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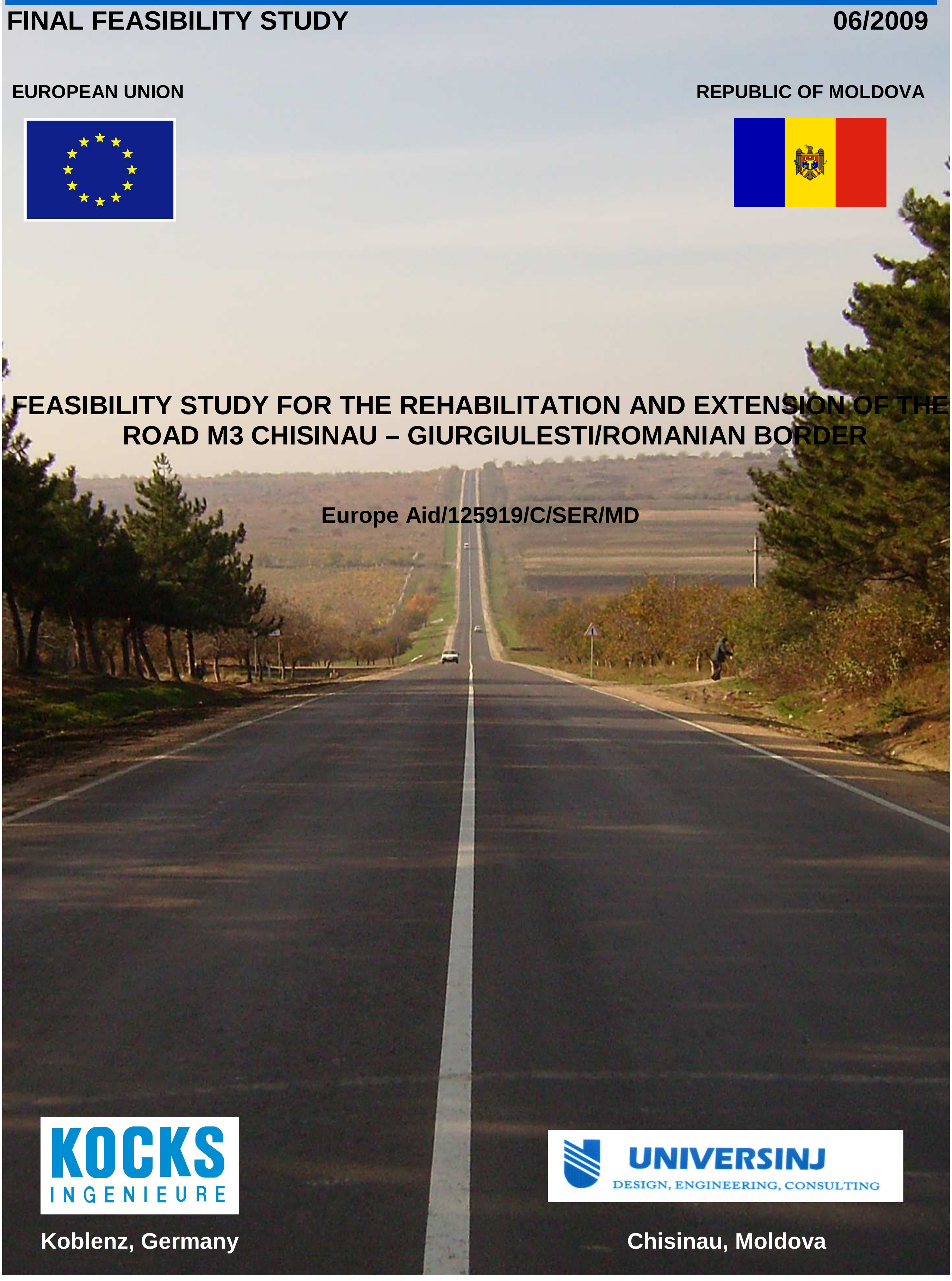
FINAL FEASIBILITY STUDY **06/2009**

EUROPEAN UNION

REPUBLIC OF MOLDOVA

FEASIBILITY STUDY FOR THE REHABILITATION AND EXTENSION OF THE ROAD M3 CHISINAU – GIURGIULESTI/ROMANIAN BORDER

Europe Aid/125919/C/SER/MD



KOCKS INGENIEURE

Koblenz, Germany

UNIVERSINJ
DESIGN, ENGINEERING, CONSULTING

Chisinau, Moldova

REPORT COVER PAGE

Project Title:	Feasibility Study for the Rehabilitation and Extension of the Road M3 Chisinau - Giurgiulesti/Romanian Border		
Contract Number:	2008/156-690		
Countries:	Republic of Moldova		
Name:	**Local Recipient** Republic of Moldova Ministry of Transport / State Road Administration	**EC Consultant** Kocks Consult GmbH & Universinj Ltd	
Address:		Bucuriei Street 12a Chisinau MD 2004 Republic of Moldova	
Tel. Number:		+373 22 595849 +373 22 716655	
Fax Number:		+373 22 748850	
Contact Person:		Ulrich Sprick Project Director	Thomas Herz Dept. Team Leader
Signatures:			

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Author of the Report: Kocks Consult GMBH

EC M & E team	[name]	[signature]	[date]
ÉU Delegation	[name]	[signature]	[date]
	[name]	[signature]	[date]

SYNOPSIS

Project Title:	Feasibility Study for the Rehabilitation and Extension of the Road M3 Chisinau - Giurgiulesti/Romanian Border
Project Number:	2008/156-690
Country:	Republic of Moldova

Project objectives:	Provide a bankable technical, financial, environmental and institutional feasibility study for the rehabilitation and extension of the M3 road Chisinau-Giurgiulesti / Romanian Border.
Planned outputs:	• Identification of Transport Needs • Assessment of technical, environmental, financial and economic feasibility • Assessment of institutional sustainability of the road rehabilitation • Detailed Technical Surveys and Engineering Design • Coordination with International Financial Institutions • Preparation of tender documents for the rehabilitation of one or two priority sections chosen
Project activities:	• Conduct of traffic surveys and traffic forecasts • Technical assessment of the present infrastructure • Road condition survey • Survey of factual pavement condition • Road safety assessment (black spots) • Road maintenance standards • Present traffic management • A review of the Status of institutional development and policy reforms • Evaluation criteria based on poverty indicators for rural roads and bridges • A socio-economic analysis and environmental and social impact assessment • Cost estimates for infrastructure and maintenance costs • Economic and financial cash flow calculations • Calculation of internal rates of return and net present values • Assessment of Institutional sustainability for carrying out the necessary works and maintenance tasks • Geo-technical and topographic surveys • Soil and Materials Investigations • Preliminary Design • Detailed Drawings • Technical Specifications • Design Report • Tender documents for the rehabilitation of one or two priority sections chosen based on the Feasibility study • Road Maintenance Plan including regular and periodic maintenance • Coordination with IFIs

LIST OF ACRONYMS

Abbreviations

AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
asl	above sea level
ATC	Automatic Traffic Count
BIU	Bump Integrator
BR	Biosphere Reserve
CAP	Conservation Action Plan
CBD	Convention of Biodiversity
CBR	California Bearing Ratio
CITES	Convention on Int.l Trade in Endangered Species of Wild Flora and Fauna
CMR	Cold Mix Recycling
CMS	Convention on Migratory Species of Wild Animals
DCP	Dynamic Cone Penetrometer
DIN	Deutsche Industrie Norm
E	east/eastern
EA	Environmental Assessment
EBRD	European Banc for Reconstruction and Development
EGPRSP	Economic Growth and Poverty Reduction Strategy Paper
EIA	Environmental Impact Assessment
EIB	European Investment Banc
EIRR	Economic Internal rate of Return
EIS	Environmental Impact Study
EMP	Environmental Management Plan
ESA	Equivalent Standard Axles
ESAL	Equivalent Standard Axles Loads
EU	European Union
FDI	Foreign Direct Investment
FRG	Federal Republic of Germany
FS	Feasibility Study
FSU	Former Soviet Union
GDP	Gross Domestic Product
GIFP	Giurgiulesti International Free Port
GOST	Государственный Стандарт/ FSU State Standard
GOMR	Government of Moldovan Republic
GPS	Global Positioning System
GRM	Government of Republic of Moldova
HDM-4	HDM-4 Specialized Programme for Road Design
HGV	Heavy Goods Vehicle
HMR	Hot Mix Recycling
IDA	International Development Association
IDP	Indigenous People Plan
IES	State Ecological Inspectorate
IFI	International Financial Institutions
IMF	International Monetary Fund
IUCN	International Union for the Conservation of Wildlife
LHS	left hand side
LGV	Light Goods Vehicle
MCA	Millennium Challenge Account
MCC	Millennium Challenge Corporation
MCC	Manual Classification Counts

MCTD	Ministry of Construction and Territorial Development
MENR	Ministry of Environment and Natural Resources
MGV	Medium Goods Vehicle
MTRI	Ministry of Transport and Roads Industry
N	north/northern
NEN	National Ecological Network
NGO	Non Government Organization
NP	National Park
NPV	Net Present Value
NR	Nature Reserve
NSPAF	Natural State Protected Areas Fund
O-D	Origin Destination Survey
PA	Protected Areas
p.a.	Per annum
PR	Performance Requirements
PRSC	Poverty Reduction Strategy Credit
QRSII	Quick Response System II
RHS	right hand side
RoW	Right of Way
RPD	Road Police Department
S	south/southern
SCS	Speed Calming System
SEE	State Ecological Expertise
SNiP	Строительные нормы и правила/ FSU Construction Norms and Standards
SRA	State Road Administration
TEN	Trans European Network
TEU	Twenty feet Equivalent Unit
TfCA	Trans-Frontier Conservation Area
TMC	Turning Movement Count
TRACECA	Transport Corridor Europe Central Asia via South Caucasus
TRL	Transport Research Laboratory
ToR	Terms of Reference
UA	Ukraine
USAID	US Agency for International Development
USD	US Dollar
VOC	Vehicle Operating Cost
VCT	Voluntary Counseling and Testing
W	west/western
WB	World Bank
WWF	World Wildlife Fund for Nature

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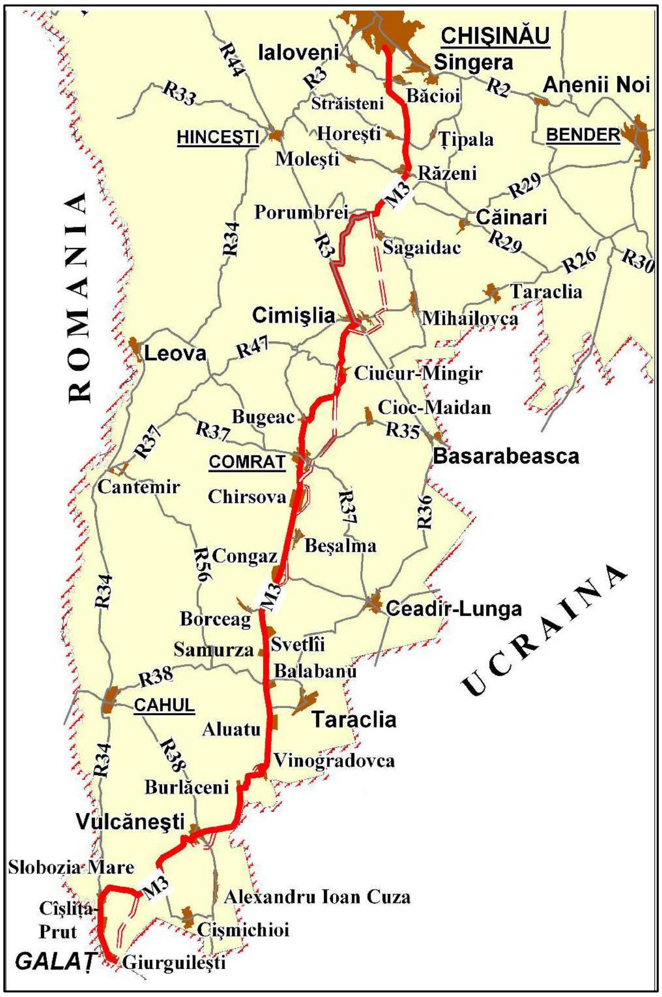
EXECUTIVE SUMMARY

Study Overview

The Moldovan M3 road provides the most important and shortest link between Chisinau and Giurgiulesti – giving access to the Danube and the Black Sea. In addition, the M3 corridor is an integral part of the European Road E577 Poltava – Kirovograd – Chisinau –Giurgiulesti – Galati – Slobozia. It provides a link between TEN corridors IV and IX. Currently, the corridor has, in parts, a high level of deterioration and reduced bearing capacity, resulting in axle load restrictions and the diversion of freight traffic, high transportation costs and subsequently reduced local business opportunities and transit traffic.



The overall objective of this EU- financed study is, as identified in the Terms of Reference (ToR), "… *to provide a bankable technical, financial, environmental and institutional feasibility study for the rehabilitation and extension of the M3 road Chisinau-Giurgiulesti / Romanian Border*" and to identify economically suitable sections for road improvement. Further on, "*the study shall be suitable for presentation to International Financing Institutions to attract financing of the road improvement in order to prepare loans by International Financing Institutions*". The scope of services focuses on:

1. Assessment of need for, and feasibility of a continuous category II corridor from Chisinau to Giurgiulesti
2. Evaluation of several extensions and bypass options
3. Identification of engineering and economically feasible sections for roadway improvements
4. Provision of engineering design and tender documents for selected sections

This document covers points 1 through 3 of the tasks identified above and identifies preliminary design and economic feasibility of the analysed roadway sections. This study recommends those sections that should be carried on to the engineering design and tender documents stage. Since no specific International Financial Institution (IFI) has been identified to fund the potential improvements the study addresses, to the extend possible the guidelines and requirements of potential donors and IFIs.

Approach

This feasibility study provides condition data, traffic forecasting, economic evaluation and preliminary design, for the project road sections. The main approach is to make maximum use of the existing road, rehabilitated to an acceptable level using modern geometrical and physical standards. New sections of road shall be considered only where it can be demonstrated that the rehabilitation of the existing road does not provide sufficient benefits to the area and local population; or does not sufficiently improve any negative environmental impact to an acceptable level.

