Economic Cost

The construction and maintenance costs of the road projects presented as financial cost and described in Chapter 10 are converted into economic costs by excluding tax and import duty. Table 9.2-5 presents the estimated economic costs.

9.2.4 Economic Benefit

Benefit is calculated as difference of total travel costs over the entire network between 'Do Nothing' case and alternative case. Travel cost consists of Vehicle Operating Cost (VOC) and Travel Time Cost (TTC). VOC can be divided into:

- VOC with regard to travel distance (Running Cost), and
- VOC with regard to travel time (Fixed Cost).

(1) Unit Vehicle Operating Cost (VOC)

The unit VOC is principally used by updating of 'Highway User Cost 1998 (HUC 98) of Oman. Details of description of the unit VOC estimation are presented in Appendix 9.1. Tables 9.2-6 (1) to (3) are summary of VOC on paved and unpaved surface.

Table 9.2-4 (a) Comparison of Capacity and Traffic Volume on Main Corridors (Northern Part: Year 2030)

Corridor	Alternative	Route	No of Lane	Capacity (veh/day) (C)	Traffic Volume (veh/day) (V)	C/V	Remarks
Muscat - Sohar	Alt-1, Alt-2	Exist. Batinah Highway	4	60,000	40,000	1.50	
		New Batinah Expressway	4	60,000	52,500	1.14	
		Batinah Coastal Road	2	20,000	(1,000)	(20.0)	Traffic volume is estimated arbitrary
		Total	10	140,000	93,500	1.28	
	Alt-3, Alt-4	Exist. Batinah Highway	8	120,000	92,500	1.30	
		Batinah Coastal Road	2	20,000	(1,000)	(20.0)	Traffic volume is estimated arbitrary
		Total	10	140,000	93,500	1.28	

Table 9.2-4 (b) Comparison of Capacity and Traffic Volume on Main Corridor (Central and Southern Part: Year 2030)

Corridor	Alternative	Route	No of Lane	Capacity (veh/day) (C)	Traffic Volume (veh/day) (V)	C/V	Remarks
Muscat – Salalah	Alt-1, Alt-3	NR 31	4	60,000	9,600	6.3	
		NR 33, 32, 41,39	4	60,000	1,700	35.3	
		Total	8	120,000	11,000	10.9	
	Alt-2, Alt-4	NR 31	4	60,000	10,000	6.0	
		NR 33, 32, 41,39	2	25,000	1,000	25.0	
		Total	6	85,000	11,000	7.7	

Table 9.2-5 Financial and Economic Costs of Alternative Plans (RO million)

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Financial Cost				
Construction Cost	1,006.47	959.33	954.66	907.52
Maintenance Cost	36.02	34.26	35.47	30.44
Economic Cost				
Construction Cost	956.15	911.36	906.93	862.14
Maintenance Cost	34.22	33.42	33.72	28.92

Table 9.2-6 (1) Unit Running Cost by Vehicle Speed and Surface Type (RO/1,000 km)

Travel Speed (km/h)	Paved Surface			Unpaved Surface		
	Passenger Car	Bus	Truck	Passenger Car	Bus	Truck
5	66	109	116	104	177	143
30	34	43	49	53	69	61
50	33	41	47	53	66	58
70	36	44	50	57	70	62
90	41	49	55	64	79	69
110	47	57	63	73	92	78
130	54	67	73	85	108	91
150	63	79	85	99	127	105

Note: All unit costs are presented in 2004 prices

Table 9.2-6 (2) Unit Fixed Cost by Vehicle Type (RO/Hr)

	Fixed Cost
Passenger Car	1.088
Bus	1.835
Truck	2.661

Note: All unit costs are presented in 2004 prices

Table 9.2-6 (3) Unit Travel Time Cost by Vehicle Types (RO/Hr)

	TTC (Person Base)	TTC (Vehicle Base)
Passenger Car	0.58	1.27
Bus	0.47	5.75
Truck	0	0

Note: All unit costs are presented in 2004 prices

(2) Economic Benefit

Table 9.2-7 shows the vehicle operating costs and benefits by alternative plans.

Table 9.2-7 Economic Benefit by Alternatives (RO million / Year)

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Saving in Running Cost	25.44	29.10	24.72	25.44
Saving in Fixed Cost	69.82	75.54	67.91	66.62
Saving in Travel Time Cost	23.60	25.22	22.54	22.48
Total Benefit	118.85	129.86	115.17	114.53

9.2.5 Economic Parameters

The economic parameters of benefit/cost ratio (B/C) and net present value (NPV) are estimated by applying the estimated unit costs and the traffic parameters of the four (4) alternative plans. Table 9.2-8 presents the economic parameters of the four (4) alternative plans.

Table 9.2-8 Economic Parameters of Alternative Plans

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Net Present Value (RO Million)	294	368	293	310
B/C Ratio	1.66	1.87	1.70	1.78

9.2.6 Reliability and Flexibility of Road Network

One of the important major objectives of this road network planning is to provide alternate or detour routes to establish reliable and flexible road network. To examine the availability of alternate or detour routes for main corridors, traffic volume and capacity for each main corridor was compared considering closure of a main route as presented in Appendix 9-1. Table 9.2-9 summarizes the result of this examination. As described in Table 9.2-9, serious traffic confusion is anticipated to occur when the Existing Batinaha Highway is closed, in cases of Alternative 3 and 4, since only Batinah Coastal Road (2 lane urban road) will be available as the detour route. (There is a possiblity that both Existing Batinah Highway and Batinah Coastal Road are closed in case of strong flash floods since these roads are located close to with each other, and Batinah Coastal Road cannot function as the detour route for Existing Batinah Highway.)

Table 9.2-9 Summary of Availability of Alternate Routes

Corridor	Alternative	Description of Emergent Case	Problem
Muscat - Sohar	Alt-1, Alt-2	Closure of Exist. Batinah Highway or New Batinah Expressway	Traffic can be accommodated by the remaining roads: No serious problem anticipated
	Alt-3, Alt-4	**Closure of Exist. Batinah Highway**	**Only Batinah Coastal Road is available and serious traffic jam anticipated.**
Muscat - Ibri	Alt-1, 2, 3, 4	Closure of NR 15 (Rusayl-Nizwa Rd)	Traffic will divert 2 to 3 alternative routes: No serious problem anticipated
Muscat - Sur	Alt-1, 2, 3, 4	Closure of either NR 17 (Muscat- Quryyat-Sur Rd) or NR 23 (Bidbid-Sur Rd)	Traffic can be accommodated by the remaining road: No serious problem anticipated
Muscat - Salalah	Alt-1, 2, 3, 4	Closure of NR 31 (Central Route)	Traffic can be accommodated by the remaining road (Coastal Route: NR 33, 32, 41, 39): No serious problem anticipated

9.2.7 Development Effect (Achievement of Targets)

One of the important quantitative targets of the Master Plan is to connect the major cities with Muscat within 12-hour travel time. Table 9.2-10 shows the travel time between Muscat and major cities as estimated by JICA STRADA program.

Table 9.2-10 Travel Time between Major Cities (Unit: hour)

Section	2005	2030				
		Do Nothing	Alt-1	Alt-2	Alt-3	Alt-4
Muscat-Salalah	16.6	23.5	12.3	12.3	12.3	12.3
Muscat-Sur	5.3	26.2	2.5	2.5	2.9	2.9

All the alternatives can satisfy the target of connecting major cities with Muscat within 12 hours.

Other targets such as (a) connecting major cities with dualized primary roads, (b) connect Wilayat centers with secondary roads, and (c) improve pavement ratio to 80 %, are achieved in all the alternatives.

9.2.8 Environmental Aspects

1) Impact on Natural Environment

In all of the four alternatives, it is assumed that appropriate mitigation measures for negative impacts on natural environment, if any, are taken. These measures include alteration of alignment or even abandoning of a project in case where serious negative impact is anticipated and no measures to mitigate the impact to the acceptable degree can be taken. Therefore, it can be conclude that all the alternatives are not anticipated to create any serious negative impact.

2) Impact on Living Environment

Due to the increase in traffic volumes in the future, negative impacts such as increase in traffic accidents, noise, vibration and air pollution are normally anticipated. Traffic accidents can be reduced by implementing appropriate safety measures such as enforcement, traffic regulation, provision of facilities such as pedestrian bridges and education of drivers and pedestrians. No substantial differences among the alternatives on these impacts are anticipated.

As for air pollution, decrease of pollutants, compared with Do-Nothing Case is expected as presented in Table 9.2-11. The decrease of pollutant is attributed to the decrease or savings in Gross Vehicle Kilometer (pcu-km) as presented in Table 9.2-2. Differences in the magnitude of decrease in emission of pollutants among the alternatives are small and all the alternatives are evaluated to be equal in this aspect.

Table 9.2-11 Quantity of Air Pollutants - 2030 (ton/day)

Pollutants		Do-Nothing	Alt. 1	Alt. 2	Alt. 3	Alt. 4
NOx	Total	10.81	9.16	9.16	9.26	9.21
	Reduction from Do-Nothing Case	-	1.65	1.65	1.55	1.60
HC	Total	11.07	9.38	9.38	9.48	9.44
	Reduction from Do-Nothing Case	-	1.69	1.69	1.59	1.63
CO	Total	91.51	77.54	77.53	78.38	78.01
	Reduction from Do-Nothing Case	-	13.97	13.98	13.13	13.50

3) Social Impact

In all the alternatives, it is assumed that appropriate relocation plan be prepared and implemented, if any relocation becomes necessary. As for separation/splitting of communities, it is assumed that bypasses be constructed where planned dualized roads passes through cities. Therefore, there are no substantial differences among the alternatives on this aspect.

9.2.9 Selection of Optimum Plan

Table 9.2-12 shows the results of evaluations described in the previous subsections in a comprehensive manner. Alternative 2 and 4 get largest number (4) of "Very Good" rating (expressed by ◎ mark). However, Alternative 4 has serious (unacceptable) problem (X mark). Therefore, Alternative 4 is not recommended. Similarly, Alternative 3 also has serious problem and not recommended.

By comparing Alternative 1 and Alternative 2, it is evident that Alternative 2 gets better score. Accordingly, **Alternative 2 is selected as the Optimum Road Plan.** It is judged to fulfill the requirements for the future road network to the target year 2030.

However, the difference of score between Alternative 1 and 2 is not large to the extent to completely deny Alternative 1. Therefore, **Alternative 1 should be maintained as the "Substitute Plan"** to be considered for later years in the future depending on the future development of Central and Southern Part, especially that of coastal area, as well as the availability of fund. If the Government will decide investment in the coastal area more than that estimated in this Study dualization of coastal route will become necessary. Also, if the current high price level of oil and gas will continue in the future, the Government will have sufficient fund for road development.

Table 9.2-12 Comparative Evaluation of Alternatives

Evaluation Items			Do Nothing Case	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
Cost*	(RO Million)		-	1,271.9	△	1,141.8	○	1,180.4	○	1,070.4	◎
Traffic Efficiency (2030)	Congestion (V/C)		0.463	0.169	◎	0.199	◎	0.174	◎	0.204	◎
	Ave. Travel Speed (km/hr)		60.4	83.9		83.0		83.2		82.1	
	LOS in Northern Part	A-C	4,516 (76%)	7,581(95%)		7,599 (95%)		7,497 (97%)		7,427 (97%)	
		D	351 (6%)	413 (5%)		380 (5%)		224 (3%)		268 (3%)	
		E	338 (6%)	0 (0%)		0 (0%)		0 (0%)		0 (0%)	
		F	720 (12%)	0 (0%)		0 (0%)		0 (0%)		0 (0%)	
Economic Efficiency	VOC Saving (RO 1,000)		-	271.129	○	269,315	◎	262,741	◎	256,529	◎
	Single Year B/C		-	1.96		2.04		2.03		2.08	
	Single Year NPV (1,000)		-	133.160		137,330		133,500		133,410	
Reliability / Flexibility of Network				Requirements satisfied	◎	Requirements satisfied	◎	Severe confusion of traffic is anticipated if Batinah Highway is closed	X	Severe confusion of traffic is anticipated if Batinah Highway is closed	X
Development Effects				Requirements satisfied	◎	Requirements satisfied	◎	Requirements satisfied	◎	Requirements satisfied	◎
Environmental Impact	Natural Environment		-	Satisfactory	○	Satisfactory	○	Satisfactory	○	Satisfactory	○
	Living Environment & Social Impact		-	Pollutant decreased		Pollutant decreased		Pollutant decreased		Pollutant decreased	
Score	Very Good ◎			3		4		3		5	
	Good ○			2		2		2		1	
	Acceptable △			1		0		0		0	
	Unacceptable X			0		0		1		1	
Evaluation				Future Substitute		**Optimum Plan**		Not Recom-mended		Not Recom-mended	

* Costs for Alternatives for entire Sultanate include cost of Improvement and Maintenance as explained in Section 11.1, and do not agree with the total costs for Alternatives N-1, N-2, S-1 and S-3.

