Chapter 11 Vehicle Operating Costs

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11.1 General

The running of vehicles on road incurs several type of costs to the road user such as cost of fuel, tire, spare parts, maintenance etc. These costs incurred in running vehicles on road are termed as Vehicle Operating Costs (VOC) and, depend on several factors such as surface condition of road, geometric characteristics of road, vehicle characteristics, cost of vehicle and resources consumed in vehicle operation such as fuel, tire, spare parts etc. The improvement in road section such as improvement in type/condition of pavement or geometric characteristics leads to reduction in VOC on that road section. These reductions (or savings) in VOC constitute the major portion of benefits arising from the road improvement projects.

In this chapter, the VOCs are estimated for the road and vehicle conditions in Western Kazakhstan. Since the VOCs vary considerably by the road surface condition and type of vehicle, the VOCs were estimated by type of vehicle and by types of road surface condition. The HDM-VOC model developed by the World Bank was used to compute the VOCs as discussed in the next section.

It must be noted that Kazakhstan has undergone (and is still under going) rapid changes in past few years such as the break-up from Soviet Union, the introduction of market economy, new currency and new fiscal and tax structures. These changes in addition to the fact that several pricing methods still persist that of the Former Soviet Union makes it difficult to estimate the economic price of resources. So the economic prices and the VOC estimated here should be interpreted with care. The economic prices and VOC's are estimated in US Dollar. The rate of 1US$ = 66.5 Tenge was used to convert Tenge, the local currency into the US Dollar.

11.2 HDM-VOC Model

The HDM-VOC model is a computer program developed by the World Bank for estimating the various components of VOC such as cost of fuel consumption, lubricant consumption, tire consumption, maintenance and crew labor costs, depreciation costs etc. Since the VOC vary considerably depending on the type of vehicle, this model is designed to estimate VOC for 10 types of vehicles ranging from small car to an articulated truck. For estimating the different components of VOC, this model requires the following main input data;

a) Roadway characteristics such as roughness (IRI), gradient, curvature etc.

b) Vehicle characteristics and vehicle utilization data such as average annual veh-kms, average life of vehicle etc.

c) Average consumption rate of resources such as fuel consumption, tire consumption etc.

d) Unit cost of resources such as cost of new vehicles, cost of fuel, lubricants, tire, maintenance and crew labor rates, interest rate etc.

The HDM-VOC model is derived from the Highway Design and Maintenance Standards Model (HDM-III) of the World Bank and uses the relationships contained in the original model. The output from the model includes physical quantities of resources consumed, average running speed, unit VOC for different components of VOC in any desired currency.

For the purpose of this study, the input data was collected through field surveys, traffic surveys, road inventory data; the costs of resources were obtained from visits to relevant firms and organizations, interviews with vehicle dealers and operators and discussion with Kazdornii. The input data used for estimating the VOC is described later in this chapter.

11.3 Representative Vehicles and Prices

Most of the vehicles observed in Western Kazakhstan were manufactured in Former Soviet Union. The buses were mostly from Hungary. Some foreign-made vehicles especially passenger cars from South Korea and light trucks from Germany were also observed but their share is very small. The representative models for estimation of VOCs were decided based on field observations and discussions with Kazdornii, and are shown in Table 11.3.1. The purchase prices of vehicles in economic terms were collected during the field study and with interviews with car dealers and truck operators.

The physical and operating characteristics of some of the representative models is shown in Table 11.3.2.

Table 11.3.1 : Representative Models of Vehicles in Western Kazakhstan

Vehicle Type	Representative Models	Prices (in US$)
Passenger car	LADA, Moskvich 2140, Volga	8,500
Bus	Ikarus 250, LAZ 699P	48,000
Light Truck	UAZ-452V, UAZ-452D, RAF 2203	15,000
Heavy Truck	Kamaz 53212, Maz 5335, ZIL 131	42,000

Table 11.3.2 : Physical and Operating Characteristics of Vehicles in Western Kazakhstan

Type of Vehicle	Name/Type of Model	No. of Seats	Maximum Speed (km/h)	Fuel Consumption (1) (liters/100 km)	Fuel Capacity (liters)	Gross Weight (2) (kg)	Net Weight (3) (kg)	Payload (4) (kg)	No. of Tires	No. of Axles
Passenger Car	1) LADA	4	135	8.0	40	1,435	1,045	-	4	2
	2) Moskvich 2140	4-5	142	8.8	46	1,480	1,080	-	4	2
	3) Volga	5	147	11	55	1,820	1,420	-	4	2
Light Vehicles	1) UAZ-452V	10	95	13	56	2,690	1,870	200	4	2
	2) RAF 2203	11	120	12	55	2,710	1,675	-	4	2
	3) UAZ-452D	2	95	13	56	2,620	1,720	800	4	2
Bus	1) Ikarus 250	42	106	18.5	200	15,180	11,000	-	6	2
	2) LAZ 699P	41	102	41	2x150	12,998	8,896	-	6	2
Heavy Trucks	1) Kamaz 53212	3	80-100	24	170	18,425	8,200	10,000	10	3
	2) MAZ 5335	2	85	22	200	14,950	6,725	8,000	6	2
	3) ZIL 131	2	80	40	170	11,925	6,460	5,000	6	3

(1) Under Standard Speed Conditions; For Passenger car = 80 km/hr; For Bus = 50 km/hr; For Heavy Trucks = 30-40 km/hr
(2) Gross Weight = Net Weight + Weight of Passengers + Weight of Cargo
(3) Net Weight includes only the weight of fuel and one spare tire.
(4) Payload includes only the weight of the cargo.

Source : "Reference Book on Vehicles", Research Institute of Traffic and Transport, Moscow, 1982.

11.4 Vehicle Life and Utilization

The average vehicle utilization in terms of kms per year, hours per year and age of vehicle constitute an important input for the estimation of VOCs. The average vehicle utilization data was collected during the field study and with discussion with Kazdornii, and is shown in Table 11.4.1.

Table 11.4.1 : Average Vehicle Life and Utilization in Western Kazakhstan

Vehicle Type	Kms per Year	Hours per Year	Average age (in Years)
Passenger car	25,000	500	9
Bus	140,000	2,750	11
Light Truck	75,000	1,750	9
Heavy Truck	150,000	3,100	8

11.5 Cost of Other Resources

(1) Cost of Fuel and Lubricants

Three main type of gasoline is sold in Kazakhstan namely 95 octane, 92 octane and 76 octane. The 76 octane type of gasoline is the widely used one because of its low price, although some users prefer to use the more expensive and better quality gasoline such as 92 and 95 octane type. The market prices of Gasoline, Diesel and Lubricants is as follows.

(a) Cost of Gasoline
- 95 octane US$ 0.38/liter
- 92 octane US$ 0.34/liter
- 76 octane US$ 0.24/liter

(b) Cost of Diesel US$ 0.20/liter

(c) Cost of Lubricants US$ 1.02/liter

The market prices of fuel and lubricants mentioned above includes several types of state subsidies at the stage of production, distribution and sales. Some gasoline shops sell gasoline at subsidized rates decided by the government. The buses and trucks which are mostly state-owned gets subsidized fuel and lubricants from government. For estimating the VOC, it is necessary to estimate the economic cost of fuel and lubricant by type of vehicle. The presence of state subsidies and the availability of different brands makes it difficult to calculate the economic price. The economic costs of fuel and lubricants by type of vehicle were decided based on discussions with Kazdornii and are shown in Table 11.5.1.

(2) Cost of Tire

Almost all the tires used in Kazakhstan are imported from the CIS states and Eastern Europe. The economic prices of tires by type of vehicle were decided based on interviews with car dealers and discussions with Kazdornii and are shown in Table 11.5.1.

Table 11.5.1 : Cost of Fuel, Lubricant and Tire by Type of Vehicle (in US$)

Vehicle Type	Fuel Cost per Liter	Lubricant Cost per liter	Single Tire Cost
Passenger car	0.3	1.2	55
Bus	0.25	1.0	250
Light Truck	0.25	1.0	140
Heavy Truck	0.25	1.0	225

(3) Cost of Crew and Maintenance Labor

Because of the long distances traveled by vehicles in Western Kazakhstan, the crew of most buses and trucks consist of one driver and one or two assistants. The hourly wage of bus drivers is around US$ 2.25 and for trucks it varies from US$ 1.25 to US$ 1.75 depending on the size of the truck. Most of the buses and trucks belong to state-owned organizations which have their own maintenance staff of skilled mechanics. The average hourly maintenance labor cost was taken as US$ 3.00 for buses and for trucks it varies from US$ 1.75 to US$ 2.25. For passenger cars, this figure is around US$ 3.00.

(4) Interest Rate

The annual interest rate on purchase of new vehicles was taken as 5%. This figure was arrived at considering the economic situation in Kazakhstan and discussions with Kazdornii. This figure is similar to those used by other studies of similar nature in Kazakhstan.

11.6 Estimation of VOC

As discussed earlier, the HDM-VOC computer program developed by the World Bank was used to estimate the VOCs. This model predicts the various components of VOC using the input data related to roadway characteristics, vehicle characteristics and unit costs of resources consumed in vehicle operation such as fuel, tire, spare parts etc. The input data was collected through field surveys, traffic surveys, road inventory data; the costs of resources were obtained from visits to relevant firms and organizations, interviews with vehicle dealers and operators and discussion with Kazdornii. The input data used for estimating the VOC is shown in Table 11.6.1.

The HDM-VOC model follows the following four steps to compute the VOC for each vehicle type;

1. Computes the average operating speed for the vehicle.
2. Computes the amount of resources (such as fuel, tires) required per 1000 veh-km of vehicle operation for the different components of the VOC.
3. Multiplies the amount of resource consumption to the unit cost of resources to compute the VOC for each item.
4. Sum the VOC of each item to compute the total VOC per 1000 veh-km.

Since VOC vary considerably depending on the type of vehicle and road surface condition, the VOC was estimated for the following four types of vehicles and five types of road surface condition.

The four type of vehicles considered were;

(1) Passenger car
(2) Bus
(3) Light Truck
(4) Heavy Trucks

The five categories of road surface condition were considered depending on its International Roughness Index (IRI in m/km) value as follows;

(1) Good (IRI <= 4)
(2) Fair (4 < IRI < 7)
(3) Poor (7 <= IRI < 9)
(4) Very Poor (IRI >= 9)
(5) Very Poor -Gravel (IRI >= 12)

For the purpose of estimating VOC, the IRI value of 3, 5, 9, 12 and 15 was used for the road category of Good, Fair, Poor, Very Poor and Very Poor (Gravel) respectively.