Corridor Description

The M3 corridor connects Chisinau, the capital of Moldova, with Giurgiulesti in the very south of Moldova over a distance of approximately 216 km and can be distinguished in 7 major sections:

1. The corridor starts in Chisinau as a concrete four lane Category I motorway and leads to the village Sagaidacul Nou and extends to the village of Porumbrei on 2 lanes. From here on south, an extension of M3 was designed to bypass the town of Cimislia. Design, land acquisition as well as earthworks have been started in the period from 1985 to 1995. Rights for land acquisition might have expired since then.

2. Because the Cimislia bypass is not completed, the corridor continues from Porumbrei on in south-western direction on local roads, as a Category IV roadway, to connect with Republican Road R3. The Porumbrei to R3 section was never planned to form an integral part of the M 3 corridor, but due to the stoppage of works on the Porumbrei – Cimislia Section the corridor is in fact leading through the villages Porumbrei, Iurievca and Gradiste. The section has a load restriction which is often not observed but the alternative route via Hincesti to Chisinau is much longer and thus transport cost is higher.

3. The M3 corridor then follows the R3 alignment to Cimislia. The section of R3 between Hincesti and Cimislia is planned to be rehabilitated by the end of 2009.

4. From Cimislia onward the corridor (Category III) continues as M3 south to the town of Comrat (sharing the E 577 designation). Comrat is the capital of the autonomous Gagauzia region. Here, M3 intersects with R 37 which leads west to Cantemir and R 35 east to Basarabeasca. The section has been rehabilitated as of the end of 2008.

5. From Comrat south the M3 continues as a Category II/III road – connecting the villages of Chirsova and Congaz to the intersection with R38. Regional Road 38 provides access westward to the City of Cahul with a border crossing to Romania and eastward to the town of Taraclia.

6. From the intersection with R38 the M3 continues south to the village of Ciumai. In order to avoid a double crossing of the Ukrainian Border the corridor follows a local road in a south-western direction to reconnect with the M3, 7 km east of the town of Vulcanesti. The "Bolgrad – Bypass" (Ukraine) is 15.5 km in length and a result of the break up of the Soviet Union. The original M3 Road passed through

Bolgrad – now part of the independent Ukraine – so an alternative route entirely within Moldova was created at low cost and over a limited time period. The carriageway is extremely narrow with sharp (90°) curves and is highly unsuitable fo r heavy truck traffic.

7. From Vulcanesti on the corridor (as Category IV) follows the M3 alignment for 14 km to an intersection with a local road. Here the corridor turns westward to intersect with R34 in the village of Slobozia Mare. Following R34 south, the study corridor terminates in the village of Giurgiulesti. Giurgiulesti is located between a border crossing over the Prut River to Romania in the west and a border crossing with the Ukraine to the east. The southern sections from Vulcanesti to the Danube River which are classified as category IV have a maximum axle load of 8 tons.

Previous Planning Efforts

Several planning efforts have been undertaken over previous decades and various alignment options have been identified for the M3 corridor. During periods of higher traffic volumes several bypass options were identified. See list below.

M3 extension	Bypass Congaz
Cimislia Bypass	Bypass Svetliî
Realignment Ciucur-Minjir	New alignment and bypass Ciumai – Burlaceni
M3 extension and Comrat Bypass	Bypass Vulcăneşti
Bypass Chirsova	Bypasses of Slobozia Mare, Câşliţa-Prut, Giurgiuleşti

Development of Giurgiulesti Freeport

One of the objectives of improving the M3 corridor is to provide a direct link between Chisinau and Giurgiulesti, the most southern village in Moldova. Giurgiulesti is located at the confluence of the Prut and Danube rivers between Romania to the west and Ukraine to the east. Border crossings to each country exist for road as well as rail traffic.

Between the international border of Romania and Ukraine the Republic of Moldova owns 800 m of shore line on the Danube, providing for the only access to international waters for the otherwise landlocked country.

A long-standing project, the development of the Port has been revitalized and is currently being completed and expanded. The port will provide tri-modal transport infrastructure consisting of up to six berths, road access and railway links to Russian and European standard railway systems. The water depth at the six berths will vary – one berth with a water depth of 7m will be dedicated to sea vessels and the other five berths with a water depth of 3-5m will be dedicated to river vessels. Once completed, the port will consist of:

- Oil Terminal
- Dry Cargo-Terminal and Storage
- Industrial Free Zone
- Administration Centre

In addition, current plans for the port development include the finalization of a passenger port by the Government, and possibly a bio-ethanol production site.

Study Background
Several studies were undertaken in the recent past that examined transportation conditions in Moldova on a countrywide as well as road specific level. The studies range from a National Transportation Needs Assessment to pre-feasibility and feasibility studies for individual corridor sections. In addition, The Republic of Moldova recently approved the National Transport Infrastructure Strategy paper providing a short, medium and long-term outlook for programmed road rehabilitation projects for the years 2008-17. The 120 km section of M3 from Comrat to Giurgiulesti is included in the *Transport Infrastructure Strategy* based on the following criteria:

- Technical criteria – current and future traffic
- International connections
- Socio-economic criteria
- Commerce and business facilitation

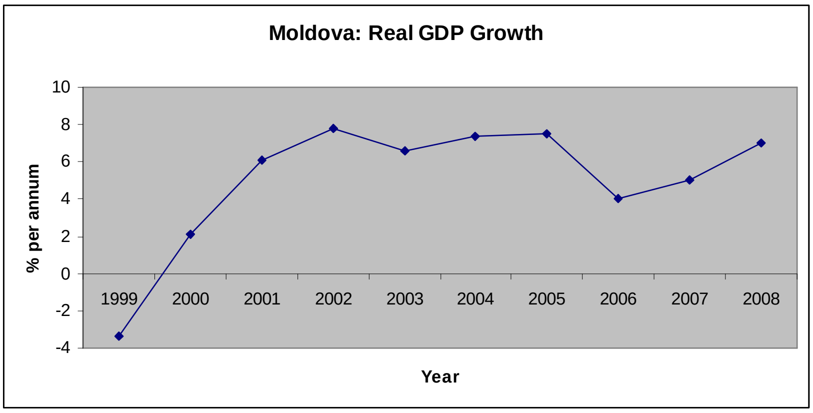
The National Transport Infrastructure Strategy summarizes the benefits of the Comrat to Giurgiulesti section of M3 as follows:

- M3 connects three administrative territories with the centre and north of the country
- The corridor is part of the European road E 577
- The road provides access to important agricultural areas
- Continuous traffic growth is anticipated through the development of the port and petrol terminal in Giurgiulesti (planned to be finalized in 2012)

Transport and Economic Characteristics
Moldova underwent severe economic contraction after the collapse of the Soviet Union and the subsequent loss of diverse markets and cheap energy resources. Increases in energy prices and exports led to high inflation. This was one of the main factors behind the rise in Moldova's international debt and a drop in the GDP over the period to 2000.

The Moldovan economy has been growing at an average annual rate in excess of 5 per cent since 2001 and the overall performance is expected to improve over 2008:

- The GDP to increase by 7.5 per cent.
- The budget deficit is targeted at 0.5 per cent of GDP.
- Poverty will continue declining to 26 per cent from 30 per cent in 2006.



Foreign Direct Investment (FDI) has increased in recent years: in 2008 alone, the FDI inflows increased by 2.4 times compared to 2007 and reached 15% of GDP, due to the improved investment environment. Remittances inflows continue to be strong, exceeding 30 percent of GDP in the last three years. This shows that the Moldovan economy is becoming further integrated into the global economy, with both the resulting positive and negative consequences. The global economic slowdown and financial market turbulence has, however, cast considerable doubt over the prospects of maintaining recent rates of national economic growth. The major international development agencies are currently revising their short term economic growth forecasts for Moldova to reflect the more pessimistic and uncertain international economic outlook. In the first half of 2008, forecasts for GDP growth had been of the order 7 per cent per annum for the period 2008-2013; these are now being revised downwards.

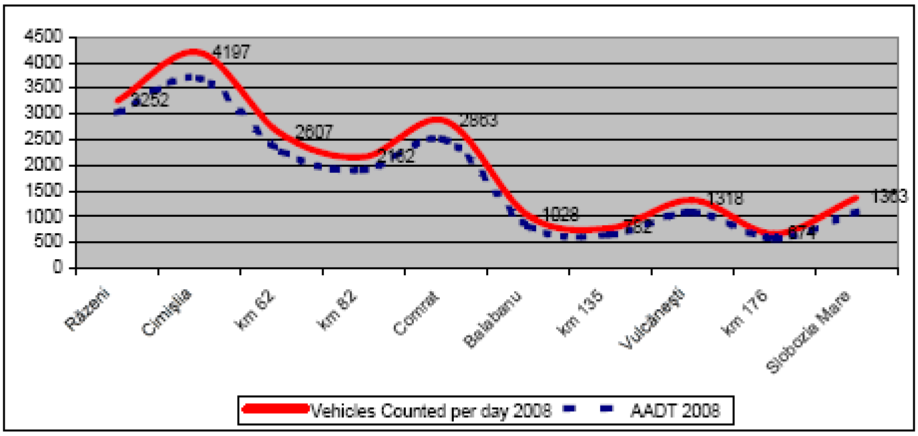
Similarly to the economic development, traffic volumes are growing on the Moldovan road network.

Transport Sector

The current road network was built mostly between the 1930's and 1990, with the most intensive period of network improvement and expansion being between 1965 and 1985. During the years immediately preceding and following independence, funding for maintenance and rehabilitation of the road network was very limited and consequently little work was carried out. The road network has progressively deteriorated.

Traffic Counts and Traffic Forecasts

In order to asses the current traffic conditions along the study corridor an extensive traffic survey program was conducted, comprised of nine Manual Classification Counts, three Origin-Destination Surveys, Turning Movement Count and an Axle Load survey.

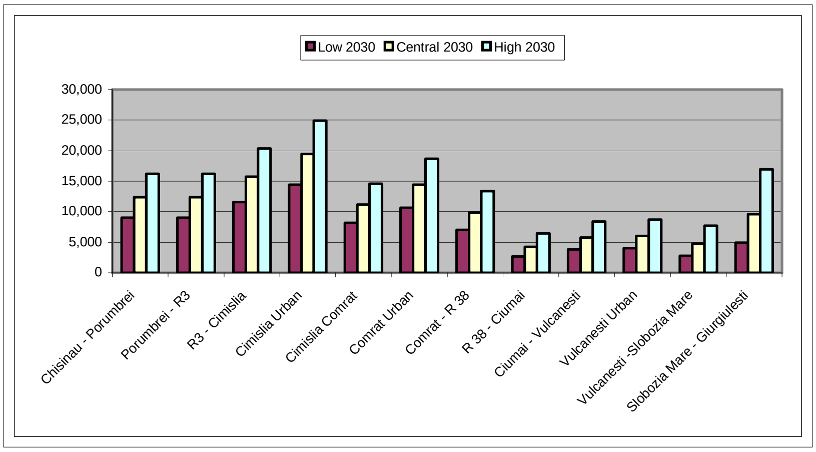


Traffic ranges from around 4,000 vpd on the northern section of M3 to around 700 vpd between Vulcanesti and Slobozia Mare in the south. In the northern section distinct commute patterns are observed. Additionally, a fair number of traffic exchanges between Cimislia, Comrat, Cahul and Giurgiulesti. On the basis of the existing trafficvoöumes, forecasts were developed considering:

1. Base year traffic volume and corridor travel characteristics
2. Traffic generation – new traffic induced by additional or expanded travel options
3. Traffic diversion - traffic diverted to a potentially improved facility from other corridors
4. Special traffic generators: traffic generated through new economic activities such as the Giurgiulesti Free Port

The developed traffic forecast indicated a range of traffic from around 5,000 vpd in the south to close to 20,000 vpd around Cimislia, by 2030.

Using diversion estimation the amount of traffic that would use any of the major bypass options was determined and used in the economic feasibility analysis.



Assessment of Existing Conditions

Numerous surveys have been carried out determining existing conditions of materials, pavement, road and bridge conditions.

Most of the existing roads sections are in fair to poor, and only locally very poor, condition. However the existing bituminous road surface on some road sections is widely in a condition which needs major maintenance and repair where rutting, depressions, alligator cracking and frequent transverse cracks have been recorded.

Environmental and Social Impact Assessment

Environmental and Social Impact Assessments have been carried out on a corridor level, since the individual sections for engineering design are being identified with this document. The Environmental and Social Impact Statements will be finalized for those sections that are being carried forward to the engineering design.

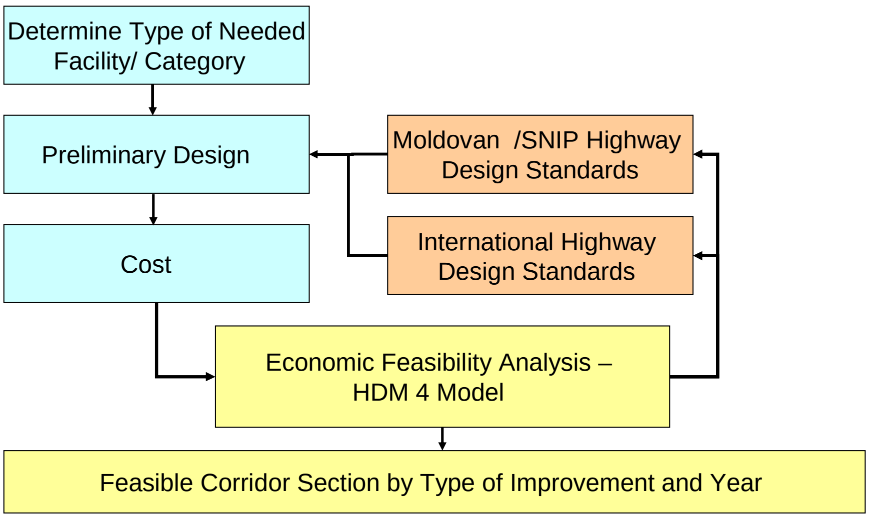
However, since most improvements will most likely be road rehabilitation on existing alignments and potential by-passes have been previously identified and R-o-W has been reserved, the findings of the corridor level assessment tend to suggest that no major environmental and social impacts are anticipated.

A series of stakeholder meetings were conducted to introduce the project and receive comments from the public. One area of concern are the effects of high traffic volumes paired with the mix of heavy truck traffic expected through the development of the port. Especially, since existing cross-sections are narrow in many of the settled areas and the possibility of road-widening is limited. Particularly the transport of oil and gasoline products through the densely populated areas poses a risk and is a concern of the population.