CHAPTER 10

OPTIMUM ROAD NETWORK

CHAPTER 10

OPTIMUM ROAD NETWORK

10.1 OPTIMUM ROAD NETWORK

10.1.1 Basic Measures

Various types of basic measures are proposed in Chapter 8 to alleviate the existing and future problems as well as to strengthen the function of road network to support future socioeconomic development of the Sultanate, as listed in Table 10.1-1. These measures need to be incorporated in the future road network.

Table10.1-1 Countermeasures for Identified Problems

No.	Problem	Countermeasure
Network Problem		
1	Weak connection across the mountain ranges	- Construction of roads across mountain ranges
I2	Primary road network not suitable for high-speed, long-distance trip	- Dualization - Grade separation of major intersections - Construction of bypasses - Providing facilities for drivers
3	Vulnerability to flash floods	- Construction of detour routes - Convert Irish crossing into culverts (Batinah Highway)
4	Lack of alternate route to Batinah Highway	- Construct New Batinah Expressway
5	Coastal missing links	- Construction of missing link roads
6	Insufficient capacity at some sections	- Widening of congested section - Provision of alternate route for congested section
7	Low pavement ratio of lower-class roads	- Paving local and access roads
Road Link Problem		
8	Poor pavement conditions on some sections	- Paving unpaved roads - Rehabilitation of deteriorated pavement
9	Insufficient shoulder width along some sections	- Widening of shoulders
10	Substandard alignment on some sections	- Improvement works for the sections with substandard alignment
11	Defective bridges and culverts	- Repair defects
12	Traffic accident black spots	- Physical improvement - Enforcement - Driver and pedestrian education

While the countermeasures for road-link problems (8) to (12) are rather straightforward, those for network problems (1) to (7) need some explanation, as follows:

1) Construction of Roads Across The Mountain Ranges

a. Al Hajar Al Gharbi Mountain Range

As described in Section 4.5, four roads are being constructed (track roads are being improved to paved roads) across Al Hajar Al Gharbi; (a) NR No. 08 (Wadi Haybi Road), (b) NR No. 09 (Al Khaburah-Ibri Road), (c) NR No. 10 (Rustaq-Miskin Road), and (d) Al Hamra-Wadi Hatt Road (construction of a new road), as shown in Figure 10.1-1. These projects should be continued and completed in accordance with the schedule. Among these roads, the alignment of the last section of Al Hamra-Wadi Hatt Roads has not been finally decided. Therefore, the alignment of this section needs to be determined and road should be completed. Upon completion of these roads, sufficient connection across Al Hajar Al Gharbi will be established.

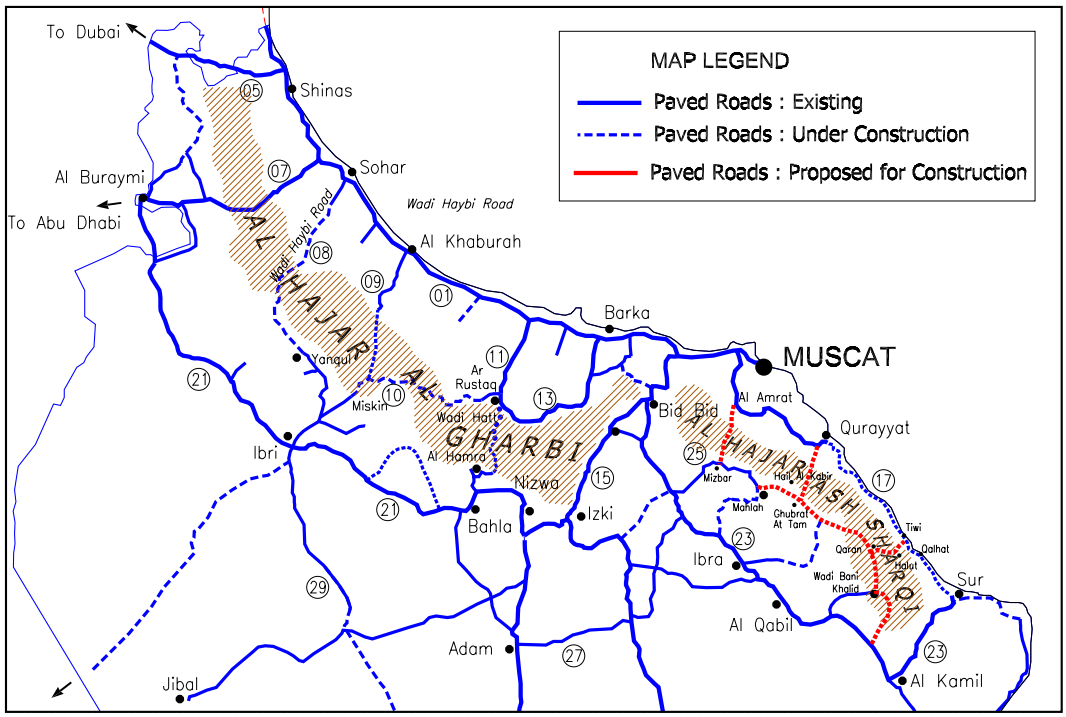


Figure 10.1-1 New Roads at Al Hajar Al Gharbi and Ash Sharqi Mountain Ranges

b. Al Hajar Ash Sharqi Mountai Range

In contrast to the situation of Al Hajar Al Gahbri where four roads are being constructed, practically there is no road passable for motorized vehicles across Al Hajar Ash Shariqi Mountain Ranges. Currently track roads are being constructed

between (a) Al Amrat and Mizbar, (b) Ghubbrat At Tam and Hail Al Kabir (towards Quryyat), (c) Tiwi and Qaran, and (d) Qalhat and Halut. Upon completion of these roads, (a), (b) and (c) (or (d)) should be improved to paved roads.

c. Dhofar Mountains Chain

Currently there are two roads across this mountain range; NR No. 31 (Thumrayt-Salalah Road) and NR No. 45 (Rakhyut-Mudayy-Thumrayt Road). Rakhyut- Aydam Section of NR No. 45 has been paved and Thumrayt-Mudayy Section is currently being paved. Therefore, the remaining section (Mudayy-Aydam Section) should be paved.

In addition, it is desirable to construct another paved road to connect Taqah or Mirbat (in the east of Salalah) to NR No. 39. Figure 10.1-2 shows road across Dhofar Mountains Chain sections proposed for construction or paving.

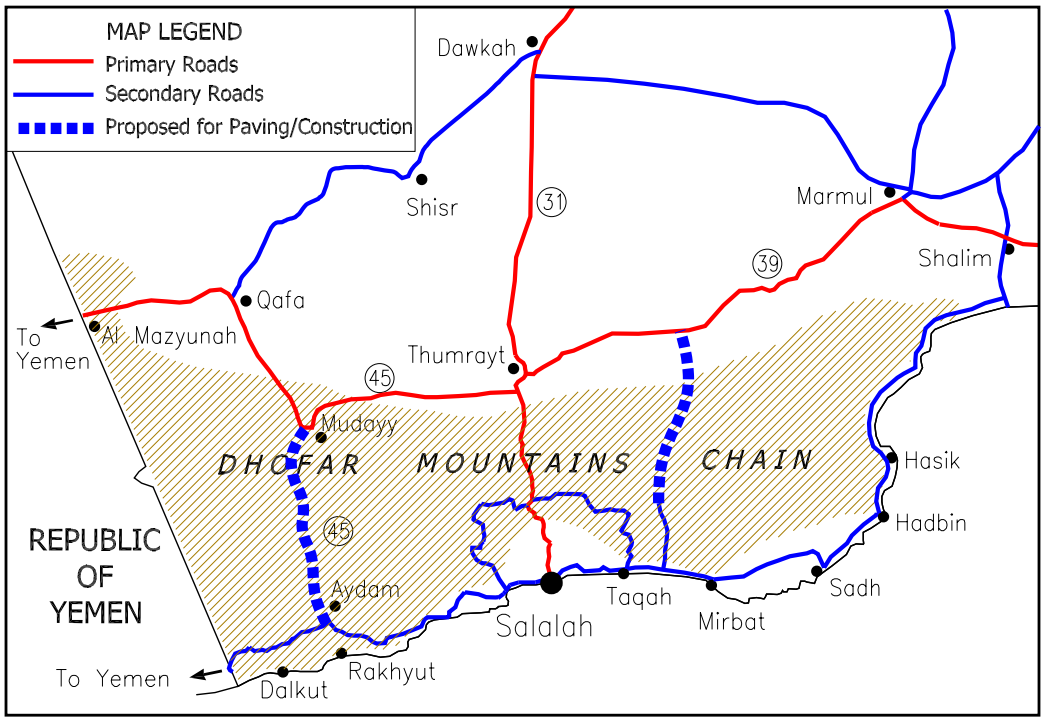


Figure 10.1-2 Sections across Dhofar Mountains Chain

2) Establishing Network of Main Primary Roads Suitable For High-Speed, Long-Distance Trips

For this purpose, two measures are considered; (a) dualization of existing single carriageway roads, and (b) construction of bypasses.

a. Dualization

Dualization is desirable for securing safe high-speed travel for the following main reasons:

- Traffic in opposite directions is separated by the median division (island) and chances of head-in collision are greatly reduced compared with single- carriageway highway, resulting in much better traffic safety. (Head-in collision is one the causes of severe damage such as fatalities.)
- Two lanes are provided for one direction, allowing fast-traveling vehicles to take overtake slow-traveling vehicles, such as loaded trucks, safely (without using the opposite lane as in the case of single-carriageway highway).

ESCWA Road Network

Some of the primary roads are designated as the routes of the international road network (ESCWA[1] Road Network). These roads should be dualized to cater for long-distance international traffic. Figure 10.1-3 shows the ESCWA Road Network. In this international road network, the following roads are designated:

ESCWA Road No.	Omani Road No.	
	Road No.	Section
M05	NR 01 NR15 NR 31	Sohar-Muscat Rusayl-Nizwa Nizwa-Salalah
M07	NR 07	Buraymi-Sohar
M09	NR21	Buraymi-Nizwa
M100	NR 45 (Part)	Thumrayt-Al Mazyunah

Existing dualized roads and currently being dualized roads

Currently, the following primary roads have been dualized:

- NR No. 01
- NR No. 05
- NR No. 15

[1] Economic and Social Committee for Western Asia

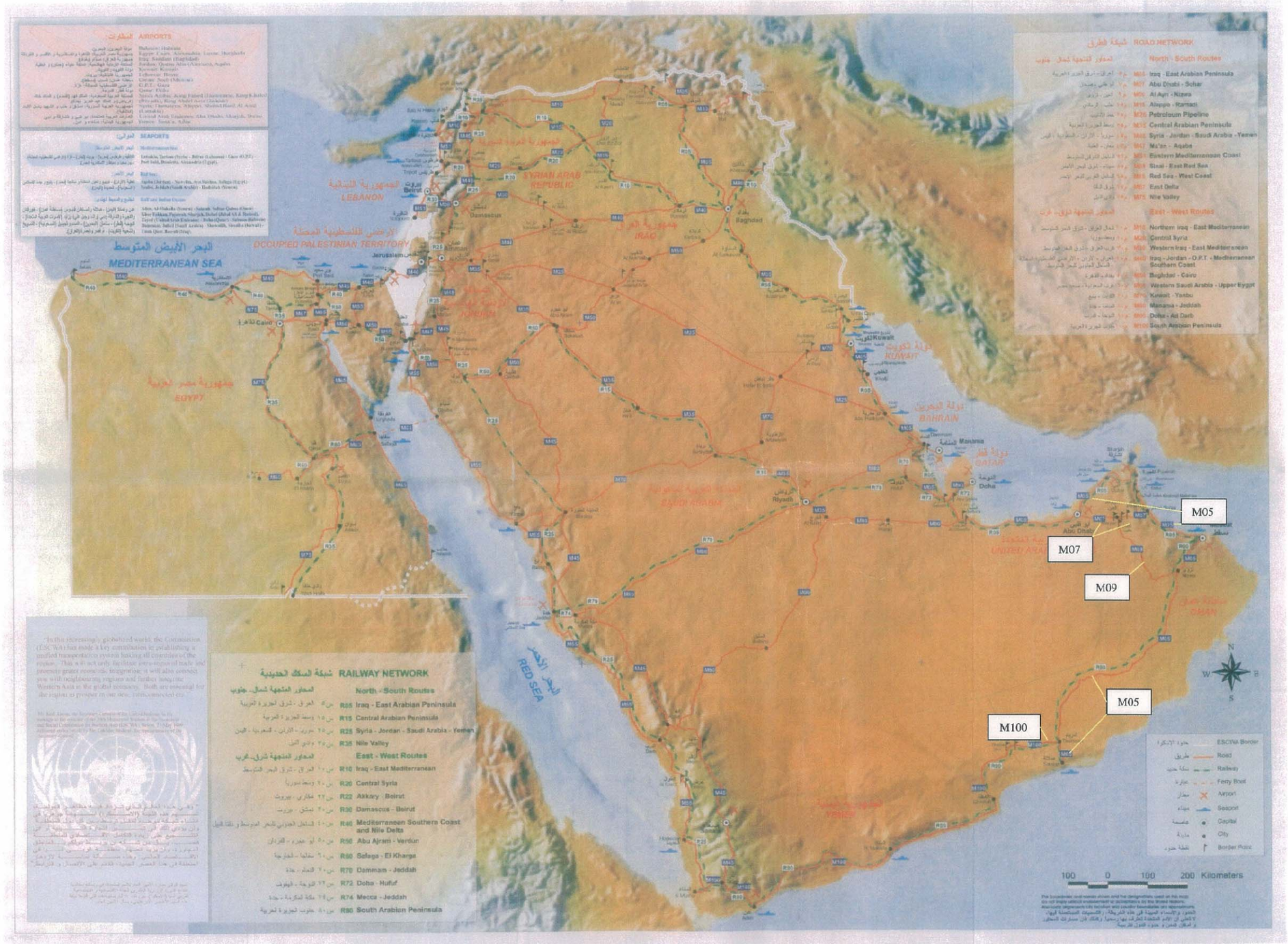


Figure 10.1-3 ESCWA Road Network

In addition to the above, the dualization of the following primary roads is on-going:

- NR No. 23, Hafit-Ibri Section
- NR No. 17 Qurayyat-Sur Section

Dualization of the remaining sections of other main primary roads, namely, NR No. 31 (Nizwa-Salalah), Nizwa-Ibri Section of NR No.21, NR No. 23 and NRs Nos. 33, 32, 41 and 39 (Izki-Sinaw-Mahawt-Ad Duqm-Sawqrah-Marmul- Thumrayt), are desirable. However, dualization requires relatively high cost and, therefore, it needs diligent consideration as to which road should be dualized.

To increase the efficiency of dualization, grade-separation works at major intersections along the dualized road should be implemented together with dualization works.

b. Construction of Bypasses

Even if a road is dualized, travel speed is reduced when the road passes through urbanized area. Bypassing urbanized area is desirable to maintain high travel speed for traffic and to decrease traffic volumes in built-up areas. Construction of bypasses along major cities/towns on the route is desirable also for the following reasons.

- Bypassing urbanized area can reduce the merging and diverging of vehicles resulting in reduction in chance of accidents.
- When a road passing through or nearby a town/city is improved, the town/city starts to grow along the road and urbanized section that the road has to traverse becomes longer. The solution to this problem is usually the construction of bypass.
- Even if a road is not passing through a town/city but passes nearby it, growth (expansion) of the town/city is very possible and the present suburbs of the town/city where the road is passing may be urbanized in the near future.
- Well-planned bypass can promote desirable form of urban development.

The Highway Design Manual (HDM) of the Sultanate recommends that primary roads be constructed to avoid cities/towns to minimize adverse impact of road to the living environment of the town/city.

3) Reinforcement of Road Network Against Flash Floods

a. Securing Detour Routes

Three areas have been identified as the locations where road sections are prone to damage by flash floods, as discussed in Section 11.1.7. They are (a) Ibri-Diriz Section

of NR No. 9 and its vicinity, (b) Bid Bid-Izki Section of NR No. 15 and its vicinity, and the section of NR No. 17 near Qurayyat. Among these locations, Qurayyat belongs to the Governorate of Muscat which is out of scope of this Study, and, thus, is excluded from the main discussion.

Since it is difficult to forecast magnitude, exact location and exact time of flash floods, one of the most practical countermeasures for securing reliable road network against flash floods is to secure detour routes for the road sections prone to flood damage.

As for Bid Bid-Izki Section of NR No. 15, minimum necessary detour route is being constructed as Al Hamra-Wadi Hatt Road. In addition, when Amrat-Mizbar Road, which is being constructed as a track road at present, will be improved to a paved road, it will serve as a part of another detour route between Muscat and Izki, together with existing NR No. 25, Sabikah-Al Kharma Road which is being constructed, and existing NR No. 33. Also the existing paved roads in the area near Izki and surrounded by NR No. 15, NR No. 33 and NR No. 23 are expected to function as detour routes to NR No. 15. Figure 10.1-4 shows the detour routes of NR No. 15.

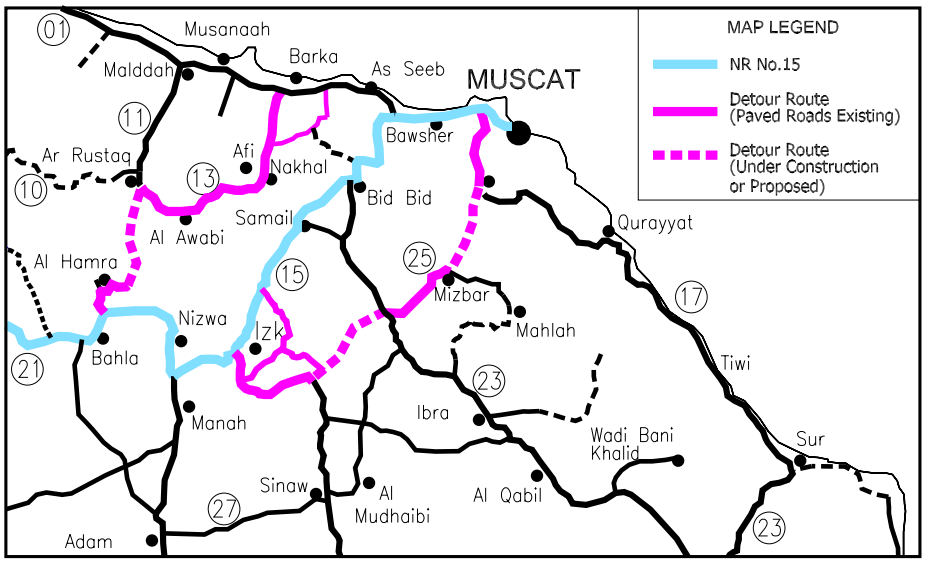


Figure 10.1-4 Detour Routes for Bid Bid - Izki Section of NR No. 15

On the other hand, currently, there is no detour route for Ibri-Diriz Section of NR No. 09. This section is very important in the network because two primary roads (NR No. 08: Sohar-Dariz Road and NR No. 10: Rustaq-Miskin Road) and one important secondary road (NR No. 09: Al Khaburah-Ibri Road) merge into one road and connect Ibri, one of the most important cities in this region to important cities along the coast in Batinah Region. Further this Ibri-Diriz Section is connected to the international road reaching the border with Saudi Arabia which is presently under-construction. Accordingly, detour route needs to be constructed as schematically shown in Figure 10.1-5.

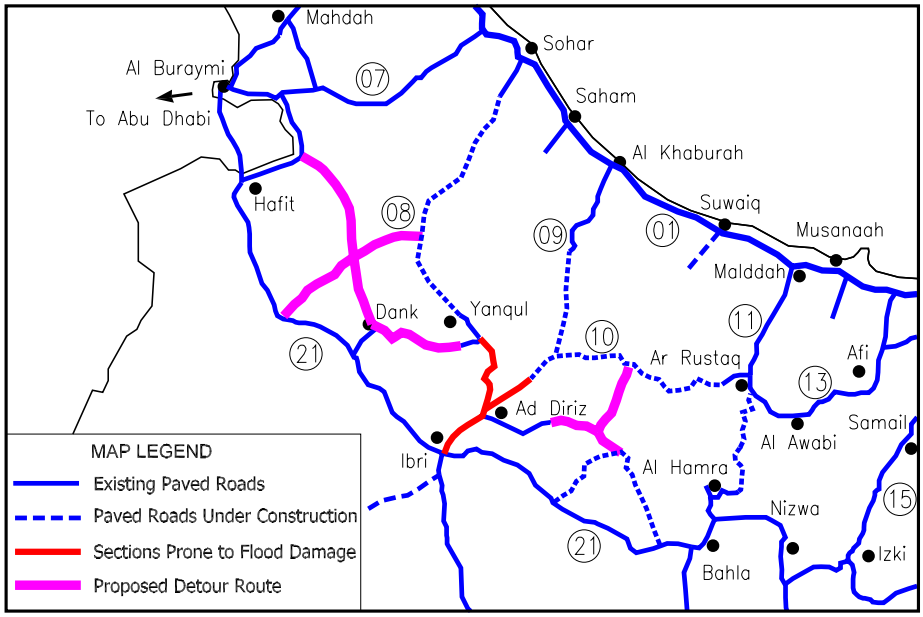


Figure 10.1-5 Proposed Detour Routes for Ibri-Ad Diriz Road Section

b. Converting Irish Crossing on Batinah Highway to Box Culverts (Irish Bridges)

NR No. 01 (Batinah Highway) is the most important road in the Sultanate in many senses. Its importance cannot be compared with other roads. At present there are 31 locations of Irish Crossing with a total length of about 13.7 kms (including slopes on both sides; not including Irish crossings on the section within Muscat). Although the probability of severe flash flood occurring at these Irish crossings is regarded lower than those sections discussed above, the influences of closure of NR No. 01 on many aspects are very large. Therefore, it is recommended that major Irish crossings on NR No. 01 be converted to box culverts (Irish Bridges).

Furthermore, these culverts can be used as underpasses for pedestrian and vehicle crossing as flash floods occur seldom. The height of such culverts should be a minimum of 2.5 m to allow passage of pedestrians thereby reducing the chance of traffic accidents. Where possible, the height of culverts is recommended to be 3.5 m to allow the passage of small vehicles (passenger car and small trucks) and contribute to reduce at-grade crossing of these vehicles on NR No. 01. Figure 10.1-6 shows a cross section of the proposed multi-function culverts.

