CHAPTER 19

MADHA - DAFTA ROAD

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19.1 OBJECTIVE OF THE PROJECT

The existing Madha - Dafta Road (Project No. N30, Musandam Region) is unpaved stony and rough road in most of the stretch which is passable only by 4WD vehicle. However, this road is temporarily closed at the border between Oman and UAE blocked by a mass of soil placed on the road surface. Even without this soil mass, the gradient of existing road is very steep at this border point and safe travel of vehicles is doubted. The road can be divided into 2 sections: One is eastern stretch in Omani territory and the other is western stretch in UAE's territory.

The existing alignment of the eastern stretch partly traverses an isolated UAE's territory existing in the Omani Territory. (see Figure 19.2-2) The local residents want to alter the alignment so that the road reaches without passing the UAE's Territory. This is possible by altering the route to another wadi as shown in Figure 19.2-2.

Considering the importance of this road for the local residents, the Government intends to improve this Madha - Dafta Road.

Location map is shown in Figure 19.1-1.

Figure 19.1-1 Location of the Project Site

The objectives of the project are:

a) To open the road linkage between east end and west end of Omani territory,
b) To provide proper access road for people who are living along the project road, and
c) To provide the access to Omani territory from Fujayrah - Dhayd highway (UAE road).

19.2 ALIGNMENT AND PRELIMINARY DESIGN

19.2.1 Physical Features of the Project Site

Madha - Dafta Road is the only access for the isolated Omani territory (a part of Governorate of Musandam). The project road passes through the mountainous terrain located between Jabal Daftah and Jabal Mayamt, but the road is passing with generally moderate grade except at few locations where it cross over the ridges.

The project site can be divided into roughly 2 sections; eastern side in Omani territory and western side in Fujayrah Eimirate's territory of UAE. The (western) border point (has closed) is located at the ridge separating Oman and UAE. Accordingly, the access to Omani Territory (Madha) is possible from east side of the territory.

The eastern side is rocky mountainous terrain and the road passes through mostly inside the wadis. The western side is moderate rolling terrain deeply eroded by Wadi Limarit and its several offshoots, which are sometimes deeper than 5 meters. The river banks are standing almost vertically.

19.2.2 Existing Road Condition

Regarding the existing road in eastern side, the section from the city center up to Saruji is paved and remaining section from Saruj to Sad (gravel road) is under construction as paved road, at present. Beyond the village of Sad, the road passes UAE's territory for approximately 2 kilometers and re-enters Omani territory. The road goes up and down the slopes of the mountains along Wadi Madhah up to the village of Najar, then the road just follows the river bed of the Wadi Half. Even though the road reaches the foot of the ridge, where is the border of two countries, the wadi does not end there and turns back to the village of Najar again as like a maze.

In the western side, the first section of 100 meters of the road seems to be recently constructed by excavating the rocky ridge. However it is practically impassable for vehicles because of the steep grade. From the foot of the ridge up to Fujayrah - Dhayd highway, where is the end point of the project road, the road passes inside Wadi Limarit

in most of the stretch and sometimes goes up on the side bank. The wadis have carved the moderate hills and made a lot of deep and narrow valleys. Those valleys are used as the road, and the tread of the vehicles can be seen at the every wadis.

Total length of the existing road is approximately 15 kilometers in eastern stretch and 4 kilometers in western stretch. The proposed route in eastern stretch is 11 kilometers long, and it will be shorter than existing route by approximately 4 kilometers.

The existing condition is shown in Figure 19.2-1.

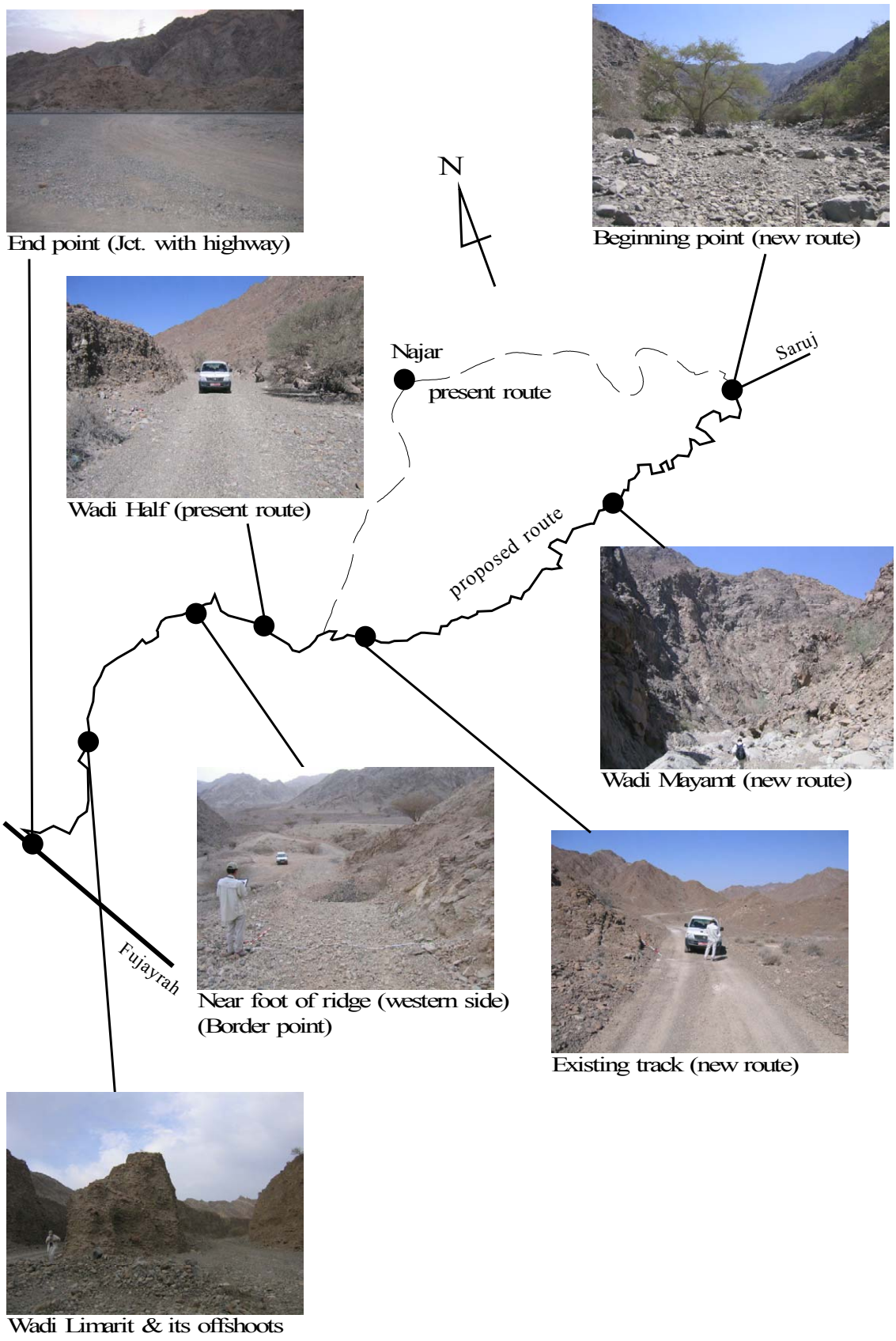


Figure 19.2-1 Existing Road Condition

19.2.3 Proposed Road Alignment

The local residents desire to open a new route through Wadi Mayamt, up to meeting point with Wadi Half, approximately 9 kilometers in length. In case of this route, there is no existing road or track in the first 6.6 kilometers, and there is only a track on the moderate hills in the following 2.3 kilometers. Then the route meets with Wadi Half and follows the existing route. At the end of eastern side, there is no existing road or track from the wadi to the top of the ridge for approximately 100 meters in length and 40 meters in elevation.

In case of this alignment, the section through Wadi Mayamt approximately 6 kilometers in length will be newly opened, while total length of the project road will be shorter than the existing road by approximately 4 kilometers.

From Chainage 0.0 kilometer, beginning point of the project road beyond Sad village, the proposed route passes inside Wadi Mayamt. Generally the wadi is narrow confined by the adjacent rocky cliffs on both sides. The section from Chainage 6.6 kilometer to 8.9 kilometer, the proposed route follows the existing track passing on the river bank. At Chainage 8.9 kilometer, the route meets with the existing road. From Chainage 8.9 kilometer to 10.9 kilometer, existing road is passes inside Wadi Half, but new alignment shall be shifted to the left side, on top of the right bank of the wadi, to avoid the influence of the flood. From Chainage 10.9 kilometer to 11.0 kilometer, where is the border of Oman and UAE, this 100 meters section in eastern stretch will be newly opened and climbs up the ridge approximately 20 meters in elevation.

From Chainage 11.0 kilometer to the end of the project road in western stretch, the road is located in UAE's territory. In the section of first 100 meters, the road have to climb down to the foot of the ridge for about 40 meters in elevation. So the road shall be detoured on the halfway of the mountain to reduce its present vertical grade of the road around 15 - 20 percent. From Chainage 11.1 kilometer, the existing road passes inside wadi, but the new alignment shall be shifted on the river bank for all of its stretch to avoid the influence of the flood. In this case, the road will cross the major wadis 3 times by Irish bridge in the 4 kilometers stretch.

Figure 19.2-2 shows the proposed alignment of the project road.