The VOCs were estimated in US$ per 1000 veh-km and the total VOC consisted of the following 8 components as follows.

1. Fuel
2. Lubricants
3. Tires
4. Crew
5. Maintenance labor
6. Maintenance parts
7. Depreciation
8. Interest

The unit VOCs by type of vehicle and road surface condition as estimated in this Study are shown in Table 11.6.2 to Table 11.6.5.

11.6.1 : Input Data for Estimating VOC

S. No	Item	P. Car	Bus	L.Truck	H.Truck
1. Vehicle Characteristics					
1.1	No. of axles	2	2	2	3
1.2	No. of tires	4	6	6	10
1.3	Tare weight (kg)	1,250	11,000	3,700	8,200
1.4	Load carried (kg)	400	3,150	3,500	10,000
2. Vehicle Utilization					
2.1	Annual veh-kms	25,000	140,000	75,000	150,000
2.2	Annual veh-hrs	500	2,750	1,750	3,100
2.3	Average service life (yrs)	9	11	9	8
2.4	Average age (in kms)	115,000	925,000	400,000	600,000
2.5	Hourly utilization Ratio	0.5	0.8	0.9	0.9
3. Economic Costs (US$)					
3.1	New vehicle price	8,500	48,000	15,000	42,000
3.2	Fuel price (per lt)	0.3	0.25	0.25	0.25
3.3	Lubricant price (per lt)	1.2	1.0	1.0	1.0
3.4	Tire price	55	250	140	225
3.5	Crew time cost (per hr)	0	2.25	1.25	1.75
3.6	Maintenance labor cost (per hr)	3.5	3.0	1.75	2.25
3.7	Annual interest rate (%)	5	5	5	5

Table 11.6.2 : Unit VOCs for Passenger Car in Western Kazakhstan

(US$ per 1000 veh-km)

VOC Component	Road Surface Condition				
	Good	Fair	Poor	Very Poor	Very Poor (Gravel)
Fuel	23.25	23.22	21.92	20.89	21.16
Lubricants	2.40	2.77	3.49	4.03	4.58
Tires	3.68	4.47	6.03	7.21	8.39
Crew Time	0.00	0.00	0.00	0.00	0.00
Maintenance Labor	9.03	10.98	16.21	20.64	24.40
Maintenance Parts	17.06	24.36	49.66	77.26	104.91
Depreciation	34.40	34.53	35.38	36.39	37.63
Interest	6.57	6.63	7.06	7.63	8.40
TOTAL	**96.40**	**106.95**	**139.75**	**174.05**	**209.45**

Table 11.6.3 : Unit VOCs for Bus in Western Kazakhstan

(US$ per 1000 veh-km)

VOC Component	Road Surface Condition				
	Good	Fair	Poor	Very Poor	Very Poor (Gravel)
Fuel	79.24	79.95	80.09	81.62	85.86
Lubricants	3.52	3.82	4.43	4.88	5.33
Tires	32.38	33.75	35.52	36.84	38.64
Crew Time	31.34	32.26	37.46	44.31	54.13
Maintenance Labor	38.46	46.54	68.18	90.78	120.86
Maintenance Parts	74.33	81.54	98.12	112.73	129.50
Depreciation	26.48	26.85	28.83	31.21	34.21
Interest	6.58	6.72	7.53	8.59	10.11
TOTAL	**292.32**	**311.44**	**360.16**	**410.96**	**478.63**

Table 11.6.4 : Unit VOCs for Light Trucks in Western Kazakhstan

(US$ per 1000 veh-km)

VOC Component	Road Surface Condition				
	Good	Fair	Poor	Very Poor	Very Poor (Gravel)
Fuel	52.50	53.37	56.50	60.95	67.32
Lubricants	2.65	2.95	3.56	4.01	4.46
Tires	31.31	32.80	35.27	37.39	40.06
Crew Time	18.37	19.08	22.72	27.12	32.72
Maintenance Labor	16.53	21.13	28.28	32.70	36.62
Maintenance Parts	28.96	46.49	81.54	107.83	134.11
Depreciation	16.90	17.30	19.22	21.32	23.69
Interest	3.33	3.44	4.01	4.68	5.55
TOTAL	**170.57**	**196.56**	**251.10**	**295.99**	**344.53**

Table 11.6.5 : Unit VOCs for Heavy Trucks in Western Kazakhstan

(US$ per 1000 veh-km)

VOC Component	Road Surface Condition				
	Good	Fair	Poor	Very Poor	Very Poor (Gravel)
Fuel	96.03	96.71	97.12	99.94	105.63
Lubricants	3.52	3.82	4.43	4.88	5.33
Tires	38.80	40.34	43.09	45.54	48.58
Crew Time	27.52	28.82	34.73	41.53	50.14
Maintenance Labor	32.39	38.37	48.29	54.63	60.35
Maintenance Parts	119.67	165.89	258.33	327.66	396.98
Depreciation	29.85	30.68	34.20	37.80	41.79
Interest	5.49	5.72	6.75	7.93	9.43
TOTAL	**353.27**	**410.35**	**526.93**	**619.90**	**718.24**

Chapter 12 Environmental Assessment

Chapter 12 Environmental Assessment

The Initial Environmental Examination (IEE) and the Environmental Impact Assessment on the priority projects was prepared in accordance with JICA guideline and requirements of Department of Highways, the Ministry of Transport and Communication for the environmental review of road reconstruction and rehabilitation project, based on "The Nature Conservation Law of Kazakhstan, 1991" and the "Environment Impact Assessment Act, 1993".

12.1 Environmental Condition in Western Kazakhstan

12.1.1 Land Condition

The land conditions of the study area can be roughly classified into four groups. These are 1) steppe, 2) desert, 3) solonchak soil area and 4) continuous shrubbery.

1) Steppe — Steppe with spotted shrubbery covers most of the study area. The soil of the steppe area is mostly clayey. The vegetation is poor due to low rainfall (100~200mm per year). Because this area is unsuitable for rainwater dependent agriculture, grazing is the main activity. The area that is utilized for agriculture is limited. There are irrigated areas along Ural river, farmlands near towns and along roads mainly in the north of the study area.

2) Desert — There is the Ryn Peski desert (sand desert) in western Atyrauskaya and West Kazakhstan state. There is sand or salt desert due to draw-down of the water level in the northern part of the Aral Sea basin, and calcic desert in southern Mangistauskaya state. Aktyubinakaya and Mangistauskaya state are dotted with small deserts due to long-term overgrazing.

3) Solonchak soil area — Solonchak soil is white salty soil affected by salt water, and there is a solonchak soil area in the lowlands and around the Caspian Sea. Only plants with high salinity tolerance can grow naturally. This area is quite unsuitable for agriculture and some of it is inundated seasonally by water from the Caspian Sea and rivers.

4) Continuous shrubbery — There are small areas of continuous shrubbery in northern Mangistauskaya state and southwestern West Kazakhstan state. Plants of *Persicaria* or *Chenopodiaceae* are the dominant species. If grazing activities were stopped completely, most of the steppe area would become continuous shrubbery that is the natural climax of the study area.

12.1.2 Flora and Fauna

Except for some small areas, most of the study area is steppe or desert, so the diversity of flora and fauna is poor. But in sheer ledge areas called Chinks where the Ustyurt plateau descends to the surrounding lowlands, rare or endemic species exist. The part of sheer ledges is designated as "Ustyurtskay nature conservation area" in Mangistauskaya state. The east coast of the Caspian Sea is along the route of many kinds of migratory birds.

12.1.3 Cultural and Architectural Monuments

The Silk Road had crossed the area, and one of its two main roads, called the steppe road, had run from Nukus in Uzbekistan to the northern part of the Caspian Sea. The road branched off around Beyneu city in Mangistauskaya state. The branch led to around Fort Shevechenko port, where it connected to the Caspian Sea route. For that reason, this area is dotted with the remains of the Silk Road period. Especially in Mangistauskaya state, there are not only remains of the Silk Road period, but also many medieval or early modern graveyards. About half of the cultural and architectural monuments of Kazakhstan are concentrated in Mangistauskaya state. These monuments are culturally of great importance to the residents.

12.2 Environmental Considerations

Some road construction or rehabilitation project may have negative effects on the environment in the project area during the construction stage and/or after implementation. The environmental impacts in this road development study are summarized as follows.

12.2.1 General

The project types in this study are rehabilitation, reconstruction and/or pavement of existing roads, and so the negative impacts are much smaller than for new road construction projects. As the road width of most existing roads is wide enough to rehabilitate or pave, important earth-moving and resettlement will not be required. Most existing roads are far away from residential areas, so the impact of noise, vibration and air or water pollution will not occur. The roadside slopes in the steppe area are so gentle that livestock are not prevented from crossing.

12.2.2 Flora and Fauna

The causes of impact on flora and fauna due to road construction are removal of vegetation, extinction of habitats, generation of exhaust gas and noise from vehicles and disruption of migratory routes and habitats. With regard to this project, as most of the project area is steppe with spotted shrubbery, the vegetation is poor, moreover substantial removal of vegetation is not required at the construction stage, so the impact on flora is very small. As most existing roads are far removed from the main habitats of rare fauna and there will not be a lot of traffic on these roads, the impact on fauna is expected to be small. But a detailed study of the habitats will be required,

especially in the sheer ledge areas of the Ustyurt plateau, at the F/S stage. If the planned road construction affects the migration routes, mitigating measures should be taken to keep the routes open. Mitigating measures for the impact are careful road design including construction methods and installation of road signs showing the habitats.

12.2.3 Cultural and Architectural Monuments

As most existing roads are far enough from the cultural and architectural monuments, there is no direct impact on the monuments during the construction stage and after implementation. These monuments are valuable sightseeing resources and culturally important for the residents. In Mangistauskaya state and the northern part of the Caspian Sea where the Silk Road had passed before, a study on planned utilization of the monuments and the protection will be required at the F/S stage.

12.2.4 Hydrological Situations / Coastal Zone

The causes of impact on the hydrological situation and coastal zone due to road construction are changes in flow and river bed due to bridges or road embankments, dredging and changes in sedimentation in coastal zones. With regard to this project, as large bridge and road embankment construction are not included, the impact is very small. In the future, in the case of embankment or levee road construction for flood control at the mouth of Ural river or the Caspian Sea coast, detailed study of the effects and a protection plan will be required at the F/S stage.

