JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF INFRASTRUCTURE
AND DEPARTMENT OF ROADS
THE GOVERNMENT OF MONGOLIA

THE FEASIBILITY STUDY
ON
CONSTRUCTION OF EASTERN ARTERIAL ROAD
IN
MONGOLIA

FINAL REPORT

SUMMARY

JUNE 2002

PACIFIC CONSULTANTS INTERNATIONAL

JAPAN OVERSEAS CONSULTANTS

The following foreign exchange rate was applied in the study:

US$1.0 = JP¥133 = Tg1,100 (as of January 2002)

PREFACE

In response to the request from the Government of Mongolia, the Government of Japan decided to conduct the feasibility study on construction of eastern arterial road in Mongolia and entrusted the study to Japan International Cooperation Agency (JICA).

JICA dispatched a study team headed by Mr. Kenji Maruoka of Pacific Consultants International and consisting of Pacific Consultants International and Japan Overseas Consultants Co., Ltd. to Mongolia, four times between March 2001 and March 2002. In addition, JICA set up an Advisory Committee headed by Mr. Kenichiro OI of Metropolitan Expressway Public Corporation between March 2001 and March 2002, which examined the Study from specialist and technical point of view.

The team held discussions with the officials concerned of the Government of Mongolia and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Mongolia for their close cooperation extended to the team.

June 2002

Takao Kawakami
President
Japan International Cooperation Agency

June 2002

Mr. Takao Kawakami
President
Japan International Cooperation Agency

Letter of Transmittal

Dear Sir,

We are pleased to submit herewith the Final Report of "The Feasibility Study on Construction of Eastern Arterial Road in Mongolia".

The report contains the results of the study, which has been carried out by Pacific Consultants International in association with Japan Overseas Consultants between March 2001 and June 2002. The report consists of four volumes, Summary, Main Report, Appendix, and Drawings.

The Summary briefly illustrates the findings in the study. The Main Report consists of 17 chapters and presents traffic demand forecast, engineering designs, road maintenance system, environmental impact assessments, project implementation plan, economic and financial analysis and conclusion and recommendations for the project implementation. It recommends that the institutional arrangements for project implementation should be organized as soon as possible.

We wish to express our greatest appreciation to officials of the Ministry of Infrastructure and the Government of Mongolia for their assistance extended to the Study Team, and also to the personnel of your Agency, the JICA Advisory Committee, the Ministry of Foreign Affairs, the Ministry of Land, Infrastructure and Transport, and the Embassy of Japan in Mongolia. The Study Team sincerely hopes that the results of the Study will contribute to the development of the road network in Mongolia.

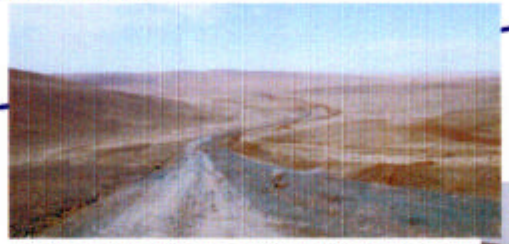
Yours faithfully,

Kenji Maruoka
Team Leader
The Feasibility Study on Construction of
Eastern Arterial Road in Mongolia

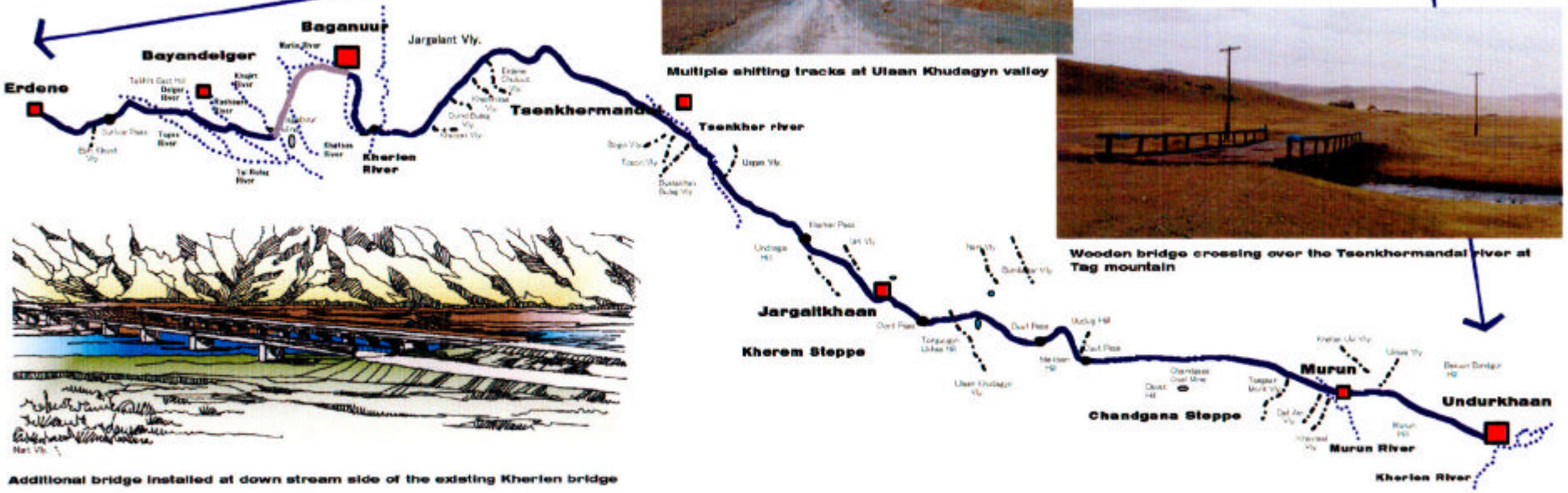
THE FEASIBILITY STUDY
ON CONSTRUCTION OF