Design Standards

Designs should be justified economically, and the optimum choice will vary with both construction and road user costs. Within this Project the Consultant recommends that while SNIP standards will be applied, design and constructions standards shall be representative of international best practice for geometrical elements, pavement, drainage and structures.

It should also be noted that the application of design standards for a rehabilitation project is usual inherently different from a new construction project, especially considering that the project roads are expected to follow the existing road alignments. It is widespread practice that for these projects, the existing design elements are maintained at their existing values, with the possible exception of limited improvements of geometric characteristics to eliminate safety hazards.



Overall, the Consultant supports the revision of the current Moldovan design standards and norms, with special reference to international standards, economic feasibility and construction costs. Plan and Profile for improvements to the exsiting alignment as well as for each bypass-section have been produced and are the basis for the subsequent cost estimates and economical evaluation.

Cost Estimates

The capital costs of M3 Corridor major off-line projects range from over €45M for the M3 extension/Cimislia Bypass to the new alignment/bypass, Ciumai – Burlaceni at just over €10M. On average cost per kilometre for new construction lies at €1.2M. Online reconstruction cost varies widely between the necessary works and ranges considerably between rehabilitation works and reconstruction works to a Category II standard. The average per kilometre costs lies at €0.74M

Land Acquisition

During the course of the study it became more apparent that current land acquisition process and practice in Moldova will be an issue to consider in the conduct of the engineering design as well as implementation of improvement projects. Especially since some of the by-pass sections are almost entirely in private ownership. Additionally, ownership is shared by many individuals, in some cases more than 170 owners per bypass section.

Economic Evaluation and Project Recommendation

The overall conclusion of this feasibility study is that improvements to the M3 Corridor as an overall scheme are warranted and that an improved high level roadway will be beneficial to the development of Moldova, especially in interconnecting the central to southern parts of the country. However, as in many other transition countries, traffic volumes are low, which together with relatively high construction costs determine the economic feasibility. Several section of the corridor show sufficient economic rates of return and are economically feasible:

- Porumbrei to Cimislia reconstruction existing alignment or Alternative B
- The Comrat urban section - online reconstruction as well as the Comrat bypass
- The sections Comrat to R38 and R38 to Ciumai (the southern portion more vulnerable to changes in cost)
- The Ciumai to Vulcanesti reconstruction or realignment option
- The new alignment and bypasses of Slobozia Mare – Giurgiulesti is currently marginable viable and depend much on the development of the Giurgiulesti freeport.

While the economic analysis is one major decision criteria in the project selection process other aspects need to be considered in the development and staging of a continuous M3 corridor. These are:

- Making best economic use of existing investment (i.e. M3 km0 to km34)
- Development of a seamless, continuous corridor
- National network connectivity
- Overall economic development benefit of the corridor
- Negative and positive social as well as environmental effects of existing traffic conditions as much as potential future conditions.
- Land Acquisition

Summarizing the above, a project assessment matrix is used to qualitatively assess the impacts of the above named factors together with the economic evaluation. The table on the next page presents the project evaluation.

Table 1. Project Recommendation and Phasing: M3 Chisinau to Giurgiulesti

Section	Existing Road Category	Proposed Road Category	Type of Work	Cost per km	Economic Feasibility.	Economic development	Network connectivity	Social	Land Acquisition	Env. Category	Env. Impact	Rating	Time frame	Eng. design eligible
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Chisinau- Porumbrei	I	I	Maintenance and Repair	+	+	o	+	o	o	+	o	+++	s	**yes**
M3 extension Alternative B1	N/A	II	New build of 2 L on 4 L RoW	-	+	+	+	+	-	-	o	+	m	
Cimislia Bypass Alternative B2	N/A	II	New build of 2 L bypass	-	-	o	+	+	-	-	o	--	l	
Porumbrei- Valea Perjei, (R 3)	IV	III / II	Rehabilitation /Reconstruction	+	++	o	-	-	o	+	-	+	s	
Intersection R 3 – Cimislia	III	II[1]	Rehabilitated by 2009										l	
Cimişlia urban	III	II[1]	Currently rehabilitated										l	
Cimislia -Comrat	III	II[1]	Currently rehabilitated										l	
Comrat – Urban Area	III	II	Reconstruction	+	+	o	-	-	+	+	-	+	m	
Bypass Comrat	N/A		New 2 L bypass	o	+	+	+	o	-	-	+	++	s	no
Comrat –Balabanu(R38)	III	II	Reconstruction	+	+	o	o	o	+	+	-	+++	s	**yes**
Balabanu(R38) -Ciumai	III	II	Reconstruction	+	+	o	o	o	+	+	-	+++	s	**yes**
Bypasses of Ciucur-Minjir, Chirsova, Congaz, Svetlii	N/A	II	New bypass	-	-	o	o	+	-	-	+	--	l	
Ciumai – Vulcaneşti	IV	II	Reconstruction	+	+	o	+	+	-	-	+	+++	s	no
Vulcaneşti urban section	III	III	Reconstruction	+	+	o	o	-	+	+	-	++	s	**yes**
Bypass Vulcanesti	N/A	II	New 2 L bypass	-	-	+	-	+	-	-	+	--	l	
New alignment and bypass of Slobozia Mare - Giurgiulesti	IV / N/A	II	New 2 L bypass	o	o	+	+	+	-	-	+	++	s	no
Vulcanesti -Slobozia Mare- Giurgiulesti	IV	IV[2]	Rehabilitation	+	o	-	-	-	+	+	-	-	m	
Slobozia Mare- Giurgiulesti	IV	IV[2]	Rehabilitation	+	-	-	-	-	+	+	+	o	m	

[1] Because of current rehabilitation improvements to Cat II postponed	Colum 8: will connect or shorten corridor	Colum 12: + if addresses current neg. environmental impact on population
[2] If Giurgiulesti – Vulcanesti new alignment no change	Colum 9: + if addresses current neg. social impact on population	Colum 13: Sum of + & -, o = neutral
Colum 5 & 6: Results of Economic Feasibility Analysis	Colum 10: Land Acquisition Needed	Colum 14: Timeframe s= short; m= medium= long
Colum 7: Contributes to regional economic development	Colum 11: if Env. Category A then – / if Env. B Category then +	Colum 15: can design work carried out immediately?

Recommendations

Chisinau – Porumbrei

The maintenance and repair of the existing concrete section of M3 needs to be carried out as soon as possible to avoid further deterioration of the existing roadway. Particular emphasis should be given to measures for accident reduction including signage, speed reduction and separation of traffic modes on the high-speed section of M3.

Porumbrei – Valea Perjei, M3 extension and Cimislia bypass

These three projects are interrelated and need to be analysed together. The new Alternative B1 Porumbrei to Cimislia north proved to be economically feasible, however, other considerations such as land acquisition and environmental and social impact assessments will need to be undertaken in greater detail. The short term recommendation is to use the current alignment from Porumbrei to Valea Perjei until land acquisition is conducted.

Intersection R3 to Cimislia, Cimislia urban section, Cimislia – Comrat

The section of M3 from the intersection with R3 to Cimislia, as well as the section from Cimislia to Comrat have recently been rehabilitated or are scheduled to be rehabilitated. Because of the ongoing rehabilitation measure, no short-term improvements are proposed. In the medium to long term, traffic needs to be monitored and potential improvements reassessed, particularly in conjunction with the potential M3 extension and Cimislia bypass.

Comrat Bypass

The Comrat bypass alignment is shorter then the current existing route and will allow long-distance trips to bypass the urban section of Comrat. The residents of Comrat would be relieved of the through traffic. Since the bypass alignment is partially build and social and environmental negative effects of the new construction be limited.

Sections: Comrat –Balabanu (R38) and Balabanu (R38) - Ciumai

The rehabilitation of the two sections: Comrat to Balabanu and Balabanu to Ciumai will allow establishing a continuous corridor, especially in light with the currently ongoing rehabilitation measures between Comrat and Cimislia. In addition no land acquisition is anticipated and works can be accommodated within the existing Right-of-Way.

Ciumai – Vulcaneşti

The Ciumai-Vulcanesti realignment – reconstruction would have an immediate benefit in creating a continuous improved corridor, by providing a higher level and a more direct route addressing the so-called “Bolgrad bypass” issue: The currently 15 km connection is a direct result of the break up of the Soviet Union. The original M3 road passed through Bolgrad – now part of the independent Ukraine – so an alternative route entirely within Moldova was created at low cost and over a limited time period. The carriageway is extremely narrow with sharp (90°) curves and is highly unsuitable for heavy truck traffic.

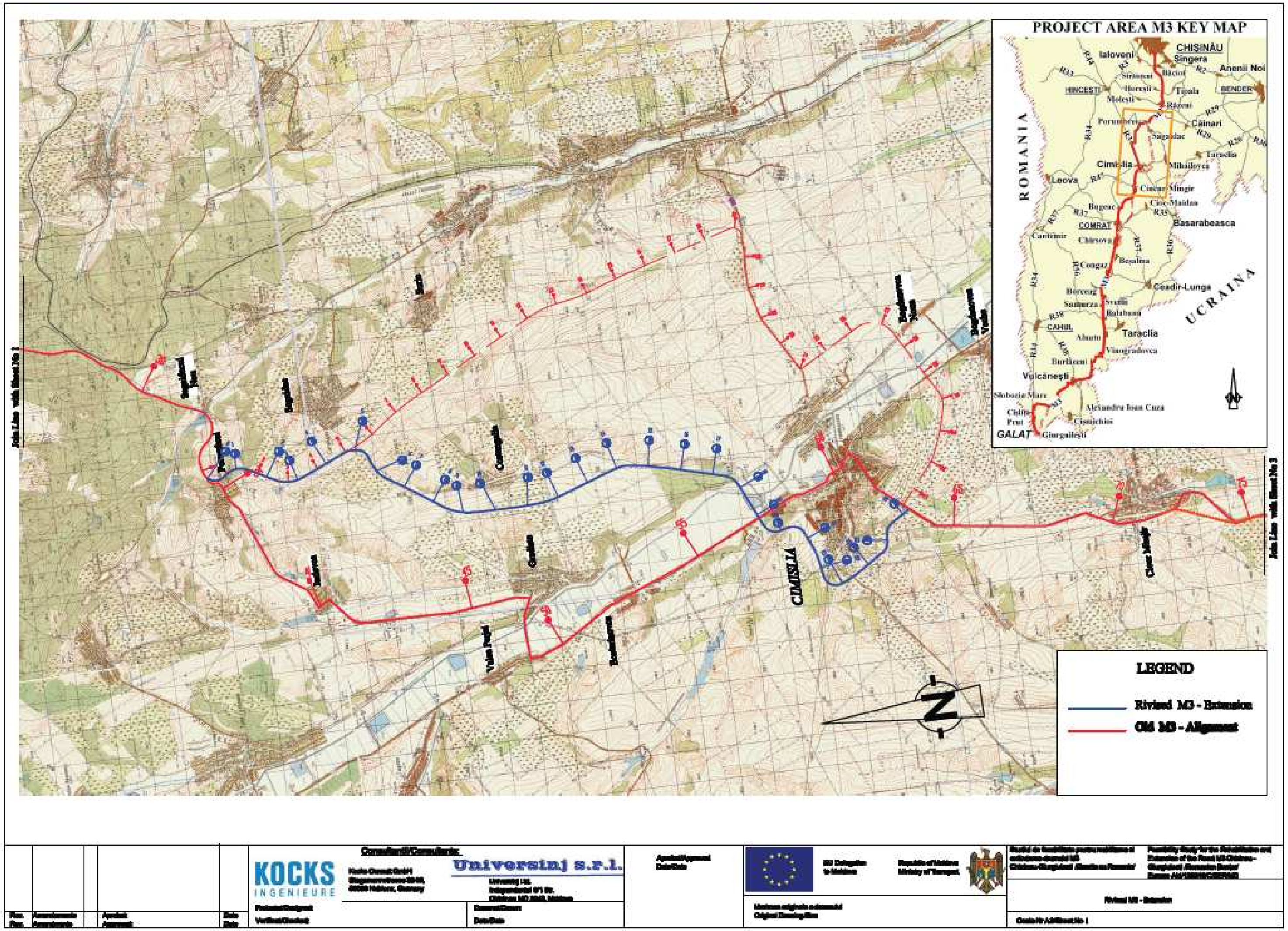
Vulcanesti urban section

Vulcanesti urban section reconstruction should be considered in the medium term since bypass of Vulcanesti is not viable as currently proposed.

Vulcanesti -Slobozia Mare-Giurgiulesti

Improvements to the Vulcanesti -Slobozia Mare-Giurgiulesti section of M3 will be necessary eventually with or without the bypasses of Slobozia Mare – Giurgiulesti in place. However, because of the reasons stated above, preference should be given to the bypass option. With the bypass option in place improvements to Slobozia Mare-Giurgiulesti can be postponed.

Figure 1. Alternate Alignment for M3 Extension Porumbrei to Cimislia



New alignment and bypasses of Slobozia Mare – Giurgiulesti
The alternative does not perform well economically, however with an EIRR of 9.2%, is close to be economically viable. Because of low traffic volumes between Giurgiulesti and Vulcanesti, the reconstruction of the existing alignment does not score significantly higher than the new alignment option. However, due to the expected traffic from Giurgiulesti Port and particularly the type of heavy truck traffic and dangerous goods traffic it is not advisable to route existing and future traffic through the village of Giurgiulesti, Cislita-Prut and Slobozia Mare.

The project should be included in the short term project category with additional emphasis on possible cost savings in the new construction.

Other Bypasses
The bypasses of Vulcanesti, Ciucur-Minjir, Chirsova, Congaz, and Svetlii are currently not viable mainly because of low traffic volumes together with additional length of travel on the bypass options. Traffic volumes along the M3 corridor need to be monitored and if warranted the feasibility of the bypass options reassessed.

The short term projects listed above will contribute considerably to the development of a continuous M3 corridor. The improvements between Giurgiulesti and Comrat will also contribute to the fulfilment of the host investment agreement between the Investor of Giurgiulesti port and the Government of Moldova, in addition to providing adequate access to and from the Giurgiulesti Freeport.

Projects recommended for Engineering Design

The ToR specifies to identify 1 to 2 roadway sections for engineering design and preparation of detailed drawings and Tender Documents for the priority sections. One major obstacle in implementing the candidate projects is the unresolved question of land acquisition. As identified in Chapter 14 the bypass sections are predominantly in private ownership and land acquisition process will be lengthy. In addition, to facilitate engineering design level of detail governmental approval for the land acquisition process is needed.