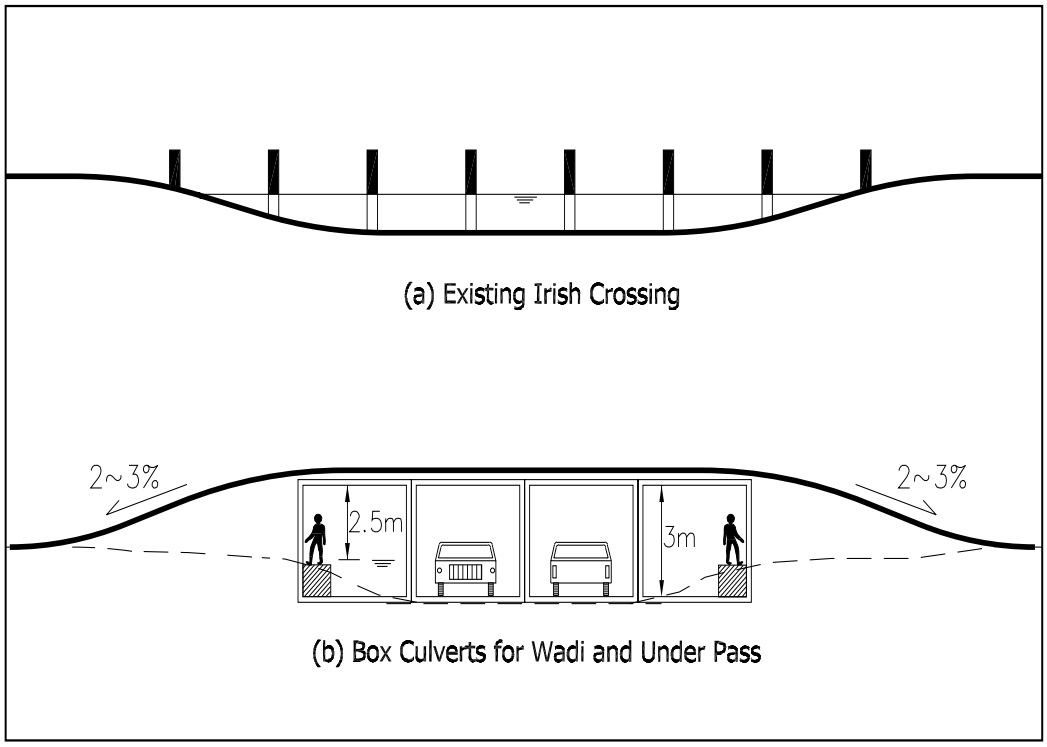


Figure 10.1-6 Concept of Multi-Function Box Culvert for Wadi Crossing

4) Construction of New Batinah Expressway as the alternate route for the existing Batinah Highway.

As discussed in Subsection 4.5.2 (iv), there is no alternate route for the existing Batinah Highway (NR No. 01). The New Batinah Expressway is planned to be 20 to 30 km to the south of and parallel to, the existing Batinah Highway (NR No. 1). The New Batinah Expressway and NR No. 01 are connected by several roads at strategic and important locations. Therefore, in case of emergency, the New Batinah Expressway will function as the detour route for NR No. 01.

5) Construction of Missing Link Road Sections

Countermeasure to the problem of missing link is the construction of roads at these sections. Therefore, Khwayma-Shanna Section and Hasik-Shuwaymiyah Section are proposed to be constructed. There are difficulties to construct roads at these severe topographical locations, either in sand dune or cliff areas that will require high costs and advanced civil-engineering techniques to overcome such difficulties.

6) Widening of, And Provision Of Detour Route For, Congested Section

Widening of some sections of existing roads and the construction of some new roads are proposed in Sections 10.2 and 10.3. A typical example of provision of detour route

for congested section is construction of New Batinah Expressway which is to relieve the congestion on the existing Batinah Highway (NR 01).

7) Paving Local and Access Roads

Although this problem is out of the scope of this study, it is an important problem because good condition of local roads and access roads is essential to strengthen the function of primary and secondary road networks to play their expected role to the full capacity.

In the past five years, the total length of paved national roads increased at the average rate of approximately 500 km per year. Of course, this increase of paved roads includes paving of primary and secondary roads. As explained later, the increase in the total length of paved road proposed in the Master Plan is about 4,900 km for 25-year period of 2006 – 2030, meaning an average annual increase about 200 km. Accordingly, if the current rate of paving (200 km/year) is maintained, the rest (500 – 200 = 300 km) can be directed toward paving of existing track roads. Thus, if about 200 km of existing track roads are paved every year (as conservative estimation), approximately 5,000 km of track roads can be paved by the year 2030. When this target will be attained, the total length of paved roads will be approximately reach 16,100 km which accounts for about 70 % of the total length of the future road network (and about 80 % of the present road network).

8) Consideration on Environmental Aspects

The Optimum Road Network, incorporating the measures as described above, is required not to give negative impact on either social or natural environment.

The HDM clearly recommends that primary national roads should be constructed to avoid cities and towns in order to minimize adverse impacts of roads on the living environment of the town/city. In the existing road network, some of the primary roads are passing cities or towns. In the Optimum Road Network, therefore, construction of bypasses is proposed. In addition, it is also assumed that alignments of project roads in the Optimum Road Network will be adjusted wherever necessary to avoid any negative impacts on living environment. Further, paving of unpaved road usually results in less vibration and dust (suspended particles). In view of these, it is expected that the implementation of these project under the plan will generally reduce the negative impact of road traffic on living environment.

Improvement of structures and facilities achieved through implementation of the projects is expected to contribute to enhance the traffic safety for the increased traffic

volume. However, there may be some cases that increased speed of vehicles and traffic volume may cause increase of traffic accidents. It is assumed that sufficient attention and measures are given to traffic safety in the deign stage of the projects.

Some projects may require relocation of houses. In the planning/designing stage, however, alignment can be adjusted to minimize any possible relocation. Further it is assumed that appropriate relocation plan is prepared and implemented during the project's implementation stage.

As for natural environment, the majority of the projects is improvement of existing roads and generally gives small impacts on natural environment. There are some projects, such as construction of missing link road between Hasik and Shuwaymiyah, which may possibly exert considerable negative impact on natural environment. These projects are proposed in order to improve living standard of the local people as well as to enhance the function of road network. It is assumed that sufficient consultation will be held between DGC and MRMEWR and appropriate mitigation measures are taken in the planning-designing stage of such projects. Where grave negative impacts on natural environment are anticipated and no effective mitigation measure can be established, discarding the project is considered.

10.1.2 Optimum Road Network

Figure 10.1-7 shows the proposed Optimum Road Network. All the measures described in the previous subsection are incorporated in this network. The main features of this road network is as follows:

- Main primary roads are dualized to cater for high-speed, long-distance vehicle travel.
- Connections across the mountain ranges are strengthened.
- Detour routes for strategically important sections are secured.
- All missing link sections are constructed.
- Sections where traffic volumes are forecasted to increase in the future are widened.
- Specifically, New Batinah Expressway is constructed and NR No. 31 (Nizwa-Thumrayt-Salalah Road) is dualized as discussed in Section 9.

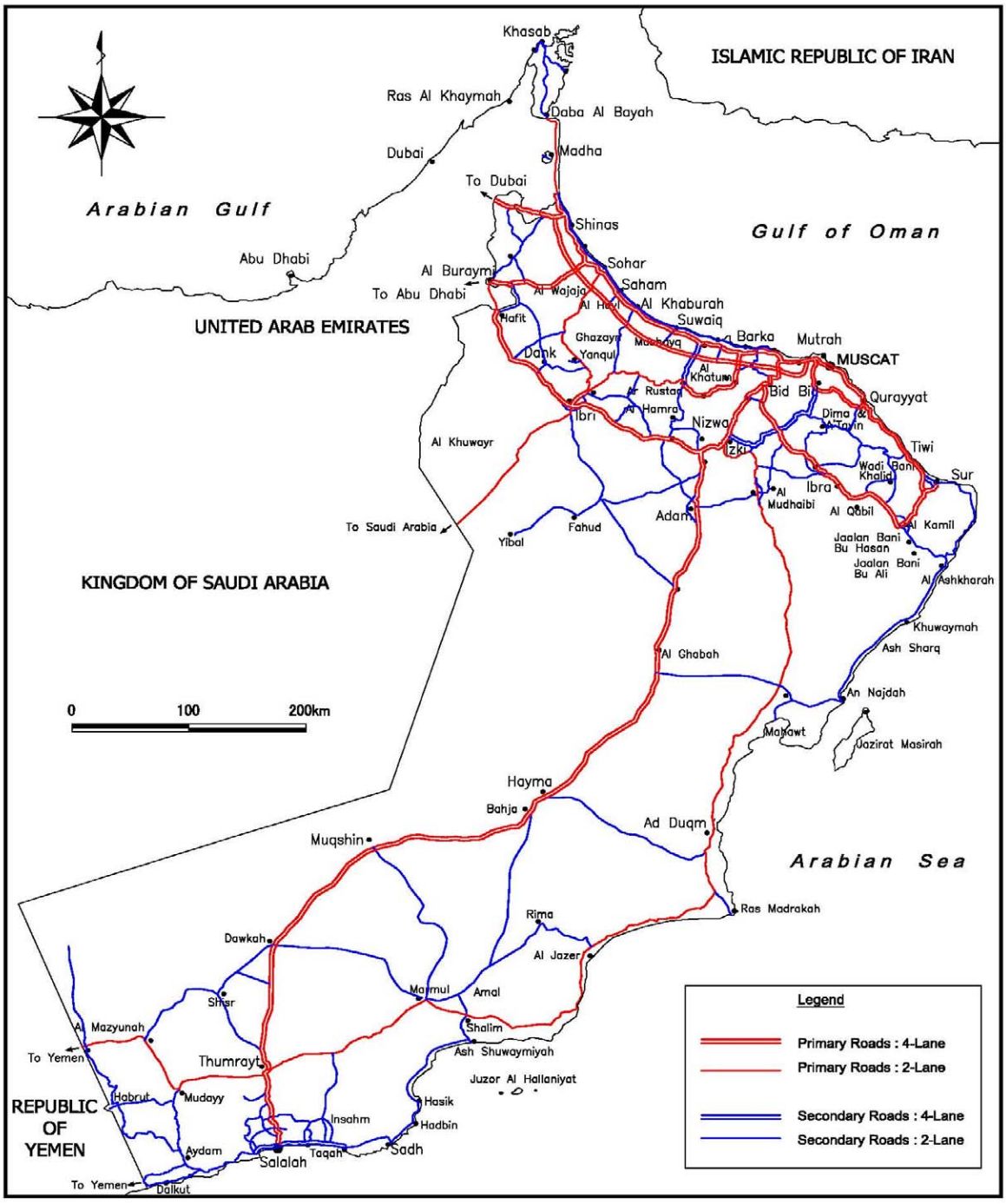


Figure 10.1-7 Optimum Road Network

10.2 ROAD NETWORK DEVELOPMENT PROJECTS

10.2.1 Types of Projects

Various projects are required, as the measures as described in the previous subsection, in order to realize the targeted function of the road network to attain the Optimum Road Network in the target year 2030. The projects needed to attain the Optimum Road Network are classified into the following types:

(i) Upgrading

This type of improvement is to replace Irish crossings to culverts (box or pipe), as appropriate. The road development plan includes the upgrading of the existing Batinah highway to a full-weather highway

(ii) Widening

This is the works to increase the number of lanes of the same carriageway from 2-lane to 3-lane. Widening from 2-lane (undivided) to 4-lane (divided) is classified as "Dualization" as described later. Therefore, "Widening" practically means addition of lanes to "divided, multiple-lane road (dual carriageway road)".

(iii) Dualization

This is to construct new carriageway parallel to an existing one. Here, the single carriageway 2-lane road will be converted into divided or diualized 4 or more-lane road. This includes the construction median (island) between the two carriageways

(iv) New Construction

This is conversion of an unpaved road to a paved road. It may or may not include improvement of alignment, cross section, drainage and other facilities. "New Construction" also includes construction of new paved roads where there is no existing road.

Bypass Construction

This is simply to construct a bypass at an urbanized road section of cities and towns.

(vi) Grade Separation

This is to provide grade-separated structures at congested roundabouts and intersections by constructing a viaduct (flyover) or underpass.

(vii) Other Improvements (Mainly Measures for "Road Link Problems)

Construction of pedestrian crossing, rehabilitation of defective bridges, improvement (widening) of shoulder and physical improvement of black spots are the major

improvements included under this type.

In addition to the above proposed projects, due consideration should be given to the maintenance and rehabilitation of existing road facilities. (Please refer Chapter 13 for discussion of Maintenance Plan.) Required maintenance works are classified into the following two types:

(viii) Routine Maintenance

Existing road facilities and those which are proposed to be constructed need proper maintenance. The cost for maintenance, thus, is included in the cost of the Road Development Plan.

(ix) Periodic Maintenance (Rehabilitation of Pavement)

Pavement deteriorates after certain life period, and rehabilitation is required. In this Study, the average life period of pavement is assumed to be 25 years, based on the observation of existing pavements and the discussion between the GGR officials in charge of maintenance, the expatriate expert attached to the Maintenance Department of DGR and the Study Team.