EASTERN ARTERIAL ROAD

IN MONGOLIA



Multiple shifting tracks at Ulaan Khudagyn valley



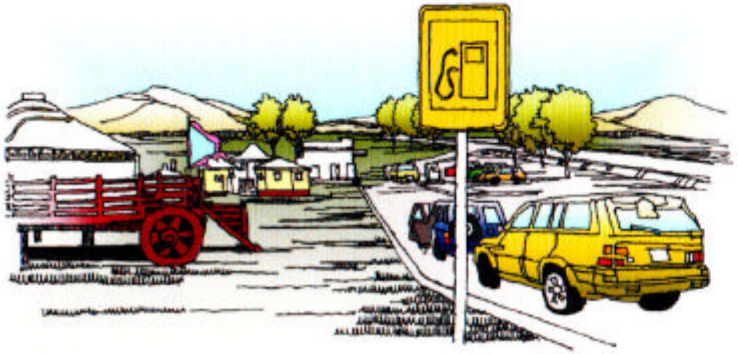
Wooden bridge crossing over the Tsenkhermandal river at Tag mountain

Additional bridge installed at down stream side of the existing Kherlen bridge

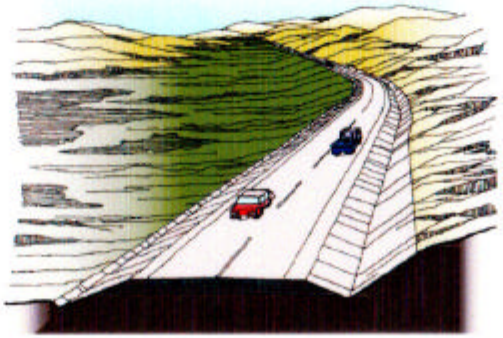
Project at a Glance

By paved road to all-weather international standard as a part of Millemium Road Plan;

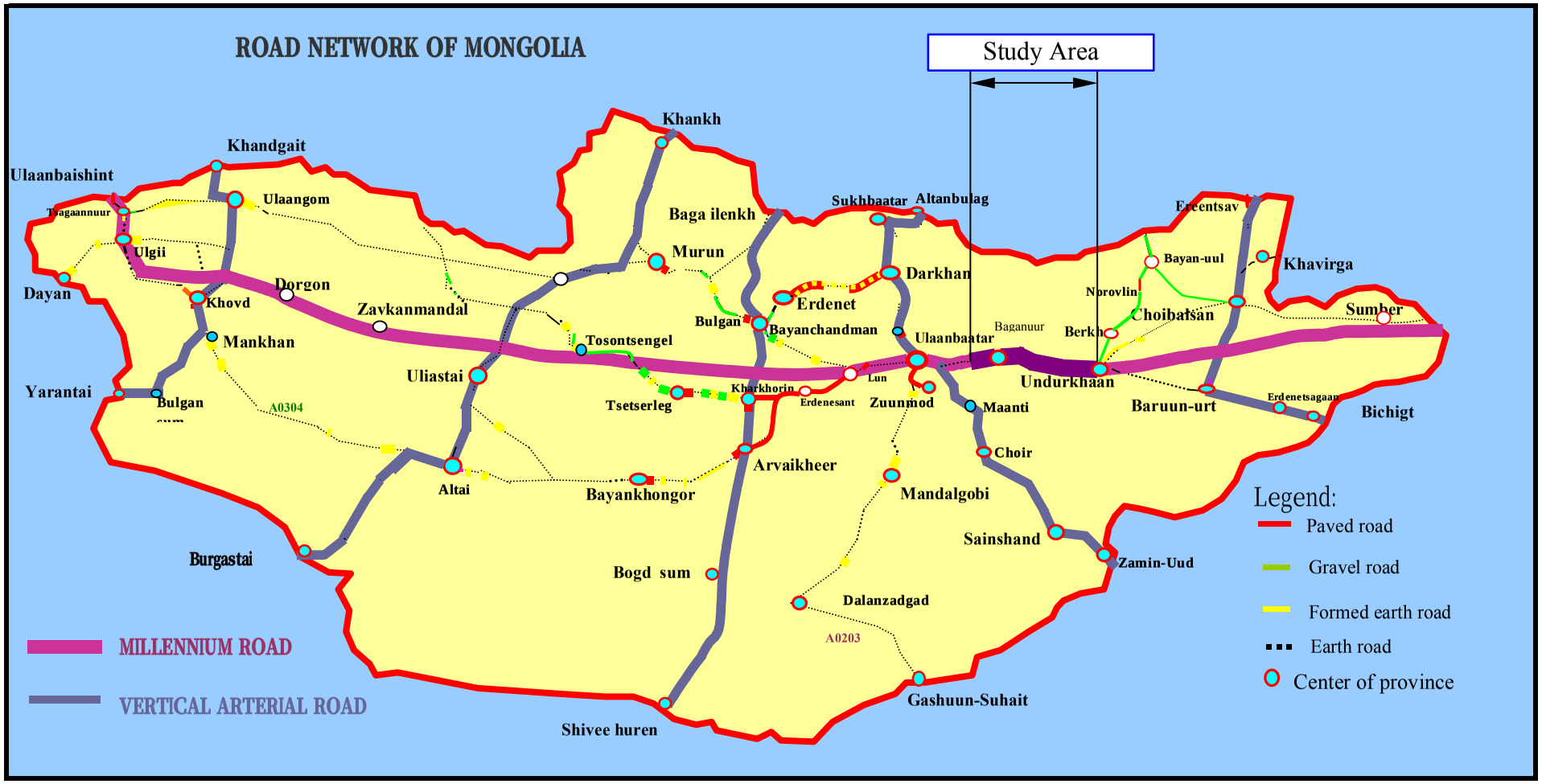
1. **Stimulate high development potential**
2. **Secure traffic safety and conserve environment**
3. **Contribute poverty alleviation and improve accessibility to markets**