12.2.5 Soil Erosion

As most of the study area is flat ground covered by clayey soil and is seldom damaged by heavy rain, soil erosion due to road construction is a minor problem. But mitigating measures for soil erosion are required in the sheer slope areas and the riverbanks. The natural vegetation is poor, so except for limited areas, artificial planting as the mitigating measure is very difficult and not recommended. Slope protection, provision of appropriate side slope ratios, consideration of construction plan and stream protection works are useful as mitigating measures.

12.2.6 Landscape/Topography and Geology

As much earth-moving is not required during the construction stage, the direct impact on landscape or topography and geology is very small. The sheer ledge areas of the Ustyurt plateau and Mangistauskaya state are exciting visually and valuable sightseeing resources. Consideration should be given to maintaining harmony with the surrounding landscape at the design stage.

12.3 Environmental Impact Assessment (EIA) of Priority Projects

This EIA provides a description of the project and of the environment in the project area, considers potential environmental impacts and mitigation measures, and conclusions.

12.3.1 EIA on Kzyl-Orda Border - Karabutak Section

(1) Description of the project

This project includes the reconstruction of the Kzyl-Orda Border - Karabutak road section, about 275km long, of the Samara - Chimkent road (International Highway). The reconstruction works will consist mainly of removal of existing surface asphalt and placement of base course, replacement of asphalt and bridge rehabilitation or reconstruction. Most of the reconstruction works will be confined to the existing road structure.

(2) Description of the Environment in the Project Area.

(a) Social Environment

The population density is very low in this area. The towns along this road are Karabutak and Irgiz. Other settlements include the villages of Zharotkely, Araltogai, Zhakyp, Dongeleksor, Milysai, Karakuduk, Kalybai and Kurylys. Except for Karabutak town and Kalybai, Irgiz town and other villages are far from the road.

There is little land that is utilized for agriculture in this area. Nomadic activity is also small, and major industries have not been developed. But this road has a very important transportation function because it is the shortest way to connect central Asian countries with Russia. From Irgiz, the secondary road continues to Chelkar town where there is a railway station.

There are no important cultural and architectural monuments along the road.

(b) Natural Environment

The topography along the Kzyl-Orda Border - Karabutak road section is almost flat and slopes toward the south gently, -only small areas are rolling. The ground elevation ranges from 100m to 250m. The rainfall is 100 ~ 200 mm per year. Steppe covers most of this area, -there are no woods. The soil is mostly clayey, and in the lowlands, includes salt. There are small sand desert due to long-term overgrazing nearby Kalybai village and sand deserts with spotted shrubbery to the west of Irgiz.

The vegetation is poor, especially in the lowlands, -only few plants with high salinity tolerance and drought resistance can grow naturally. In general sagebrush (*Artemisia*) is the dominant species in the north of this area, perennial saltwort (*Anabasis*) is the dominant species in the lowlands and the south.

With regard to fauna, -saigas, elks, marmots, martens, musk-rats, foxes, wolves and various birds inhabit this area. Steppe eagles entered in "The RED DATA BOOK" of USSR and saigas inhabit the area as a decreasing and endangered species. Especially to the east of Irgiz, there are areas where many kinds of animals are found.

Figure 12.3.1 shows the environmental conditions along the Kzyl-Orda Border - Karabutak road section.

(3) Potential Environmental Impact and Mitigation Measures

(a) Social Environment

Potential environmental impact items that can be related to this road reconstruction project include resettlement, economic activity, split of communities and waste.

Resettlement will not occur, since there are no population centers located directly on the road and most of the reconstruction works will take place on and/or close to the existing road structure.

The impact on agricultural and nomadic activity will be minimal, since there is little agricultural land along the road and the roadside slope is so gentle that livestock not prevented from crossing. The impact on other economic activities and split of communities will be minimal too, since the road has been in existence for decades.

During the construction stage, the removed existing asphalt layer will generate waste. The asphalt will be reused as shoulder material. In case some asphalt is left, a disposal plan for the remainder should be prepared. Since most of the road side is open space, it is easy to find dump sites and the sites can be used as parking space. Consequently the remaining asphalt will have little environmental impact.

As there are few settlements along the road, the temporary contractor's facilities, such as potable water supply, sanitary facilities, garbage and solid waste disposal and medical facilities, should be provided. After completion of the works, these contractor's facilities should be removed completely and the sites should be restored to their former condition.

(b) Natural Environment

Potential environmental impact items that can be related with this road reconstruction project include soil erosion and flora and fauna.

Soil erosion at the road side as a result of the reconstruction works will be minimal, since most of the works will take place on and/or close to the existing road itself without changes in drainage patterns and most of the area is flat and is seldom damaged by heavy rain. The mitigation measures to prevent soil erosion include provision of appropriate side slope ratios and sodding the face of side slopes. But the sodding is not useful in highly saline soil and sand desert areas. In sand desert areas nearby Kalybai village and to the west of Irgiz, it is necessary to prevent removal of

natural vegetation during the construction stage.

Saigas and steppe eagles inhabit this area as rare species. The direct impact on these fauna can be expected to be small, since this road is far removed from the main habitats and there will not be a lot of traffic on this road.

The impact on flora will be minimal too, since substantial removal of vegetation is not required during the construction stage. Conversely, after the completion, the road side along the Kzyl-Orda Border - Irgiz road section where vehicles have been passing due to the poor condition of the existing road, can be expected to recover its vegetation.

(c) Public Nuisance

Potential environmental impact items that can be related with this road reconstruction project include air pollution, water pollution, soil contamination, noise and vibration.

Air pollution results from emissions by construction equipment and vehicles. In general, lead, CO, Hydrocarbon and NOx emission levels from construction equipment and vehicles are high compared with Western European levels. But these toxic substances will have minimal impacts, since this road section does not cross population centers, there will not be a lot of traffic and there are no other pollution sources.

Water pollution and soil contamination result from fuel and oils spilling from construction equipment, and from bridge rehabilitation or reconstruction work. Such pollution will have minimal impact and be of short duration. The impacts can be minimized by maintaining equipment in good running condition and by the proper disposal of used oil.

Impacts of noise and vibration will be negligible, since there are no houses facing this road.

(4) Conclusions

This project will have limited and trivial environmental impacts, so further environmental studies are not required.

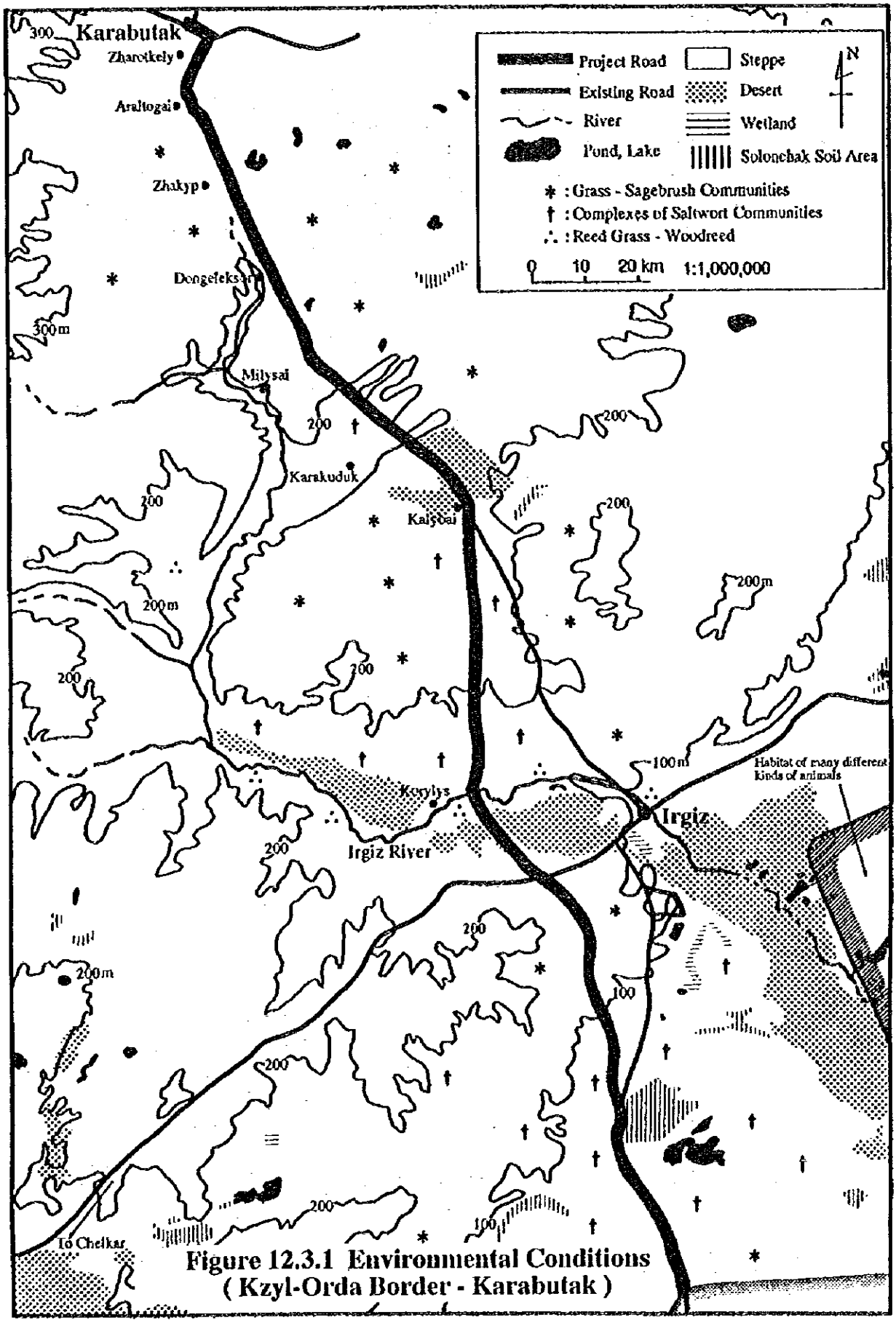


Figure 12.3.1 Environmental Conditions (Kzyl-Orda Border - Karabutak)

12.3.2 EIA on Atyrau - Mahambet Section

(1) Description of the project

This project includes the reconstruction of the Atyrau - Mahambet road section, about 83km long, of the Atyrau - Uralsk road (International Highway). The reconstruction works will consist mainly of removal of existing surface asphalt and placement of base course replacement of asphalt and bridge rehabilitation or reconstruction. Most of the reconstruction works will be confined to the existing road structure.