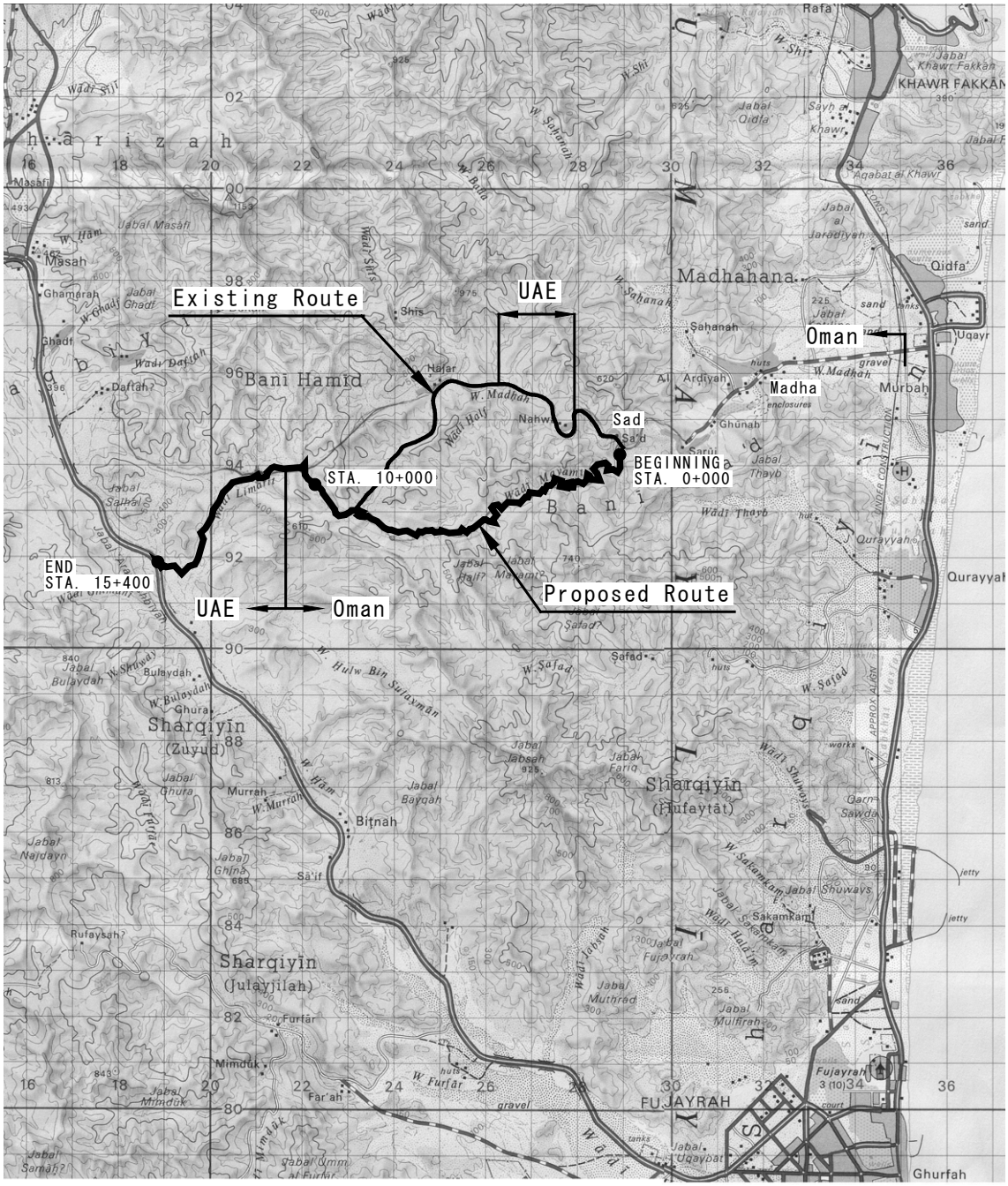


Figure 19.2-2 Proposed Alignment

19.2.4 Preliminary Design

The proposed cross sections follow HDM. As mentioned in HDM, the carriageway of secondary road shall be 7.0 meters and paved shoulder of 1.5 meters in width shall be provided on both sides in this project. Basically the verge of 2.0 meters in width shall be adopted on both sides as stated in HDM.

However, the widths of wadis are very narrow at some portions and sufficient clearance

for the flood stream cannot be secured if the road is constructed in the river bed. So basically the road center shall be shifted on the side slope of the mountain to secure the clearance at least 10 meters in width for the flood stream. In addition, the verge will be omitted to reduce the cut of the rocky slope. The ditch lined by the grouted riprap shall be provided at the section where the verge is omitted, to protect the pavement structure from the scouring.

Inside the wadi, the elevation of the road shall be raised up by 1.0 meter on average from the river bed and the embankment shall be protected from the flood stream by the grouted riprap.

As the result of the above consideration, the typical cross sections are proposed as shown in Figure 19.2-3.

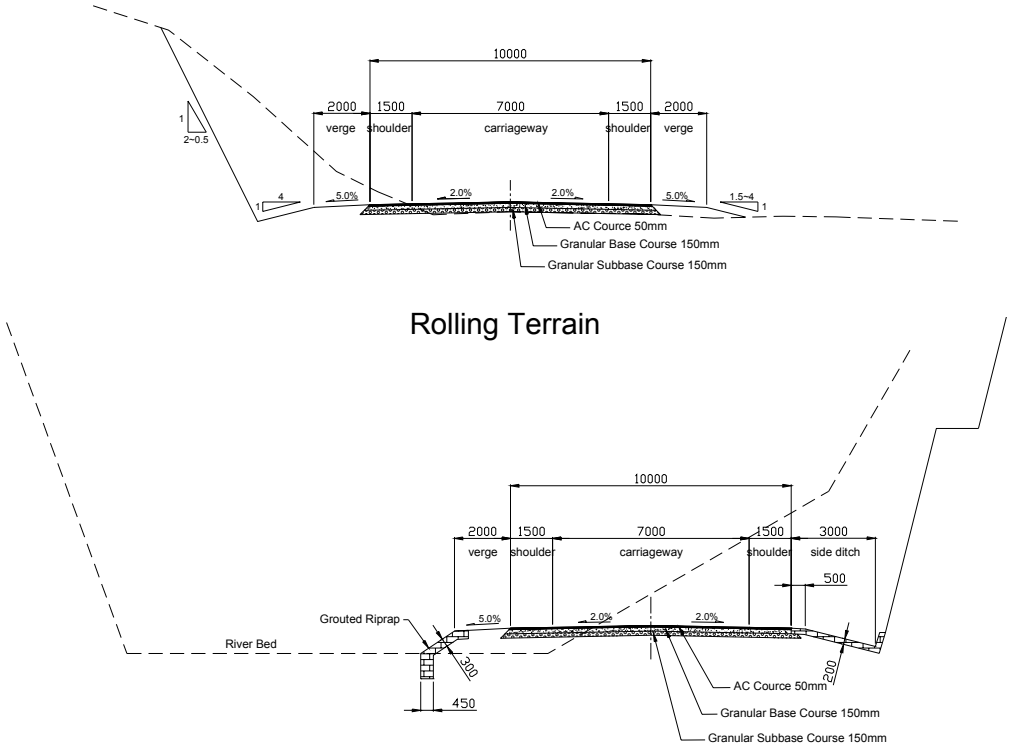


Figure 19.2-3 Typical Cross Sections

19.2.5 Pavement Design

The detail study for the pavement structure is not carried out in this Study because the traffic is forecasted to be small and bearing capacity of the subgrade seems to be high. Accordingly the pavement structure similar to other secondary road may be adopted. In

this Study, the same pavement structure with Hamra - Rustaq road is adopted.

19.2.6 Structure Design

HDM shows the standard drawings for the several types of structures and they are used commonly in the projects whether they are under designing, construction or completed. In this Study, the structures are designed in accordance with HDM and the standard drawings of HDM will be adopted in most of the cases.

19.2.7 Drainage and Cross Drainage Facilities

Through the inventory survey carried out in this Study, the necessary drainage facilities were studied and listed as shown in Table 19.2-1.

Table 19.2-1 List of the Drainage Facilities (1/2)

	Chainage	Drainage		Chainage	Drainage
1	0km+420	Irish Crossing (40m)	31	4km+800	Pipe 1-900
2	0km+520	Irish Crossing (40m)	32	4km+900	Box 2-3.0*3.0
3	0km+720	Irish Crossing (40m)	33	5km+000	Pipe 1-900
4	0km+800	Pipe 1-900	34	5km+100	Box 1-3.0*3.0
5	1km+325	Irish Crossing (50m)	35	5km+200	Box 2-3.0*3.0
6	1km+400	Pipe 1-1500	36	5km+250	Box 1-3.0*3.0
7	1km+720	Irish Crossing (40m)	37	5km+300	Pipe 2-1500
8	1km+825	Irish Crossing (50m)	38	5km+500	Pipe 1-900
9	2km+000	Pipe 1-900	39	5km+600	Pipe 1-900
10	2km+125	Irish Crossing (50m)	40	5km+700	Pipe 1-900
11	2km+225	Irish Bridge (50m)	41	5km+750	Box 2-3.0*3.0
12	2km+500	Box 1-3.0*3.0	42	5km+800	Pipe 1-1500
13	2km+600	Pipe 1-900	43	5km+908	Irish Bridge (15m)
14	2km+800	Pipe 1-900	44	6km+100	Pipe 1-1500
15	3km+000	Pipe 1-1500	45	6km+200	Pipe 1-900
16	3km+100	Box 4-3.0*3.0	46	6km+300	Pipe 1-1500
17	3km+150	Box 4-3.0*3.0	47	6km+400	Pipe 1-900
18	3km+425	Irish Crossing (50m)	48	6km+615	Irish Bridge (30m)
19	3km+450	Box 4-3.0*3.0	49	6km+710	Irish Bridge (20m)
20	3km+635	Irish Crossing (70m)	50	7km+025	Irish Crossing (50m)
21	3km+700	Pipe 1-1500	51	7km+100	Pipe 1-1500
22	3km+800	Box 3-3.0*3.0	52	7km+208	Irish Bridge (15m)
23	3km+850	Box 3-3.0*3.0	53	7km+300	Pipe 2-1500
24	4km+000	Pipe 2-1500	54	7km+600	Pipe 2-1500
25	4km+200	Box 3-3.0*3.0	55	7km+900	Pipe 1-900
26	4km+400	Pipe 1-900	56	8km+320	Irish Crossing (40m)
27	4km+515	Irish Crossing (30m)	57	8km+400	Pipe 1-900
28	4km+600	Pipe 1-900	58	8km+600	Pipe 1-900
29	4km+650	Pipe 1-900	59	8km+700	Box 2-3.0*3.0
30	4km+700	Box 2-3.0*3.0	60	8km+900	Pipe 1-1500

Table 19.2-1 List of the Drainage Facilities (2/2)

	Chainage	Drainage		Chainage	Drainage
61	9km+110	Irish Bridge (20m)	70	11km+450	Box 2-3.0*3.0
62	9km+150	Box 1-3.0*3.0	71	12km+500	Box 2-3.0*3.0
63	9km+200	Pipe 1-900	72	12km+700	Pipe 1-900
64	9km+410	Irish Bridge (20m)	73	13km+110	Irish Bridge (20m)
65	10km+500	Pipe 1-900	74	13km+400	Pipe 1-900
66	10km+600	Pipe 1-900	75	13km+450	Box 1-3.0*3.0
67	11km+000	Pipe 1-900	76	13km+700	Pipe 1-900
68	11km+108	Irish Bridge (15m)	77	14km+600	Pipe 1-900
69	11km+400	Pipe 1-900	78	15km+215	Irish Bridge (30m)

19.3 Preliminary Cost Estimation

19.3.1 Procedure of Project Cost Estimate

The procedure of project cost estimation is shown in Figure 19.3-1. The estimate is made based on the unit prices of construction material, labor costs and equipment costs which are obtained from the survey of the current market prices. The unit costs of major construction items were decided after comparing the estimated unit cost with latest bid prices.

The prices of items needed in the project, but not listed in the table are quoted from those available in Japan and converted to RO using the exchange rate of ; US$ 1.0 = RO 0.385 = JPY 108.

Engineering services cost is estimated as the percentage of the construction cost.

ROW acquisition cost for new roads and widening are not estimated because there is no necessity of new land acquisition for roads.