Road station for resting area at strategic places along the Route



Road improvement in the rolling terrain



Map of Study Area

ABBREVIATIONS

Authorities and Agencies

AASHTO	:	American Association of State Highway and Transportation Officials
ADB	:	Asian Development Bank
AZZAN	:	Road Repair and Maintenance Corporation
DNE	:	Department of Information, Inspection of the Ministry of Nature and Environment
DOR	:	Department of Roads
GOM	:	Government of Mongolia
JICA	:	Japan International Cooperation Agency
MFA	:	Ministry of Foreign Affairs
MIT	:	Ministry of Industry and Trade
MJIA	:	Ministry of Justice and Internal Affairs
MNE	:	Ministry of Nature and Environment
MOFE	:	Ministry of Finance and Economy
MOI	:	Ministry of Infrastructure
NSOM	:	National Statistics Office of Mongolia
TTT	:	Equipment Lending Company within AZZAN
WB	:	World Bank

Other Abbreviations

AADT	:	Annual Average Daily Traffic
AC	:	Asphalt Concrete
ALT	:	Alternative
BST	:	Bituminous Surface Treatment
CBD	:	Central Business District
CBR	:	California Bearing Ratio
EAR	:	Eastern Arterial Road
EIA	:	Environmental Impact Assessment
EIRR	:	Economic Internal Rate of Return
ESAL	:	Equivalent Single Axle Load
GDP	:	Gross Domestic Product
GRDP	:	Gross Regional Domestic Product
ha	:	Hectare
ΔH	:	Clearance under Girders
ICB	:	International Competitive Bid
IEE	:	Initial Environmental Examination
IP	:	Implementation Plan
IRI	:	International Roughness Index
kgf/cm^2	:	Kilogram-force per Square Centimeter
kgf/mm^2	:	Kilogram-force per Square Millimeter
km or KM	:	Kilometer
km2	:	Square Kilometer
LCC	:	Life Cycle Cost
m	:	Meter

m^2	:	Square Meter
m^3	:	Cubic Meter
m^3/h	:	Cubic Meter per Hour
m^3/s	:	Cubic Meter per Second
mm	:	Millimeter
N	:	N. Value
NPV	:	Net Present Value
OD	:	Origin Destination
ODA	:	Official Development Assistance
PC	:	Prestressed Concrete
RC	:	Reinforced Concrete
RF	:	Road Fund
RRMC	:	Road Rehabilitation & Maintenance Center
SN	:	Pavement Structure Number
SPA	:	Special Protected Area
Tg	:	Togrogs
US$	:	United States Dollar
VOC	:	Vehicle Operating Costs
σck	:	Concrete Design Stress
σpy	:	Concrete Yield Point Stress
ϕ or Φ	:	Diameter
%	:	Percent

PROJECT SUMMARY

1. COUNTRY	Mongolia
2. NAME OF STUDY	The Feasibility Study on Construction of Eastern Arterial Road in Mongolia
3. COUNTERPART AGENCY	Department of Roads, Ministry of Infrastructure
4. OBJECTIVE OF STUDY	To carry out a feasibility study on construction of Eastern Arterial Road and transfer technology to Mongolian counterparts.