(2) Description of the Environment in the Project Area.

(a) Social Environment

The towns along this road are Atyrau and Mahambet. Other settlements include the villages of Pamyaty-Ilyicha, Almary, Reduty, Chkalovo, Saraichik, Opytnoe-Pole and Zhalgansai. Except for Atyrau and Mahambet, other settlements are far from the road and located in the western bank of Ural river.

There are irrigated farmlands using Ural river water along the road. Atyrau is a major industrial center, producing crude oil, petroleum, fish processing, precast concrete material, and also a transportation center of the Caspian Sea. This road is a life road and has a important transportation function because it is the way to connect central Asian countries with Russia.

There are no important cultural and architectural monuments along the road.

(b) Natural Environment

The topography along the Atyrau - Mahambet road section is flat and slopes toward the south gently. The ground elevation ranges from -23m to -17m. The rainfall is 100 ~ 200 mm per year.

The area all over Atyrau flooded in 1993 and 1994 because of rise of the Caspian Sea level, increase of Ural river flow.

Except for farmlands, steppe covers most of this area, -there are little woods. The soil is mostly clayey, and in the lowlands, includes salt. The natural vegetation is poor. In general reed grass (*Phragmites*), white willow (*Salix*) and tamarisk (*Tamarix*) are the dominant species in the western bank of Ural river, sagebrush (*Artemisia*) and saltwort (*Anabasis*) are the dominant species in the eastern bank. There is a colony of Ephedra strobilacea (*Ephedra*) that is a rare plant to the north of Atyrau.

Marmots, musk-rats, foxes, wolves and various birds inhabit this area, but no rare or endangered species have been reported.

Figure 12.3.2 shows the environmental conditions along the Atyrau - Mahambet road section.

(3) Potential Environmental Impact and Mitigation Measures

(a) Social Environment

Potential environmental impact items that can be related to this road reconstruction project include resettlement, economic activity, split of communities and waste.

Resettlement will not occur, since there are no population centers located directly on the road.

The direct impact on agricultural activity will be minimal, since there are the buffer zones (about 30m) between road structure and the farmlands and most of the reconstruction works will take place on and/or close to the existing road structure. The impact on other economic activities and split of communities will be minimal too, since the road has been in existence for decades.

During the construction stage, the removed existing asphalt layer will generate waste. The asphalt will be reused as shoulder material. In case some asphalt is left, a disposal plan for the remainder should be prepared. Since the buffer zones of the road side is open space, it is easy to find dump sites and the sites can be used as parking space. Consequently the remaining asphalt will have little environmental impact.

(b) Natural Environment

Potential environmental impact items that can be related with this road reconstruction project include soil erosion and flora and fauna.

Soil erosion at the road side as a result of the reconstruction works will be minimal, since most of the works will take place on and/or close to the existing road itself without big changes in drainage patterns and the area is flat and is seldom damaged by heavy rain. The mitigation measures to prevent soil erosion include provision of appropriate side slope ratios and sodding the face of side slopes.

The impact on flora will be minimal, since substantial removal of vegetation is not required during the construction stage. But in the north of Atyrau where there is a colony of Ephedra strobilacea that is a rare plant, it is especially necessary to prevent removal of natural vegetation during the construction stage.

(c) Public Nuisance

Potential environmental impact items that can be related with this road reconstruction project include air pollution, water pollution, soil contamination, noise and vibration.

Air pollution results from emissions by construction equipment and vehicles. The toxic substances (lead, CO, Hydrocarbon and NOx) will have minimal impacts, since this road section does not cross population centers and there will not be a lot of traffic.

Water pollution and soil contamination result from fuel and oils spilling from construction equipment, and from bridge rehabilitation or reconstruction work. The impact of water pollution and soil contamination on the farmlands, irrigation water and Ural river can be expected to be small, since such pollution will be of short duration and there are the buffer zones. The impacts can be minimized by maintaining equipment in good running condition and by the proper disposal of used oil.

Impacts of noise and vibration will be negligible since there are no houses facing this road.

(4) Conclusions

This project will have limited and trivial environmental impacts, so further environmental studies are not required.

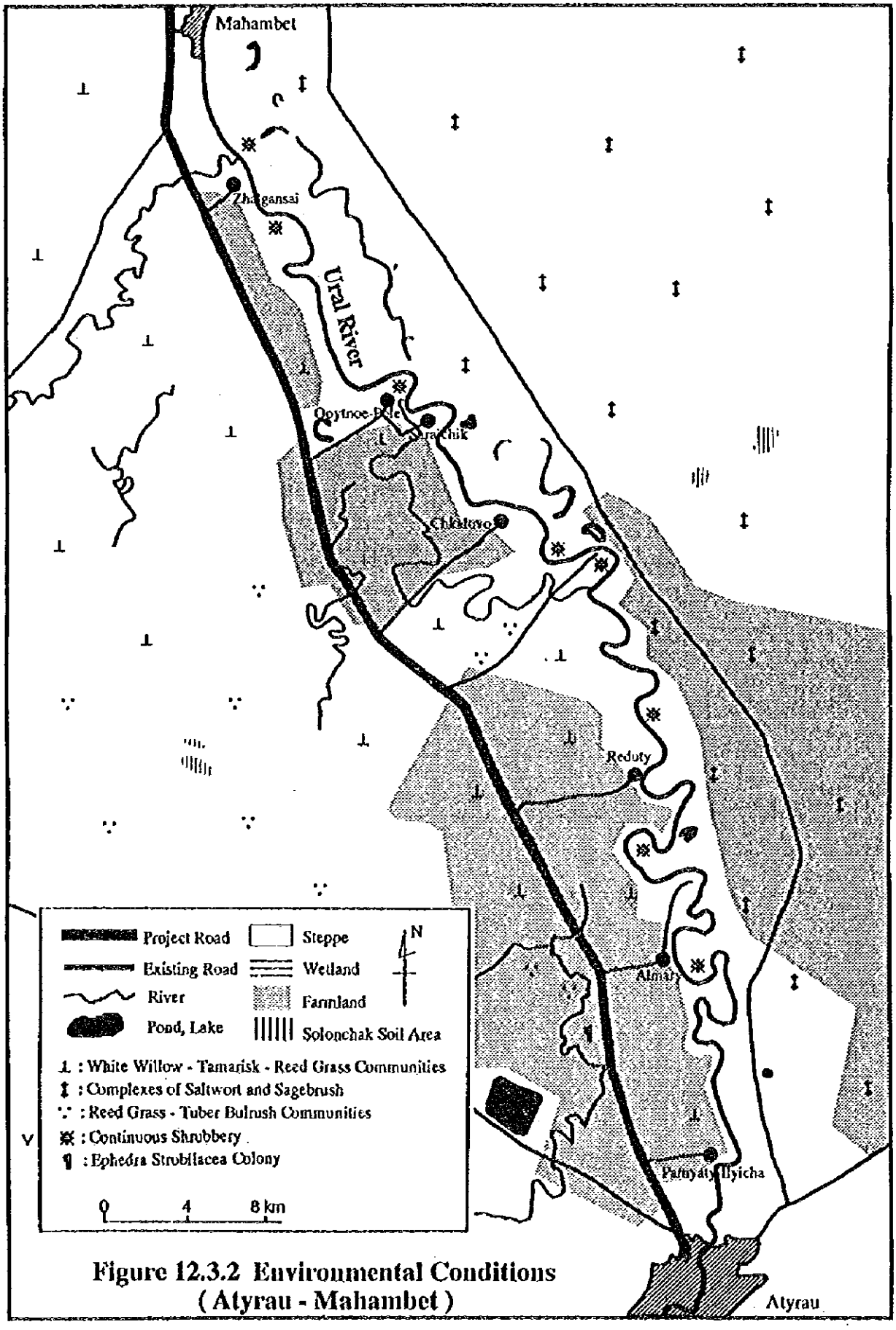


Figure 12.3.2 Environmental Conditions (Atyrau - Mahambet)

Chapter 13 Economic Evaluation and Implementation Plan

Chapter 13 Economic Evaluation and Implementation Plan

13.1 Economic Evaluation

Economic evaluation was carried out for the three priority projects selected for the feasibility study. These three priority project are as follows.

- Road section from Kzyl-Orda Border to Irgiz (86 km)
- Road section from Irgiz to Karabutak (189 km)
- Road section from Atyrau to Mahambet (83 km)

The economic evaluation was carried out using the standard cost-benefit techniques in which costs are compared with benefits over the project's life. As an output of economic analysis, three economic evaluation indices i.e. NPV (Net Present Value), B/C (Benefit-Cost Ratio) and IRR (Internal Rate of Return) were computed for all the three priority projects to check their economic feasibility. The methodology used for economic analysis is described below.

13.1.1 Methodology of Economic Analysis

For each priority project, the road improvement cost (including cost of bridges and culverts), maintenance costs and vehicle operating costs (VOC) were estimated for the "With Project" case and the "Without Project" case. These costs were estimated for each year of the project's life. The project's life was taken as 20 years from the completion of the project. The VOC and maintenance costs of "With Project" case were subtracted from that of "Without Project" case for each year to obtain the VOC benefits and the maintenance benefits. These VOC benefits and the maintenance benefits for each year were added to obtain the total benefits of the project for that year. This total benefit and the road improvement cost was discounted to obtain the discounted cost-benefit stream over the project's life. The discount rate of 12% was taken. The discounted cost-benefit stream was used to compute NPV and B/C. IRR was computed from the undiscounted cost-benefit stream.

For economic analysis, the road improvement costs, maintenance costs and vehicle operating costs were estimated for the "With Project" case and the "Without Project" case as follows.

(a) Estimation of road improvement costs

The estimation of road improvement costs is discussed in detail in Chapter 9 and the methods of road improvement in Chapter 7. The road improvement costs also includes the cost of rehabilitation of bridges and culverts on that road section. These road improvement costs consists of direct costs (cost of labor, materials and equipment), indirect costs, costs of engineering services (10%) and an contingency of 15%. The road improvement costs estimated in Chapter 9 are the financial costs and includes several

types of transfer payments such as taxes, subsidies, social charges and import duties on equipment and materials.

For economic analysis, it is necessary to estimate the "economic costs" of road improvement and maintenance. Since the break-up from the Former Soviet Union, Kazakhstan has undergone rapid changes such as introduction of market economy, new currency and new fiscal and tax structures. These changes in addition to the fact that a lot of rules and regulations still persist that of the Former Soviet Union has made it difficult to estimate the economic cost of resources consumed in road construction. In this study the economic costs were estimated based on previous studies and discussion with concerned government organizations. It was assumed that the economic costs are about 95% of the financial costs and the same is used here in the economic analysis.