10.2.2 Road Network Development Projects

Table 10.2-1 lists the projects proposed for the period from year 2006 to year 2030. These projects are designed to attain the Optimum Road Network. Figure 10.2-1 shows the locations of the projects listed in Table 10.2-1. The objectives of each these projects are described in the next section of this chapter.

The table includes some projects that are located in Muscat Governorate, i.e. outside of the Study Area. These project, however are required to be connected to proposed road network plan in order to increase its efficiency.

Table 10.2-1 List of Road Development Plan Projects (1/3)

Project No.	Project	Improvement Type	Region	Length (km)
1. Roads				
	On-going Major Projects			
	Rustaq - Miskin (to 2006)	2-L		[76]
	Quriyat - Sur II-1 (to 2007)	4-L		[60]
	Quriyat - Sur II-2 (to 2006)	4-L		[30]
N6	Al Ashkharah - Shanna	2-L		[164]
N9	Marmul - Shelim - Sharbithat - Sawqrah	2-L		[140]
N10	Shelim - Shuwaymiyah	2-L		[48]
N26	Thumrait - Marmul	2-L		[86]
N34	Tawi Attair-Jibjat	2-L		[41]
U	**Upgrading**			
U1	Batinah Highway	Culverts	Batinah	270
W	**Widening**			
W1	Bait Al Barakah - Al Muladdah	4-L to 6-L	Batinah	54
D	**Dualization**			
DM1	Al Amrat - Qurayyat	2-L to 4-L	Muscat*	[63]
D2	Bidbid - Sur		A'Sharqiya	277
D3	Nizwa - Bahla - Ibri		A'Dakhliyah	125
D4	Karsha - Al Ghaba - Thumrayt - Salalah		A'Dakhliyah/Wusta/Dhofar	841
D5	Majis (Sohar) - Az Zarub - Buraymi		Batina/A'Dhahira	97
D6	Mizbar - Qaryatan - Izki		A'Sharqiya	85
D7	Ma'mura - Taqah		Dhofar	20
D8	Muladdah - Hazm		Batinah	24
D9	Quriyat - Sur, Phase III		A'Shraqiya	18
D10	Barka - Rustaq		Batinah	84
D11	Ibri - Ad Dariz		A'Dhahira	19
D12	Taqah - Mirbat		Dhofar	37
D13	Raysut - Rakhyut		Dhofar	80
D14	Rakhyut - Yemen Border		Dhofar	45
D15	Dawkah - Al Mazyunah		Dhofar	226
D16	Izki - Thumrayt, Coastal		A'Sharqiya/Wusta/Dhofar	1007
D17	Ibri - Saudi Arabia		A'Dhahirah	143
D18	Sohar - Ibri		Batinah/A'Dhahirah	162
D19	Barka - Ibri		Batinah/A'Dhahirah	220
N	**New Construction**			
NM1	Southern Expressway		Muscat*	[54]
NM2	Mutrah - Quriyyat Coastal		Muscat*	[70]
NM3	Sultan Qaboos Port Highway		Muscat*	[8]
NM4	Amrat - Mizbar (Tunnel)		Muscat*	[26]
N1	New Batianh Expressway	4-L	Batinah	247
N3	Bait Al Barakah - Khatmet Malahah, Coastal	2-L	Batinah	255
N4	Diba - Khasab		Musandam	95
N5	Lima Link - Khasab		Musandam	25
N7	Hasik - Shuwaymiyah		Dhofar	120
N11	Rakhyut - Dalkut Coastal Road		Dhofar	25
N12	Madinat AL Haq - Nashib		Dhofar	28

Table 10.2-1 List of Road Development Plan Projects (2/3)

Project No.	Project	Improvement Type	Region	Length (km)
N13	Hujaif - Jahnin - Asir		Dhofar	22
N14	Teetam - Qaftut		Dhofar	12
N15	Haluf - Masahilah		Dhofar	12
N16	Dawkah - Shisur - Qafaa		Dhofar	165
N17	Wadi Haruf - Shisur		Dhofar	83
N18	Mudayy - Aybut - Aydam		Dhofar	74
N19	Al Mazyunah - Tawsinat - Habrut - Aydam		Dhofar	120
N20	Shahb Asayb - Rakhyut		Dhofar	16
N21	Dalkut - Khadrafi - Sarfait		Dhofar	14
N22	Al Mazyunah - Mitan		Dhofar	96
N23	Hajaif - Masahilah		Dhofar	14
N24	Jibjat - Barbazum		Dhofar	65
N25	Haylat - Ar Rakah		Dhofar	25
N27	Hatt - Rustaq Road Stage (4)		Bat/Dhakh	28
N28	Yanqul - Fida - Dank		A'Dhahira	41
N29	Yanqul - Murry		A'Dhahira	26
N30	Madha - Dafta		Musandam	15
N31	Amal - Muqshin		Dhofar	180
N32	Marmul - Dawkah		Dhofar	140
N33	Tiwi - Ismaiyah		A'Sharqiyah	60
N36	Mahlah - Ghubrat at Tam - Ismaiyah		A'Sharqiya	38
N37	Qaran - Maqal - Sabt - NR 23		A'Sharqiya	55
N38	Al Mazari - Ghubrat at Tam		Muscat*/Shar	80
N40	Wadi Saa - Al Feth - Dank		A'Dhahira	80
N41	As Sunaynah - Al Feth - Al Wqba		A'Dhahira	45
N43	Al Wajajah - Ash Shwayhah		A'Dhahira	80
N44	Murri - Ar Rumaylah - Al Ayn		A'Dhahirah	30
N45	Al Ayn - Sint - Al Wadi Al Ala		A'Dhahirah	30
N46	Bahja - Amal		Al Wusta	170
N47	Al Hij - Flim		Al-Wusta	19
N50	Flim - Mahowt (Box Culvert based on EIA)		Al-Wusta	6
N48	Qatbit - Al Mushash (Saudi Border)		Dhofar	152
N49	Al Ghaba - Ramlet Khaylah (Saudi Border)		A'Dakh/A'Dhah	298
N51	Aybut - Habrut		Dhofar	65
B	**Bypass**			
B1	Sinaw Bypass		A'Sharqiyah	6
B2	Ibri South Bypass	300m Tunnel	A'Dhakhliyah	13
B3	Ibra Bypass		A'Sharqiyah	11
B5	Ibri East Bypass		A'Dhakhliyah	10
B6	Salalah Outer Bypass		Dhofar	42
B7	Adam Bypass		A'Dhakhliyah	5
B8	Al Kamil North Bypass		A'Sharqiyah	9
B9	Al Wafi East Bypass		A'Sharqiyah	11
Total				**7,092**

Note: *Muscat Governorate is not included in the Study Area, however, presented projects are required to improve the overall road network.

[ ] Length between brackets is not included

Table 10.2-1 List of Road Development Plan Projects (3/3)

Project No.	Project	Improvement Type	Region	Location
2. Structures	(Grade Separation)			
G1	Naseem Garden		Batinah	1
G2	Baraka Roundabout		Batinah	1
G3	Al Muladdah Junction		Batinah	1
G4	Khaburah Roundabout		Batinah	1
G5	Saham Roundabout		Batinah	1
G6	Sohar Roundabout		Batinah	1
G7	Falaj Al Qabail		Batinah	1
G8	Aqr Roundabout		Batinah	1
P1/12	Pedestrian Crossing 1	12 Locations		
P13/22	Pedestrian Crossing 2	10 Locations		
Improvement	Bridge Repair			
	Shoulder Improvement - Primary			
	Shoulder Improvement - Secondary			
	Black-spot Improvement			
Maintenance	Routine Maintenance of Roads and Bridges			
	Periodical Maintenance and Rehabilitation			

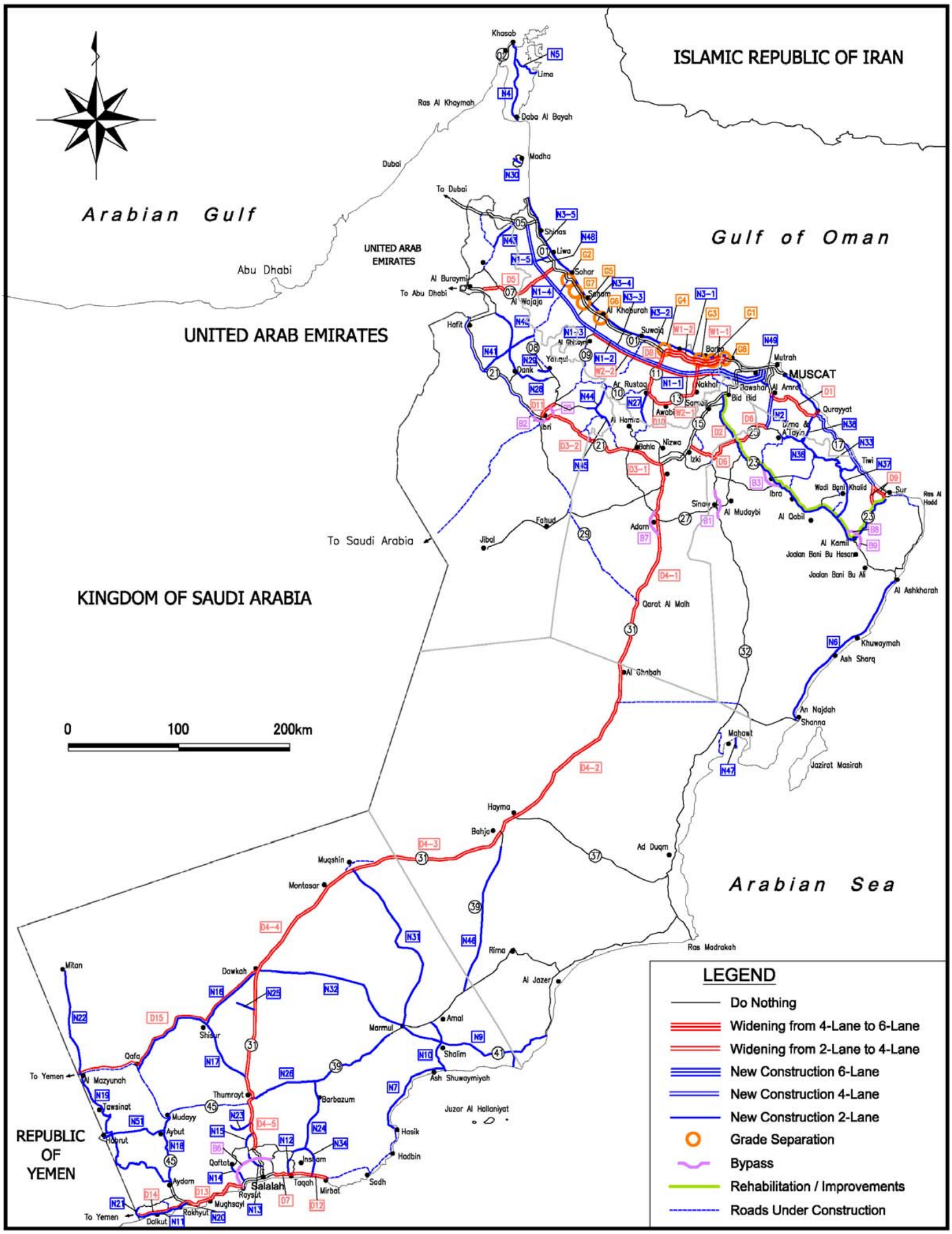


Figure 10.2-1 Location Map of Road Development Plan Projects

10.3 DESCRIPTION OF PROJECT

The proposed projects can be categorized into several groups based on their objectives. The projects are to meet the policies and targets of the development plan by implementing countermeasures that are required to solve the problems identified for both present and future networks. This section explains the objectives of projects by category. Comprehensive summary of each including location map, forecasted traffic volume, estimated project const and objectives is given in Appendix 14-2 "Project Profile Sheets".

10.3.1 Widening

Project No. W1: Bait Al Barka – Al Muladah Section of NR No. 01
Length = 54 km
Objective: Provide sufficient capacity for increased traffic volume

Widening is proposed for the sections where the ratio of traffic volume to capacity is anticipated to exceed 0.8, which is the Level of Service (LOS) D as defined in the Highway Capacity Manual (HCM) of Transportation Research Board (TRB), USA. Such widening will be necessary only on the section between Bait Al Barka and Al Muladdah) of NR No. 01 (Batinah Highway) to meet the future traffic demand.