1. STUDY AREA Road section from Erdene to Undurkhaan on State Road A0501, approximately 250km in length and four eastern provinces.

2. TARGET YEAR Year 2015

4. TRAFFIC DEMAND FORECAST 1,417～994veh./day (1,986～1,484 PCU/DAY)

3. ECONOMIC FRAMEWORK

Population in Study Area	Thousand	544.1
GRDP per person	M Tg./Person	0.507
Annual Growth Rate	%	4.45

5. OUTLINE OF FEASIBILITY STUDY AND PRELIMINARY DESIGN

(1) ROAD

- First the route selection was made to select the crossing point of the Kherlen River. The existing bridge and its surrounding was selected as the most suitable point somewhere in 20 km stretch, considering river morphology, scale of required structures, maintenance, etc.
- Referring to the existing tracks along the study route, alternative routes were found in three sections, namely Baganuur, Kherlen East and Tsenkhermandal West. The proposed route was selected through quantitative and qualitative comparison at each section.

(2) PAVEMENT

- ALT-1: (The whole of the project road paved by asphalt concrete) is selected compared with ALT-2: (The road stretch up to Tsenkhermandal will be paved by asphalt concrete and the remaining road stretch will be paved by bituminous surface treatment). The design of pavement was conducted every 10km assuming the design CBR (8, 10 & 12 according to ground condition and fill material) and cumulative ESAL.

(3) BRIDGE

- Case-3: (Use of existing bridge for non-motorized traffic + new parallel bridge) was selected because of advantages such as high economy, short construction period and utilization of existing bridge as temporary bridge during construction.
- PC-T shape girder (33.6m in span length) is applied to the super-structure of Kherlen Bridge because of high economy, short construction period and less influence of obstacle against river stream. RC-T shape girders (15m & 17.5m in span length) are applied to other bridges.

6. ROAD IMPROVEMENT PLAN

- Study Road Length: 258.8 km between Erdene and Undurkhaan
- Highway Classification: Category III (as per Mongolian Standards)
- Road Width: 7m +2@1.5m (total 10m)
- Major Road Facilities: Five road stations and two observation platform
- Kherlen Bridge: Location: 30m down stream of existing bridge
  Superstructure: 8-span PC T Girder with 8m effective width and span length 8@33.6m = 268.8m
  Substructure: RC wall shaped elliptical column and beams
- Other Bridges: Superstructure: RC T Girder with 8m effective width, Khujirut River: 15.0m (Replacement due to lack of strength), Khutsaa River: 17.5m, Tsenkher River: 52.5m, Murun River: 52.5m(Replacement due to wooden bridge), Urt Valley: 15.0m(New Construction)
- New Box Culvert: 29 locations
- New Pipe Culvert: 197 locations
- Establishment of Road Rehabilitation and Maintenance Center with procured equipment in AZZAN and construction of operation depot in Khentii province for strengthening road maintenance capability.

7. ENVIRONMENTAL ASPECTS（IEE and EIA）

The assessment result concluded the Project is moderate negative impact thought IEE and EIA. Environmental management plans for each major item of environmental parameters and environmental monitoring programs for the same are made.

8. PROJECT IMPLEMENTATION PLAN AND EVALUATIONS

(1) Project Implementation Plan

The study road is divided into six construction sections based on consideration of the villages and connecting roads. The period of 4-year construction may be justified considering the achievements of other previous projects. Following two schemes are considered within the project implementation plan excluding Section I which is being constructed by DOR using the Government's own fund.

Scheme-I: Construction by international contractors selected through tendering in a competitive environment (The highest priority should be given to Section II and VI because relatively high economic return is anticipated due to the higher traffic volumes.)

Scheme-II: Construction by DOR as a pilot project (Section III, IV and V should be implemented by DOR using the proposed road rehabilitation and maintenance center.)

(2) Comprehensive Evaluation

The result of economic analysis, both alternatives has sufficient EIRR and is confirmed high feasibility for the project implementation. ALT-1 is suitable for the project in consideration of qualitative advantages compared with BST.

Section	Construction Period	Road Length	Project Cost (ALT-1)	EIRR	
				ALT-1	ALT-2
IP Section 1 (I, II)	2001 - 2005	67.6 km	9,780,675 US$	17.3%	17.3%
IP Section 2 (III, IV)	2003 - 2006	94.4 km	22,053,292 US$	9.4%	10.6%
IP Section 3 (V)	2003 - 2006	50.0 km	10,229,784 US$	17.6%	19.0%
IP Section 4 (VI)	2003 - 2005	46.8 km	8,134,068 US$	23.2%	25.6%
Total Section		258.8 km	50,197,819 US$	15.7%	16.8%

Notes: ALT-1: The whole of the project road will be paved by asphalt concrete.
ALT-2: The road stretch up to Tsenkhermandal will be paved by AC and remaining will be paved by BST.