The financial and economic costs of the three priority projects is shown in the Table 13.1.1.

Table 13.1.1 : Economic and Financial Costs of Priority Projects

	Road Section	Financial Cost (in 1000 US$)	Economic Cost (in 1000 US$)
1.	Kzyl-Orda Border to Irgiz	19,079	18,125
2.	Irgiz to Karabutak	43,605	41,425
3.	Atyrau to Mahambet	26,729	25,392
	TOTAL	89,413	84,942

(b) Estimation of maintenance costs

The estimation of maintenance costs and the method of maintenance of roads in Western Kazakhstan is discussed in detail in Chapter 10. These maintenance costs consists of routine maintenance such as patching, repair of potholes etc. which need to be carried out every year and periodic maintenance works such as surface dressing and overlays.

For economic analysis, the maintenance costs were estimated for both, the "With Project" case and the "Without Project" case. For the "Without project" case, all maintenance works necessary to keep the road open to traffic and to maintain a minimum acceptable serviceability were considered. The maintenance costs were estimated separately for paved roads (mainly AC pavement) and unpaved roads (mainly gravel).

For the "With Project" case the maintenance costs were estimated so as to keep the road in good condition. These maintenance costs were estimated based on discussions with

Kazdornii and relevant studies in the road sector and are shown in Table 13.1.2. Here again, similar to the road improvement costs, the economic maintenance costs were assumed to be about 95% of the financial costs.

Table 13.1.2 : Economic Maintenance Costs per km in Western Kazakhstan

(Costs are in US$ per km)

Case	Routine Maintenance	Periodic Maintenance	Frequency (years)
"With Project" Case	1,590	56,050	7
"Without Project" Case			
AC Road	4,590	13,420	3
Gravel Road	4,110	5,110	2

(c) Estimation of VOC

The estimation of VOC, the method used and the input data required are discussed in detail in Chapter 11. In that Chapter, unit VOC were estimated for four types of vehicles and for five types of road surface conditions. The four vehicle types were passenger car, bus, light truck and heavy truck. The five surface conditions consisted of good, fair, poor, very poor and very poor (gravel) road surface conditions. The method of classification of roads in these five categories is also discussed in that Chapter.

The unit VOC for roads in Western Kazakhstan by type of vehicle and road surface condition is shown below in Table 13.1.3.

Table 13.1.3 : Unit Vehicle Operating Cost (VOC) in Western Kazakhstan

(US$ per 1000 veh-km)

Vehicle Type	VOC by Type of Road Surface Condition				
	Good	Fair	Poor	Very Poor	Very Poor (Gravel)
P. Car	96.40	106.95	139.75	174.05	209.45
Bus	292.32	311.44	360.16	410.96	478.63
L. Truck	170.57	196.56	251.10	295.99	344.53
H. Truck	353.27	410.35	526.93	619.90	718.24

The total VOC for any particular type of road surface condition and vehicle type is estimated by multiplying its unit VOC by total traffic volume for that vehicle type and the length of the road section.

13.1.2 Economic Analysis of Priority Projects

The economic analysis of the three priority projects was carried out based on the following data.

Discount rate :	12% per annum
Economic life of project :	20 years after construction (from year 2002 to 2021)
Implementation period :	4 years from 1998 to 2001

The economic analysis was carried out using the standard cost-benefit techniques in which the costs and benefits accrued from the project are compared over the life of the project. Two project scenarios were considered. The first scenario is the "Without Project" case in which the project is not implemented and the second scenario refers to the "With Project" case in which the project is fully implemented. The benefits of the project are estimated by subtracting the total costs (road improvement costs, VOC and maintenance costs) for the "Without Project" case from that of "With Project" case.

For the purpose of economic analysis, two main types of benefits were considered viz. VOC benefits and the maintenance benefits, although the project will have several other benefits such as savings in travel time for passengers and freight, increased opportunities for economic development, increased road safety and others.

The VOC benefits were estimated by subtracting the VOC of the road sections for the "Without Project" case from that of "With Project" case. The VOC's of the "With Project" case are generally lower due to the increased speed of the traffic resulting from improved surface condition and pavement structures. The VOC benefits during the construction period was assumed to be zero. In actual, due to construction work the speed of vehicles reduces leading to higher VOC, however this increase in VOC's is offset by the reduced VOC's on the completed sections. The VOC for the "Without Project" case, "With Project" case and the VOC benefits for the three priority sections are shown in Table 13.1.4.

Similar to the VOC benefits, the maintenance benefits were estimated by subtracting the maintenance costs for the "Without Project" case from that of "With Project" case. The maintenance costs for the "With Project" case are generally lower due to the improved and more durable pavement and drainage structures. The maintenance costs for the "Without Project" case, "With Project" case and the maintenance benefits for the three priority sections are shown in Table 13.1.5.

The economic analysis of the three priority projects is shown in Table 13.1.6, Table 13.1.7 and Table 13.1.8 and for all the three projects together in Table 13.1.9.

Table 13.1.4 : Vehicle Operating Costs (VOC) for the Three Priority Projects

(Costs and Benefits are in US$)

Year	Kzyl-Orda Border to Irgiz			Irgiz to Karabutak			Atyrau to Mahambet		
	Without Project Case	With Project Case	VOC Benefit	Without Project Case	With Project Case	VOC Benefit	Without Project Case	With Project Case	VOC Benefit
1998	7,699,208	7,699,208	0	13,416,613	13,416,613	0	8,689,156	8,689,156	0
1999	8,364,387	8,364,387	0	14,596,178	14,596,178	0	10,279,406	10,279,406	0
2000	9,096,170	9,096,170	0	15,900,574	15,900,574	0	12,160,698	12,160,698	0
2001	9,526,248	9,526,248	0	16,734,150	16,734,150	0	12,706,386	12,706,386	0
2002	9,976,669	4,893,529	5,083,140	17,611,674	10,081,814	7,529,860	13,276,563	8,089,941	5,186,622
2003	10,448,395	5,125,029	5,323,366	18,535,477	10,610,783	7,924,693	13,872,327	8,452,769	5,419,557
2004	10,942,433	5,367,485	5,574,949	19,508,012	11,167,665	8,340,348	14,494,826	8,831,871	5,662,955
2005	11,459,841	5,621,415	5,838,426	20,531,868	11,753,940	8,777,928	15,145,262	9,227,977	5,917,285
2006	12,001,723	5,887,363	6,114,359	21,609,767	12,371,170	9,238,597	15,824,886	9,641,849	6,183,037
2007	12,569,237	6,165,899	6,403,338	22,744,580	13,020,998	9,723,582	16,535,010	10,074,285	6,460,726
2008	13,163,598	6,457,618	6,705,980	23,939,329	13,705,157	10,234,172	17,277,003	10,526,116	6,750,886
2009	13,786,074	6,763,144	7,022,931	25,197,200	14,425,472	10,771,728	18,052,293	10,998,214	7,054,080
2010	14,437,998	7,083,131	7,354,867	26,521,547	15,183,864	11,337,683	18,862,377	11,491,486	7,370,891
2011	15,120,762	7,418,264	7,702,498	27,915,904	15,982,358	11,933,546	19,708,815	12,006,884	7,701,931
2012	15,835,825	7,769,260	8,066,565	29,383,995	16,823,088	12,560,907	20,593,238	12,545,398	8,047,840
2013	16,584,717	8,136,870	8,447,847	30,929,743	17,708,301	13,221,442	21,517,353	13,108,067	8,409,286
2014	17,369,039	8,521,881	8,847,157	32,557,280	18,640,366	13,916,914	22,482,940	13,695,974	8,786,965
2015	18,190,466	8,925,118	9,265,349	34,270,960	19,621,777	14,649,183	23,491,860	14,310,251	9,181,609
2016	19,050,756	9,347,442	9,703,314	36,075,370	20,655,162	15,420,208	24,546,058	14,952,080	9,593,978
2017	19,951,748	9,789,759	10,161,990	37,975,343	21,743,290	16,232,053	25,647,567	15,622,698	10,024,869
2018	20,895,368	10,253,014	10,642,354	39,975,971	22,889,080	17,086,891	26,798,509	16,323,396	10,475,113
2019	21,883,634	10,738,200	11,145,434	42,082,619	24,095,605	17,987,014	28,001,104	17,055,524	10,945,581
2020	22,918,659	11,246,355	11,672,304	44,300,940	25,366,105	18,934,835	29,257,670	17,820,490	11,437,180
2021	24,002,657	11,778,567	12,224,090	46,636,890	26,703,993	19,932,897	30,570,628	18,619,769	11,950,859
Total	355,275,613	191,975,355	163,300,258	658,951,987	403,197,504	255,754,483	459,791,936	297,230,687	162,561,249

Table 13.1.5 : Maintenance Costs for the Three Priority Projects

(Costs and Benefits are in US$)

Year	Kzyl-Orda Border to Irgiz			Irgiz to Karabutak			Atyrau to Mahambet		
	Without Project Case	With Project Case	Maintenance Benefit	Without Project Case	With Project Case	Maintenance Benefit	Without Project Case	With Project Case	Maintenance Benefit
1998	792,920	0	792,920	3,403,890	0	3,403,890	1,494,830	0	1,494,830
1999	353,460	0	353,460	867,510	0	867,510	380,970	0	380,970
2000	792,920	0	792,920	867,510	0	867,510	380,970	0	380,970
2001	353,460	0	353,460	3,403,890	0	3,403,890	1,494,830	0	1,494,830
2002	792,920	136,740	656,180	867,510	300,510	567,000	380,970	131,970	249,000
2003	353,460	136,740	216,720	867,510	300,510	567,000	380,970	131,970	249,000
2004	792,920	136,740	656,180	3,403,890	300,510	3,103,380	1,494,830	131,970	1,362,860
2005	353,460	136,740	216,720	867,510	300,510	567,000	380,970	131,970	249,000
2006	792,920	136,740	656,180	867,510	300,510	567,000	380,970	131,970	249,000
2007	353,460	136,740	216,720	3,403,890	300,510	3,103,380	1,494,830	131,970	1,362,860
2008	792,920	4,957,040	-4,164,120	867,510	10,893,960	-10,026,450	380,970	4,784,120	-4,403,150
2009	353,460	136,740	216,720	867,510	300,510	567,000	380,970	131,970	249,000
2010	792,920	136,740	656,180	3,403,890	300,510	3,103,380	1,494,830	131,970	1,362,860
2011	353,460	136,740	216,720	867,510	300,510	567,000	380,970	131,970	249,000
2012	792,920	136,740	656,180	867,510	300,510	567,000	380,970	131,970	249,000
2013	353,460	136,740	216,720	3,403,890	300,510	3,103,380	1,494,830	131,970	1,362,860
2014	792,920	136,740	656,180	867,510	300,510	567,000	380,970	131,970	249,000
2015	353,460	4,957,040	-4,603,580	867,510	10,893,960	-10,026,450	380,970	4,784,120	-4,403,150
2016	792,920	136,740	656,180	3,403,890	300,510	3,103,380	1,494,830	131,970	1,362,860
2017	353,460	136,740	216,720	867,510	300,510	567,000	380,970	131,970	249,000
2018	792,920	136,740	656,180	867,510	300,510	567,000	380,970	131,970	249,000
2019	353,460	136,740	216,720	3,403,890	300,510	3,103,380	1,494,830	131,970	1,362,860
2020	792,920	136,740	656,180	867,510	300,510	567,000	380,970	131,970	249,000
2021	353,460	136,740	216,720	867,510	300,510	567,000	380,970	131,970	249,000
Total	13,756,560	12,375,400	1,381,160	41,111,280	27,197,100	13,914,180	18,054,160	11,943,700	6,110,460