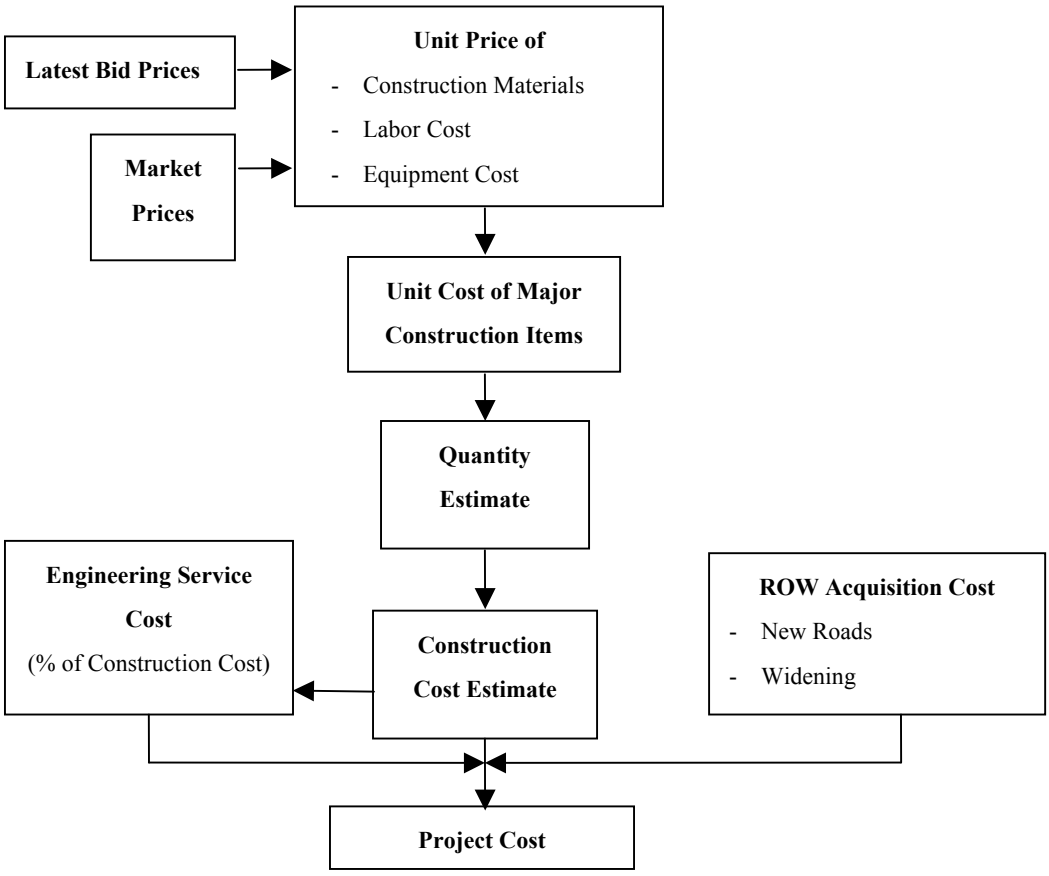


Figure 19.3-1 Procedure of Project Cost Estimate

19.3.2 Unit Price and Cost of Major Construction Items

Unit prices of major construction materials, labor cost and equipment cost, which are determined based on the investigation of the latest market prices, are shown in Tables 19.3-1, 19.3-2 and 19.3-3, respectively.

The major construction items are defined from "The Sultanate of Oman, General Specification for Roads, April 1994" and their unit costs of the road is presented in Table 19.3-4.

Table 19.3-1 Average Prices of Major Construction Materials (2004 Prices)

No.	Material Description	Unit	Unit Price (RO)
1	Aggregates for granular sub-base course	Cu.m.	3.000
2	Aggregate for aggregate base course	Cu.m.	3.000
3	Aggregates for bituminous base course	Cu.m.	3.000
4	Fine aggregate for concrete	Cu.m.	4.000
5	Coarse aggregate for concrete	Cu.m.	3.500
6	Stone for drainage, masonry and slope protection	Cu.m.	3.000
7	Asphalt cement, grade 60-70 on site	Ton	90.000
8	Asphalt cement, grade 50-60 on site	Ton	80.000
9	Emulsified asphalt, grade RS-1 on site	Ton	100.000
10	Cutback asphalt, MC and RC type on site	Ton	100.000
11	Portland cement on site	Ton	25.000
12	Deformed billet steel bars, AASHTO M31 grade 60 (High Yield) of any diameter	Ton	250.000
13	Deformed billet steel bars, AASHTO M31 grade 40 (High Yield) of any diameter	Ton	225.000
14	Highway signs	Sq.m.	50.000
15	Highway sign support	Nr.	25.000
16	Timber plank, on site	Cu.m	150.000
17	Timber props, on site	Cu.m.	150.000
18	Wire mesh gabion, on site	Ton	225.000
19	Explosive, on site	Kg	50.000
20	Gas oil, on site	Liter	0.500
21	Gasoline, Premium	Liter	0.120
22	Gasoline, Regular	Liter	0.114
23	Diesel	Liter	0.102

Source: Study Team Survey

Table 19.3-2 Labor Cost (2004 Prices)

No.	Labor Category	Unit	Unit Rate (RO)
1	Supervisor	Hour	3.000
2	Site Surveyor	Hour	3.000
3	Foreman	Hour	2.000
4	1st Class Operator	Hour	2.000
5	2nd Class Operator	Hour	1.800
6	Mechanic	Hour	1.700
7	Driver	Hour	1.800
8	Skilled Labor	Hour	1.200
9	Semi-skilled Labor	Hour	1.000
10	Mason	Hour	1.200
11	Painter	Hour	1.200
12	Carpenter	Hour	1.200
13	Steel Fixer	Hour	1.200
14	Electrician	Hour	1.200

Source: Study Team Survey

Table 19.3-3 Hourly Cost of Major Construction Equipments (2004 Prices)

No.	Construction Equipment	Hourly Cost (RO)
1	Motor grader from 100 HP to 120 HP	12.000
2	Motor grader from 120 HP to 150 HP	15.000
3	Tractor from 60 HP to 100 HP	12.000
4	Bulldozer with ripper from 100 HP to 150 HP	12.000
5	Bulldozer with ripper from 150 HP to 200 HP	16.000
6	Bulldozer with ripper from 200 HP to 250 HP	18.000
7	Bulldozer with ripper from 250 HP to 300 HP	20.000
8	Wheel Tractor up to 50 HP	8.000
9	Wheel Tractor over 50 HP	9.000
10	Motor scraper capacity up to 18 cu.m.	18.000
11	Motor scraper capacity 18 to 24 cu.m.	22.000
12	Sheeps foot roller from 5 to 10 ton	7.000
13	Vibratory compactor with prime mover up to 5 ton	5.000
14	Pneumatic compactor with prime mover from 30 to 50 ton	5.000
15	Pneumatic self-propelled roller from 15 to 20 ton	6.000
16	Tandem roller up to 8 ton	5.000
17	Tandem roller from 8 to 12 ton	7.000
18	Triaxle roller from 10 to 15 ton	8.000
19	Light frog-rammer 0.1 ton	1.000
20	Heavy frog-rammer 0.5 ton	1.500
21	Wheel loader 1.2 to 1.6 cu.m.	6.000
22	Wheel loader 1.6 to 2.5 cu.m.	8.000
23	Excavator up to 0.8 cu.m.	6.000
24	Excavator from 0.8 to 1.2 cu.m.	9.000
25	Bituminous mixing plant with batching apparatus up to 80 ton/hr	20.000
26	Bituminous mixing plant with batching apparatus 80 to 150 ton/hr	30.000
27	Finisher up to 80 ton/hr	10.000
28	Finisher from 80 to 120 ton/hr	12.000
29	Bitumen sprayer up to t ton	7.500
30	Tanker truck up to 6 cu.m.	5.500
31	Dump truck up to 10 ton	5.000
32	Dump truck from 10 ton to 15 ton	6.000
33	Screening plant from 80 to 100 ton/hr	18.000
34	Crushing plant up to 40 ton/hr	13.000
35	Crushing plant from 40 to 60 ton/hr	15.000
36	Air compressor up to 6000 l/m	2.500
37	Air compressor over 6000 l/m	4.000
38	Mechanical broom	4.000
39	Power water pump	1.500
40	Steel cutting machine	1.000
41	Steel bending machine	1.000
42	Belt conveyor	2.000
43	Concrete mixer up to 0.5 cu.m.	2.500
44	Concrete mixer over 0.5 cu.m.	4.000
45	Automatic concrete batch plant without mixing	16.000
46	Transmixer up to 5 cu.m.	15.000
47	Concrete vibrators	1.000
48	Crane up to 5 ton	5.000
49	Crane with boom and jib from 5 to 10 ton	10.000
50	Crane with boom and jib over 10 ton	15.000
51	Generator 60 ~ 75 Kw	2.500
52	Generator 100 Kw	5.000
53	Generator 150 ~ 200 Kw	9.000
54	Drilling Equipment	10.000
55	Gravel strewer	5.000
56	Asphalt cutter	2.000
57	Vehicle for foreman and surveyor	5.000