In a meeting between the Consultant, the Ministry of Construction and Territorial Development, State Road Administration, as well as The Millennium Challenge Corporation, as potential funding agency, it was determined that a two-staged approach should be pursued.

Within the time frame and scope of this project the two sections:

1. Comrat to Balabanu (R38)
2. Balabanu (R38) to Ciumai

are proposed for the engineering design and preparation of tender documents.

At the same time the Ministry of Construction and Territorial Development will initiate the land acquisition process for the other short to mid term priority sections. Once completed, design and potential funding for these section could be incorporated in the MCC efforts.

ACRONYMS

1. INTRODUCTION

The Moldovan M3 road provides the most important and shortest link between Chisinau and Giurgiulesti – giving access to the Danube and the Black Sea. In addition, the M3 corridor is an integral part of the European Road E577 Poltava – Kirovograd – Chisinau –Giurgiulesti –Galati – Slobozia. It provides a link between TEN corridors IV and IX. Currently, the corridor has, in parts, a high level of deterioration and reduced bearing capacity, resulting in axle load restrictions and the diversion of freight traffic, high transportation costs and subsequently reduced local business opportunities and transit traffic. Figure 1-1 presents an overview of the study corridor. Appendix 1 presents a location map of the corridor.

The construction and rehabilitation of the road M3 Chisinau-Giurgiulesti will improve transport links between Moldova, Ukraine and other TRACECA countries. The rehabilitation and partial realignment of the first section of the road (Chisinau-Cimislia) will improve transport connections avoiding inhabited areas and substantially decrease transport costs. The rehabilitation of the second (existing) part of the road Cimislia-Giurgiulesti is very important since road conditions are poor for current traffic levels. The rehabilitation and reconstruction of the whole road will facilitate trade, transport, industry and tourism development and strengthen access to agricultural markets in the region and will be a prerequisite for securing transportation connections between the country's centre and its southern regions.

1.1. The Assignment

With the Contract Agreement for Consultancy Services dated 06 May 2008 the European Commission Delegation in Moldova appointed Kocks Consult GmbH, Germany, as the leading firm, in association with Universinj SRL, Republic of Moldova as Consultant for the

"EuropeAid/125919/C/SER/MD FEASIBILITY STUDY FOR THE REHABILITATION AND EXTENSION OF THE ROAD M 3 CHISINAU - GIURGIULESTI/ROMANIAN BORDER".

The scope of services comprises:

- Identification of transport and economic characteristics of the project influence area;
- Carrying out traffic counts on each road sub-section and updating of existing traffic pattern;
- Preparation of traffic forecasts in terms of vehicles per day by representative vehicle types;
- Assessment of existing road condition;

- Detailed bridge inspection and identification of bridge bearing capacity;
- Investigation of soils and materials, including pavement thickness, sampling and testing of various layers, location of quarries and borrow pits;
- Preparation of preliminary road, pavement and bridge designs;
- Proposing of possible phasing of the construction works;
- Preparing an environmental impact assessment;
- Preparation of cost estimates, indicating foreign exchange costs, and as a separate item the amount of local taxes and duties;
- Assessing vehicle operating costs using the Highway Design and Maintenance Model;
- Carrying out an economic analysis for each road section based on current traffic volumes, vehicle operating costs, construction and maintenance cost to provide an estimated Internal Economic Rate of Return, Net Present Value and appropriate analyses;
- Evaluation of economic benefits of each road segment with and without improvement;
- Undertake sensitivity analysis to test the economic results against possible and likely changes in key variables, that may include the growth rate for forecast traffic, construction costs, implementation delays, and vehicle operating costs;
- Identify 1 to 2 roadway sections for engineering design
- Preparation of Detailed Drawings;
- Preparation of Tender Documents for Priority Sections.

Study Objective

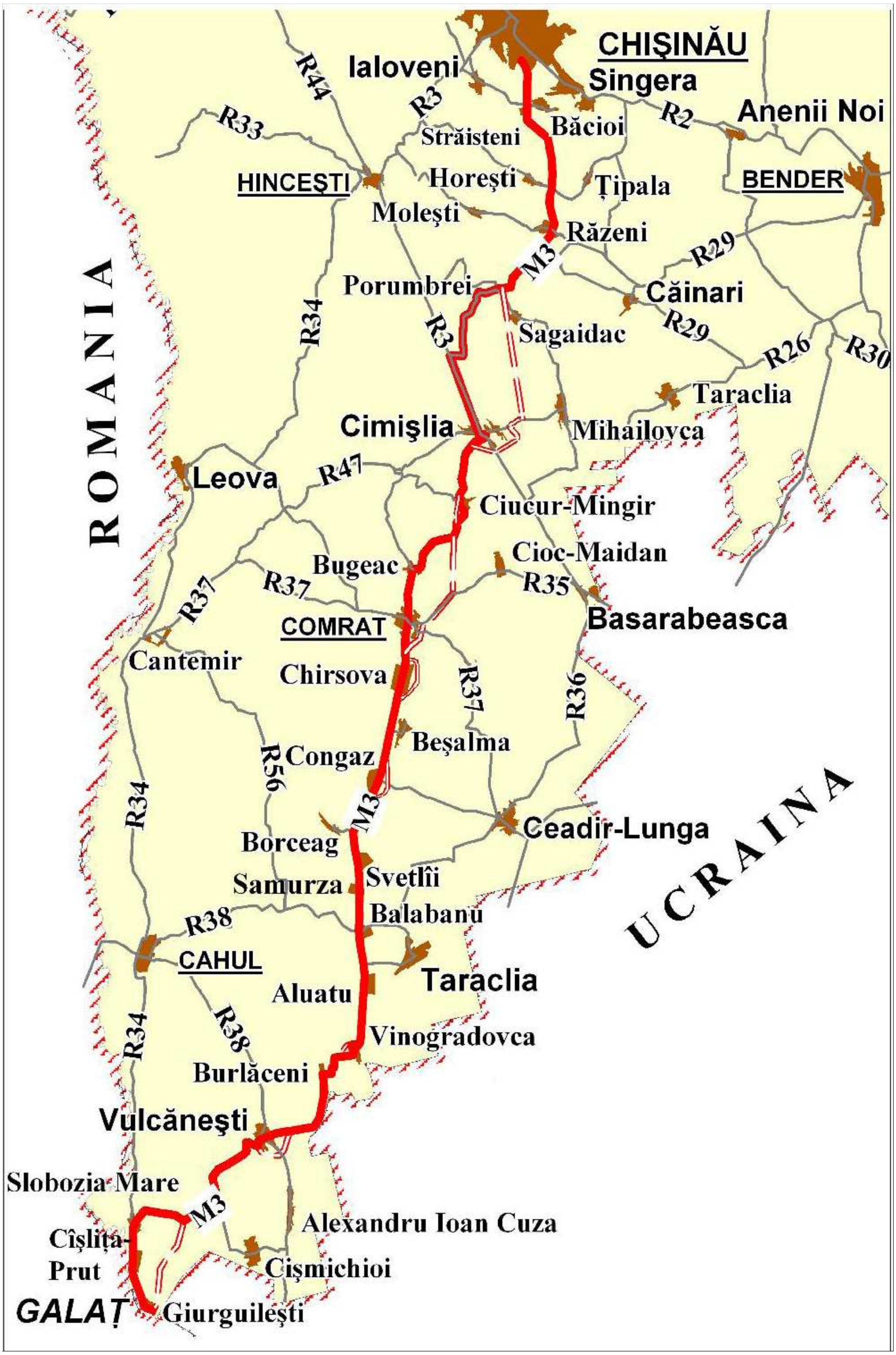
The overall objective of the study is, as identified in the Terms of Reference (ToR), *"… to provide a bankable technical, financial, environmental and institutional feasibility study for the rehabilitation and extension of the M3 road Chisinau-Giurgiulesti / Romanian Border*" and to identify economically suitable sections for road improvement. Further on, "*the study shall be suitable for presentation to International Financing Institutions to attract financing of the road improvement in order to prepare loans by International Financing Institutions"*. These loans will allow the Republic of Moldova to catch up with its backlog in road maintenance and to cope with growing local, international and transit traffic. Appendix I-2 presents the Terms of Reference.

1.2. Study Background and Context

1.2.1. Background

The Republic of Moldova is a landlocked country situated between Romania and the Ukraine, with the exception of a short frontage of about 500 meters on the river Danube in the extreme South of the country. Moldova is a gateway between the former Soviet Union countries and the West, both trade-wise, language-wise and culturally. With the recent accession of Romania to the European Union in early 2007, Moldova has now become a border state between the European Union (EU) and the countries further to the East. The Pan European Corridor IX (Moscow-Kiev-Bucharest) crosses Moldova from East to West, going through the capital city of Chisinau. The challenge of Moldova, similar to that of all low income CIS' countries, is to secure better access to EU markets and thus to encourage exports and foreign direct investment inflows into the country. At the same time, it must also seek to maintain access to its traditional markets in the CIS countries. However, presently it appears that Moldova might not be able to seize its opportunities, because of its deteriorating transport infrastructure, and its crumbling road network, in particular.

Figure 1-1. M3 Corridor Overview



Source: The Consultant

Moldova's road network totals about 16,800 km, of which 3,666 km are classified as National Roads and the remainder as Local Roads. Considering the size of the country and its population, the road network size is generally adequate, with little or no need for expansion. If Moldova's road network had been sufficiently maintained and were in good condition, its asset value would be close to US$12 billion. However, the World Bank reported that in 2006 less than 10 per cent of the road network was in good to fair condition, compared to approximately 70% in 1992. This is the direct result of severe and prolonged neglect of the road network during the intervening period when very few resources have been committed to road maintenance and rehabilitation. About 400 km of formerly paved roads have lost their pavement and have reverted to unpaved gravel or earth roads. The present asset value of the Moldovan road network is only about US$8.4 billion, instead of the US$12 billion it would be if the network had been well maintained. The loss of road network asset value which resulted from insufficient maintenance and rehabilitation is a shocking US$3.6 billion, equivalent to 1.4 times the entire GDP of Moldova in 2004.

Nevertheless, there is no doubt that the road network is still Moldova's single most important physical infrastructure asset, and certainly much larger in value than all power plants, railway lines and the electricity grid combined. An urgent and important effort is needed to save what is left and to gradually improve the road network, without which sustained economic and social development will not be possible. The Economic Growth and Poverty Reduction Strategy Paper (EGPRSP) objectives include the improvement of road infrastructure through the implementation of a programme to first stop the further degradation of the road network. It also includes the creation of a sustainable and transparent system of road maintenance funding, modernizing the technical assessment of roads, and negotiation with international donors, with a view towards obtaining financing resources for road rehabilitation.

In recognition of the above, the Government has (with technical support from the World Bank and a Grant from the Government of Spain) prepared a comprehensive Transport Sector Program for the period 2008-2017 with special focus on the road sector. It includes a Strategy for Road Infrastructure Recovery and a prioritized 10-year Road Sector Investment and Expenditure Plan which will be the sole basis for decision-making on road investments. The Strategy addresses the underlying causes and issues of the road infrastructure crisis and proposes legal, institutional and physical measures to overcome this situation. The Strategy constitutes the framework for all actions, investments and expenditures in the Road Sector starting from 2008 onwards, including those to be financed by external donors.

The Strategy has defined the most urgent reforms in the road sector:

- the creation of a reliable and stable financing mechanism for road maintenance,
- the reform of the way road maintenance is executed, and
- the introduction of an axle load control system to curb the circulation of overloaded trucks on Moldova's roads.

1.2.2. Country Background

The Republic of Moldova became independent in August 1991 following the demise of the Soviet Union. It is bordered by Romania and Ukraine. The total area of the country is 33,843.5 km^2. It has a total of 1,389 km of international borders.

The relief of the country represents a hilly plain sloping from northwest to southeast with an average elevation of 147 m above sea level. The central part of the country is occupied by Codrii woods, the most elevated topographical region with a maximum altitude of 429.5m at Balanesti

Hill, and a terrain fragmented by valleys. The terrain of the southwest of the country and the region along the lower course of the Nistru River represents a less fragmented plain.

The climate of the Republic of Moldova is moderately continental. It is characterized by a lengthy frost-free period, short mild winters, lengthy hot summers, modest precipitation, and long dry periods in the south. The average annual temperature increases southward from around 8-9℃ in the north to around 10-11℃ in the south. The average annual precipitation varies between 600-650 mm in the north and the centre and 500-550 mm in the south and the southeast.

As of 1 July 2008 the total population of the Republic of Moldova was some 4.32 million (including Transnistria) or 3,938,000 according to the 2006 Census as published by the National Bureau of Statistics with a negative annual growth of approximately 0.09% per year. The population density was 131.6 persons per km^2. Approximately 78% of the population is ethnic Moldovan/Romanian with Russians (5.8 %) and Ukrainians (8.4 %) and Gagauz (4.4 %) being the largest minority groups. Some 60% of the population lives in rural areas. Chisinau, the capital city, has a population of some 600,000. The average age of the population is 34 with more than 40% under the age of 20.

1.3. National Economic and Financial Background

Moldova underwent severe economic contraction after the collapse of the Soviet Union and the subsequent loss of diverse markets and cheap energy resources. Increases in energy prices and exports led to high inflation. This was one of the main factors behind the rise in Moldova's international debt and a drop in the GDP over the period to 2000.

The Moldovan economy has been growing at an average annual rate in excess of 5 per cent since 2001 (see Figure 1-2) and the overall performance is expected to improve over 2008:

- The GDP to increase by 7.5 per cent.
- The budget deficit is targeted at 0.5 per cent of GDP.
- Poverty will continue declining to 26 per cent from 30 per cent in 2006.

Foreign Direct Investment (FDI) has increased in recent years: in 2008 alone, the FDI inflows increased by 2.4 times compared to 2007 and reached 15% of GDP, due to the improved investment environment. Remittances inflows continue to be strong, exceeding 30 percent of GDP in the last three years. This shows that the Moldovan economy is becoming further integrated into the global economy, with both the resulting positive and negative consequences. The high inflow of foreign exchange exerts significant pressure on the Moldovan currency leading to its appreciation. During the last two years, the Moldovan Lei has appreciated by over 25 per cent against the US dollar. In turn, this has affected the competitiveness of exports and, as a consequence, Moldova has a continuously growing trade deficit.