Table 13.1.6 : Economic Evaluation of Kzyl-Orda Border to Irgiz Section

Section Kzyl-Orda Border to Irgiz
Length 86 km

Discount Rate = 12%
Economic Life = 20 years (after construction; i.e. 2002 - 2021)
Implementation Period = 4 years (1998 - 2001)

(Costs and Benefits are in US$)

Year	AADT	VOC	Maintenance	Total	Total	Discounted	
	veh/day	Benefit	Benefit	Benefit	Cost	Benefit	Cost
1998	648	0	792,920	792,920	-1,812,500	792,920	-1,812,500
1999	710	0	353,460	353,460	-5,437,500	315,589	-4,854,911
2000	778	0	792,920	792,920	-5,437,500	632,111	-4,334,742
2001	815	0	353,460	353,460	-5,437,500	251,586	-3,870,305
2002	853	5,083,140	656,180	5,739,320	0	3,647,441	0
2003	894	5,323,366	216,720	5,540,086	0	3,143,593	0
2004	936	5,574,949	656,180	6,231,129	0	3,156,884	0
2005	981	5,838,426	216,720	6,055,146	0	2,739,040	0
2006	1,027	6,114,359	656,180	6,770,539	0	2,734,507	0
2007	1,076	6,403,338	216,720	6,620,058	0	2,387,259	0
2008	1,127	6,705,980	-4,164,120	2,541,860	0	818,411	0
2009	1,180	7,022,931	216,720	7,239,651	0	2,081,227	0
2010	1,236	7,354,867	656,180	8,011,047	0	2,056,236	0
2011	1,295	7,702,498	216,720	7,919,218	0	1,814,880	0
2012	1,356	8,066,565	656,180	8,722,745	0	1,784,847	0
2013	1,420	8,447,847	216,720	8,664,567	0	1,582,984	0
2014	1,487	8,847,157	656,180	9,503,337	0	1,550,200	0
2015	1,558	9,265,349	-4,603,580	4,661,769	0	678,960	0
2016	1,632	9,703,314	656,180	10,359,494	0	1,347,144	0
2017	1,709	10,161,990	216,720	10,378,710	0	1,205,039	0
2018	1,790	10,642,354	656,180	11,298,534	0	1,171,282	0
2019	1,875	11,145,434	216,720	11,362,154	0	1,051,677	0
2020	1,964	11,672,304	656,180	12,328,484	0	1,018,857	0
2021	2,057	12,224,090	216,720	12,440,810	0	917,982	0
Total	-	163,300,258	1,381,160	164,681,418	-18,125,000	38,087,738	-13,059,958

NPV (million US$)	25.028
B/C	2.916
IRR (%)	28.55

Table 13.1.7 : Economic Evaluation of Irgiz to Karabutak Section

Section Irgiz to Karabutak
Length 189 km

Discount Rate = 12%
Economic Life = 20 years (after construction; i.e. 2002 - 2021)
Implementation Period = 4 years (1998 - 2001)

(Costs and Benefits are in US$)

Year	AADT veh/day	VOC Benefit	Maintenance Benefit	Total Benefit	Total Cost	Discounted Benefit	Discounted Cost
1998	605	0	3,403,890	3,403,890	-4,142,500	3,403,890	-4,142,500
1999	658	0	867,510	867,510	-12,427,500	774,563	-11,095,982
2000	716	0	867,510	867,510	-12,427,500	691,574	-9,907,127
2001	755	0	3,403,890	3,403,890	-12,427,500	2,422,822	-8,845,649
2002	795	7,529,860	567,000	8,096,860	0	5,145,701	0
2003	838	7,924,693	567,000	8,491,693	0	4,818,415	0
2004	884	8,340,348	3,103,380	11,443,728	0	5,797,749	0
2005	931	8,777,928	567,000	9,344,928	0	4,227,171	0
2006	982	9,238,597	567,000	9,805,597	0	3,960,316	0
2007	1,035	9,723,582	3,103,380	12,826,962	0	4,625,531	0
2008	1,091	10,234,172	-10,026,450	207,722	0	66,881	0
2009	1,150	10,771,728	567,000	11,338,728	0	3,259,613	0
2010	1,212	11,337,683	3,103,380	14,441,063	0	3,706,661	0
2011	1,278	11,933,546	567,000	12,500,546	0	2,864,803	0
2012	1,347	12,560,907	567,000	13,127,907	0	2,686,230	0
2013	1,420	13,221,442	3,103,380	16,324,822	0	2,982,484	0
2014	1,497	13,916,914	567,000	14,483,914	0	2,362,640	0
2015	1,578	14,649,183	-10,026,450	4,622,733	0	673,275	0
2016	1,663	15,420,208	3,103,380	18,523,588	0	2,408,800	0
2017	1,753	16,232,053	567,000	16,799,053	0	1,950,484	0
2018	1,848	17,086,891	567,000	17,653,891	0	1,830,122	0
2019	1,949	17,987,014	3,103,380	21,090,394	0	1,952,119	0
2020	2,054	18,934,835	567,000	19,501,835	0	1,611,681	0
2021	2,166	19,932,897	567,000	20,499,897	0	1,512,646	0
Total	-	255,754,483	13,914,180	269,668,663	-41,425,000	65,736,168	-33,991,258

NPV (million US$)	31.745
B/C	1.934
IRR (%)	23.28

Table 13.1.8 : Economic Evaluation of Atyrau to Mahambet Section

Section : Atyrau to Mahambet
Length : 83 km

Discount Rate = 12%
Economic Life = 20 years (after construction; i.e. 2002 - 2021)
Implementation Period = 4 years (1998 - 2001)

(Costs and Benefits are in US$)

Year	AADT veh/day	VOC Benefit	Maintenance Benefit	Total Benefit	Construction Cost	Discounted Benefit	Discounted Cost
1998	1,183	0	1,494,830	1,494,830	-2,539,200	1,494,830	-2,539,200
1999	1,400	0	380,970	380,970	-7,617,600	340,152	-6,801,429
2000	1,656	0	380,970	380,970	-7,617,600	303,707	-6,072,704
2001	1,730	0	1,494,830	1,494,830	-7,617,600	1,063,990	-5,422,057
2002	1,808	5,186,622	249,000	5,435,622	0	3,454,436	0
2003	1,889	5,419,557	249,000	5,668,557	0	3,216,492	0
2004	1,973	5,662,955	1,362,860	7,025,815	0	3,559,497	0
2005	2,062	5,917,285	249,000	6,166,285	0	2,789,314	0
2006	2,154	6,183,037	249,000	6,432,037	0	2,597,792	0
2007	2,251	6,460,726	1,362,860	7,823,586	0	2,821,263	0
2008	2,352	6,750,886	-4,403,150	2,347,736	0	755,908	0
2009	2,457	7,054,080	249,000	7,303,080	0	2,099,461	0
2010	2,567	7,370,891	1,362,860	8,733,751	0	2,241,736	0
2011	2,682	7,701,931	249,000	7,950,931	0	1,822,148	0
2012	2,802	8,047,840	249,000	8,296,840	0	1,697,698	0
2013	2,928	8,409,286	1,362,860	9,772,146	0	1,785,334	0
2014	3,059	8,786,965	249,000	9,035,965	0	1,473,962	0
2015	3,196	9,181,609	-4,403,150	4,778,459	0	695,956	0
2016	3,339	9,593,978	1,362,860	10,956,838	0	1,424,823	0
2017	3,489	10,024,869	249,000	10,273,869	0	1,192,866	0
2018	3,645	10,475,113	249,000	10,724,113	0	1,111,734	0
2019	3,809	10,945,581	1,362,860	12,308,441	0	1,139,264	0
2020	3,979	11,437,180	249,000	11,686,180	0	965,775	0
2021	4,157	11,950,859	249,000	12,199,859	0	900,203	0
Total	-	162,561,249	6,110,460	167,176,879	-25,392,000	39,453,511	-18,296,190

NPV (million US$)	21.157
B/C	2.156
IRR (%)	23.01

Table 13.1.9 : Economic Evaluation of all the Three Priority Projects Together

Priority Sections : 1) Kzyl-Orda B. to Irgiz; 2) Irgiz to Karabutak; 3) Atyrau to Mahambet
Total Length : 358 km

Discount Rate = 12%
Economic Life = 20 years (after construction; i.e. 2002 - 2021)
Implementation Period = 4 years (1998 - 2001)

(Costs and Benefits are in US$)