The roadside is developed area but the space for widening is available between the existing carriageway and the service roads.

10.3.2 Dualization

In addition to accommodating the increased traffic demand expected in the future, dualization is planned for the following objectives:

(i) To make main primary roads suitable for high-speed long-distance vehicle trips.
(ii) To secure necessary capacity as the detour route for an important road with heavy traffic.
(iii) As continuation/extension purposes of the existing dualized sections to strengthen the function of local road network, mainly around large cities.

As stated before, the word "dualization" means, unless otherwise noted, that addition of two lanes to the exiting opposed 2-lane road and convert it into divided 4-lane road.

1) Dualization of Main Primary Roads

As discussed in Chapter 9, main primary roads are recommended to be dualized. Among those roads recommended for dualization, some are already dualized or currently being dualized. Therefore, the remaining roads or sections proposed to be dualized.

Project No. D2: NR No. 23 (Bid Bid-Sur Road)
Length = 277 km
Objective: To improve a main primary road and make suitable for high-speed long-distance travel

This road is to connect Sur, a city with an important port and an oil refinery facility to Muscat via NR No.15. This road is the eastern part of the East-West Corridor on the southern side of Al Hajar Ash Sharqi Mountain Range, and functions as the alternate route for NR 17 (Muscat-Quryyat-Sur Road) which runs along the coast.

Project No. D3: NR No. 21 (Nizwa-Bahla-Ibri Road)
Length = 125 km
Objective: To improve a main primary road and make suitable for high-speed long-distance travel

This road is the western part of the East-West Corridor on the southern side of Al Hajar Al Ghabri Mountain Range and connects Nizwa and Ibri, two major cities in the southern side of the mountain range. This road further extends to Buraymi, the major town at the border with UAE and further to Dubai and Abu Dhabi. The road from Buraymi to Nizwa is designated as ESCWA Road M 09. Therefore, this road is important both for domestic and international traffic.

Project No. D4: NR 31 (Karsha-Salalah)
Length = 764 km
Objective: To improve a main primary road and make suitable for high-speed long-distance travel

NR No. 31 (Nizwa-Hayma-Thumrayt-Salalah Road) is the main road connecting Dhofar Governorate and Al Wusta Region with the Capital Region. This road is the Central Route of the North-South Corridor and also designated as ESCWA Road M 05. Therefore this road is important for strengthening the connection between the Northern Part and Southern/Central Part of the Sultanate and also very important for from viewpoint of international traffic.

Since the length of entire section is long (841 km), it is divided into the following 5 sections.

D4-1: Karsha – Al Ghaba, 196 km
D4-2: Al Ghabe – Hayma, 174 km
D4-3: Hayma – Muntasar, 200 km
D4-4: Muntasar – Thumaryt, 200 km
D4-5: Thumrayt – Salalah, 71 km

Project No. D5: NR 07 Majis-Az Zarub-Buaymi
Length = 97 km
Objective: To improve a main primary road and make suitable for high-speed long-distance travel

NR 07 connects Sohar and Burayimi. The Project Road is connected to the road in UAE going to Dubai and Abu Dhabi. This road constitutes a part of ESCWA Road Network (ESCWA M 07). On the side of UAE, the roads connected to the Project Road are already dualized. Therefore, dualiztion of this road is very important to maintain consistency in road condition for international traffic.

The entire section is divide into the following 2 section, considering number of bridges to be included each section, or the amount of construction cost.

D5-1: Majis – Az Zarub, 81 km
D5-2: As Zarub – Buraymi, 16 km

Project No. D9: NR 17 (Qurayyat-Sur, Phase III)
Length = 18 km
Objective: To improve a main primary road and make suitable for high-speed long-distance travel

Dualiztion of NR 17 Qurayyat-Sur is on-going. The on-going project starts from Qurayyat and ends at a few kilometers east of Qalhat where a major oil refinery is being constructed. Project D2 is to dualize the remaining section of the same road. The Project consists of two lines; one between Qalhat and Sur and the other branch out from the Qalhat-Sur route and connects to NR 23 at about 10 km south of Sur to bypass the urbanized area of Sur.

2) Securing Necessary Capacity as Detour Route for Important Road

Dualization is proposed for some road links which are expected to function as detour

route(s) for important and heavily traffic road. If sufficient capacity is not secured on the detour route, the detour route will be congested by the diverted traffic. For this reason, the following project is included in the Master Plan.

Project No. D6: Mizbar-Qaryatan-Izki
Length = 85 km
Objective: Secure sufficient capacity as the detour route for NR 15 (Rusayl-Nizwa Road)

NR 15 (Rusayl-Nizwa Road) is the main road connecting Muscat with the southern side of the mountain range. The result of traffic forecast shows that the traffic volume on NR 15 will be about 15,000 pcu/day in 2030. NR 15 is located in the area where severe damages due to flash flood have been experienced in the past. The Project road is expected to function as the detour route in case of closure of NR 15. The traffic volume on the Project road is forecasted to be 8,000 to 10,000 pcu/day. Accordingly, if half of the traffic of NR 15 diverts to the Project Road, the traffic volume on the Project Road will exceed 17,000 pcu/day. Dualization of this road is proposed to secure smooth traffic even when NR 15 is closed.

3) Continuation/Extension of Existing Dualized Sections

Some road links around large cities have been already dulalized. Continuation/ extension of these already dualized sections are planned to enhance the effect of already dualized sections and promote sound development of the area. For this category, the following sections are proposed for dualization:

Project No. D8: NR 11 (Muladdah-Hazm)
(Length = 24 km), and
Project No. D10: NR 13 (Barka-Rustaq)
(Length = 84 km)
Objective: Extension of existing dualized section (Rustaq-Hazm Section of NR No. 11) and strengthening road network in Barka- Al Awabi area.

NR 11 and NR 13 together with Batinah Highway, form a circuit route connecting Barka-Nakhal-Awabi-Rustaq- Muladdah. Rustaq-Hazm Section of NR11 has been already dualized. This area is located adjacent to the governorate of Muscat and one of the most developed area in Batinah Region. The two projects of dualization are to complete dualized circuit route connecting these cities.

Project No. D7 NR 49 (Ma'mura-Taqah)
Length = 20 km, and

Project No. D12 NR 49 (Taqah-Mirbat)
Length = 16 km
Objective: Extension of existing dualized section in the east of Salalah

These projects are to extend the existing dualized road within and around Salalah, and planned to enhance the effect of already dualized sections and promote sound development of the area.

Project No. D11: NR 09 (Ibri-Ad Dariz)
Length = 19 km
Objective: Strengthening of section where 2 primary roads and one important secondary road merge

At the town of Ad Dariz, two primary roads (NR 08 and NR 09) merge. Before merging with NR 08, NR 09 merges with NR 10. NR 10 starts at Al Rustaq where NR 13 and NR 11 are connected. Therefore, all the traffic coming via these important roads join together at Ad Dariz and comes to Ibri and further goes to Saudi Arabia. The traffic volume on this section is estimated to exceed 10,000 cpu/day in year 2030. The Project is to strengthen the function of this important section.

10.3.3 New Construction

New Construction projects include paving of existing track roads and construction of completely new roads where there is no existing road. Paving of existing roads may or may not include improvement of alignment, slopes, curvatures, carriageway width, and any part of road facilities such as drainage. Unless specifically noted, the word "new construction" means construction of 2-lane road.

Objectives of New Construction Projects can be categorized into the following types:

(i) Provision of additional route to cope with increase in traffic volume,
(ii) Construction of missing link, including paving of unpaved section of primary road,
(iii) Provision of detour/alternate route for strengthening of reliability of road network, including detour routes for flood damage prone section,
(iv) Strengthening of network function by providing connection between primary roads, short-cut/detour route for primary road or international route,
(v) Strengthening connection between regions/areas, including connection across mountain ranges,
(vi) Strengthening of the function of local network for promotion of socioeconomic activities of the area., and

(vii) Others.

1) Provision of Additional Route to Cope with Increase in Traffic Volume

Project No. N1: New Batinah Expressway
Length = 247 km
Objective: To share the increased traffic on the existing Batinah Highway (NR No. 01) as well as to provide detour rout for the existing Batinah Highway.

This project is to construct a divided, 4-lane, full access-controlled expressway. The Project Road is to run parallel to the existing Batinah Highway. The location of the route is currently being studied by the Supreme Committee for Town Planning (SCTP). According to SCTP, the most probable location of the route is approximately 10 km from the existing Batinah Highway to south (to the mountain). At the Muscat-side end (near Filaiji R/A or Halban R/A), this expressway is to be connected to the Southern Expressway which traverses As Seeb and reach Al Qurm. Construction of the Southern Expressway is expected to be started in near future. (Tender documents have been prepared.)

The Government intends to introduce "private participation" for financing the cost of the New Batinah Expressway. This subject is discussed in detail in Chapter 24.

Since this road is planned to traverse the area relatively less developed, the project road is expected to promote the development of the area.

The entire section is divided into the following 5 sections:

N1-1: 58 km
N1-2: 60 km
N1-3: 53 km
N1-4: 26 km
N1-5: 49 km

Project No. N3: Batinah Coastal Road
Length = 255 km
Objective: (i) To share the increased traffic on the existing Batinah Highway (NR No. 01).
(ii) To provide detour rout for the existing Batinah Highway, especially for those vehicles which travel short distance between the cities along the coast.
(iv) Promotion of tourism along the coast.

At present, there are many short paved roads (internal roads) along the coast between

Muscat and Sohar (Liwa). These roads can be connected buy constructing new 2-lane roads between these roads. When a continuous road will be completed, it will shoulder some portion of Batinah Highway. The Project Road is also expected to support tourism along the coast.

The entire project is divided into the following 5 sections:

N3-1: Bait Al Barka-Barka, 17 km
N3-2: Barka-Suwayq, 53 km
N3-3: Suwayq-Saham, 71 km
N3-4: Saham-Sohar, 30 km
N3-5: Sohar-Khatmat Malahah, 84 km

2) Construction of Missing Link

Project No. N6: Al Ashkharah-Shannah
Length = 164 km
Objective: To connect the dead end of NR 35 to NR 32 and form a circuit route

Currently, there is a paved road (NR 35) which branches out from NR 23 (Bid Bid-Sur Road) near the city of Al Kmail and extends to the town of Al Ashkahrah. From Al Ashkharah to Khuwaimah, about 80 km south of Al Ashkharah, there is a track road maintained by DGR. This area is the eastern periphery of Wahaybah Desert. From Khuwaymah to Shanna (An Najidah), about 56 km east of Hij, there is no road passable for motor vehicles hampered by Wahaybah Desert.

The Project Road is to connect Al Ashkharah and Shanna by paved road (secondary road). Upon completion of the Project Road, a circuit route connecting NR 23 – NR 35 – Project Road – NR 32 – NR 28 (or NR 27) will be formed surrounding Wahaybah Desert, connecting such cities/towns as Al Kamil, Al Ashkharah, Hij, Sinaw and Al Mudaybi.

The Project Road is expected to improve the living environment of local residents along the coast between Al Ashkharah and Shanna, as well as promotion of tourism of Wahaybah Desert.

Project No. N7: Hasik-Shuwaymiyah
Length = 80 km
Objective: To connect Hasik and Shuwaymiyah and form a circuit route

There is a strong traditional tribal ties between Hasik and Shwaymiyah. The

communication of people between these villages mainly is depending on boat, which may be sometimes dangerous when Arabian Sea is rough. On the land, there is a paved road connecting Hasik to Salalah via Mirbat and Sadah. On the side of Shwaymiyah, there is a track road connecting Shwaymiyah with Shelim. (Paving of this road is included in the Master Plan as Project No. N10.) The Distance between Shelim and Thumrayt is approximately 220km and there are long unpaved sections. Therefore, the distance between Hasik and Shwaymiyah along the existing road exceeds 400 km while the distance along the coast is less than 100 km. Currently, there is no road along the coast connecting these two villages hampered by extremely ragged terrain along the coast.