The increase in international energy and food prices, combined with the significant inflow of foreign exchange, has stoked inflationary pressures (see Figure 1-3). Nevertheless, the annual inflation rate has reduced from 16.9 per cent to 10.7 per cent between May and September 2008 and the Government of Moldova hope to bring this indicator to below 10 per cent by the end of the year. Recent fiscal performance has been strong. National Public Budget revenues increased from 38.6 per cent of GDP in 2005 to 41.8 per cent in 2007. Strong revenue performance allowed the Government to implement a three-fold “liberalization” initiative which includes: capital legalization, tax amnesty and the introduction of zero corporate tax rates on the reinvested income. The reform aims at reducing the tax burden and creating a better business environment. Public external debt to GDP ratio has been reduced from 22 per cent in 2005 to 12 per cent in 2008.

However, the difficult business climate, government interference and the slow pace of privatisation all represent obstacles to continued economic development. Weaknesses related to corporate governance, supervision and lack of transparency in banking ownership need to be addressed. Corruption remains a serious problem, undermining the administrative and legal efforts to improve the business environment. While in the short run economic growth is likely to continue, long term prosperity will depend on renewed efforts to implement structural reforms, strengthen institutional capacity building and improve the investment climate.

Accordingly, the Moldovan Government has begun the implementation of the National Development Strategy for 2008–2011, which aims at:

(i) Enhancing the competitiveness of the national economy,
(ii) Development of human resources, enhancing employment and promoting social inclusion and
(iii) Regional development.

Both IMF and World Bank support the National Development Strategy.

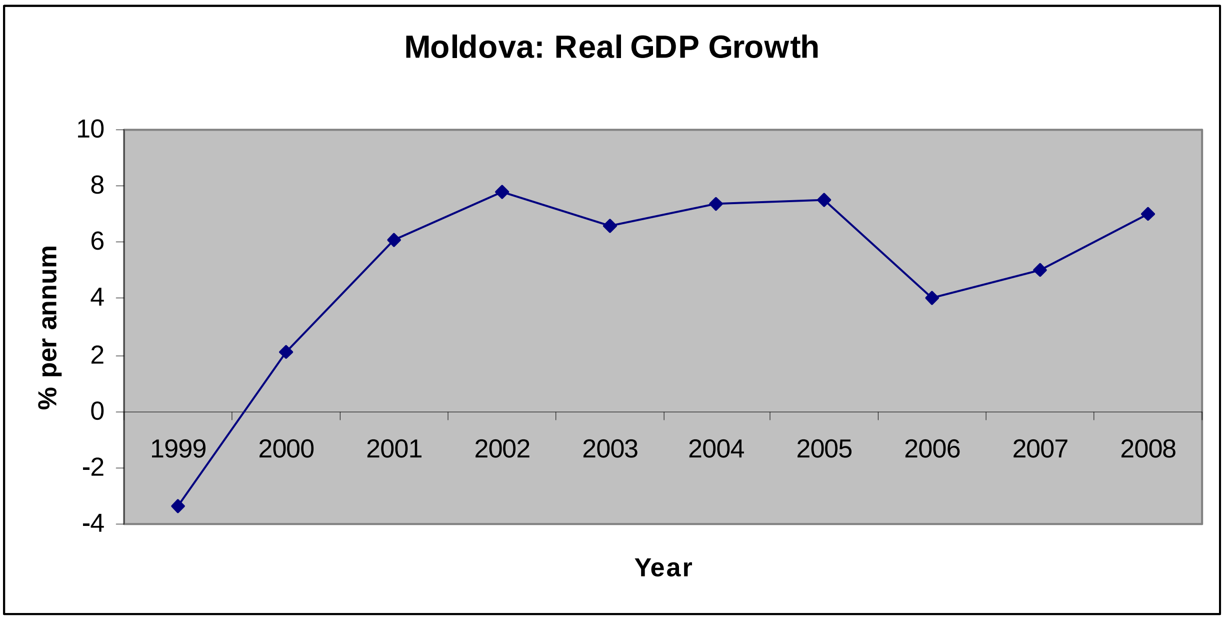
The European Neighbourhood Policy (as outlined in the EU Action Plan for Moldova) sets ambitious objectives for partnership with neighbouring countries based on strong commitments to shared values and political, economic and institutional reforms. The Union offers the prospect of a stake in its Internal Market and of further economic integration. The speed and intensity of this process depends on the will and capability of the partner country to engage in this broad agenda.

The global economic slowdown and financial market turbulence has, however, cast considerable doubt over the prospects of maintaining recent rates of national economic growth. The major international development agencies are currently revising their short term economic growth forecasts for Moldova to reflect the more pessimistic and uncertain international economic outlook. In the first half of 2008, forecasts for GDP growth had been of the order 7 per cent per annum for the period 2008-2013; these are now being revised downwards.

Economic Prospects

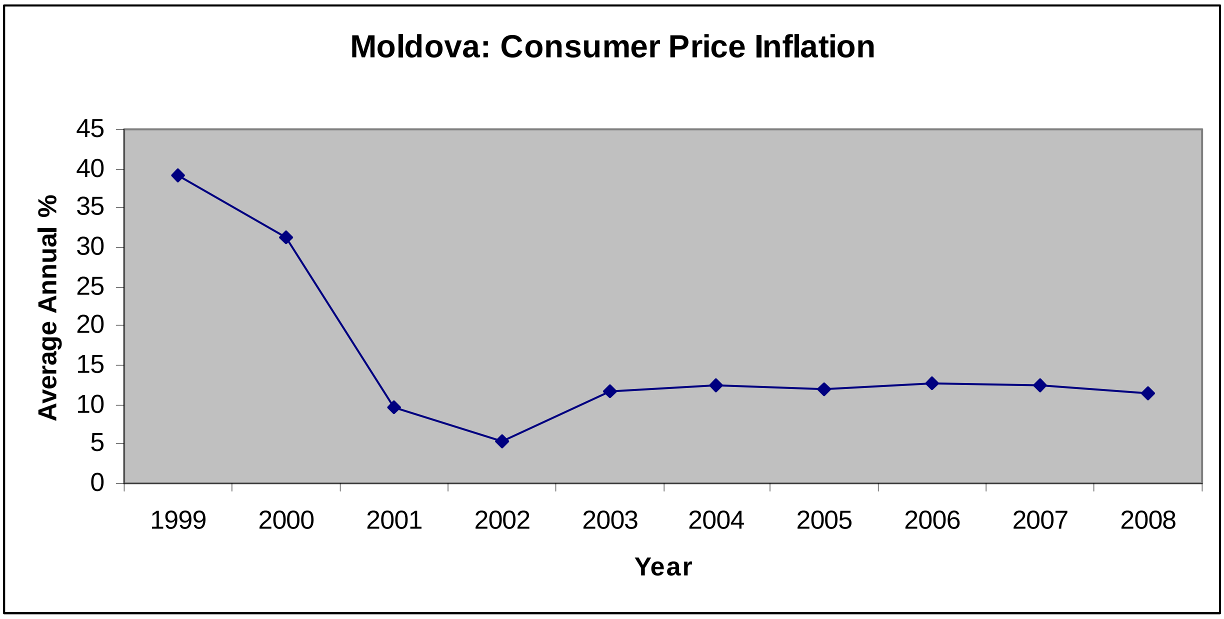
The immediate prospects for the economy of Moldova remain fair. The Republic of Moldova and the EU agreed at the EU Moldova Cooperation Council of 24 February 2004 that the European Neighbourhood Policy offers an ambitious and realistic framework for strengthening their relationship, allowing Moldova to benefit fully from EU enlargement.

Figure 1-2. Moldova: Gross Domestic Product (GDP) Growth



Source: IMF

Figure 1-3. Moldova: Consumer Price Inflation



Source: IMF

1.4. Transport Sector Profile

The existing transport infrastructure in Moldova, inherited from the FSU, was developed as a regional network to serve the requirements of the Soviet Union without taking into consideration the administrative boundaries of Moldova while paying little attention to the needs of regional co-operation. The network was primarily designed to serve intra-FSU traffic. This has created a number of difficulties following independence as Moldova found itself with a fragmented transport network. The transport sector was left with the challenge of the rehabilitation of deteriorating existing assets while making improvements to system capacity, connectivity, and efficiency.

The dominant transport mode in Moldova is road transport. In 2006 road carried the overwhelming majority of both freight and passenger traffic (61.3% of the total). Of the other modes rail transport accounted for 38.33 %. The remaining volumes are negligible and represent air and fluvial traffic.

The highway network of Moldova is about 16,800 km in length of which 3,665 km (21.8%) are state or national roads and 13,134 km (78.2%) are local roads. Not considering Transnistria the length by surface type are as shown in Table 1-1.

Table 1-1. Moldovan Road Network Data

Moldovan Road Network*					
Pavement Structure	**National Roads**			**Local Roads**	**Total Roads**
	Magistrale	**Republicane**	**Total**		
	km	**Km**	**km**	**km**	**km**
Total Network	816	1,998	2,814	6,588	9,402
Concrete	424	**	424		424
Asphalt Concrete	365	1,678	2,043	2,741	4,784
Surface Treatment	18	167	185	426	611
Macadam	9	153	162	2,953	3,097
Earth/Gravel				486	486

*** Length given by the State Road Administration**
**** During the execution of the field works for the Transport Sector Study concrete surface with total length of some 318 km was also found on "Republican" Roads**
Source: Support to the Preparation of a Transport Sector Strategy for Moldova, GABINETE DE ESTUDIOS TÉCNICOS INGENIERÍA, S.A, June 2007

The density of the road network is low, 55.7 km per 1000 m^2 and 4.5 km per 1,000 persons. 97.5% of the public roads were originally realised as paved roads but some of them have already deteriorated back to earth roads. The responsibility for the national public road network lies with the State Road Administration under the Ministry of Construction and Territorial Development.

Under the former system, the Government was both a policy maker and an operator. The Ministry of Transport was responsible for the planning of new roads and the organization of the maintenance of roads, executed the works under force account and assumed quality control of the works executed.

Although most of the entities act today under a corporate structure, a part of the road sector industry (including maintenance operators and public works companies) is still controlled by the State, even if for a short time in 2001, the road administration existed as an autonomous and financially independent public road authority.

As of July 2008 the Ministry of Construction and Territorial Development is responsible for the general oversight of the country's roads, which is delegated to a Road Department within the Ministry. This department is understaffed but still has complete responsibility for the entire sector. Figure 1-4 presents an overview of the current organizational structure of the Ministry of Construction and Territorial Development.

The Ministry controls the State Road Administration, which is a corporate road agency responsible for the day to day management and maintenance of the country's entire road network. It holds the title of ownership of the roads and their right of way. It is in charge of all road construction, maintenance and rehabilitation and responsible for road safety. The State Road Administration is also responsible for all decisions concerning the use of funds for roads, both from the State Budget and from the Road Fund. Contractors for road construction and road rehabilitation are totally or partially privatised. Those which were partially privatised have been transformed into joint stock companies.

Maintenance of the public road network has proved difficult since independence, the early years of which consisted of a major contraction of the economy.

1.5. Institutional Development and Project Sustainability

The institutional component of the study can be summarised as:

- A review of recent institutional and policy reforms in the road sector in Moldova
- An assessment of the institutional and financial sustainability of the M3 Chisinau – Giurgiulesti rehabilitation and extension project

1.5.1. Road Sector Development and Funding

Moldova's road network is its single most important physical infrastructure asset. It totals about 9,500 km, of which 3,329 km are classified as National Roads and the remainder as Local Roads. Considering the size of the country and its population, the road network size is generally appropriate. Principal roads in Moldova are managed by the Ministry of Construction and Territorial Development through the State Road Administration. The public highway network is entirely state-owned and is legally protected from privatisation or tolling.

The current road network was built mostly between the 1930's and 1990, with the most intensive period of network improvement and expansion being between 1965 and 1985. During the years immediately preceding and following independence, funding for maintenance and rehabilitation of the road network was very limited and consequently little work was carried out. The road network has progressively deteriorated.

The Ministry of Construction and Territorial Development (MCTD) is in charge of the general planning and oversight of Moldova's roads; it has a small Roads Department within its organisational structure. The MCTD controls the State Road Administration (SRA), a corporative road agency responsible for executing road maintenance, road investments and road safety. The SRA only has limited autonomy given its direct control by MCTD.

The SRA controls 40 local district road maintenance firms located throughout the country. These were formerly fully state-owned, but are now joint-stock companies with between 10 and 30 percent of their shares held by staff and the remainder by the state. These firms have limited managerial or financial independence. Each year the SRA allocates an average of approximately €140,000 to each firm through a maintenance contract to be used for routine maintenance tasks. Occasionally, road construction equipment is provided from the State budget for the district road maintenance firms.

These firms play an important role providing routine maintenance and winter maintenance to a basic level and at low cost, thus ensuring a minimum level of service for road users. In commercial terms these firms are not currently viable; their future is unclear.

The SRA also controls five joint-stock road construction firms with various degrees of private participation. All of these firms have little physical capacity and not all are active.

With the government expenditure on roads being low, turnover figures for the construction industry are low and it is very difficult for a proficient road construction industry to develop. Many

Moldovan contractors have turned to other construction activities, such as building apartments or fabricating tiles, while losing competent road staff to contractors in neighbouring countries.

1.5.2. Road Maintenance Funding

During the Soviet period, financing of road infrastructure expenditure was based essentially on two separate sources. These were:

(i) domestic revenues raised through the Road Funding Law of 1958, and
(ii) transfers of important resources from the budget of the Soviet Union, in the form of specific subsidies to Moldova for the construction of “strategic roads”. Transfers of such subsidies essentially ended in the late 1980’s.

The Road Funding Law of 1958 remained in place until 1993 and established a broad-based tax to finance the development and maintenance of the country’s road network. The tax rate was set at:

(i) a general rate of 1.5% of the revenues of all legal productive entities;
(ii) a reduced rate of 0.5% on the turnover of all trading enterprises; and
(iii) varying percentages of the revenues of transport enterprises, depending on the type of vehicle used.

Overall, available resources for roads exceeded the absorption capacity of the road construction sector in most years. However, the early 1990’s were marked by a dramatic overall reduction of economic activity in Moldova, as a result of the disintegration of the Soviet Union. The ensuing collapse and shutdown of a large number of state enterprises rendered the long-standing system of road financing through taxation of general economic activity non-viable.