9.CONCLUSION AND RECOMMENDATIONS

It is concluded that the Study reveals high feasibility for the project implementation. Namely, the project has high technical feasibility, the EIA concluded there is no substantial or irreversible adverse environmental impacts arising form the project, and it is concluded that the project is economically viable based on the economic analysis. It is recommended that the institutional arrangement for project implementation should be taken without delay.

OUTLINE OF THE PROJECT

The Feasibility Study on Construction of Eastern Arterial Road in Mongolia

- Study period :Mar. 2001 - Jun. 2002
- Counterpart Agency :Department of Roads, Ministry of Infrastructure, The Government of Mongolia

1. Background of the Study

Transport plays a crucial role in the efficient functioning of the domestic economy as well as development of international trade due to dependence on both coal-based energy production and imports. However, the issues in the transport sector of Mongolia are mainly derived from the salient features of a landlocked country with a low population and a long distance between population centers.

A major characteristic of transportation in Mongolia is the collection and distribution by road of both passenger traffic and cargo transport from the north-south transport axis centering on Ulaanbaatar. The main north-south axis comprises both rail and road. Within road transport, the density of the arterial road network remains very low and unpaved earth roads or multiple shifting tracks occupy a large portion of arterial roads. More than 30% of population and a half of the national car ownership are concentrated in Ulaanbaatar City, while very low level of mobility is found in rural area because non-motorized traffic such as horse and cart prevails. Recently, such gap of mobility level is increasing and under such circumstances, it is necessary to reverse this trend by reducing the gap. One method of achieving this is to develop the strategically important east-west arterial road by constructing to an all weather and international standard paved road.

Due to the road construction work in between Erdene and Baganuur which is being undertaken by Government of Mongolia (GOM), the agreed scope of work was amended in September 2001 to exclude the area where GOM have commenced the road construction work. Accordingly, the work items such as preliminary design, construction plan and cost estimation were carried out excluding the road section between Erdene and Baganuur. However, the Study still incorporates the work items such as environmental impact assessment, road maintenance plan, economic and financial analysis and implementation plan as these have a close relationship to the study context as a whole.

2. Objective of Study

Objective of Study is to carry out a feasibility study on construction of Eastern Arterial Road and to transfer technology to Mongolia counterparts.

3. Study Area

The study area of the Eastern Arterial Road is the road section from Erdene to Undurkhaan on State Highway No. A0501, approximately 250 km in length. The area influenced by the study road consists of four eastern provinces of Tuv, Khentii, Dornod and Sukhbaatar as well as the Kherlen river basin. The target year of the plan is the year 2015, which accords with that of relevant studies and projects implemented by the Government of Mongolia.

4. Outline of the Project

4.1 Selection of Route Alternatives

Selection of Route had been carried out by two methods. One is to establish the alternative routes and select the optimum route from these and the other is to improve the existing

multi-shifting tracks. The crossing point of the Kherlen River was set in the area of the existing bridge for both economical and technical reasons. This proposal was agreed with the Mongolian government in August 2001. The alternative routes were set in the three sections and the details are given below.

(1) Section A: Baganuur

There are two alternatives in Baganuur area that detour the Baganuur coal mine. Alternative A-1 is the southern route with railway crossing and A-2 is the northern route that goes through urban area of Baganuur city. The study team has selected A-2 as the optimum selection for economical and construction reasons.

(2) Section B: Kherlen East

This is located on the southern end of Nogoon Modot Mountains. Alternative B-1 passes Ust Valley (south side of the Mountains) and B-2 passes Jargalant Valley (north side of the Mountains). B-1 was selected as the optimum route for economical and construction reasons.

(3) Section C: Tsenkhermandal West

This section is located on Khunkh Mountain area. Alternative C-1 passes Bor Khujirt Pass which is located on the south side of the mountain and C-2 passes Naran Pass on the north side. C-2 was considered as the optimum route for economical and construction reasons.

4.2 Selection of Optimum Pavement Structure

Pavement structure was designed in 2 sections based on the traffic demand forecast, the first is Baganuur - Jargaltkhaan and the second is Jargaltkhaan - Undurkhaan.

To make the pavement structure economical, the Life Cycle Cost (LCC) was taken into account. LCC analysis was carried out in the 2 sections which are Erdene - Baganuur and Murun - Undurkhaan as a model case. The former represents high embankment section with heavy traffic and the latter represents low embankment with non-heavy traffic.