Upon completion of the Project Road, the following main effects are expected:

- Provision of detour route and short-cut route for the Coastal Route of the North-South Corridor (NR 39 and NR 41) between Shelim and Salalah.
- Improvement of social activities of the area.
- Promotion of tourism of the coastal area, especially that of Wadi Sanaek.

Since the road between Shwaymiyah and Shelim is given the national road number of No. 42, it is proposed that the Project Road be given the same number upon completion.

On the other hand, this area is designated as a Natural Reserve Area. Therefore, diligent examination of influence on the environment is required.

Detailed examination of engineering aspects and environmental consideration are presented in Chapter 22.

Project No. N9: NR 41 (Marmul-Shelim- Sharbitat-Sawqrah)
Length = 140 km
Project No. N26: NR 39 (Marm-Thumrayt)
Length = 86 km
Objective: Completion of the Coastal Route of North-South Corridor

These are the unpaved sections of the Coastal Route of the North-South Corridor. The rest of the Coastal Route is already paved. By completion of pavement of these projects, there will be two paved primary roads connecting Salalah with the Capital Region.

3) Strengthening of Network Reliability

Project No. N28: Yanqul-Fida-Dank
Length = 41 km,
Project No. N29: YanqulMurry
Length = 26 km
Project No. N40: Wadi Saa-Ajran-Al Feth-Dank
Length = 80 km
Project No. N41: As Sunaynah-Al Feth-Al Wqba
Length = 45 km,
Project No. N44: Murry-Ar Rumaylah-Al Ayn
Length = 30 km, and
Project No. N45: Al Ayn-Sint-Al Wadi Al Ala
Length = 30 km

As explained in the description of D11 (dualization of Ibri-Ad Dariz Section), the section of NR 09 between Ibri and Ad Dariz – Miskin has very significant meaning in the proposed network because two primary roads and one important secondary road merge into one road in this section.

On the other hand, this section is prone to damage of flash flood in wadis and there is high possibility of closure (see Subsection 11.1.8).

Considering these conditions, provision of more than one detour route for this section is recommended. Projects N28, N41, N44 and N45 are to establish local network on the both sides of Ibri-Ad Dariz-Miskin Section of NR 09. DGR is now paving the unpaved road sections adjacent to these Project Rods. These Projects are basically continuation of these roads which are currently being paved.

These Project Roads are also expected to form local network on the northern side of NR 21 and support the development of the area, as well as function as the detour route for NR 23. N28 Project is to connect two wilayat centers, Ynaqul and Dank.

4) Strengthening of Network Function

Project No. N10: NR42 (Shelim-Shuaymiyah)
Length = 48 km
Objective: Connection between coast and primary road network

As explained in Project No. N7 (Hasik-Shuwaymiyah), project is to pave the existing unpaved road connecting the two towns. Upon completion, the Project Road will the

part of the circuit route connecting Shelim – Marmul – Thumrayt – Salalah – Mirbat. Although the length of this link is short, this road is numbered as NR No. 42, indicating the importance of this road.

Project No. N16: Dawkah-Shisur-Qafa-Al Mazyunah
Length = 156 km
Objective: Provision of short-cut/detour route between NR No. 31and Al Mazyunah

Currently, the roads connecting Thumrayt – Mudayy – Qafa Mazyunah is designated as ESCWA Road M100. However, the road connecting Dawkah, located about 100 km north of along NR 31, and Mazyunah is than the designated M100 route. Therefore, it is expected that majority of the traffic coming the northern part of the Sultanate or UAE and going to Yemen will divert to the Project Road when it will be paved.

Project No. N31: Amal-Muqshin
Length = 180 km
Project No. N32: Marmul-Dawkah
Length = 140 km
Project No. N46: NR 39 (Bahja-Amal)
Length = 170 km
Objective: Connection of the Central Route and Coastal Route of North-South Corridor

These projects are to provide connection (as secondary roads) between the Central Route and Coastal Route of North-South Corridor and enable diversion of traffic between these primary roads when necessary.

They are also expected to contribute to promotion of communication between the coastal area an inland area of the region and support socioeconomic development of the region.

Currently there are many paved and unpaved roads maintained by PDO and not designated as national roads. If possible, some of these PDO roads which are suitable for the objectives of these Project Roads should be transferred from PDO to DGC and designated as national roads. For example, there is a paved roads connecting Bahjah and Amal/Marmul. If these road can be designated as national road (DGC road), Project N46 (paving of NR 39) is not necessary. Actually, the Road Inventory Survey revealed that there is track road at the location of NR 39 as shown in the road map published by National Survey Authority (NSA) (1:1,300,000 Map, NSA, June 2003). But this track road is not continuous and is not passable for vehicles at many locations. Instead, there is a paved PDO road about 50 km in east of NR 39 which are used by general traffic.

Project No. N43: Al Wajajah-Ash Shwayhah
Length = 80 km
Objective: Provision of detour route for NR No. 05 (Al Aqr-Ar Rawdah Road)

NR 05 is an international road connecting Al Aqr and Dubai and is already dualized. This road, however, passes UAE territory before reaching the town of Rawdah before coming to the UAE border. If the section passing this UAE territory becomes impassable, there is no detour route between Aqr and Ar Rawdah/Dubai. Although the possibility of occurrence of such situation is rather low, minimum alternate route should be secured.

Currently, a track road between Mahdah, a town located about 30 km northeast of Al Buraymi, and Ar Rawdah is being paved by DGR. Therefore, if a new road is constructed between Al Wajajah, a town on NR 05 before first coming to UAE territory, and Ash Shwayhah, a town on Mahdah-Rawdah Road, it will function as the necessary detour route for NR 05.

5) Strengthening Connection between Regions/Areas (Strengthening Connection across Mountain Range)

Project No. N18: NR 45 (Mudayy-Aybut-Aydam)
Length = 71 km
Project No. N24: Jibjat-Barbazum
Length = 65 km
Objective: Strengthening of connection across Dhofar Mountains Chain

Project No. N27: Hatt–Rustaq Road Phase (4)
Length = 28 km
Objective: Strengthening of connection across Al Hajar Al Ghabri

A 2-lane paved road connecting Ar Rustaq in Batinah Region and Al Hamra in Ad Dakhliyah Region is currently being constructed across Al Hajar Al Ghabri Mountain Range. This road project is divided into 4 phases. Phase 1 (L = 15.0 km) is already completed. Phase 2 (L = 13.7 km) is under construction. Phase 3 (L = 9.5 km) is being designed. Phase 4 is the final section of this road and connects this road with NR No. 13.

Upon completion, Al Hamra-Rustaq Road is expected to contribute to strengthen the communication between Barka/Rustaq area and Al Hamra/Bahla/Nizwa area. It is also expected to function as a detour route for NR 15 (Rusayl-Nizwa Road).

More detailed explanation of this project is given in Chapter 18.

Project No. N33: Tiwi-Ismaiyah
Length = 60 km
Project No. N38: Al Mazari-Ghubrat At Tam
Length = 80 km
Objective: Strengthening communication across Al Hajar Ash Sharqi Mountain Range

N33 Project Road is to connect Tiwi, a town located along the coast between Qurayyat and Sur, to N36 Project Road which connects to NR 23 (Bid Bid - Sur Road). N38 Project Road is to connect Mazari (near Qurayyat) and Ghubrat At Tam, a town along N36 Road. These two roads are expected to strengthen the communication across the Al Hajar Ash Sharqi Mountain Range.

DGR is currently constructing track roads along routes of these Project Roads. Projects N33 and N38 are to improve these track roads after they are constructed.

6) Strengthening of the Function of Network for Local Traffic

Project No. N4: Diba-Khasab
Length = 95 km
Project No. N5: Lima Link - Khasab
Length = 25 km
Objective: Strengthening of the function of road network in the Governorate of Musandam

Governorate of Musandam is the isolated territories of Oman existing in the territory of UAE. There are three major cities/town in Musandam; Kahasab on the north coast facing Strait of Hormuz, Lima on the northeastern coast and Diba at the south border with UAE.

Kahasb and Diba are connected by a track road traversing very ragged terrain. This track road is passable only for 4DW vehicles. Town of Lima is located along the very ragged coast and can be accessed only by boat. Therefore, these two projects are indispensable for establishing the unity within the Governorate. They are also important for the unity of the nation from viewpoint of reducing regional disparities.

Further, improvement of road conditions in Musandam is expected to support development of tourism since there are several potential tourist spots.

Project No. 12: Madinat Al Haq-Nasib
Length = 28 km
Project No. N13: Hujaif-Jahnim-Asir
Length = 22 km
Project No. 14: Teetam-Qaftut
Length = 12 km
Project No. N15: Haluf-Masahilah
Length = 14 km
Project No. N17: Wadi Haruf-Shisur
Length = 83 km
Project No. N20: Shahb Asayb-Rakgyut
Length = 16 km
Project No. N23: Hajaif-Masahilah-Haruf
Length = 25 km
Project No. N25: Haylat-Ar Rakah
Length = 25 km
Project No. N34: Tawi Attair-Jibjat-Sibr
Length = 41 km
Project No. N51: Aybut-Habrut
Length = 65 km
Objective: Strengthening of network function in and around Salalah- Thumrayt area.

These projects are to connect the towns and villages around Salalah and nearest paved road, and strengthen the function of the local network in and around the Salalah-Thumrayt area.

Project No. N11: Rakhyut-Dalkut Coastal Road
Length = 25 km
Project No. N21: Dalkut-Khadrafi-Salfait
Length = 14 km
Objective: Strengthening of network function in and around Salalah-Yemen Border area

These projects are to strengthen the function of local network between Salalah and Yemen border.

Project No. N30: Madha-Dafta
Length = 15 km
Objective: Strengthening of the function of local road network.

Madha is the central town of Oman territory in UAE territory, isolated from the main

Oman territory of Musandam. (See Chapter 19) There is a road connecting Qidfa in UAE (in the east of Madha) and Dafta in UAE (in the west of Madha), traversing the territory of Oman in east-west direction. This road passes an isolated UAE territory existing in Oman territory around Madha. The local residents desire to go to Dafta without passing the isolated UAE territory in Madha area. Therefore, they requested DGR to alter the route of the existing road so that they can go to Dafta without passing the isolated UAE territory.

This Project has significant meaning from viewpoint of national unity. Detailed explanation of this project is given in Chapter 19.

Project No. N36: Mahlah-Ghubrat at Tam- Ismaiyah
Length = 45 km
Project No. N37: Qaran-Maqal-Sayq-Sabt- NR 23
Length = 55 km
Objective: Strengthening the function of road network in the central valley of Al Hajar Ash Sharqi Mountain Range

The central valley of Al Hajar Ash Sharqi Mountain Range has rich underground and surface water. Accordingly, this area has high potential of agriculture and tourism. Actually, Qaran, the starting point of N37 Project, is being developed as a tourist spot for its beautiful valley with a stream of rich clear water.

The Project Roads longitudinally traverse the central valley. The section of NR 25 from Sabikah on NR 23 to Mahlah is already paved. Therefore, Projects N36 and N37 are extension of this NR 25. Also, Project N33 (Tiwi-Ismaiyah) and N38 (Al Mazari-Ghubrat At Tam) are to be connected to Project N36 Road nad N37 Road. Accordingly, N36 Road and N37 Road are expected to function as the axis of the local network. They are also expected to function as the local detour route for NR 23(Bid Bid - Sur Road).

Detailed explanation of N36 is given in Chapter 21.

7) Others

Project No. N19: Al Mazyunah-Tusnat-Habrut-Aydam
Length = 71 km
Project No. N22: AL Mazyunah-Mitan
Length = 96 km
Objective: Request form the Ministry of Defense

These roads are requested by the Ministry of Defense.

Project No. N47: Hij-Flim

Length = 18 km

Objective: Promotion of tourism, as well as improvement of welfare of the local residents

Flim is small fishing village. There is a small island called Mahawt Island about 5 km offshore from Flim. This island is currently used as the base for fishing. The sea between Mahawt Island and Flim is very shallow and the bottom of the sea is visible during ebb tide. Substantial part of the island and shore is covered by mangrove. The sea water is clear. There is plan to develop this area as a tourist spot. The Project is to support the tourism development, as well as to improve the access of the local residents to the market (to sell fish).