The adoption by Parliament of the Road Law Nr. 509-XI11 of June 22, 1995, still in force today, established a variety of funding sources for the road sector. However, all these revenues became general budget revenues, not directly linked to roads or road maintenance and failed to solve the funding problem for roads which had become increasingly serious.

Another attempt was made in 1996 through Law Nr. 720-XI11 which established the Road Fund and which is still valid today. The purpose of the law was to channel to the road sector those funds collected as the result of the Road Law of 1995. At the same time, the fuel excise tax was more than doubled, to 270 Lei per ton of gasoline and 96 Lei per ton of diesel fuel. However, the Road Fund was set up as a special account held at the Ministry of Finance, and this made the Road Fund again a budgetary instrument which falls short of the required basic criteria of Road Maintenance Funds. Only a small proportion, 15 % in 2005, of the finance raised by the fuel excise tax was allocated to the Road Fund, the remainder going to the general budget. This undermines the original objective of creating a stable and reliable road funding source, independent of short-term political decisions.

The shortcomings of the existing Road Fund are as follows:

- Its single largest revenue source is diverted to the general budget;
- It lacks autonomy and is instead managed by the Ministry of Finance as a sub-account of the general budget;
- It mostly finances annual across-the board allocations to State-controlled district road maintenance enterprises;
- No participation of road users in the decision-making on use of funds;
- There is no competitive bidding for works funded;

- There is no clear accountability for outputs and quality control of works funded; and
- There are no independent financial and technical audits of the Road Fund and of the activities it funds.

A revised draft law to reform the Road Fund was prepared and sent to parliament in 2001. Briefly, the road administration existed as an autonomous and financially independent public road authority, which would obtain its revenues directly from the road users through a newly established "second generation" Road Fund, fully separated from the budget, transparent, with the participation of road users, and with technical and financial audits carried out annually by independent and internationally recruited auditing firms. After operating independently for a few months the road authority was transformed into a state enterprise, subordinated to the Road Department of the Ministry of Transport and Communications. In the meantime, the draft law for a new road fund was never adopted. Yearly road budget allocations are discussed in parliament resulting in increases which are clearly insufficient.

1.5.3. Road Sector Reform

Road Sector Program
These earlier attempts at road sector reform with a view to improving and protecting the finance available for road maintenance and rehabilitation have largely been unsuccessful with the result that the national road network has continued to deteriorate and the value of this national asset to diminish.

In recognition of the bad condition of the road network, the Government decided in 2005 to sharply increase spending on road maintenance and rehabilitation, using both domestic and external funding. 2006 saw the beginning of increased expenditures which rose from the previous annual average of about €6 million (routine maintenance only) to about €11 million for both maintenance and some rehabilitation. The 2007 budget included €10 million for road maintenance alone, plus another €11 million for road rehabilitation.

In early 2006 the World Bank and the Government of Moldova reached an agreement in principle that the World Bank would support the Government's Transport Sector Program for 2008-2017 (including a Transport Sector Strategy and a prioritized 10-year Transport Investment and Expenditure Plan) through IDA funds. Subsequently, both EBRD and EIB indicated their willingness to participate in the funding of the project. The Transport Sector Strategy's main focus is on roads.

Significant additional external financing for the Road Sector Program has become available from 2008 (i) from the EU under its New Neighbourhood Program, and (ii) from the U.S. Government through the Millennium Challenge Account.

According to agreements with the donor community within the Poverty Reduction Strategy Credit (PRSC) framework, Moldova's road sector spending should reach at least €70 million in 2009. However, this can only materialize with the support of the international donor community.

Axle Load Control
Many of Moldova's roads were designed for axle loads of about eight tons or less. The current legal axle load limit in Moldova is now 11.5 tons for National Roads, recently raised from ten tons to move into line with EU regulations. At the same time, the lack of investment and maintenance of Moldova's roads over the past 15 years has led to a weakening of existing road structures, and thus to a high vulnerability of roads to structural damage due to vehicle overloading. This needs to be countered through a system of axle load controls and the imposition of substantial fines for

overloading. However, the only public vehicle weigh-stations in Moldova are at the borders, and these are used exclusively to determine transit fees for trucks.

As part of the Sector Program Support Project the SRA has commissioned a study to
to design and implement an axle load control system for the protection of the Moldovan road system by reducing overloading on public roads. This includes the examination of the existing legal framework and proposals for appropriate modifications. These measures will be put in place in consultation with major road users such as truckers associations and the owners and managers of major sources of heavy cargo. In addition, specific anti-corruption measures will be designed and implemented.

Recent Developments
The establishment of a road authority for Moldova which operates along commercial practices, is autonomous and financially independent and is protected from frequent political intervention has been foreseen more than once in the recent past, by both Moldovan and international advisors. Briefly in 2001, it appeared that the SRA would fulfil this role but its political and financial independence did not last long. Road sector reform has, to date, stumbled at this challenge.

Developments in 2008 were not particularly encouraging. In July responsibility for the road sector was transferred to the Ministry of Construction and Territorial Development, of which the SRA forms a direct subsidiary. In this realignment of political responsibility the road sector has been separated from the other transport modes which are now served by a National Transport Agency. This, perhaps, indicates the importance placed on roads by the Government of Moldova but does not in any way move the SRA towards greater independence from political activity.

In December 2008 the World Bank announced that it was cancelling an amount equivalent to US$ 11 million (€ 8m) for the Government's Road Sector Program because of misprocurement. The World Bank's funding for other activities in the road sector, such as technical assistance to the Ministry of Construction and Territorial Development and to the State Road Administration were unaffected by the cancellation. This echoes an earlier suspension of funding of a road rehabilitation project by the EBRD in 1998 following alleged political interference in contract management.

Prospects
Administrative reform of the road maintenance financing mechanism is, however, urgently required to address the continued deterioration of Moldova’s road network.

There is room for an increase in fuel prices to raise taxes for road maintenance. However, before this can take place it is essential that the administrative changes required to independently manage the revenues raised are implemented. This does entail the establishment of an independent road authority which will provide financial and technical control over the maintenance and management of the Moldovan road network through the use of a “Second Generation” Road Fund. To date, there has not been sufficient political will to achieve this goal. This is by no means unusual because governments prefer to exercise maximum control over the distribution of available revenues. However, the justification for increased fuel taxes can only be convincing to the road user if these additional funds are specifically allocated to the obviously urgent requirement for road rehabilitation and maintenance in Moldova.

The relationship with the international donor community is also vital for the future of the Moldovan road network, at least in the short to medium term. The condition of the road network has reached the stage where considerable resources are needed to raise the network to acceptable standards as a starting point for future maintenance. This level of resources can only currently be provided by the IFIs. Of recent years Moldova has not always enjoyed the smoothest of relationships with these organisations and it is important for the immediate future of the road network that further upsets are avoided. In particular, the IFIs appear unhappy with the relationship between the Government and the highway contracting business. This is another area in which a truly independent road authority would perform an effective role.

Assessment of the Institutional and Financial Sustainability of the Project
This work will be completed between Draft Final and Final Feasibility Report stages and included in the Final Feasibility Report.

1.6. Relevant Studies

Several studies were undertaken in the recent past that examined transportation conditions in Moldova on a countrywide as well as road specific level. In addition, general guidelines provided by the International Financial Institutions including The Millennium Challenge Corporation were used to guide the development of this Feasibility Study. (See Appendix 2 for a list of relevant studies.) The studies range from a National Transportation Needs Assessment to pre-feasibility and feasibility studies for individual corridor sections. In addition, The Republic of Moldova recently approved the National Transport Infrastructure Strategy paper providing a short, medium and long term outlook for programmed road rehabilitation projects for the years 2008-17. See Appendix 3 for detail. Identified rehabilitation projects regarding the M3 corridor are listed in Table 1-2 and presented in Figure 1-5. The 120 km section of M3 from Comrat to Giurgiulesti is included in the *Transport Infrastructure Strategy* (See Appendix 3) based on the following criteria:

- Technical criteria – current and future traffic
- International connections
- Socio-economic criteria
- Commerce and business facilitation

The National Transport Infrastructure Strategy summarizes the benefits of the Comrat to Giurgiulesti section of M3 as follows:

- The road connects three administrative territories with the centre and north of the country
- The corridor is part of the European road E 577
- The road provides access to important agricultural areas
- Continuous traffic growth is anticipated through the development of the port and petrol terminal in Giurgiulesti (planned to be finalized in 2012):
    - o The Dutch company that is implementing the port and petrol terminal and has also obtained the rights to build approximately 50 gas stations throughout the country
    - o Planned construction of a bio-ethanol production site.

Table 1-2. M3 Identified Rehabilitation Projects

Corridor	Section	Length	Planned Year	Cost (in Mio. USD)	Proposed Financing	Map reference
M3	Cimişlia-Comrat	32 km	2008	9,22	State Budget	3 & 4
R3	Hînceşti – Cimişlia	29 km	2009	9,27	State Budget	7
M3	Comrat – Vulcăneşti	77 km	2010	20,48	Foreign Invest	15
M3	Vulcăneşti-Giurgiuleşti	45 km	2011	14,91	Foreign Invest	15
M3	Chisinau – Porumbrei	34 km	2012	14,97	Foreign Invest	N/A

Source: National Transport Infrastructure Strategy

Figure 1-4. Organization of Ministry of Construction and Territorial Development

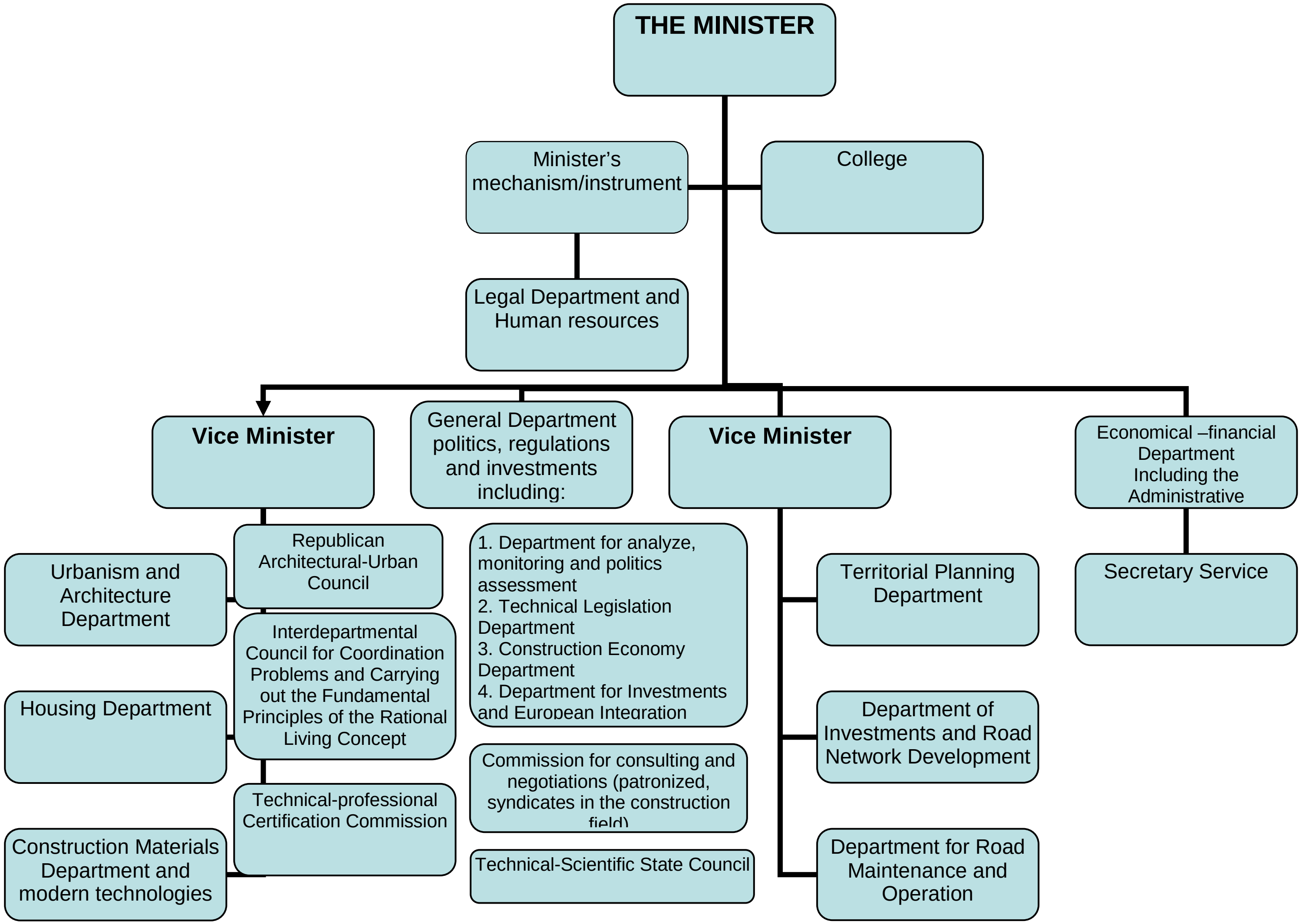
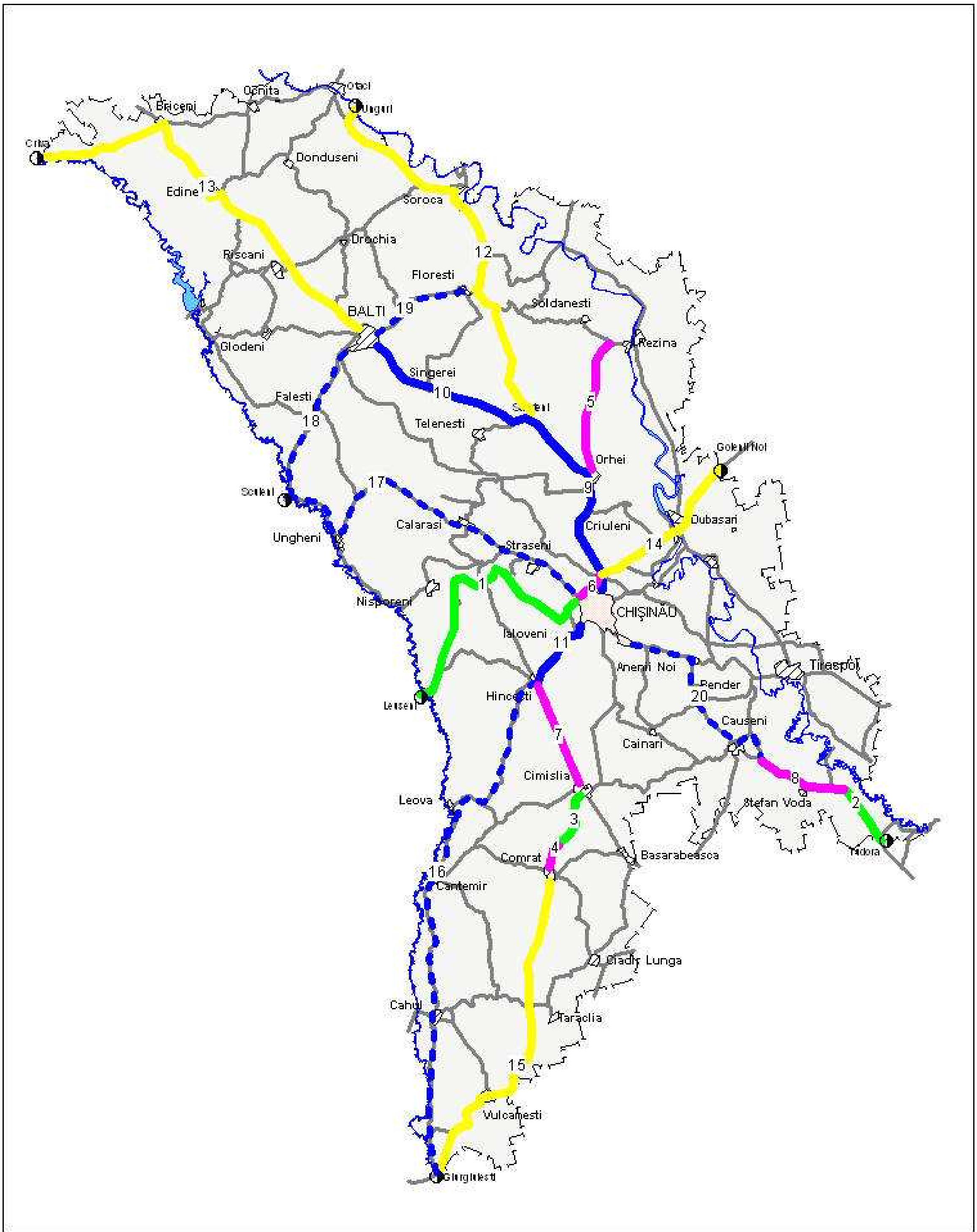