Source: Study Team Survey

Table 19.3-4 Unit Cost of Major Construction Items

No.	Description	Unit	Unit Cost (RO)	Foreign component		Local Component		Taxes	
	200 EARTHWORKS								
203	**Earthworks Excavation**								
	Suitable excavation to embankment	Cu. m.	2.856	1.522	53%	1.258	44%	0.076	3%
	Suitable excavation to waste	Cu. m.	1.839	0.980	53%	0.810	44%	0.049	3%
	Borrow excavation to embankment	Cu. m.	3.660	1.300	36%	2.295	63%	0.065	2%
206	**Excavation and Backfilling for Structures**								
	Structural excavation in soils to a depth of 2m.	Cu. m.	4.661	1.898	41%	2.668	57%	0.095	2%
	Structural excavation in rock to a depth of 2m.	Cu. m.	2.625	1.388	53%	1.167	44%	0.069	3%
	Structural excavation in rock to a depth more than 2m.	Cu. m.	3.391	1.675	49%	1.632	48%	0.084	2%
	300 GRANULAR AND STABILIZED SUBBASE, BASECOURSE AND STABILIZED SUBGRADE								
302	**Granular Subbase**								
	Class A Subbase	Cu. m.	5.000	2.094	42%	2.801	56%	0.105	2%
	Class B Subbase	Cu. m.	4.000	1.675	42%	2.241	56%	0.084	2%
303	**Aggregate Basecourse**								
	Class A Basecourse	Cu. m.	5.000	2.112	42%	2.783	56%	0.106	2%
	Class B Basecourse	Cu. m.	4.000	1.689	42%	2.226	56%	0.084	2%
	400 BITUMINOUS PAVEMENT								
401	**Bituminous Prime Coat and Tack Coat**								
	Prime Coat such as MC70	Kg	0.120	0.078	65%	0.039	32%	0.004	3%
	Tack Coat such as RC250	Kg	0.150	0.097	65%	0.048	32%	0.005	3%
402	**Bituminous Basecourse**								
	Bituminous Basecourse	Cu. m.	17.000	10.893	64%	5.563	33%	0.545	3%
405	**Bituminous Wearing Course**								
	Bituminous Wearing Course	Cu. m.	17.000	10.893	64%	5.563	33%	0.545	3%
	500 CONCRETE AND CONCRETE STRUCTURES								
504	**Concrete for Structures**								
	Concrete Class 28/20	Cu. m.	40.000	13.954	35%	25.348	63%	0.698	2%
509	**Reinforcing Steel**								
	High yield steel bars	ton	250.000	153.428	61%	88.901	36%	7.671	3%
	Mild steel bars	ton	250.000	152.690	61%	89.676	36%	7.634	3%
	800 DRAINAGE AND SERVICE DUCTS								
801	**Pipe Culverts**								
	Reinforced Concrete Pipe Culvert 600 mm	Lin. m.	35.000	18.270	52%	15.817	45%	0.914	3%
	Reinforced Concrete Pipe Culvert 900 mm	Lin. m.	75.000	39.150	52%	33.893	45%	1.958	3%
	Reinforced Concrete Pipe Culvert 1500 mm	Lin. m.	155.000	80.910	52%	70.045	45%	4.046	3%
	900 SLOPE PROTECTION AND STABILIZATION								
901	**Rip Rap**								
	Loose stone riprap Class A	Cu. m.	6.000	2.477	41%	3.399	57%	0.124	2%
	Loose stone riprap Class B	Cu. m.	6.000	2.477	41%	3.399	57%	0.124	2%
	Mortared stone riprap	Cu. m.	15.000	4.438	30%	10.340	69%	0.222	1%
902	**Gabions**								
	Gabions	Cu. m.	13.000	4.977	38%	7.774	60%	0.249	2%
906	**Ditch lining**								
	Ditch lining (150mm thick)	Sq. m.	2.000	0.573	29%	1.399	70%	0.029	1%
	1200 SIDEWALKS, PAVED AREAS AND CURBS								
1202	**Curbs**								
	Precast concrete curb, Class 28/20 non-mountable type	Lin. m.	5.000	1.744	35%	3.169	63%	0.087	2%
	Precast concrete curb, Class 28/20 mountable type	Lin. m.	5.000	1.744	35%	3.169	63%	0.087	2%
	Precast concrete curb, Class 28/20 lip type	Lin. m.	5.000	1.744	35%	3.169	63%	0.087	2%
	1300 SAFETY BARRIERS, DELINEATORS AND FENCES								
1301	**Corrugated Steel Beam Safety Barrier**								
	Safety barrier beam (Class B, W-section)	Lin. m.	5.000	3.610	72%	1.210	24%	0.180	4%
	Safety barrier post (Type C) including foundation	Nr.	12.000	8.664	72%	2.903	24%	0.433	4%
	End anchorage (ramp down), including post (Type C) and foundation	Nr.	25.000	18.050	72%	6.048	24%	0.902	4%
	W-beam terminal section								
	Re-fixing of safety barrier beam	Nr.	15.000	10.830	72%	3.629	24%	0.541	4%
	Re-fixing of safety barrier post including foundation	Lin. m.	0.500	0.361	72%	0.121	24%	0.018	4%
	Re-fixing of end anchorage (ramp down) including posts	Nr.	3.000	2.166	72%	0.726	24%	0.108	4%
	Re-fixing of W-beam terminal section	Nr.	16.000	11.552	72%	3.870	24%	0.578	4%
1302	**Concrete safety barrier**								
	Concrete safety barrier (Type A)	Lin. m.	55.000	19.186	35%	34.854	63%	0.959	2%
	Concrete safety barrier (Type B)	Lin. m.	30.000	10.465	35%	19.011	63%	0.523	2%
1303	**Reflectorized Markers for safety barriers**								
	Reflectorized markers (red) attached to Guardrail	Nr.	4.000	2.888	72%	0.968	24%	0.144	4%
	Reflectorized markers (red) attached to concrete barrier	Nr.	3.000	2.166	72%	0.726	24%	0.108	4%
1304	**Delineators**								
	Flexible delineators	Nr.	12.000	8.664	72%	2.903	24%	0.433	4%
	Irish crossing markers	Nr.	35.000	25.270	72%	8.467	24%	1.263	4%
	Irish crossing water depth gauges	Nr.	42.000	30.324	72%	10.160	24%	1.516	4%
	1400 HIGHWAY SIGNS AND ROAD MARKINGS								
1401	**Highway Signs**								
	Triangular, side 900mm	Nr.	25.000	18.050	72%	6.048	24%	0.902	4%
	Triangular, side 1100mm	Nr.	30.000	21.660	72%	7.257	24%	1.083	4%
	Triangular, side 1200mm	Nr.	40.000	28.880	72%	9.676	24%	1.444	4%
	Circular, diameter 900mm	Nr.	30.000	21.660	72%	7.257	24%	1.083	4%
	Circular, diameter 1200mm	Nr.	85.000	61.370	72%	20.562	24%	3.068	4%
	Rectangular sign	Sq.m.	50.000	36.100	72%	12.095	24%	1.805	4%
	Kilometer post (sign No. 323)	Nr.	25.000	18.050	72%	6.048	24%	0.902	4%
	Sign post support assembly, (Type 1A)	Nr.	25.000	18.050	72%	6.048	24%	0.902	4%
	Sign post support assembly, (Type 1B)	Nr.	54.000	38.988	72%	13.063	24%	1.949	4%
	Sign post support assembly, (Type II)	Nr.	68.000	49.096	72%	16.450	24%	2.455	4%
	Sign post support assembly, (Type IIIA)	Nr.	150.000	108.299	72%	36.286	24%	5.415	4%
	Sign post support assembly, (Type IIIB)	Nr.	155.000	111.909	72%	37.495	24%	5.595	4%
	Re-fixing of removed highway sign (any size with single post)	Nr.	20.000	14.440	72%	4.838	24%	0.722	4%
	Re-fixing of removed highway sign (any size with multiple post)	Nr.	25.000	18.050	72%	6.048	24%	0.902	4%
1402	**Road Markings**								
	Traffic lines (mechanically sprayed)	Sq. m.	1.600	1.155	72%	0.387	24%	0.058	4%
	Curb painting (black and yellow)	Sq. m.	1.000	0.722	72%	0.242	24%	0.036	4%
	Reflecting road studs (double face)	Nr.	3.500	2.527	72%	0.847	24%	0.126	4%

19.3.3 Construction Cost

Estimated construction cost is presented in Table 19.3-5. Detailed cost estimate is shown in Annex 19-1. The construction cost was estimated at RO 4,810,000, composed of 56.0% of a foreign currency component (or RO 2,694,000), 41.2% of a local currency component (or RO 1,982,000) and 2.8% of a tax component (or RO134,000). Indirect costs (contingency) was assumed at 10% of direct cost, referring to the latest bid prices.

Table 19.3-5 Construction Cost (RO 1,000)

	Foreign	Local	Tax	Total
Amount	2,694 (56.0%)	1,982 (41.2%)	134 (2.8%)	4,810 (100%)

19.3.4 Engineering Service and Construction Supervision Cost

The engineering services cost covering detailed design (D/D) and construction supervision cost (C/S) is estimated as a certain percent of the project construction cost. The investigation of the recent projects in the Sultanate of Oman shows that the current percents for D/D and C/S are about 3% and 4%, respectively. Estimated engineering services and construction cost is presented in Table 19.3-6.

Table 19.3-6 Engineering Services and Construction Supervision Cost (RO 1,000)

	Foreign	Local	Tax	Total
Detailed Design	116 (80.0%)	14 (10.0%)	14 (10.0%)	144 (100%)
Construction Supervision	154 (80.0%)	19 (10.0%)	19 (10.0%)	192 (100%)
Total	270 (80.0%)	33 (10.0%)	33 (10.0%)	336 (100%)

19.3.5 Summary of Project Costs

Summary of Project Cost is shown in Table 19.3-7.

Table 19.3-7 Summary of Project Cost (RO 1,000)

	Foreign	Local	Tax	Total
Detailed Design	116 (80.0%)	14 (10.0%)	14 (10.0%)	144 (100%)
Construction	2,694 (56.0%)	1,982 (41.2%)	134 (2.8%)	4,810 (100%)
Construction Supervision	154 (80.0%)	19 (10.0%)	19 (10.0%)	192 (100%)
Total	2,964 (57.6%)	2,015 (39.2%)	167 (3.2%)	5,146 (100%)

19.4 ENVIRONMENTAL CONSIDERATIONS AND TOR FOR EIA

19.4.1 Environmental Considerations

1) General

The objectives of environmental considerations at the stage of the "Pre-Feasibility Study (Pre-F/S)" are:

- To confirm the results of the "Initial Environmental Examination (IEE)";
- To clarify present conditions in the project site and specific environmental impacts due to proposed road construction;
- To re-evaluate comprehensively proposed project road; and
- To provide the "Terms of Reference (TOR)" for EIA in the next "Feasibility Study".

The examined environmental considerations are:

1. Review of result of the IEE with data and information concerning the project.
2. Environmental investigation at the project site using "Environmental Checklist" (refer to Table 12.1-1).
3. Analysis of environmental conditions and impacts.
4. Comprehensive evaluation.
5. Provision of TOR for EIA.

The content of the site investigation consists of the following environmental items:

(1) Air pollution
(2) Effluent
(3) Noise and vibration
(4) Land subsidence
(5) Topography and geology
(6) Soil and soil erosion
(7) Hydrology and groundwater
(8) Ecosystem, flora and fauna
(9) Landscape (including coastal zone)
(10) Regional development on the natural environment
(11) Hazards
(12) Other impacts on the natural environment
(13) Wastes
(14) Cultural heritage

(15) Regional development on the social environment
(16) Other impacts on the social environment

2) Environmental checklist for the project "MADHA - DAFTA ROAD"

More detailed environmental investigation, analysis and comprehensive evaluation for the road section between Madha and Dafta were carried out using the environmental checklist. The results of investigation and evaluation are shown in Annex 19-2.

Consequently, environmental impacts due to the proposed road are likely to occur on the environmental items of Topography and Geology and Eco-system, Flora and Fauna.

a. Topography and Geology

- Present condition:

The topographic feature in the project area is low to moderate relief mountainous terrain, Jabal Half. The road mostly follows along Wadi Mayamt, Wadi Half and Wadi Limarit.

1-1 From 0 km (Start point: Madha) to 5.8km:

0 km point is junction between Wadi Mayamt and Wadi Madhah (mainstream). This section belongs to the catchment area of lower to uppermost stream of Wadi Mayamt. The route is much meandering with several hundred meters along of Wadi Mayamt. Slope of both sides is steep and small Low Terrace is locally developed. There are many small-scaled slope failures.

1-2 From 5.8km to 10.0 km:

This section belongs to the catchment area of upper to uppermost stream of Wadi Half, consisting of two tributaries of Wadi Madhah. The route of existing truck road passes along wadis with vertically eroded cliff of the Low Terrace deposits. Around 10 km point, wide terrace plain is formed.

1-3 From 10.0km to 15.4km (End point: Dafta):

This section belongs to the catchment area of uppermost to lower stream of Wadi Limarit, being tributary of Wadi Ham. The eastern half of the route of existing truck road passes along wadis with vertically eroded cliff of the Low Terrace deposits. The western half of the road mostly passes on the Low Terrace.

- Impacts with project:

The project will require massive excavation and embankment for paved 2-lane road construction, and the road alignment in the western half of the route mostly follows along the existing road alignment on the Low Terrace, but in the eastern half of the route mostly follows along the narrow wadi channels. Hence, large to small-scale alteration of topography is likely to occur in the eastern half of the route. In addition, much cuttings caused in the slope will be dumped to the slope side and in the wadis, so that topographically larger area more than right-of-way (ROW) is likely to be irreversible altered and wadis will become narrowed.

- Evaluation: 1~2:

Slight to moderate impact due to road construction, particularly eastern half of the project area.

b. Eco-system, Flora and Fauna

- Present condition:

Flora:

Sparse vegetation is found along the entire stretch of the project area, but numerous scattered trees, including acacia, willow, cypress, are found in the wadis. The current graded roads in the western part of the route have already impacted the vegetation along the proposed alignment and therefore further impacts to the vegetation are generally considered to be insignificant so long as the current alignment is followed as far as possible. However, plants in the eastern part of the route are not harmed yet.

Fauna:

There are not known specific wildlife travel corridors crossing project area. Although endangered or threatened species have not been identified in the area, Hedgehog, Red Fox, Wild Cat, Arabian Gazelle, birds, etc. are likely to inhabit in and around the project area. Some poachers are likely to hunt Arabian Gazelles, etc. Numerous domestic animals are present.

- Impacts with project:

Destruction of wadi vegetation and increased chance of traffic accident of wild and domestic animals. And poachers of Arabian Gazelles, etc. are likely to increase due to improved access road to the area.

- Evaluation: 1~2:

Slight to moderate impact to eco-system, flora and fauna due to road construction.

c. Other environmental items: Not significant impact.

3) Results of IEE

The comprehensive evaluation for the Madha - Dafta Road is concluded to be 1~2 as impact rating; summarized in Table 19.4-1. Hence, the implementation of EIA before road construction is recommended.