1) Analysis period is 20 years for both AC pavement and BST pavement.
2) Routine maintenance including thermal cracks filled with asphalt emulsion slurry for both AC pavement and BST pavement.
3) Overlay at 7 years interval on AC pavement as the result of comparison with 4 cases.
4) Surface dressing at 3 years interval on BST pavement due to the need to keep similar roughness as AC pavement and to avoid surface treatment problems.

The results of LCC analysis as shown below indicate that both pavement types are expected to have sufficient economic return and in the section of Erdene to Baganuur, both have almost equal EIRR.

Section	Length	Type	Initial Investment (M. $)	NPV (Thousand $)	EIRR
Erdene - Baganuur	33 km	AC	9,310	4,239	17.6%
		BST	8,619	4,610	18.4%
Murun - Undurkhaan	67 km	AC	7,834	11,895	26.7%
		BST	6,691	12,833	29.4%

The following two alternative schemes are examined for the purpose of optimum implementation plan in economic analysis, considering results of LCC analysis, equipment availability and ease of maintenance.

Section	Type of Pavement	
	Alternative - 1	Alternative - 2
Erdene - Tsenkhermandal	AC Pavement	AC Pavement
Tsenkhermandal - Undurkhaan	AC Pavement	BST Pavement

4.3 Selection of the Type of the Kherlen Bridge

The alternatives set in the area of the existing bridge are as follows:

Alternative	Location	Contents
1	Existing Route	Utilize the existing bridge after reinforcing it.
2	New Route	Construct a new bridge 1km downstream of the existing bridge
3	Existing Route	Utilize the existing bridge for light vehicles after repairing it and construct a new bridge beside the existing bridge.

After study, Alternative-3 was considered to be the optimum selection considering economical, technical and periodical reasons. The new bridge to be constructed is planned to be 268.8m long with 8 spans of 33.6m. It will be located 30 m downstream of the existing bridge. It will have a carriage way of 8m width. It is also designed to have the structure that is able to satisfy the design river section (360m long) in the future. Super-structure type is pre-stressed concrete (PC) T-shaped girder and sub-structure is elliptical shaped re-enforced concrete (RC) wall type pier with spread foundation.

4.4 Other Bridges and Culverts

5 other bridges, 29 box culverts and 197 pipe culverts are planned in this study based on research covering the geology, geography and hydrology. Of the 5 other bridges, 3 will be replacements of wooden bridges, 1 replacement of an RC bridge and 1 new construction of an RC bridge.

Super-structure was standardized due to the similar conditions. 2 types of RC T-shaped girder were set as standard girder and these are 15m and 17.5m long. The shape of girder is simplified considering the need for reducing the cost while at the same time satisfying the quality and construction difficulties.

The other types of standard girder are proposed in this study so as to be used for bridges in any other projects in Mongolia, which are RC T-shaped girder of 15 to 22.5m and PC T-shaped girder of 25 to 35m long.

Culverts for this project were also standardized to 4 boxes and 3 pipes. Mongolian current standards were taken into consideration to propose these culverts. The section of box culvert is also designed to be large enough for the livestock and big natural animals to go through.

4.5 Environmental Impact Assessment

The project of The East Arterial Road has moderate negative impact.

In the implementation of the project, it is necessary to set up a protection management plan to mitigate negative impacts both on the social and natural environment and on the pollution such as impacts to urbanized area, quarry sites, construction sites, permafrost, wastes and endangered species. Also it is imperative to set the control and monitoring program of the project and follow its criteria. It is also required to carry out the most appropriate mitigation measures by checking the differences between monitored values and control index. The two following instructions are especially needed to be carried out.

a) To provide adequate traffic and warning signs and information at the crossing points. These are provided to allow children and elder people to cross the road with safety and to avoid possible risks for drivers and passengers.
b) To use community leaders and public relations to inform the public especially drivers about safe use of the road during the construction and operation period.

4.6 Road Maintenance System

The Nalaikh branch of the state-owned Road Repair and Maintenance Corporation "AZZAN" maintains 70 km from the beginning point and also the Kherlen River Bridge. The State Stock-shared Road Maintenance Company of Khentii Province maintains the remainder of the project road. These two entities have similar problems such as follows:

- shortage of road and bridge construction equipment and machinery
- shortage of local engineers well-qualified in managing and supervising the operation
- lack of skillful construction equipment operators, mechanics, and electricians
- lack of repair facility and tools

The road rehabilitation/maintenance center is proposed to set in the AZZAN as a training center to solve the problems above and strengthen road maintenance capacity. The targets of the road rehabilitation/maintenance center are:

a) To establish one road rehabilitation/maintenance center that will serve as a training facility for construction operators and mechanics.
b) To procure equipment and machinery necessary for training and road rehabilitation/maintenance.
c) To train operators, mechanics, road-maintenance personnel, and managers.
d) To upgrade and update the existing technically skilled operators, mechanics, road-maintenance personnel, and managers.
e) To utilize and accumulate those skills through actual practices as a pilot model.
f) To establish regional sub-centers for further development.