There is an idea to construct a causeway connecting Mahawt Island and the mainland. This is technically feasible but not recommended in view of serious impact on marine environment.

There is an unpaved road between Hij and Flim. Hij is connected to NR 32 (the Coastal Route of North-South Corridor) via a paved road. The Project is to improve the existing unpaved road into paved road.

Detailed explanation on this project is given in Chapter 20.

8) Projects within Muscat Governorate

The roads in Muscat Governorate are out of the scope of the Master Plan. However, the following projects, locate in Muscat Governorate, are closely related to the Master Plan Projects and necessary to let the Master Plan function to its intended capacity. Therefore, DGR needs to coordinate with the Municipality of Muscat on the implementation of this project.

These projects are listed in the Master Plan but their costs are not included in the Master Plan.

Project No. NM1: Southern Expressway

Length = 54 km

Objective: Reduction of traffic congestion in Muscat

This project is to connect Filaiji R/A in the west of As Seeb and Al Qurm in the center of Muscat. Since this project is located in Muscat Governorate, it is out of the scope of Master Plan. However, it has significant influence on some of the Master Plan Projects

such as Project Number N1 (New Batinah Expressway).

Project No. NM2: Mutrah-Qurayyat Coastal
Length = 70 km
Objective: Provision of shortcut route between Muscat and Qurayyat, as well as promotion of tourism of the coastal area

The existing road between Muscat and Qurayyat traverses rolling to mountainous inland area. This project is to construct a new road along the coast. Upon completion of this road, the distance between Muscat and Qurayyat will be shortened by about 20 km. Also, the Project Road is planned along the coast where there are many potential tourist spots.

Project No. NM3: Sultan Qaboos Port Highway
Length = 8 km
Objective: Strengthening of the access to the Sultan Qaboos Port

The plan of expanding the capacity of the Sultan Qaboos Port is being studied. The existing access to the port has a problem of traffic congestion at Darsayt R/A. The Port Authority is considering to construct (or request to construction to the Municipality) a new access to the port.

Project No. NM4: Al Amrat-Mizbar (Al Amrat-Miss)
Length = 26 km
Objective: (i) Connect Muscat with NR 25/NR 23 with sorter distance (across Al Hajar Ash Sharqi Mountain Range)
(ii) Provision of detour route for NR 15 (Ruayl-Nizwa Road)

Currently, DGR is constructing a track road connecting Al Amrat on NR 17 (Muscat-Qurayyat-Sur Road) and Mizbar on NR 25. (The name of this project for construction of the track road is Al Amrat-Miss.) Construction of this track road is progressing slowly hampered by very ragged terrain. When completed, this track road will probably be passable only for 4WD vehicles. However, this road will greatly reduce the travel distance between Muscat and Ibra/Sinaw. Therefore, it is proposed to improve the unfavorable geometry and paving the surface of this road so that general vehicles can travel. Considering the severity of terrain, it is proposed to excavate tunnel to cross the mountain.

Upon completion, the Project road is expected to function as the detour route for NR 15 (Ruayl-Nizwa Road).

Project No. DM1: NR 17 (Al Amrat-Quryyat)
Length = 63 km
Objective: To improve a main primary road and make suitable for high-speed long-distance travel
This project is a part of NR 17 connecting Muscat with Sur. Therfore, there is a strong relation with on-going and planned dualization of NR 17, and, therefore, listed in the Master Plan.

Actually, the forecasted traffic volume of NR 17 increases towards Muscat. Therefore, dualiztion of Al Amrat-Qurayyat Section is more urgent than that of Qurayyat-Sur Section.

10.3.4 Construction of Bypass

Construction of bypass is proposed where primary road passes through, or nearby, large city. In case of Salalah, outer ring road is proposed to prevent the through traffic entering the congested urban area as well as to promote desirable form of urban development. The proposed bypass projects are listed in Table 10.3-1.

Table 10.3-1Bypass Construction

Project No.	Name of Bypass	Road No.
B1	Sinaw Bypass	32
B2	Ibri South Bypass	21
B3	Ibra Bypass	23
B5	Ibri East Bypass	09-23
B6	Salalah Outer Bypass	-
B7	Adam Bypass	31
B8	Al Kamil North Bypass	23
B9	Al Wafi East Bypass	23-35

10.3.5 Structures

JICA Study of 1995 on road development[2] proposed grade separation projects for 8 locations of roundabout intersections of NR No. 01 (Batinah Highway) and construction of 22 pedestrian underpasses along Batinah Highway. These projects are effective to reduce traffic congestion and/or traffic accidents, and, thus, proposed to be implemented after further study for implementation taking into consideration the implementation of New Batinah Expressway and coastal roads along Batinah Region.

[2] The Study on the Road Development Projects in the Sultanate of Oman, JICA, 1995

10.3.6 Future Projects

The Master Plan Projects are planned with the target year in 2030. These projects described above are planned based on the future traffic demand and future development plans. Socioeconomic development is expected to continue also after 2030. Even before 2030, new development projects may be planned and implemented. In addition, there may be further development of relations with neighboring countries. The followings describe the possible projects to cope with such future development beyond the target year of 2030 or unforeseen development. Some of these future projects may become feasible before 2030 due to some change in conditions which cannot be predicted at this moment.

1) Widening of the Coastal Route of North-South Corridor

In Chapter 9, it was proposed that dualization of the Coastal Route of North-South Corridor (NR 33 – NR 32 – NR 41 – NR 39; connecting Sinaw – Ad Duqm – Sawqrah – Shelim – Thumrayt) be maintained as "substitute" or "reserve" plan. In the future, this plan should be considered in such situation as;

(i) the Government decides extensive development of the coastal area, or
(ii) the Government has sufficient fund as presently occurring due to high international oil price.

2) Road Connecting Dhofar and Saudi Arabia

At present, only one road is being constructed to connect the Sultanate directly with the Kingdom of Saudi Arabia. This road is originated at Ibri in Adh Dharirah Region, in the north of the country, to the border point of Ramlat Khaylah. As for the southern areas of Oman (Dhofar Governorate), there is no direct link to Saudi Arabia, as desert with huge sand dune areas known as Al Rub Al Khali or "the Empty Quarter" (of the Arabian Peninsula) is hindering road traffic.

DGC in Salalah proposed to include a direct connection with Saudi Arabia that can be used as a short-cut for trade and tourism between the two countries. The road is proposed to connect Qatbit (Wilayat Muqshin in Dhofar) on NR No. 31 to the border point of Al Mushash. Another link is also proposed to connect NR No. 31 at Al Ghaba to the border at Ramlat Khaylah through the newly constructed road from Ibri. Figure 10.3-1 shows all the proposed links that connect the Sultanate with Saudi Arabia.

Implementation of links proposed at the south is based on contacts through political

channels with Saudi Arabia to provide required roads that will meet those of Oman. At this stage, such roads are listed in the road development plan for future consideration.

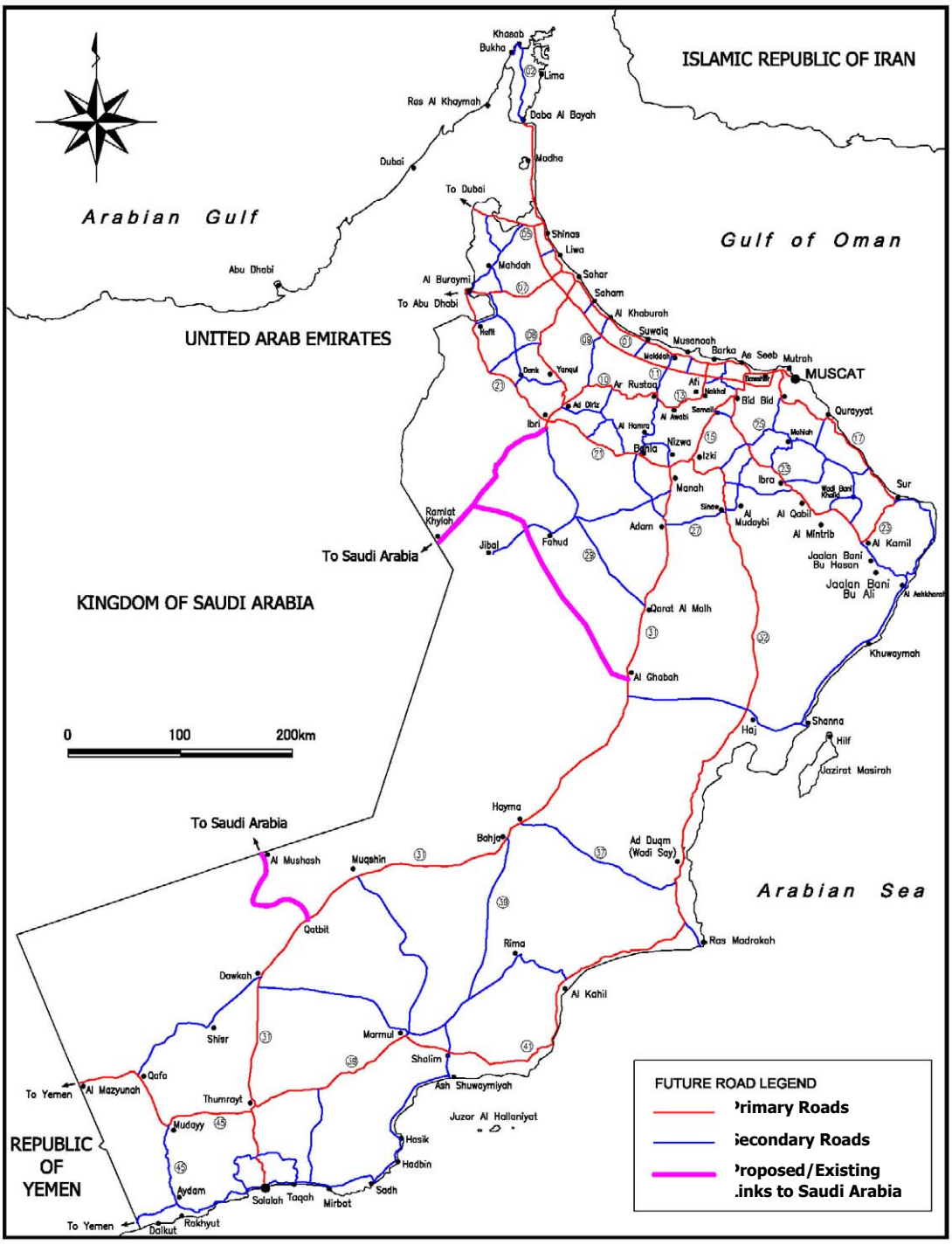


Figure 10.3-1 Oman - Saudi Roads

3) Widening of New Batinah Expressway

By the year 2030, V/C ratio on the planned New Batinah Expressway approaches 0.8. Therefore, widening of New Batinah Expressway may be required in the period of 12th 5-Year Plan (2031 – 2035). However, this is beyond the target year of this Study and should be considered in the future keeping enough right-of-way for future widening.

10.3.7 Improvement (Countermeasures for Road Link Problems)

As discussed in Chapter 4, there are some problems in the facilities of existing road network (Road Link Problems). These problems need to be rectified. The projects for these countermeasures are as follows:

(i) Bridge rehabilitation

JICA study, 95 pointed out the necessity of repair/rehabilitation of bridges. Total 12 bridges were proposed to be repaired / rehabilitated. These bridges are listed in Appendix 4-2..

(ii) Shoulder widening

The results of Road Inventory revealed that there are some sections where width of shoulder does not satisfy the stipulation of HDM. Widening of the shoulder of these sections should be implemented in the order of urgency. Appendix 4-2 shows the total length of such sections with classification of shoulder width. Widening of the sections of primary roads where shoulder width is less than 0.5 m is most urgent. Widening of the sections of primary roads with shoulder width more than 1.0 m and section of secondary roads are least urgent.

(iii) Black spot improvement

ROP has identified black spots as described in Subsection 4.8.2. Physical improvement of these black spots should be designed and implemented based on the analysis of causes of accidents.

10.3.8 Maintenance

Maintenance is indispensable for sustaining the function of constructed road network. Detailed explanation of maintenance plan and budget is given in Chapter 13.