Table 19.4-1 Results of IEE on the Madha - Dafta Road

- Topography and Geology	1~2	- Alteration of topography
- Eco-system, Flora and Fauna	1~2	- Destruction of sparse vegetation by excavation and embankment
- Other items	1	

Comprehensive Evaluation	1~2
Recommendations *1	Recommended to carry out partial EIA on assigned items after scoping

Note *1 : Comprehensive Evaluation
1 : None to slight impacts : No need to carry out EIA or need to carry out partial EIA after scoping
1~2 : Small impacts : Recommended to carry out partial EIA on assigned items after scoping
2 : Moderate impacts : Recommended to carry out EIA
2~3 : Relatively significant impacts: Recommended to carry out EIA
3 : Significant impacts : Recommended to carry out EIA

19.4.2 Terms of Reference for the Project

Terms of reference (TOR) on the Environmental Impact Assessment of the Madha – Dafta Road, Sultanate of Oman, are shown in Annex 19-3:

19.5 PROJECT EVALUATION

19.5.1 General

Madha -Dafta road project starts from Madha and terminates to Dafta in the Wilayah Madha of Governorate of Musandam. This road has total length of about 15.4 kilometers and is classified as secondary road.

The objective of this section is to examine the viability of the construction plan of Madha - Dafta road from viewpoint of national economy of Oman.

In order to achieve the objective, the following steps are carry out;

- Step 1: Future socio-economic framework in the influence area of the Project Road
- Step 2: Traffic demand forecast on the Project
- Step 3: Estimation of economic benefit based on traffic demand on the Project Road and unit vehicle operating costs
- Step 4: Estimation of economic cost based on the estimated financial cost mentioned in Section 19.3.
- Step 5: Calculation of economic indicators of the Project Road using the economic benefit and economic cost.
- Step 6: Sensitivity analysis to be made by varying factors of influenced to economic indicators such as the economic benefits, economic costs and discount rate.
- Step 7: Evaluation from technical and socio-economic view points
- Step 8: Overall evaluation

Figure 19.5-1 shows procedure for project evaluation.

19.5.2 Traffic Demand Forecast

In the Master Plan stage, the traffic demand for inter-Wilayah was forecasted in order to formulate nationwide road network development and that for intra-Wilayah was not forecasted. However, it is necessary to estimate the traffic demand for intra-Wilayah due to the Project Road being influenced within Wilayah.

The traffic demand forecast in this section is made as follows:

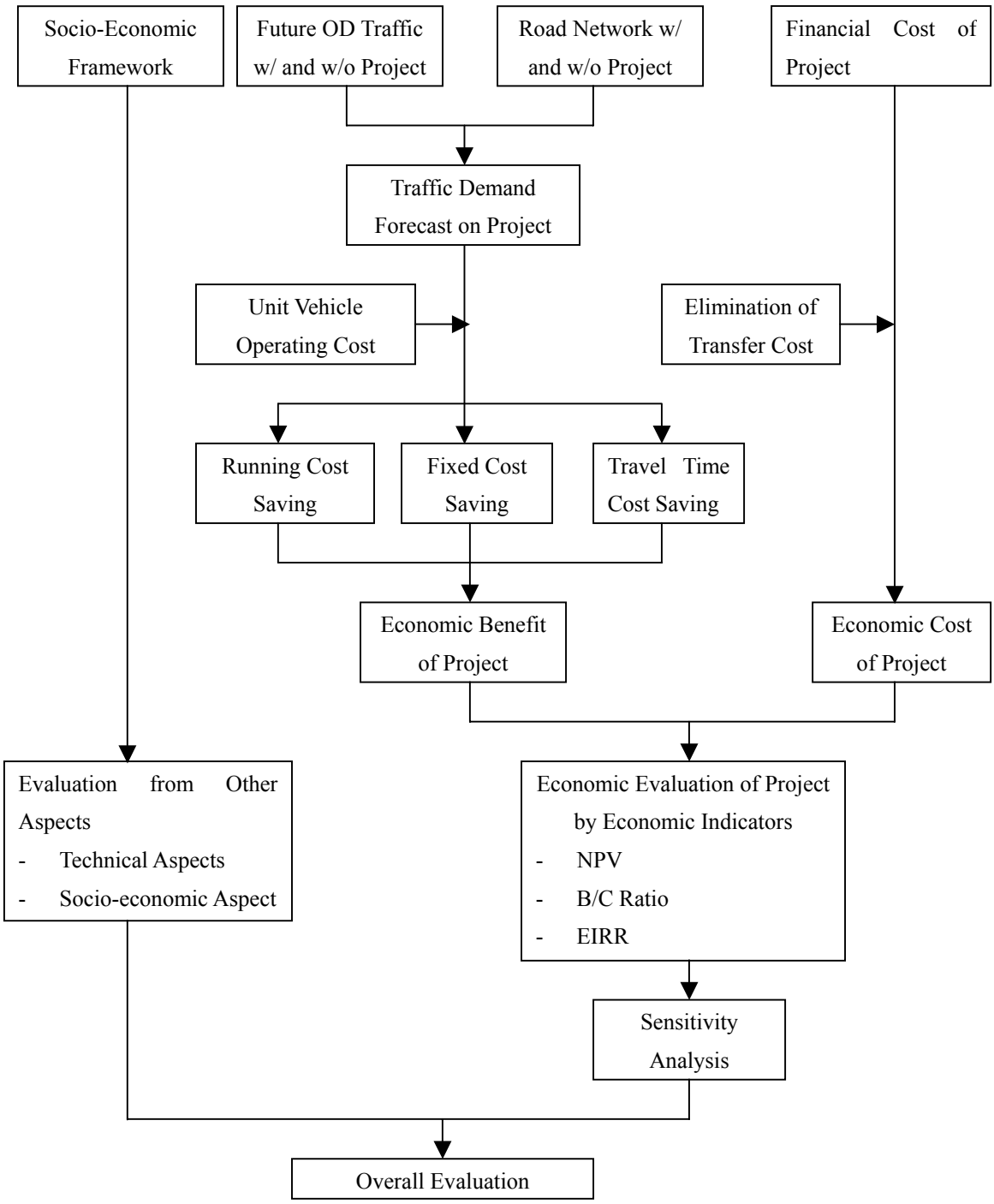


Figure 19.5-1 Procedure for Project Evaluation

1) Future Socio-Economic Framework in Influence Area

Based on 1993 population census, the socio economic data by towns and villages in Governorates and Regions such as number of household, housing unit, population and town

and village location are presented in ' Socio-Economic Atlas[1]' The socio- economic data in the influence area of the Project Road in 1993 is computed on the basis of these data. Future population, number of workers and private vehicle are applied for these growth rate of Wilayah Madha as shown in Tables 19.5-1(1), (2) and (3).

Table 19.5-1(1) Population of Direct and Indirect Influence Areas by Years (Person)

		1993[1)]	2005	2010	2020	2030
Direct Influence Area						
1	Madha	863	875	883	892	914
2	Al Jaraya	31	31	32	32	33
3	Al Harah	786	795	804	813	834
4	Al Ghunah	757	766	775	782	802
5	Al Saruj	126	128	129	130	134
6	Hajar bani	38	38	38	39	40
	Total	2,601	2,633	2,662	2,688	2,757

Table 19.5-1(2) No of Secondary and Tertiary Workers in Direct and Indirect Influence Areas by Years (Worker)

		2005	2010	2020	2030
Direct Influence Area					
1	Madha	239	2495	277	311
2	Al Jaraya	8	9	10	11
3	Al Harah	217	227	253	284
4	Al Ghunah	210	219	243	272
5	Al Saruj	35	36	40	46
6	Hajar bani	10	11	12	14
	Total	720	751	835	939

Table 19.5-1(3) Private Vehicle Ownership of Direct and Indirect Influence Areas (Vehicle)

		2005	2010	2020	2030
Direct Influence Area					
1	Madha	65	70	86	106
2	Al Jaraya	2	3	3	4
3	Al Harah	60	65	78	96
4	Al Ghunah	57	61	76	93
5	Al Saruj	10	10	12	16
6	Hajar Bani	3	3	4	5
	Total	226	284	316	378

2) Trip Production and Generation

The trip production rate (number of trips per vehicle per day) is assumed to be 2.5 trips per day in 2005 and 3.5 in 2030 taking into account daily travel characteristics of

[1] "Socio-Economic Atlas": Information & Documentation Center, Ministry of Development, November 1997

Omanie peoples. (See Table 19.5-2)

Therefore, number of trips in Wilayah Madha is estimated using trip production rate and number of private vehicles as follows;

Table 19.5-2 Number of Trips in Wilayah Madha

	2005	2010	2020	2030
Number of Private Vehicles	226	284	316	378
Trip Production Rate	2.50	3.00	3.25	3.50
Total Number of Trips	565	852	1,027	1,323

Number of trips in whole Wilayah Madha is expected to increase from 565 trips in 2005 to 852 trips in 2010, 1,027 trips in 2020, and 1,323 trips in 2030 with an average annual grow rate of 3.5 %.

Trip generation and attraction by zones are computed using the same equation as presented in Section 7.2.2 (trip generation and attraction model).

3) OD Distribution

OD distribution model is employed as the Gravity model as follows:

$$Tij = \alpha * Ui * Vj * D\,ij^{-\gamma}$$

Where,

Tij : Future trip from zone i to zone j

Ui / Vj : Trip generation in zone i / trip attraction in zone j

D ij : Travel time or distance between zone i and j

α, γ : Parameters

4) Traffic Assignment to Road Network

Since road network in the influence area of the Project Road is simple, traffic assign method of 'all or nothing' is employed in this Study. As the results, assigned traffic volume on the Project Road can be computed as shown in Table 19.5-3.

Table19.5-3 Traffic Volume on Madha -Dafta Road (Vehicles / day)

		2005	2010	2020	2030
1	Hajar Bani – Madha	155	234	299	382
2	Madha – Al Jaraya	85	128	161	205

Tables 19.5-4 and 19.5-5 show the total vehicle kilometers and total vehicle hours of the Project Road, respectively.

Table 19.5-4 Total Vehicle Kilometers on Madha -Dafta Road ('000 PCU-Km / Day)

	W/O Project	W/ Project	W/O-W/
2010	3,602	3,602	0
2020	4,602	4,602	0
2030	5,879	5,879	0

Table 19.5-5 Total Vehicle Hours on Madha -Dafta Road (PCU-Hour / Day)

	W/O Project	W/ Project	W/O-W/
2010	359	52	307
2020	458	66	392
2030	585	84	501

19.5.3 Preliminary Economic Evaluation

1) General

a. Evaluation Period

The evaluation period is assumed to be 30 years from 2012 to 2041 taking into account the service life of Madha -Dafta Road.

b. Implementation Schedule

Following the recommended implementation program in the Master Plan Study, the implementation schedule is assumed as follows:

- 2010 Detailed design, tendering and bidding
- 2011 Construction of Madha -Dafta Road

c. Evaluation method and Economic Indicators

The economic evaluation method of the infrastructure project is commonly used by benefit-cost analysis. In this Study, the same benefit-cost analysis method is employed.

This method is evaluated as investment efficiency through comparison between benefit and cost derived from the Madha - Dafta road project. It is expressed the benefit – cost

stream during evaluation period and the economic indicators used in this study are as follows:

– Net Present Value (NPV)
– Benefit Cost Ratio, (BCR), and
– Economic Internal Rate of Return (EIRR)

2) Estimation of Benefit

By implementing Madha - Dafta Road project, a variety of benefits is expected such as improvement of comfort and safety, promotion of international and inter-regional trade and promotion of regional development in long term basis. Among these benefits, limited benefits to the three (3) items of vehicle operating cost: a. saving in running cost (VRC) (distance related vehicle operating cost), b. saving in fixed cost (VFC) (time related vehicle operating cost) and c. saving in travel time cost (TTC).

a. Unit Vehicle Operating Cost (VOC)

Detailed unit VOC is described in Appendix A9-2. Tables 19.5-6 (1) to (3) summarizes unit VOC on paved road and unpaved surface type, VFC and TTC for vehicle groups.