Figure 1-5. National Transport Infrastructure Strategy Project Map



Source: Government of Moldova

The National Transport Infrastructure Strategy proposes the construction of a 21 km long new section of road to bypass Giurgiulesti, Cislita Prut and Slobozia Mare. The Giurgiulesti bypass road and its environmental as well as economic feasibility are discussed in Chapter 12 and 13 of the Moldova Roads Need Study (1997) Particular emphasis is given to the environmental impact of the transport of oil products by road as well as the projected traffic generation of the port terminal.

1.7. General Project Approach

The feasibility study will provide preliminary engineering design, traffic forecasting, and economic evaluation data for the project road sections. The main approach is to make maximum use of the existing road, rehabilitated to an acceptable level using modern geometrical and physical standards. New sections of road shall be considered only where it can be demonstrated that the rehabilitation of the existing road does not provide sufficient benefits to the area and local population; or does not sufficiently improve any negative environmental impact to an acceptable level. Existing reports and documents have already been studied.

1.8. Corridor Description

The M3 corridor, presented in Figure 1-1 and Appendix 1, connects Chisinau, the Capital of Moldova, with Giurgiulesti in the very south of Moldova over a distance of approximately 216 km and can be distinguished in 7 major sections:

1. The corridor starts in Chisinau as a concrete four lane Category I motorway to the village Sagaidacul and extends to the village of Porumbrei on 2 lanes. From here on south, an extension of M3 was designed to bypass the Town of Cimislia. Design, Land acquisition as well as earthworks have been started in the period from 1985 to 1995. Rights for land acquisition might have expired since then.

2. Because the Cimislia bypass is not completed, the corridor continues from Porumbrei on in south-western direction on local roads, as a Category IV roadway, to connect with Republican Road R3. The Porumbrei to R 3 section was never planned to form an integral part of the M 3 corridor but due to the stoppage of works on the Porumbrei – Cimislia Section the corridor is actually leading through the villages Porumbrei, Iurievca and Gradiste. The section has a load restriction which is often not observed but the alternative route via Hincesti to Chisinau is much longer and thus transport cost is higher.

3. The M3 corridor then follows the R3 alignment to Cimislia. The section of R3 between Hincesti and Cimislia is planned to be rehabilitated by the end of 2009.

4. From Cimislia onward the corridor (Category III) continues as M3 south to the town of Comrat (sharing the E 577 designation). Comrat is the capital of the autonomous Gagauzia region. Here, M3 intersects with R 37 which leads west to Cantemir and R 35 east to Basarabeasca. The section has been rehabilitated as of the end of 2008.

5. From Comrat south the M3 continues as a Category II/III road – connecting the villages of Chirsova and Congaz to the intersection with R38. Regional Road 38 provides access westward to the City of Cahul with a border crossing to Romania and eastward to the town of Taraclia.

6. From the intersection with R 38 the M3 continues south to the village of Ciumai. In order to avoid a double crossing of the Ukrainian Border the corridor follows a local road in a south-western direction to reconnect with the M3 7 km east of the town of Vulcanesti. The "Bolgrad – Bypass" (Ukraine) is 15.5 km in length and a result of the break up of the Soviet Union. The original M3 Road passed through Bolgrad – now part of the independent Ukraine – so an alternative route entirely within Moldova was created at low cost and over a limited time period. The carriageway is extremely narrow with sharp (90°) curves and is highly unsuitable for heavy truck traffic.

7. From Vulcanesti on the corridor (as Category IV) follows the M3 alignment for 14 km to an intersection with a local road. Here the corridor turns westward to intersect with R34 in the village of Slobozia Mare. Following R34 south the study corridor terminates in the village of Giurgluesti. Giurgiulesti is located between a border crossing over the Prut River to Romania in the west and a border crossing with the Ukraine to the east. The southern sections from Vulcanesti to the Danube River which are classified as category IV have a maximum axle load of 8 tons.

The corridor serves the following administrative districts (Raioane):

Chisinau: Chisinau is the most economically developed and industrialised city in Moldova. Chisinau's economy is mainly focussed on services but also includes substantial production capacities for consumer and electrical goods, building materials, machinery, plastics, rubber and textiles. According to 2007 figures some 911,400 people are living in the region (raioane), about 600,000 in Chisinau itself and the others in 6 cities and 12 communities in the district. Chisinau has an international airport, handling some 700,000 passengers/year.

Ialoveni: Ialoveni district covers an area of some 783 km^2 in the vicinity of Chisinau and has some 97,800 inhabitants (2005). Though located close to the economic centre of Moldova, Ialoveni district has hardly participated in the economic development of the capital and is still a district dominated by agricultural activities.

Cimislia: Cimislia district covers an area of some 2,084 km^2 and has some 60,900 inhabitants. Nearly one third of the population is living in the city of Cimislia, the administrative centre. The economy consists mainly of an agro-industrial complex with a well-developed network of manufacturing agricultural products, including meat, dairy, tree-fruit, and grain farming, as well as winemaking. The Cimişlia railroad station, which takes advantage of the broad network of links with the warehouses of the industrial and commercial companies of the city, is located in the village Mihailovka at a distance of 12 km.

Autonomous Territory of Gagauzia: According to the 2004 census Gagauzia had a population of 155,700, of which 58,300 lived in cities and 97,500 in rural communities.The base of the Gagauzian economy is agriculture, particularly viticulture. The main export products are wine, sunflower oil, non-alcoholic beverages, wool, leather and textiles. Twelve larger wineries are located in the region, processing over 400,000 tonnes annually. There are also two oil factories, two carpet factories, one meat factory, and one non-alcoholic beverages factory. The road network comprises 451 kilometres out of which 82% were paved originally. The capital of Gagauzia is Comrat which had a population of 23,400 in 2004. In addition to being the administrative centre of Gagauzia, Comrat is a market for agricultural produce and a centre for the southern winemaking region of Moldova.

Taraclia: Taraclia district with its administrative center Taraclia close to the Ukrainian border and some 6 km east of the road corridor has a population of some 43,100 with a strong Bulgarian community. The district has the lowest population density in Moldova and the economy is dominated by agricultural activities.

Cahul: Cahul district with its administrative centre in Cahul at the Romanian border has a population of some 119,200 (2005), 35,500 living in Cahul and the remainder mainly in small settlement and rural communities. Cahul has a university and the city's economy is based on the processing of agricultural products. The district's economy is dominated by agriculture but based on the developments at Giurgiulesti this might change in the near future. Financed by a Dutch investor and the EBRD the construction of a harbour at the River Danube has started and the oil terminal is already completed. Further extension is planned for bulk cargo and containers. As Moldova has to import all crude oil and oil products and most of its heavy construction material, the port has considerable potential and can be expected to exert a significant influence on the regional economy.

1.9. Study Coordination and Consultation

Throughout the study various individual or group meetings with study stakeholders took place, including:

- Rep. of Moldova State Road Administration
- Ministry of Construction and Territorial Development
- International Financial Institutions (WB, EBRD)
- Millennium Challenge Account Moldova,
- Millennium Challenge Corporation Delegation
- Danube Logistics (operator of Giurgiulesti Port)
- Environmental Scoping Meetings in Cimislia (2), Comrat, and Giurgiulesti
- Steering Committee Meetings

Coordination with the Millennium Challenge Corporation and the local Millennium Challenge Account were ongoing throughout the study. While National Transport Strategy projects are currently funded or underway, the MCC is in the process of finalizing a compact agreement with the Government of Moldova. In preparation of the compact agreement MCC has selected five corridors from the National Transport Strategy for potential funding. The section of M3 from Comrat to Giurgiulesti is identified by MCC as a candidate project for funding. Several meetings have taken place, particularly in the areas of environmental scoping.

Detail on the environmental and social scoping meetings is provided in the Environmental and Social Assessment Chapter 8.

2. PROJECT AND CORRIDOR DESCRIPTION

2.1. Alignment Options

Several planning efforts have been undertaken over previous decades and various alignment options have been identified for the M3 corridor. During periods of higher traffic volumes several bypass options were identified. See list below. Table 2-1 presents the identified alignment options together with schematic location maps.

- M3 extension (19.0 km)
- Cimislia Bypass (14.3 km)
- Realignment Ciucur-Minjir (2.1 km)
- M3 extension and Comrat Bypass (17.9 km)
- Bypass Chirsova (6.7 km)
- Bypass Congaz (6.4 km)
- Bypass Svetlîî (3.6 km)
- New alignment and bypass Ciumai – Burlaceni (15.0 km)
- Bypass Vulcăneşti (8.4 km)
- Bypasses of Slobozia Mare, Cişliţa-Prut, Giurgiuleşti (20.7 km)

2.2. Field Reconnaissance

Numerous reconnaissance visits were undertaken by the study team in order to assess local conditions. The purpose of the reconnaissance visits was to:

- gain an overall impression of the existing condition of the different road sections
- assess the existing condition of structures
- assess the condition and adequacy of the drainage system
- identify preferred cross-sections according to existing right-of-way width and terrain
- identify slope stability problems and the location of existing land-slides
- identify material sources
- estimate environmental and social impacts
- indicate existing traffic volumes and characteristics and travel speeds

2.3. Location referencing – Surveys

The fundamental objective of referencing is to identify a location on a road. Location referencing should enable the user to first, precisely locate an object along the road, and secondly, correctly reference the objects to each other.

The location referencing system in Moldova is based on the linear reference method, where specifying a start position, direction and distance identifies the location. The start point is the beginning of the road and the address of any point along the road is the numerical value of the distance from the beginning of the road. Chainages increase when moving away from the start point and decrease when heading back along the same road towards the start point. Due to the distance from the starting point of the road usually the address is the distance from the closest kilometre post point.

Table 2-1. Planned M3 Extensions and Bypasses – M3 Extension and Cimislia bypass

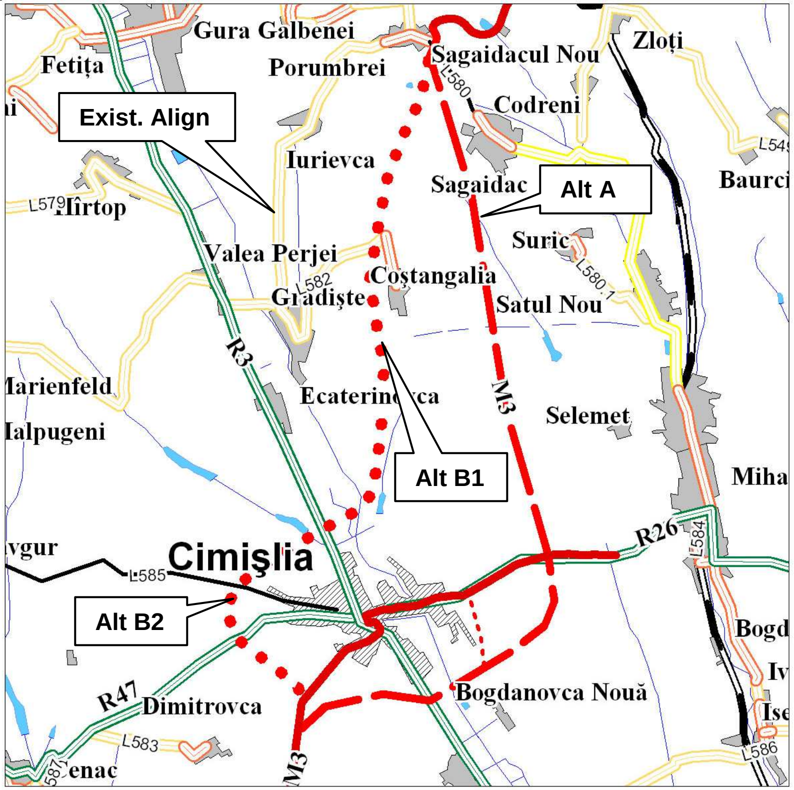
No	City Town		Length	Status	
1	2		3	4	5
	A	Porumbrei-Cimislia from km 34 until km 53+200 (intersection with R26 road)	19 km	The M3 Cimislia extension and bypass was developed as one technical project. For the section, km 34 to km 40, detailed design was developed in 1989. The design was partially carried out with alignment works, bridges and culverts. For the section from km 40 to km 53 land was acquired in 1990. However construction stopped and land acquisition rights expired. The land is still in public ownership.	
		Bypass of Cimislia town	14 km	Preliminary location studies were developed in 1991-92 in coordination with the local public administration. Other bypass alternatives of Cimislia bypass were developed.	
	B1 Alternative	Porumbrei-Cimislia from km 34 to (the intersection with R3 road at km 66+800)	19.1 km	The Alternative B1 was proposed after the conclusion of this study, that the continuation of the initial construction on M3 is not economically and technically feasible. The alignment location was accepted by the local public administration of the Cimislia town and district.	
	B2 Alternative	Northwest bypass variant of Cimislia town, from the intersection with R3 road km 66+800 to North of Cimislia to km 65 M3 to South of Cimislia.	6.5 km	The alternative alignment B1 coincides with the Northwest bypass of the Cimislia's Urban General Plan. This alignment was approved by the Urbanproiect Institute and local Public Administration of Cimislia town.	