4.7 Road Improvement Plan

The study area is planned to be improved based on following design criteria:

1) Highway Classification : Category III (as per Mongolian Standards)
2) Road Width : 7m + 2@1.5m (total 10m road width)
3) Design Speed : 100 km/h (flat terrain), 80 km/h (rolling) and 60 km/h (mountainous)

Road ancillaries such as road markings, guard posts, regulatory & warning signs, guide signs, kilometer posts and approach slope for domestic animals will be installed as traffic safety measures.

4.8 Project Implementation Plan

The project implementation plan covers the road stretch between Baganuur - Undurkhaan and totals 221.8 km. It excludes the Erdene - Baganuur 37 km long road section which is being constructed by the Department of Roads using the Government's own fund. However, since traffic demand forecast has been carried out to cover the road stretch between Erdene - Undurkhaan, the project implementation plan is made in recognition of the work to be done on the road stretch between Erdene - Undurkhaan. This is done particularly for the economic analysis based on the estimated benefit to be accrued from the forecasted traffic demand.

(1) Construction Section

The study area is divided into the six construction section as shown on the table in the next page. The following conditions were assumed considering the characteristics of this project.

1) Asphalt pavement work is limited to the period of 5 months (May to September) and earthwork is limited to the period of 7 months (April to October).
2) Stockpiling of aggregates, pre-cast concrete structures and other preparatory works are carried out through the year.
3) The period of 4-year construction to cover 221.8 km long road improvement may be justified considering the achievements of the previous projects by other donors.

(2) Implementation Plan for Sections II to VI

Following two schemes are considered within the project implementation plan:

Scheme-I: Construction by contractor selected through tendering.

The highest priority should be given to Section II and VI because they are located in the surroundings of urban area and relatively high economic return is anticipated due to the higher traffic volumes. Accordingly, these sections should be implemented by international contractors in a competitive environment.

Scheme-II: Construction by DOR as a pilot model

The remaining sections of Section III, IV and V should be implemented by DOR using the proposed road rehabilitation/ maintenance center.

Scheme-I has advantages in the aspects of using effective, efficient and accountable procedures to realize the project by fast track method and with less financial burden on the government. However, no resource except the constructed facilities will be developed and road maintenance on the constructed section may face both technical and financial difficulties.

Scheme-II has the possibility to cope with institutional requirements that are issued in the administration of road. It envisages the growth of the construction industry through actual practices to cope with incremental demand brought about by the government policy of road improvement, especially development of the "Millennium Road".

(3) Implementation Plan for Economic Analysis

The implementation plan for the economic analysis is made to cover the entire road stretch between Erdene - Undurkhaan because it should coincide with the sections set by traffic demand forecast. This will allow comparison of the estimated costs and benefit that will accrue from forecasted traffic demand. The IP section is newly set for the proposed project implementation plan for the economic analysis. Section-I that is funded and being constructed by DOR is planned to be completed in 2006. The other sections are assumed to be done in 4 years as mentioned above. Table below shows the relationship between traffic section, construction section and the IP section.

Traffic	Erdene - Baganuur		Baganuur - Jargaltkhaan		Jargaltkhaan - Murun	Murun - Undurkhaan
Construction	Section-I	Section -II	Section -III	Section -IV	Section -V	Section -VI
	Erdene - Baganuur	Baganuur - Kherlen River East	Kherlen River East - Tsenkhermandal	Tsenkhermandal - Jargaltkhaan	Jargaltkhaan - Murun West	Murun West - Undurkhaan
IP Section	IP Section-1		IP Section-2		IP Section-3	IP Section-4

4.9 Economic Analysis

Project cost as a financial cost is estimated based on the results of preliminary design, quantity take-off of each work item, and the studies on construction planning and method.

The basic premises of project cost estimates are as follows:

1) The cost is estimated on US Dollar basis, considering the fluctuation of exchange rates against foreign currencies.
2) The unit cost of each cost component is determined based on the economic conditions prevailing in January 2002 (US$ 1.0 = ¥ 133 = 1,100 Togrog).
3) Detailed design and supervisory service costs is assumed to be 7 % of construction cost.
4) Unit prices of fill materials and fine/coarse aggregates are estimated by every 10 km, considering hauling distance of materials from individual borrow pits and quarry sites.
5) Equipment cost is based on the local market price as far as they are available. The cost analysis is made in case of special equipment that is not available in Mongolia.

The financial project costs for economic analysis including the cost of road section between Erdene and Baganuur are shown in table below and assumptions of the analysis are as follows:

- The economic analysis was conducted based on IP sections mentioned above.
- The economic costs include the capital and maintenance costs of the project valued in economic prices.
- The source of quantified benefits from the project is savings in VOCs. To be conservative, benefits attributable to savings in travel time were not considered. The VOC estimates are based on the Roads Economic Decision VOC model developed by the World Bank.