Table 19.5-6 (1) Unit Running Cost by Vehicle Speed and Surface Type (RO/'000 km)

	Paved Surface			Unpaved Surface		
	Passenger Car	Bus	Truck	Passenger Car	Bus	Truck
5 km/h	66	109	116	104	177	143
20						
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

Note: All unit costs are presented in 2005 prices

Table 19.5-6 (2) Unit Fixed Cost by Vehicle Types (RO/Hr)

	Fixed Cost
Passenger Car	1.088
Bus	1.835
Truck	2.661

Note: All unit costs are presented in 2005 prices

Table 19.5-6 (3) Unit Fixed 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 2005 prices

b. Estimation of Benefits

The saving in vehicle operating costs and travel time cost were estimated as presented in Table 19.5-7.

Table 19.5-7 Estimation of Benefits (RO '000 /Year)

Year	Saving in VRC	Saving in VFC	Saving in VOC	Saving in TCC	Total Saving
2010	51.2	122.0	173.2	142.4	315.6
2020	65.5	155.5	221.3	181.9	403.2
2030	83.7	199.1	282.8	232.4	515.1

3) Estimation of Economic Cost

a. Construction Cost

The project cost calculated in the previous section is expressed as the financial cost. It is therefore to convert from financial cost to economic cost. The economic cost is estimated by deducting government taxes and import duty of imported materials from the financial cost as shown in Table 19.5-8.

Table 19.5-8 Economic Cost Estimation (Unit: RO '000)

Description		Economic Cost	Financial Cost
1	Construction Cost	4,876.0	4,810.0
1.1	Labor Cost	137.0	141.0
1.2	Material Cost	1,806.0	1,858.0
1.3	Equipment	2,732.0	2,811.0
2	Consultancy	303.0	336.0
2.1	Detailed Design	130.0	144.0
2.2	Construction Supervision	173.0	192.0
	Total	4,979.0	5,146.0

b. Maintenance Cost

In this study, the maintenance cost of Madha -Dafta Road is estimated on the basis of maintenance costs per kilometer applied to the other national roads in Musandam. The total amount of maintenance cost is estimated at R.O. 18,080 taking into account unit cost of maintenance per kilometer of similar road in Musandam is 1,174 km/year.

2) Benefit Cost Analysis

Based on the above mentioned benefits and cost estimations, the economic analysis of the Project was carried out. Table 19.5-9 show the benefit – cost analysis of Madha -Dafta Road Construction Project during project life period of 30 years and Table 19.5-10 shows the benefit cost stream. The results of the economic analysis show that a Net Present Value (NPV) of RO 465,600 and BCR of 1.13 over 30 years life of the Road using discount rate of 6 % which is designated by the Ministry of National Economy. The Economic Internal Rte of Return (EIRR) was compiled at 7.1%.

Table 19.5-9 Economic Indicators of Benefit- Cost Analysis

Net Present Value	RO 465,600
BCR	1.13
EIRR (%)	7.1 %

Note: 1) Project life is assumed to be 30 years
2) Discount rate is assumed to be 6%

3) Sensitivity Analysis

The sensitivity analysis is conducted under a worse case scenario incorporating increase and/or decrease of the estimation of economic benefit and cost. Table 19.5-11 shows the results of the sensitivity analysis.

Table 19.5.10 Benefit - Cost Stream of Madha - Dafta Road Construction Project

Undiscounted Benefit Cost Stream

RO '000

Sq	Year	Construction Cost	O & M Cost	Cost Total	Benefit	Cost-Benefit
1	2005	0.0	0.0	0.0	0.0	0.0
2	2006	0.0	0.0	0.0	0.0	0.0
3	2007	0.0	0.0	0.0	0.0	0.0
4	2008	0.0	0.0	0.0	0.0	0.0
5	2009	0.0	0.0	0.0	0.0	0.0
6	2010	130.0	0.0	130.0	0.0	-130.0
7	2011	4,849.0	0.0	4,849.0	0.0	-4,849.0
8	2012	0.0	18.1	18.1	331.4	313.3
9	2013	0.0	18.1	18.1	339.6	321.5
10	2014	0.0	18.1	18.1	348.0	329.9
11	2015	0.0	18.1	18.1	356.7	338.6
12	2016	0.0	18.1	18.1	365.5	347.4
13	2017	0.0	18.1	18.1	374.6	356.5
14	2018	0.0	18.1	18.1	383.9	365.8
15	2019	0.0	18.1	18.1	393.4	375.3
16	2020	0.0	18.1	18.1	403.2	385.1
17	2021	0.0	18.1	18.1	413.2	395.1
18	2022	0.0	18.1	18.1	423.4	405.3
19	2023	0.0	18.1	18.1	433.9	415.8
20	2024	0.0	18.1	18.1	444.7	426.6
21	2025	0.0	18.1	18.1	455.7	437.6
22	2026	0.0	18.1	18.1	467.0	448.9
23	2027	0.0	18.1	18.1	478.6	460.5
24	2028	0.0	18.1	18.1	490.4	472.3
25	2029	0.0	18.1	18.1	502.6	484.5
26	2030	0.0	18.1	18.1	515.2	497.1
27	2031	0.0	18.1	18.1	521.6	503.5
28	2032	0.0	18.1	18.1	528.0	509.9
29	2033	0.0	18.1	18.1	534.5	516.4
30	2034	0.0	18.1	18.1	541.2	523.1
31	2035	0.0	18.1	18.1	547.8	529.7
32	2036	0.0	18.1	18.1	554.7	536.6
33	2037	0.0	18.1	18.1	561.6	543.5
34	2038	0.0	18.1	18.1	568.6	550.5
35	2039	0.0	18.1	18.1	575.6	557.5
36	2040	0.0	18.1	18.1	582.8	564.7
37	2041	0.0	18.1	18.1	589.9	571.8
	Total	4,979.0	542.4	5,521.4	14,027.3	8,505.9

Discounted Benefit Cost Stream

RO '000

Sq	Year	Discounted	Construction Cost	O & M Cost	Cost Total	Benefit	Cost-Benefit
1	2005	1.000	0.0	0.0	0.0	0.0	0.0
2	2006	1.060	0.0	0.0	0.0	0.0	0.0
3	2007	1.124	0.0	0.0	0.0	0.0	0.0
4	2008	1.191	0.0	0.0	0.0	0.0	0.0
5	2009	1.262	0.0	0.0	0.0	0.0	0.0
6	2010	1.338	97.1	0.0	97.1	0.0	-97.1
7	2011	1.419	3,418.4	0.0	3,418.4	0.0	-3,418.4
8	2012	1.504	0.0	12.0	12.0	220.4	208.4
9	2013	1.594	0.0	11.3	11.3	213.1	201.8
10	2014	1.689	0.0	10.7	10.7	206.0	195.3
11	2015	1.791	0.0	10.1	10.1	199.2	189.1
12	2016	1.898	0.0	9.5	9.5	192.5	183.0
13	2017	2.012	0.0	9.0	9.0	186.2	177.2
14	2018	2.133	0.0	8.5	8.5	180.0	171.5
15	2019	2.261	0.0	8.0	8.0	174.0	166.0
16	2020	2.397	0.0	7.5	7.5	168.2	160.7
17	2021	2.540	0.0	7.1	7.1	162.7	155.6
18	2022	2.693	0.0	6.7	6.7	157.2	150.5
19	2023	2.854	0.0	6.3	6.3	152.0	145.7
20	2024	3.026	0.0	6.0	6.0	147.0	141.0
21	2025	3.207	0.0	5.6	5.6	142.1	136.5
22	2026	3.400	0.0	5.3	5.3	137.4	132.1
23	2027	3.604	0.0	5.0	5.0	132.8	127.8
24	2028	3.820	0.0	4.7	4.7	128.4	123.7
25	2029	4.049	0.0	4.5	4.5	124.1	119.6
26	2030	4.292	0.0	4.2	4.2	120.0	115.8
27	2031	4.549	0.0	4.0	4.0	114.7	110.7
28	2032	4.822	0.0	3.7	3.7	109.5	105.8
29	2033	5.112	0.0	3.5	3.5	104.6	101.1
30	2034	5.418	0.0	3.3	3.3	99.9	96.6
31	2035	5.743	0.0	3.1	3.1	95.4	92.3
32	2036	6.088	0.0	3.0	3.0	91.1	88.1
33	2037	6.453	0.0	2.8	2.8	87.0	84.2
34	2038	6.841	0.0	2.6	2.6	83.1	80.5
35	2039	7.251	0.0	2.5	2.5	79.4	76.9
36	2040	7.686	0.0	2.4	2.4	75.8	73.4
37	2041	8.147	0.0	2.2	2.2	72.4	70.2
		Total	3,515.5	175.1	3,690.6	4,156.2	465.6

Discount Rate	6.0%

NPV (RO '000)	**465.6**
B/C Ratio	**1.13**
EIRR	**7.1**

Cost	1
Benefit	1

Table 19.5-11 Sensitivity Analysis regarding Benefit and Cost of MADHA -DAFTA Road Construction Project

			Benefits		
			20% down	**Base Case**	**20% up**
Costs	20% down	NPV (RO '000)	371.9	1,203.2	2,034.5
		B/C Ratio	1.13	1.41	1.69
		EIRR (%)	7.1	9.2	11.2
	Base Case	NPV (RO '000)	-365.7	465.6	1,296.9
		B/C Ratio	0.90	1.13	1.35
		EIRR (%)	5.1	7.1	8.8
	20% up	NPV (RO '000)	-1,104.5	-273.2	558.1
		B/C Ratio	0.75	0.94	1.13
		EIRR (%)	3.7	5.5	7.1

Note: Project life of the project is assumed to be 30 years

4) Summary of Economic Analysis

The implementation of Madha -Dafta Road construction project can be marginally justified from view of national economic point. However, some cases such as 20 % increases in construction cost or 20 % decrease in economic benefit show less than an opportunity rate (6 %) of capital investment in Oman.

19.5.4 Technical Evaluation

The results of the technical analysis of Madha -Dafta Road show that the construction of the Project Road is technically feasible. There are no major technical issues at all.

19.5.5 Other Impacts

1) Improvement of Standard Living of Peoples

Construction of the Project Road is expected to contribute improvement of standard living of peoples. At present, it is estimated that 2,633 peoples in 2005 are living within the influence areas of the Project Road as shown in Table 19.5-12.

After completion of the Project Road, the Project will contribute to:

- More opportunities to access easier to various basic facilities, such as religious facilities, hospitals, markets,
- Achievement of easier daily travel to offices for employed peoples, and schools for school children,

- More chances of developing unutilized potential lands,
- Contribution to effective land use and a unity of nation

Table 19.5-12 Number of Population, Employed Population and School Children in the Influence Area of Madha -Dafta Road

	2005	2010	2020	2030
Direct Influence Area				
Population	2,633	2,662	2,688	2,757
No. of Employed Population	720	751	835	939
No. of School Children (below 15 ys old)	564	487	470	422

2) Regional Development

Improved road system would greatly contribute to regional development. Travel time reduction, transport cost reduction, accessibility improvement and safe, comfort and reliable means of transportation would be directly and indirectly impact on the following;

a. Agricultural industry

- Higher farm gate prices → higher income for farmers → Upgrading their living standards → Incentive for farmers to produce → Regional economic growth

b. Tourism industry

- Cheaper transport cost / Easy accessibility to Hotels / Sightseeing spots → More tourists to visit → Regional economic growth

19.5.6 Overall Evaluation

As mentioned above, the implementation of the Madha -Dafta road construction project can be justified from view of economic, technical, and social impact points.