Year	VOC Benefit	Maintenance Benefit	Total Benefit	Construction Cost	Discounted	
					Benefit	Cost
1998	0	5,691,640	5,691,640	-8,494,200	5,691,640	-8,494,200
1999	0	1,601,940	1,601,940	-25,482,600	1,430,304	-22,752,321
2000	0	2,041,400	2,041,400	-25,482,600	1,627,392	-20,314,573
2001	0	5,252,180	5,252,180	-25,482,600	3,738,398	-18,138,011
2002	17,799,622	1,472,180	19,271,802	0	12,247,578	0
2003	18,667,617	1,032,720	19,700,337	0	11,178,500	0
2004	19,578,251	5,122,420	24,700,671	0	12,514,129	0
2005	20,533,638	1,032,720	21,566,358	0	9,755,525	0
2006	21,535,994	1,472,180	23,008,174	0	9,292,615	0
2007	22,587,646	4,682,960	27,270,606	0	9,834,054	0
2008	23,691,038	-18,593,720	5,097,318	0	1,641,200	0
2009	24,848,739	1,032,720	25,881,459	0	7,440,301	0
2010	26,063,441	5,122,420	31,185,861	0	8,004,634	0
2011	27,337,975	1,032,720	28,370,695	0	6,501,831	0
2012	28,675,313	1,472,180	30,147,493	0	6,168,774	0
2013	30,078,574	4,682,960	34,761,534	0	6,350,802	0
2014	31,551,037	1,472,180	33,023,217	0	5,386,802	0
2015	33,096,141	-19,033,180	14,062,961	0	2,048,191	0
2016	34,717,500	5,122,420	39,839,920	0	5,180,767	0
2017	36,418,911	1,032,720	37,451,631	0	4,348,388	0
2018	38,204,359	1,472,180	39,676,539	0	4,113,138	0
2019	40,078,029	4,682,960	44,760,989	0	4,143,060	0
2020	42,044,319	1,472,180	43,516,499	0	3,596,313	0
2021	44,107,846	1,032,720	45,140,566	0	3,330,830	0
Total	581,615,990	21,405,800	603,021,790	-84,942,000	145,565,166	-69,699,105

NPV (million US$)	75.866
B/C	2.088
IRR (%)	24.44

13.1.3 Sensitivity Analysis

Sensitivity analysis was carried out to check the effect of changes in construction costs, benefits and discount rate on the economic feasibility of the project. The following cases were checked.

1. Discount rate : For 10% per annum and 15% per annum
2. Construction costs : For +10% and -10% variation
3. Total benefits : For +10% and -10% variation

These sensitivity tests were carried out by changing the above mentioned variable while keeping all other variable fixed. The results of the sensitivity analysis is shown below in Table 13.1.10.

13.1.4 Conclusions of Economic Evaluation

The results of the economic evaluation are summarized in the Table 13.1.11 below.

Table 13.1.11 : Results of Economic Evaluation (at 12% Discount Rate)

Section	Length (km)	Financial Cost (1,000US$)	NPV	B/C	IRR
Kzyl-Orda Border to Irgiz	86	19,079	25.02	2.91	28.55
Irgiz to Karabutak	189	43,605	31.74	1.93	23.28
Atyrau to Mahambet	83	26,729	21.15	2.15	23.01
Total	**358**	**89,413**	**75.86**	**2.08**	**24.44**

Table 13.1.10 : Results of Sensitivity Tests

Item		Kzyl-Orda B. to Irgiz			Irgiz to Karabutak			Atyrau to Mahambet			Overall		
		NPV	B/C	IRR	NPV	B/C	IRR	NPV	B/C	IRR	NPV	B/C	IRR
Base Case	**(12%)**	**25.02**	**2.91**	**28.55**	**31.74**	**1.93**	**23.28**	**21.15**	**2.15**	**23.01**	**75.86**	**2.08**	**24.44**
Discount Rate	10%	33.07	3.44	28.55	44.43	2.26	23.28	29.21	2.54	23.01	104.66	2.45	24.44
	15%	16.47	2.32	28.55	18.35	1.56	23.28	12.62	1.72	23.01	45.38	1.68	24.44
Construction Cost	+10%	23.72	2.65	26.34	28.34	1.75	21.22	19.32	1.96	21.10	68.89	1.89	22.38
	-10%	26.33	3.24	31.22	35.14	2.14	25.81	22.98	2.39	25.31	82.83	2.32	26.94
Traffic Volume	+10%	28.70	3.19	30.51	37.39	2.10	24.91	24.84	2.35	24.66	88.88	2.27	26.16
	-10%	21.35	2.63	26.49	26.09	1.76	21.57	17.46	1.95	21.27	62.85	1.90	22.64

13.2 Project Implementation Plan

13.2.1 Construction Period

The construction period last 30 months, including two winter seasons, each six months long. Site running costs are incurred through out the 30-month construction period. From meteorological conditions in the Karabutak and Atyrau regions shown in Appendix II-8 "Meteorological Data", it is considered that it is reasonable to work bout 6 months during the year. The following Table 13.2.1 indicated average and minimum monthly temperature on the Karabutak region.

Table 13.2.1 : Average/Minimum Monthly Temperature in the Karabutak Region

(degrees)

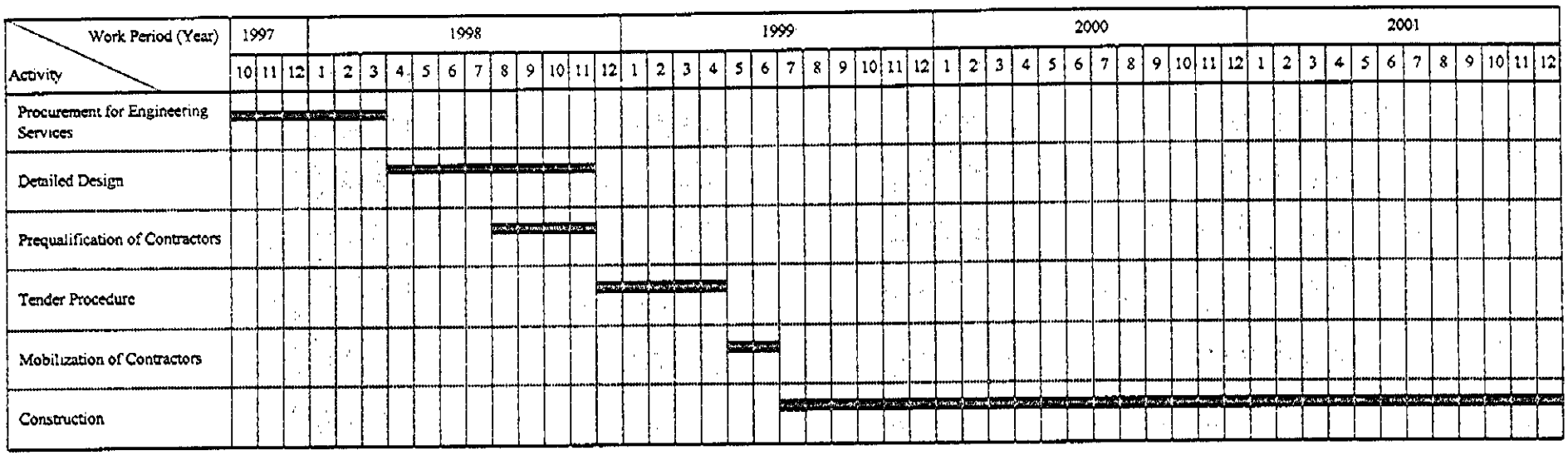
Year	Months											
	1	2	3	4	5	6	7	8	9	10	11	12
1991	-12.1	-15.8	-9.4	9.1	16.7	13.3	23.3	18.5	14.7	8.2	-2.1	-12.5
	(-30.2)	(-29.6)	(-25.6)	(-4.0)	(-4.4)	(10.9)	(9.1)	(6.3)	(3.2)	(-5.6)	(-12.8)	(-31.5)
1992	-10.5	-13.1	-11.3	6.6	12.7	16.0	19.8	16.9	15.0	3.9	-2.2	-12.2
	(-28.0)	(-32.3)	(-29.0)	(-4.0)	(-6.6)	(-0.9)	(7.6)	(4.2)	(-2.3)	(-9.8)	(-13.8)	(-24.6)
1993	-10.0	-18.3	-8.0	3.5	13.5	17.5	21.8	21.0	10.3	15.5	-14.8	-14.5
	(-28.3)	(-26.8)	(-23.7)	(-10.7)	(-3.4)	(5.8)	(8.3)	(7.9)	(-3.7)	(-10.6)	(-29.3)	(-30.7)
1994	-14.8	-20.5	-11.7	5.9	14.3	20.8	18.5	18.6	14.0	6.4	-4.5	-12.4
	(-31.9)	(-41.0)	(-29.8)	(-15.1)	(2.6)	(8.9)	(9.6)	(3.8)	(-2.2)	(-7.1)	(-29.3)	(-30.2)
1995	-17.6	-11.8	-6.0	12.5	15.2	22.6	24.5	21.6	13.8	6.5	-7.4	-11.3

Note : Figure in parentheses are minimum monthly temperatures
Data Source : Aktyubinsk Meteorological Center, June 4, 1996

13.2.2 Project Schedule

Based on discussions with the authority concerned, the Consultant prepared a tentative work implementation schedule which is presented in Figure 13.2.1.

To achieve mobilization and a start of rehabilitation work in the 1999 work season, the tender procedures should take place over the winter period of 1998/1999. Detailed design and prequalification of contractors would run concurrently., and be completed by the end of November 1998. Preparation and approval of prequalification documents should be undertaken as soon as possible.



Legend ▭ : Winter season
Data Source : JICA study, 1996

Figure 13.2.1 : Tentative Work Implementation Schedule

13.2.3 Construction Packages

The number of Construction packages would be affected by the level of funding available, location of major town and materials resources, and construction market considerations.

Construction package should preferably be in the range of 20~39 million US Dollars (in 1996 prices), each covering 80~95 km of road. Constructions under the above value would not be attractive to international contractors and over the above value would probably be too large for local contractors to have significant participation.

Based on the above consideration the Karabutak~Kzyl Orda Border road section was divided into three Construction packages, and the Atyrau~Mahambet road section in one package as shown in Table 13.2.2 below.

Table 13.2.2 : Construction Packages for the Priority Projects

(Unit : US$ x 1000)

NO.	Sub-section	Length (km)	Project Cost
1	Kzyl Orda border - Irgiz (1240-1154 km)	86	19,079
2	Irgiz - Karakuduk (1154-1060 km)	94	21,908
3	Karakuduk - Karabutak (1060-965 km)	95	21,697
4	Atyrau - Mahambet (0-83 km)	83	26,729
	Total	358	89,413

Data Source : JICA study, 1996

Final construction packaging would have to wait finalization of design and financing arrangements. If funds would not be available for all package, implementation could consider the priority shown in Table 13.2.2.

13.2.4 Procurement of Consultant and Construction Services

(1) Procurement of Consultant Services

It is recommended that any local enterprise appointed for the detailed design or construction supervision of the Karabutak-Kzyl Orda border road section and the Atyrau-Mahambet road section should work in association with an experienced international consultant, for the reasons discussed below.