Section		Road Length	Project Cost (Thousand US$)	AT-1	ALT-2	Construction Section
IP Section 1	Erdene-Kherlen River East	67.6 km	9,781	17.3%	17.3%	I, II
IP Section 2	Kherlen River East -Jargaltkhaan	94.4 km	22,053	9.4%	10.6%	III, IV,
IP Section 3	Jargaltkhaan-Murun West	50.0 km	10,230	17.6%	19.0%	V
IP Section 4	Murun West -Undurkhaan	46.8 km	8,134	23.2%	25.6%	VI
Total Section	Erdene-Kherlen River East	258.8 km	50,198	15.7%	16.8%	-

It is now clear that this project can obtain sufficient EIRR (Economic Internal Ratio of Return) with any of the pavement structure alternatives

5. Conclusion and Recommendations

The project will realize the strategic transport axis in the eastern part of the country as a part of "Millennium Road Plan" by construction of arterial road to an all-weather international standard.

(1) Implementation of the Project

1) It is recommended that Section VI (Murun West - Undurkhaan L=46.8 km) be given the highest priority in the implementation plan due to its necessity and urgency together with high feasibility. This section is located in the surroundings of urban area and relatively high economic return is anticipated due to the higher traffic volumes.
2) Section II (Baganuur - Kherlen River East L=30.6 km) involves the construction of Kherlen River Bridge for which the superstructure type is designed as PC girder totaling 268.8m (span 8@ 33.6m) in length. It is recommended that this section should also be given the highest priority in the implementation plan due to its necessity and urgency together with high feasibility.

3) It is recommended that Section III (Kherlen River East - Tsenkhermandal L=49.7 km), Section IV (Tsenkhermandal - Jargaltkhaan L=44.7 km) and Section V (Jargaltkhaan - Murun West L=50.0 km) be implemented by MOI/DOR using the proposed scheme of the road rehabilitation / maintenance center.

(2) It is proposed that the project road should be implemented using the recommended alternative of ALT-1. This will mean that the whole of the project road is paved by asphalt concrete pavement. Asphalt concrete pavement has many advantages compared to bituminous surface treatment, especially for high durability and certainty of performance.

(3) It is crucial for MOI/ DOR to levy a toll on Kherlen River Bridges and charge the private sectors for the privilege of utilizing the roadside spaces to cope with the increased fund requirement and alleviate the financial burden of the Government. Furthermore, MOI/ DOR should seize the initiative to withhold the revenues from equipment leasing at the proposed road rehabilitation/ maintenance center and earmark them for road maintenance.

(4) It is important that the development within and along the proposed route should be effectively controlled to prevent indiscriminate development and to facilitate the realization of road and road related facilities such as road station and observation platform.

(5) It is recommended that the Government request a donor country to assist in the realization of the project including procurement of equipment at the proposed road rehabilitation/ maintenance center, using bilateral ODA or loan from a multi-lateral lending agency so as to alleviate the financial burden of the Government.

(6) The scheme for a road rehabilitation / maintenance center aims to establish personnel training with construction equipment and machinery required for the road development within AZZAN and to restructure the existing organization. It is recommended that the Government request a donor country to assist in the strengthening of a road rehabilitation/ maintenance center by utilizing the system of technical cooperation in the fields of road maintenance.

Photographs of Study Area (1)

1) Current Road Condition

Multiple shifting tracks are widely spread on plane area. It heavily affects vegetation and often leads to desertification. It also extends vehicle operating distance and time, resulting high transport cost.

2) Road Condition in Winter

Multiple shifting tracks are covered with snow in winter and become slippery due to uneven surface together with compacted snow. Vehicular movement becomes risky and travel speed is forced to decrease considerably

3) Existing Wooden Bridge

Existing wooden bridge is severely deteriorated and danger always exists for heavy vehicles to go across. This is serious cause of disruption for traffic to cross the river. Heavy vehicles go across the river only when the flow is shallow.

Photographs of Study Area (2)

4) Existing the Kherlen River & Bridge

The flow of the Kherlen River narrows at the point of the picture. River flow has been stable as it is on the photograph for several decades. Revetment has set on the west bank (right side in the photograph) when the existing bridge was constructed.

5) Resting Area Formed by Ger beside the Existing Road

Ger (Mongolian traditional portable housing) forms resting area at several locations on the route. It serves meal, bed, toilette and others for the travelers. Present sanitary condition is not clean and it is wanted and needed to be improved.

6) Dust Raised by Vehicles

Current unpaved road surface produce considerable raised dust by running vehicles. It deprives drivers' sight and makes dangerous situation for the other vehicles. It also covers leaves and shuts the sunlight off. It can cause serious effects to vegetation.

SUMMARY

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