Annex 19-1

Detailed cost estimate of Madha – Dafta Road

Item No.	Description	Unit	Unit Price (RO)	Quantity	Cost (RO)	Cost Component					
						Lab.	Mat.	Equip.	For.	Local	Tax
	Earthworks										
203	**Earthworks Excavation**										
203.1	Suitable excavation to embankment	Cu. m.	2.856	56,571	161,574	2,985	7,712	150,877	86,126	71,142	4,306
203.2	Suitable excavation to waste	Cu. m.	1.839	675,805	1,242,636	24,086	55,533	1,163,016	661,994	547,541	33,100
203.4	Borrow excavation to embankment	Cu. m.	3.660	5,013	18,349	78	6,274	11,996	6,516	11,507	326
206	**Excavation and Backfilling for Structures**										
206.1	Structural excavation in soils to a depth of 2m.	Cu. m.	4.661	1,092	5,088	264	1,241	3,582	2,071	2,913	104
206.3	Structural excavation in rock to a depth of 2m.	Cu. m.	2.625	13,062	34,282	690	1,473	32,119	18,134	15,241	907
206.4	Structural excavation in rock to a depth more than 2m.	Cu. m.	3.391	41,526	140,804	4,188	16,596	120,020	69,553	67,773	3,478
	Subbase and Base course										
302	**Granular Subbase**										
302.1	Class A Subbase	Cu. m.	5.000	0	0	0	0	0	0	0	0
302.2	Class B Subbase	Cu. m.	4.000	33,000	132,000	2,711	29,300	99,988	55,278	73,959	2,764
302.3	Class C Subbase	Cu. m.	3.000	0	0	0	0	0	0	0	0
303	**Aggregate Basecourse**				0						
303.1	Class A Basecourse	Cu. m.	5.000	0	0	0	0	0	0	0	0
303.2	Class B Basecourse	Cu. m.	4.000	24,255	97,022	2,028	20,961	74,033	40,976	53,996	2,049
303.3	Class C Basecourse	Cu. m.	3.000	0	0	0	0	0	0	0	0
	Bituminous Pavement										
401	**Bituminous Prime Coat and Tack Coat**										
401.1	Prime Coat such as MC70	Kg	0.120	154,000	18,480	54	18,262	165	11,950	5,933	597
401.2	Tack Coat such as RC250	Kg	0.150	0	0	0	0	0	0	0	0
405	**Bituminous Wearing Course**										
405.1	Bituminous Wearing Course	Cu. m.	17.000	16,226	275,845	683	257,921	17,241	176,748	90,260	8,837
	Concrete and Concrete Structures										
504	**Concrete for Structures**										
504.1	Concrete Class 28/20	Cu. m.	40.000	12,922	516,880	40,631	259,617	216,632	180,311	327,554	9,016
504.2	Concrete Class 32/20	Cu. m.	45.000	0	0	0	0	0	0	0	0
504.3	Concrete Class 36/20	Cu. m.	50.000	0	0	0	0	0	0	0	0
509	**Reinforcing Steel**										
509.1	High yield steel bars	ton	250.000	1,204	300,889	11,830	262,821	26,239	184,659	106,997	9,233
509.2	Mild steel bars	ton	250.000	10	2,417	105	2,095	218	1,476	867	74
	Drainage										
801	**Pipe Culverts**										
801.1	Reinforced Concrete Pipe Culvert 600 mm	Lin. m.	35.000	0	0	0	0	0	0	0	0
801.2	Reinforced Concrete Pipe Culvert 750 mm	Lin. m.	50.000	0	0	0	0	0	0	0	0
801.3	Reinforced Concrete Pipe Culvert 900 mm	Lin. m.	75.000	364	27,300	983	6,306	20,011	14,251	12,337	713
801.4	Reinforced Concrete Pipe Culvert 1050 mm	Lin. m.	100.000	0	0	0	0	0	0	0	0
801.5	Reinforced Concrete Pipe Culvert 1500 mm	Lin. m.	155.000	224	34,720	1,250	8,020	25,450	18,124	15,690	906
	Slope Protection										
901	**Rip Rap**										
901.1	Loose stone riprap Class A	Cu. m.	6.000	3,296	19,778	548	4,753	14,477	8,164	11,206	408
901.2	Loose stone riprap Class B	Cu. m.	6.000	0	0	0	0	0	0	0	0
901.3	Mortared stone riprap	Cu. m.	15.000	7,482	112,237	6,878	61,471	43,888	33,209	77,368	1,660
902	**Gabions**				0						
902.1	Gabions	Cu. m.	13.000	3,700	48,100	3,307	27,106	17,687	18,415	28,764	921
906	**Ditch lining**				0						
906.1	Ditch lining (150mm thick)	Sq. m.	2.000	25,200	50,400	6,088	24,313	20,000	14,432	35,246	722
	MSCELLANEOUS STRUCTURES(1300 SAFETY BARRIERS, DELINEATORS AND FENCES, 1400 HIGHWAY SIGNS AND ROAD MARKINGS, AND OTHER ITEMS, 10% of SECTION 200 to SECTION				323,880	13,523	248,701	61,656	233,840	78,348	11,692
	MEASURED WORKS TOTAL (SECTION 200 to 1900)				3,562,681	122,910	1,320,475	2,119,296	1,836,229	1,634,640	91,811
	SECTION 100 PRELIMINARIES (25% of SECTION 200 to SECTION 1800)		------		890,670	7,360	400,276	483,035	658,820	198,909	32,941
	SUB TOTAL				4,453,351	130,269	1,720,751	2,602,331	2,495,049	1,833,550	124,752
	CONTINGENCY (10% of SECTION 200 to SECTION 1800)		------		356,268						
	Total				4,809,619						

Annex 19-2

ENVIRONMENTAL CHECKLIST (MADHA TO DAFTA ROAD)

Road Section: From Madha to Dafta, Existing road condition: Track gravel road

Project Road No.: N36, Planning road: Metalled 2-lane road, Distance: 15.4 km

Environmental Items	Present environmental condition	Impact Rating 1 = Slight 2 = Moderate 3= Significant	Remarks Predicted traffic volume in 2030: 6,100 veh/day
Air Pollution	- Not significant so far.	1	- Future traffic volume will increase to moderate volume, but air quality seams to be not significant and receptors in the road are very rare at present.
Effluent and Water contamination	- Not significant so far.	1	- Not significant.
Noise and Vibration	- Not significant so far.	1	- Future traffic volume will increase to moderate volume, but noise seams to be not significant and receptors in the road are very rare at present.
Land Subsidence	- Not existing.	1	- Not existing.
Topography and Geology	Topography: Topographic feature in the project area is low to moderate relief mountainous terrain, Jabal Half. The road mostly follows along Wadi Mayamt, Wadi Half and Wadi Limarit. (1) 0 km (Start point: Madha)~ 5.8km: 0 km point	1~2	- Slight to moderate impact due to large-scale excavation and embankment between 0 km point and 5.8 km point along Wadi Mayamt. It is necessary to minimize cutting of the slope on the road alignment design, particularly in the western half of the route.

Photo: 5.8 km point, Low Terrace

Photo: Small mountain path along proposed route

Photo: Narrow wadi channel in Wadi Mayamt

is junction between Wadi Mayamt and Wadi Madhah (main stream). This section belongs to the catchment area of lower to uppermost stream of Wadi Mayamt. The route is much meandering with several hundred meters along of Wadi Mayamt. Slope of both sides is steep and small Low Terrace is locally developed. There are many small-scaled slope failures.

(2) 5.8km~ 10.0 km: This section belongs to the catchment area of upper to uppermost stream of Wadi Half, consisting of two tributaries of Wadi Madhah. The route of existing truck road passes along wadis with vertically eroded cliff of the Low Terrace deposits. Around 10 km point, wide terrace plain is formed.

(3) 10.0km~ 15.4km (End point: Dafta): This section belongs to the catchment area of uppermost to lower stream of Wadi Limarit, being tributary of Wadi Ham. The eastern half of the route of existing truck road passes along wadis with vertically eroded cliff of the Low Terrace deposits. The western half of the road mostly passes on the Low Terrace.

Geology: The project area mainly consists of ultrabasic and basic plutonic rocks belonging the Ophiolite sequence as an allochthonous unit,

Photo: Meandering wadi channel

Photo: Wide terrace plain near 10 km point.

	so-called "Samail Ophiolite". The rocks generally are hard, well fractured and partly weathered. Therefore, the rocks forms steep slope and slope failures occur in many places along the route.		
Soil	(1)~ (3): Soil is poorly developed. Alluvial soil is found along the wadi and on the terraces, but mostly thin.	1	- Not significant impact to surface soil due to road construction. - It is necessary to follow the existing road alignment for minimizing of cutting, particularly in the western half of the route.
Hydrology, groundwater	(1)~ (3): Due to the mountainous topography there are a number of wadi channels, Wadi Mayamt and Half of tributaries of Wadi Madhah and Wadi Limarit of tributary of Wadi Ham. These wadis likely occur flooding every year.	1	- Not significant impact due to road construction. - As flash flood is likely to occur at the lower part of the wadis in the project area, it is necessary to examine discharge surface water and erosion.
Eco-system, Flora and Fauna  Photo: Acacia tree	Flora: Sparse vegetation is found along the entire stretch of the project area, but numerous scattered trees, including acacia, willow, cypress, are found in the wadis. The current graded roads in the western part of the route have already impacted the vegetation along the proposed alignment and therefore further impacts to the vegetation are generally considered to be insignificant so long as the current alignment is followed as far as possible. However, plants in the eastern part of the route are not harmed yet.	1~2	- Slight to moderate impact to flora and fauna due to destruction of sparse wadi vegetation by road construction. Road alignment should be followed along existing road. - Domestic animals are grazed and will be suffered traffic accidents.

 Photo: Cypress tree	Fauna: There are not known specific wildlife travel corridors crossing project area. Although endangered or threatened species have not been identified in the area, Hedgehog, Red Fox, Wild Cat, Arabian Gazelle, etc. are likely to male habitats in the area. Numerous domestic animals are present.		
Landscape	(1)~ (3): Mountainous topography.	1	- Not significant impact due to road construction.
Hazards	(1)~ (3): Flash flood.	1	- Not significant impact due to road construction.
Regional Development on Natural Environment	- Not existing so far.	1	- Unknown.
Other Impacts on Natural environment	- Not existing so far.	1	- Not existing.
Cultural Heritage	(1)~ (3): Not existing so far.	1	- Road constriction might be followed along existing road alignment. - The investigation of the cultural heritage is required in the site.
Wastes	- Not significant.	1	- Low traffic volume in future. Wastes along the road will be increased together with increasing traffic volume.
Regional Development on Social Environment	- Not existing so far.	1	-Unknown.
Other Impacts on Social Environment	(1)~ (3): One settlement and farmland are present along the project road.	1	- Increased chance of traffic accident of domestic animals due to increased traffic volume.

 Photo: Vacant village at 0.4 km point	0km: One house and small farm. 0.4km: Vacant village on the terrace, 20 houses. 2.1km: Vacant settlement on the terrace, 5 houses. 12km: 2 houses and farmland.		

Evaluation	**Topography and Geology**	**1~2**	**Alteration of topography**
	Eco-system, Flora and Fauna	**1~2**	**Destruction of sparse vegetation by excavation and embankment**
	Other items	**1**	

Comprehensive Evaluation	**1~2**
Recommendations *1	**Recommended to carry out EIA on assigned items**

*1 : Comprehensive Evaluation

1	: None to slight impacts.	: No need to carry out EIA
1~2	: Small impacts.	: Recommended to carry out EIA on assigned items
2	: Moderate impacts.	: Recommended to carry out EIA
2~3	: Relatively significant impacts.	: Recommended to carry out EIA
3	: Significant impacts.	: Recommended to carry out EIA

Annex 19-3

TERMS OF REFERENCE
ON
THE ENVIRONMENTAL IMPCT ASSESSMENT
OF
THE MADHA – DAFTA RORD,

SULTANATE OF OMAN

1. Project Title

"Environmental Impact Assessment of the Madha – Dafta Road, Sultanate of Oman" (hereinafter referred to as "Study")

2. Executive Agency

Directorate General of Road, (hereinafter referred to as "DGR"), Ministry of Transport and Communications, Sultanate of Oman.