Local engineers are experienced and competent in FSU specifications and design standards and practices. It is clear that they would gain from opportunities to study and consider other approaches towards economic design, such as are applied in western countries. Similarly, the choice of higher specifications for materials, supported by modern testing technology, would result in economies in design and better roads.

Very few engineers, if any, in Kazakhstan have experience in preparation of bid documents, and in construction supervision and monitoring, to the standards required under international forms of contract. It appears that quality of materials and workmanship has hitherto been assumed but seldom achieved in the delivered product. Effective quality control and a comprehensive understanding of contractual approval and acceptance procedures would be required by both supervising engineer and contractor.

The international consultant would provide a team leader for design perpetration of bud documents and bid evaluation; and for supervision of construction and contract administration. Various specialists would be assigned as needed, for example to assist with preparation of alternative pavement designs bid documents and cost estimates, with bid evaluation, an with contract administration. The local consultant would provide design engineers, resident engineers, and various survey and field personal.

The key objectives would be provide effective supervision and on-the-job training in design alternatives preparation of international bid documents, bid evaluation quality control supervision and contract administration from which expertise may be developed within local enterprises.

A suitable structure for supervision of the works is presented in Figure 13.2.2.

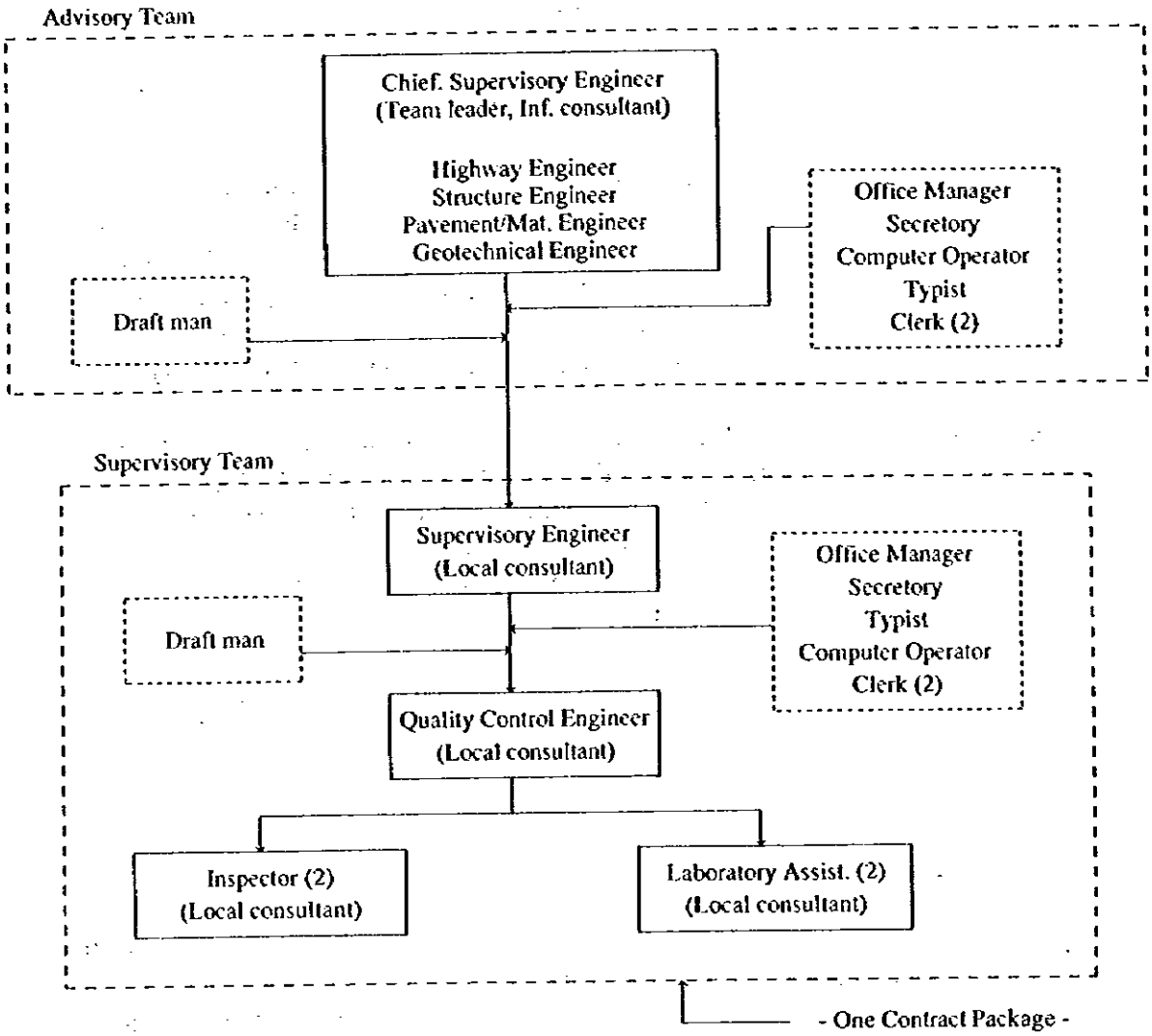


Figure 13.2.2 : Supervision Organization

(2) Procurement of Construction Services

Recommendations on the prequalification of contractors, conditions of contract and equipment procurement are presented below.

If the financial and other prequalification criteria stipulated by a foreign country or international organs are to be met fully local contractors could probably not prequalify on their own. It is therefore recommended that local construction enterprises associate with or enter into joint venture with suitable international companies. Alternatively, a memorandum of understanding for technical assistance with an experiences international firm might be considered adequate for the larger local contractors.

A major problem facing local contractors is lack of financial resources to provide satisfactory performance securities and other guarantees that would be required under a foreign country or international organs funded contract. It is recommended that concurrently with the preparation of prequalification and tender documents commercial banks and bonding agencies that would be suitable and acceptable to the Government and a foreign country or international organs be identified.

The General Conditions of Contract preferred by most international funding agencies for major projects are the FIDIC Conditions of Contract for Works of Civil Engineering Construction (Fourth Edition), with requirements specific to each project component amplified in Part II - Conditions of Particular Application.

(3) Procurement of Equipment

Improvement of the Karabutak~Kzyl Orda border road section and the Atyrau~Mahambet road section would require the use of specialized equipment where key operations would be affected by requirements for new technology, quality consistency, and higher outputs to meet construction schedules. Such equipment units including cold planers vibratory rollers and high capacity asphalt plants would have to be imported since they are not currently available in Kazakhstan.

There are several procedures that could be followed by a foreign country or international organs and the Government with regard to the purchase of new equipment for the Project. Among these the JICA study team considers that the following options might be applicable to major imported items:

The Government purchases the equipment and enters into a hire arrangement with the contractor.

Disadvantages : The Government accepts responsibility for operating and maintaining the equipment, and also for any delays to the contractor due to delays in equipment arrival or lack of production.

A provisional sum is included in the contract to purchase specified items which are operated by the contractor and revert to the Government upon completion.

Disadvantages : The Government takes responsibility for any delay in delivery after award of contract. Incentives would be required to ensure that the contractor would maintain and return the equipment in good condition.

The contract allows for an advance payment to the contractor specifically for the purchase of equipment. The advanced money would be recovered over the contract period from payments due to the contractor. The equipment remains the property of the Government until the advanced payment is satisfactorily redeemed.

Advantages : Assists foreign contractors in importing owned or new equipment. Provides local contractors with early funds for equipment purchase.

Disadvantages : Risk to the Government and local contractor if the value of the equipment a substantial part of the value of the contract.

The JICA study recommends that the third option be pursued since it would be attractive to international contractors, and would encourage local contractors to augment their equipment resources, or to enter into joint ventures with suitable international contractors.

If the Government wishes to specify the source and model of equipment to be imported to Kazakhstan and accepts the delay risks, the first two alternatives might be suitable.

Chapter 14 Findings and Recommendation

Chapter 14 Findings and Recommendations

14.1 Findings

The JICA Study Team as listed and organized in Chapter 1, conducted the study for one and half year in Kazakhstan and in Japan with close cooperation of the Department of Roads of the Republic of Kazakhstan and other organizations.

Through the study following items becomes clear.

1) Lack of budget after independence of the country has caused road deterioration and dismissal of technical personnel on roads from the government departments.

2) Since the time of the Former Soviet Union, the Government does not pay enough attention to evaluate the quality of pavement and structures, which also causes deterioration of roads and bridges.

3) Considering the recent economic situation and the future development of the country, the Government of Kazakhstan formulated a new road management and budget system at the beginning of this year. This new system is expected to be extended further in near future.

4) The Republican Roads, Local Roads and a part of Asian Highways with a total length 17,000 km form sufficient road network in the four states in Western Kazakhstan.

5) The roads which form the above mentioned road network are mainly in poor condition and the bridges are also not in good condition in order to carry the present traffic.

6) The Feasibility Study on the three road sections shows that the implementation of these sections is economically feasible.

Section No.	Name of Road	Section	Length (km)	Project Cost (1,000US$)	IRR (%)	B/C (12%)
1	Samara-Shimkent	Kzyl-Orda Border to Irgiz	86	19,079	28.55	2.91
2	same as above	Irgiz to Karabutak	189	43,605	23.28	1.93
18	Atyrau-Uralsk	Atyrau to Mahambet	83	26,729	23.01	2.15
	Total		**358**	**89,413**	**24.44**	**2.08**

7) The technical standards of roads, bridges and their maintenance are formulated but not implemented properly in order to maintain quality.

8) The implementation of the three priority projects is technically feasible and will

have minimal and trivial environmental impact, so further environmental studies are not required.

14.2 Recommendations

1) The implementation of the road improvement project on the three priority projects which have favorable economic evaluation factors, will be useful for the development of Kazakhstan and, strengthening of the road maintenance systems in the Western Kazakhstan.

2) The detailed design and construction work for the three priority projects should be carried out according to standard international practices.

3) In order to realize the project it is necessary to introduce the most modern maintenance and management system. It is also necessary to have personnel training and introduce suitable equipment.

4) Equipment for road maintenance shall be arranged under a suitable organization and staff with the help of foreign funds and also internal funds.

14.3 Training

Based on the observations of the Study Team and, field surveys of existing roads and structures, the following items are recommended for further training.

1) Method of feasibility study and economic evaluation.
2) Cost estimation of construction works.
3) Concept of quality control for construction works and materials.
4) Evaluation of road maintenance and organization.


JICA