3. Location of Project Area

Project area is enclave territory of Oman, locating in the northern part of the Al Hajar Al Gharbi Mountains. The area is located 55 km north northwest of Shinas city of Oman, as shown in Atttachment-1.

4. Background of the project

The Madha – Dafta Road belongs to Musandum Governorate in Wilayat Madha, which is surrounding by UAE. It is strategic road for Oman and serves local activities of Madha population. The road is designated as one of the 7th Plan (2006-2010) proposed projects.

5. Objectives of the Study

The Study should carry out to accord the Royal Decree No. 10/82 and its amendments entitled "Law on Conservation of the Environment and Prevention of Pollution" as well as other relevant regulations, decisions and guidelines.

The principles of the Study are as follows:

- EIA is a process to help decision makers to protect, conserve and manage Oman's environment, according to the principles of sustainable development, maintaining human well-being, healthy environment and a sound economy;
- The EIA process should ensure that the individual, company or government agency, proposing a project considers its effect on health, economy and culture of surrounding community as well as its impact on air, land and water;
- The EIA should be applied as early as possible in project's planning stage and before irrevocable decisions are made; and
- Public information is an important component of an open and balanced EIA process.

And, the specified objectives of the Study are show as below:

i) To identify, predict, and assess environmental impacts due to proposed activities on the physical, biological and social environment;
ii) To propose mitigation measures for avoiding and reducing the impacts and evaluating associated risk; and
iii) To submit the Environmental Impact Assessment report and relevant documents.

6. Project Description:

The project description of the Madha – Dafta Road shows as below:

- The project road is located in the enclave territory at the southern part of the Musandum Region and surrounding by UAE. The project area is topographically characterized by ragged topography developed in the ultrabasic igneous rocks at the Al Hajar Al Gharbi Mountains,
- The project road strategic road for Oman and serves local activities of Madha population,
- The length of the project road is 15.4 km,
- The road hierarchy of the project road is designated to the secondary road that its right-of-way is 50 m, and
- The project road traverses mostly in low to moderate relief of mountainous terrains and along the wadis, as shown in Attachment-2.

7. Scope of the Study:

This project is classified as Roads of the Group five (Service projects) in accordance of the "Guidelines for Obtaining Environmental Permits" (Directorate General of Environmental Affaires). In addition, as results of the environmental consideration of the project are recommended that the project should be carried out EIA before project implementation, comprehensive EIA should be required.

In order to achieve the objectives mentioned above, the scope of the Study consist of following items:

1) Collect and review the existing data and information relevant to the project

- Legislative information,
- Topographical, geological and pedological data,
- Aero photographs and/or satellite images covered in and around the project area,
- Meteorological data around the project,
- Hydrological and hydro-geological data relevant to the project,
- Biological and ecological data and information,
- Information of land use and its history,
- Natural scenic spots, national park, etc.,
- Information of open-air recreation,
- Information of natural hazards,
- Sociological data and information,
- Administrative data and information,
- Socio-economic data,
- Cultural and historical heritages,
- Traffic volume data, and
- Other data and information relevant to the traffic, etc.

2) Project description

- Location,
- Road design and design criteria,
- Road capacity,
- Road section for construction,
- Pre-construction activities,
- Construction plans and scheduling,
- Staffing and support,
- Associating facilities and services,
- Operating procedures and maintenances,

- Future traffic volume,
- Land use requirement, and
- Alternative alignments, etc.

3) Site description and its environment (Baseline survey)

The content of the baseline study consists of the following environmental items:

(1) Air quality: Measuring points consist of each settlement as well as start and end points and adjacent villages, and number of measuring times is two, i.e. summer and winter seasons, and measuring parameters consist of SO_2, TSP, PM_{10} and fallen-dust,
(2) Water quality: measuring points consist of wells, water spring, and adjacent aflaj water, and number of measuring times is two, i.e. summer and winter seasons, and analysis parameters consist of pH, Electric conductivity (EC), Water temperature, Ca, Mg, Fe, Mn, K, Na, CO_3, Hg, Pb, As, Cr, Cd, Se, SO_4 and Cl,
(3) Noise and vibration: measuring points consists of each villages and settlements, and number of measuring times is two, i.e. summer and winter seasons, and measuring parameter is dB(A) on the boundary of ROW,
(4) Topography and geology: Topographical and geological investigation,
(5) Soil: Pedological investigation consists of soil sections at the point of every 2 km interval and each settlement and farmland,
(6) Groundwater: Hydro-geological investigation consists of outflow of adjacent aflaj and measurement in the sites, comprising of pH, EC and Water temperature,
(7) Ecosystem, flora and fauna: Number of investigating times is two, i.e. summer and winter seasons,
(8) Landscape,
(9) Hazards,
(10) Communities,
(11) Wastes,
(12) Cultural heritage,
(13) Resettlement, and
(14) Traffic volume and traffic accidents at junction with main roads: Traffic census and interviews.

While baseline survey, the proponent should be found stakeholders, related to the project, e.g. residents of local communities in the site, indigenous people, experts from government organizations, local government officer, NGO, etc., and should be

collected their opinions in order to get an appropriate agreement and to reflect to the decision-making of the project.

4) Evaluation of project's impacts

The content of the evaluation of impacts with the project consists of the following items:

- Cumulative and indirect environmental impacts, likely to result from the project in combination with existing or planned projects or activities,
- Impact on socio-economic conditions,
- Impact on physical and cultural heritage, and
- Proposal and evaluation of reasonable alternatives to the project and their impacts.

The evaluation should be carried out to use the environmental standards or guidelines to establish significant of the harmful impacts. A risk assessment can be used when there are no applicable threshold standards or guidelines. The following criteria should be applied to determine significant or adverse impacts:

(1) Magnitude,
(2) Frequency and duration,
(3) Location and sensitivity of environment, and
(4) Irreversibility.

5) Mitigating measures and evaluating associated risks

The following approaches can be used to mitigate likely significant harmful impacts:

- Direct prevention by avoiding sensitive areas,
- Reduction by adjusting work schedules, pollution control devices, changes in design, etc.,
- Restoration and remediation measures, and
- Compensation.

6) Final assessment

The final assessment should be done to evaluate through a net effect analysis.

7) Documentation

Documentation I composed of reference and working documents. The former will

contain a detailed record of the work done on the EIA. The latter is the document, which contain the information for action, e.g. the Environmental Impact Statement as well as Summary.

The content of the Environmental Impact Statement should be contained the following items:

- Information describing the EIA,
- Information describing the project,
- Information describing the site and its environment, shown as below:
    (1) Physical features
    (2) Legislative framework
    (3) Assessment of impacts, shown as below:
        a. Impacts on human beings, buildings and man made features,
        b. Impacts on flora, fauna and geology,
        c. Impacts on land,
        d. Impacts on water,
        e. Impacts on air and climate,
        f. Other direct and secondary effects associated with the project,
        g. Environmental management plan – Mitigating measures and risk assessment, and
        h. Conclusions and additional information.

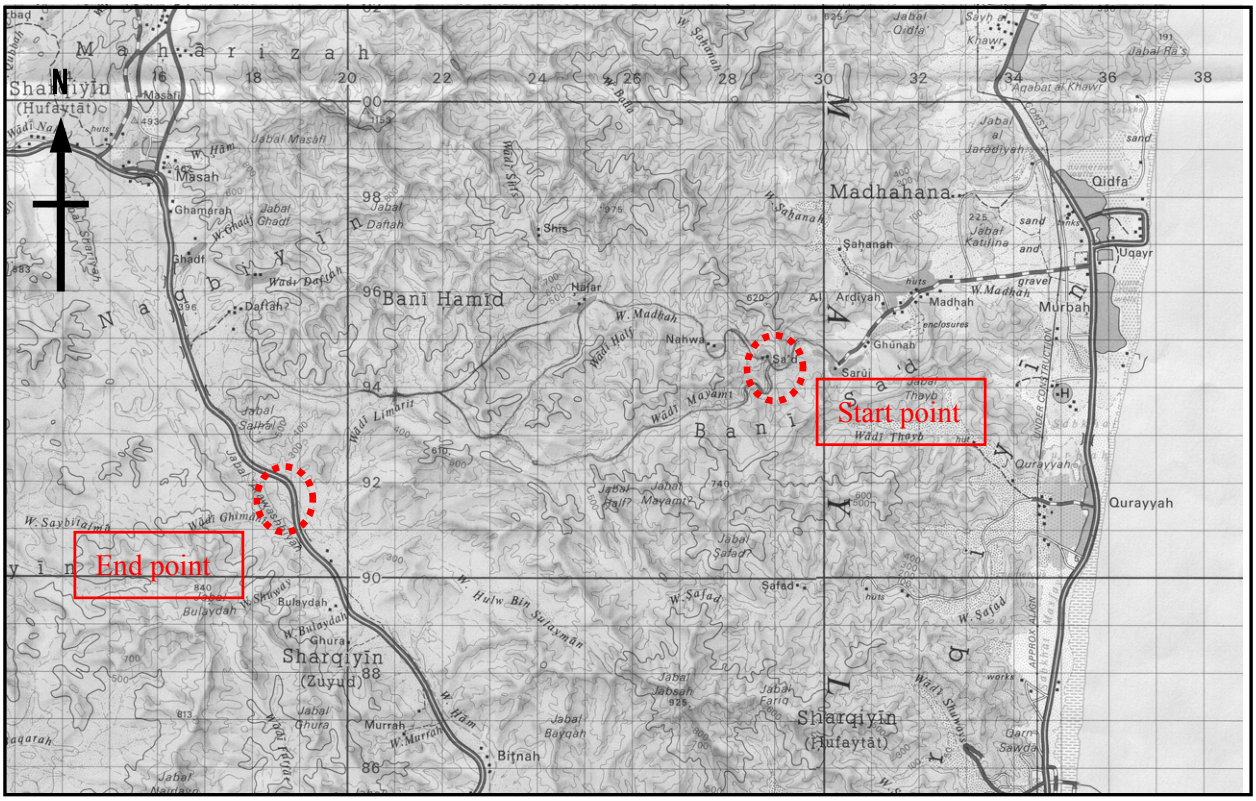
8. Study Timetable

Tentative study timetable of the project shows in Attachment-3.

Attachment:

Attachment-1 Location Map of the Project Road
Attachment-2 Topographic Map of the Project Road
Attachment-3 Tentative Study Timetable of the Project

Attachment-1 Location Map of the Project Road



Attachment-2 Topographic Map of the Project Area

Attachment-3 Tentative Study Timetable of the Project

Year	200 -															Remarks
Number of month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**-**	
1. Data collection	▬															
2. 1st. Field investigation		▬	▬	▬												Summer/winter season
3. 2nd. Field investigation								▬	▬	▬						Winter/summer season
4. Data analysis			▪▪▪	▪▪▪	▪▪▪	▪▪▪	▪▪▪			▪▪▪	▪▪▪	▪▪▪	▪▪▪			
5. Reporting	1 △	○	○	○	○	○	○	○	○	○	○	○	○	2 △	3 △	

△ 1 : Inception report
2 : Draft Final report
3 : Final report

○ **:** Monthly report

▬ **:** Work in the site

▪▪▪ **:** Chemical analysis