Table 2-1. Planned M3 Extensions and Bypasses – Ciucur Minjir & Comrat Bypass

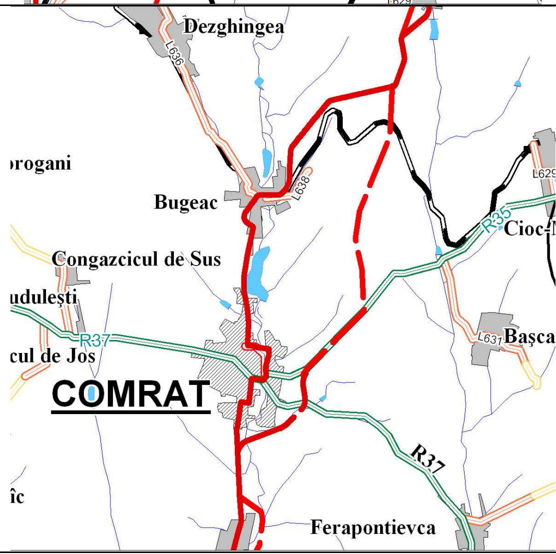
No	City Town	Length	Status	
3	Ciucur-Minjir Bypass	2.1km	A detailed design was developed in 1990 for the Ciucur – Minjir bypass. At the moment the existing road through the village is rehabilitated under another recent project.	
4	Comrat Bypass	17.9 km	Two bypass sections were developed: The first of the sections started in 1988, with initial construction of 9.0 km, but only approximately 4.0 km were finalized.	

Table 2-1. Planned M3 Extensions and Bypasses – Chirsova & Congaz

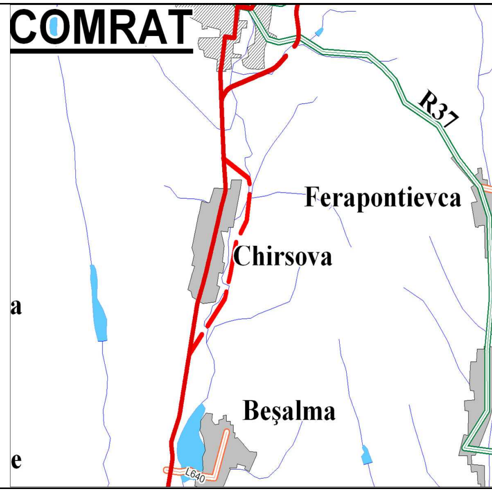
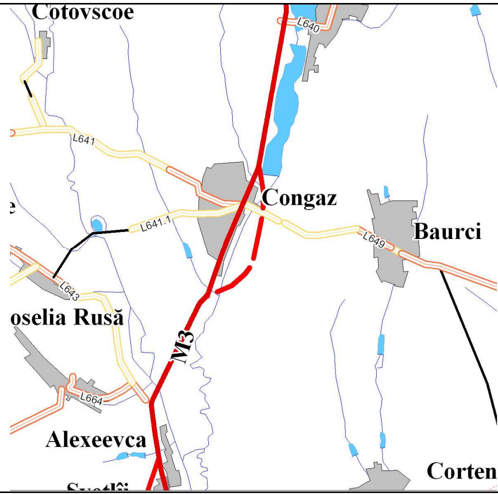
No	City Town	Length	Status	
5	Chirsova Bypass	6.7 km	In 1992 bypass location studies were carried out for the Chirsova bypass with public local administration coordination and agreement.	
6	Congaz Bypass	6.4 km	In 1992 bypass location studies were carried out, with public local administration coordination and agreement.	

Table 2-1. Planned M3 Extensions and Bypasses – Svetlii & Burlaceni

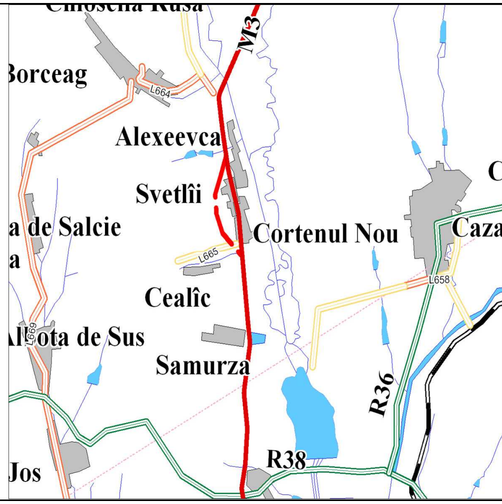
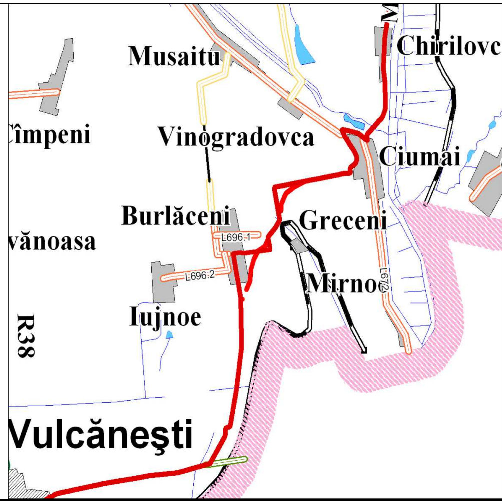
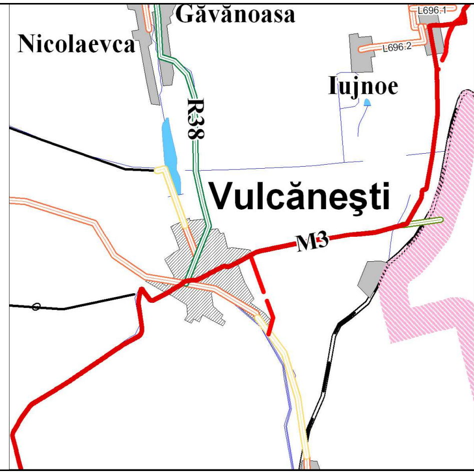
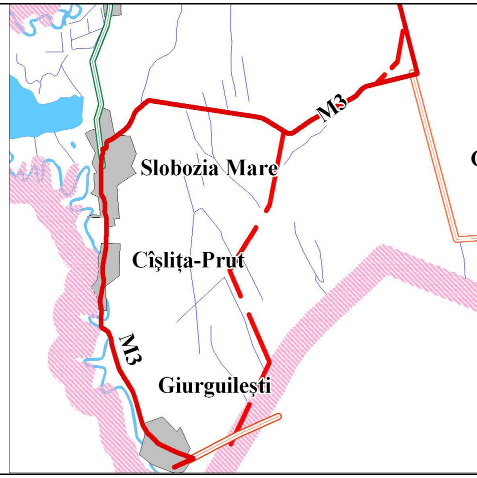
No	City Town	Length	Status	
7	Svetlîî Bypass	3.6 km	In 1992 bypass location studies were carried out, with public local administration coordination and agreement.	
8	Ciumai – Burlaceni Bypass	15.0 km	In 1997 a detailed design was developed for rehabilitation of the road section from Ciumai village to the intersection with the Vulcanesti-Bolgrad Road. The project was not implemented and requires re-examination and updating.	

Table 2-1. Planned M3 Extensions and Bypasses – Vulcanesti & Giurgiuleşti bypass

No	City Town	Length	Status	
9	Vulcăneşti Bypass	2.7 km	In 1989 a detailed design was developed for the first section of the Vulcanesti town bypass which was partially constructed.	
10	Slobozia Mare, Câşliţa Prut, Giurgiuleşti villages bypass	20.7 km	In 1994, a Feasibility Study for the bypass of Slobozia Mare, Câşliţa Prut, Giurgiuleşti villages was developed. In 1997 the Design Institute for territorial organization elaborated the documents for land acquisition and coordination for Government approval. The works stopped, and the project needs to be updated.	

Frequently, because of construction changes, kilometre posts do not indicate the true kilometre points. During the field investigations for the project road sections a number of inconsistencies could be identified, including but not limited to:

- Missing signs
- Incorrect kilometre post locations
- Incorrect numbers on kilometre posts

This creates problems of reconciling measured and existing data. However, it is essential that all the different pieces of information on the project road be synthesised and harmonised to provide a single framework for describing the road. Therefore, in order to harmonise all data, complementary spatial data from bridges, culverts and existing kilometre posts has been obtained through the Global Positioning System (GPS) system. For managing the spatial data and data transformation from a spatial to a linear system, the CAD software AutoCad has been used.

Topographical Survey
The topographic survey has been conducted by three teams recording electronically XYZ coordinates of centerline points, road edges, batter points, as well as topographical details like existing roads, tracks, drainage structures, bridges, buildings, etc. The survey started at Comrat and the teams proceeded southwards. Topographic survey works on the Comrat – Cimislia Section have been postponed as this section is already under reconstruction. All survey data will be integrated into the CAD design system, which furnishes a complete digital area model.

3. TRAFFIC STUDIES

3.1. Approach

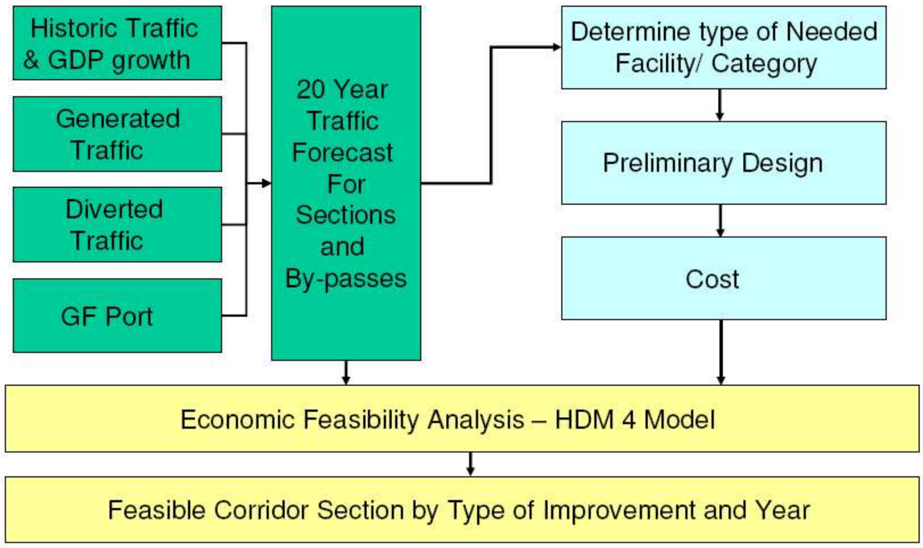
During the preparation of the National Transport Infrastructure Strategy a traffic count programme (2005/06) was undertaken with the support of the State Road Administration. However, guidance received from the study beneficiary, the Ministry of Construction and Territorial Development, as well as the need for sufficient detail for the M3 study necessitated the conduct of a detailed traffic survey programme. Especially, since historic time series traffic data in Moldova are rare and sometimes inconsistent. In order to best reflect localized conditions along the Study corridor 13 traffic sections were identified and are presented in Table 3-1.

The basis for the traffic and any subsequent analysis is a thorough understanding of the current traffic volumes and composition along the study corridor. Figure 3-1 presents the components of traffic which will be the basis for the 20 year traffic forecast along the study corridor and its further application in the M3 Feasibility study. In the case of the M3 study four distinct components of traffic need to be addressed:

1. Base year traffic volume and corridor travel characteristics
2. Traffic generation – new traffic induced by additional or expanded travel options
3. Traffic diversion - traffic diverted to a potentially improved facility from other corridors
4. Special traffic generators: traffic generated through new economic activities such as the Giurgiulesti Free Port

All four components will serve as input for the development of the 20 year traffic forecasts.

Figure 3-1. Overview of Traffic Studies



Source: Consultant

Table 3-1. Traffic Sections

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Nr	From To	From Km	To Km	Length	Surface Type	Nr. of Lanes	Carriage-way Width in m	Shoulder Width in m	Exist Road Cat.
1 A	Chisinau - Sagaidacul Nou	0.0	32.0	32.0	Concrete	4	2 x 7.50	3.75	I
1 B	Sagaidacul Nou to Porumbrei	32.0	34.3	2.3	Concrete	2	7.50	3.75	II
3	Porumbrei to R 3	34.3	48.8	14.5	Asphalt	2	6.00	2.00	IV
4	R3 to Cimislia	48.8	57.3	8.5	Asphalt	2	7.00	2.50	III
5	Cimislia urban section	57.3	62.4	5.1	Asphalt	2	7.00	**	III
6	Cimislia - Comrat	62.4	88.4	26.0	Asphalt	2	7.00	2.5	III
7	Comrat urban section	88.4	96.8	8.4	Asphalt	2	7.00	**	III
8	Comrat - R38	96.8	135.8	39.0	Asphalt	2	7.00	2.50	III
9	R38 - Ciumai	135.8	151.4	15.8	Asphalt	2	7.00	2.50	III
10	Ciumai - Vulcanesti	151.4	172.8	21.4	Asphalt	2	6.00	2.00	IV
11	Vulcanesti urban section	172.8	178.1	5.3	Asphalt	2	6.00	**	IV
12	Vulcanesti - Slobozia Mare	178.1	202.0	23.9	Asphalt	2	6.00	2.00	IV
13	Slobozia Mare - Giurguilesti	202.0	215.2	13.2	Asphalt	2	6.00	2.00	IV

Source: Consultant

3.2. Existing Traffic Data

Traffic data from automated traffic counters has been made available through the State Road Administration (SRA). Selected data for the years 2005 through 2008 is available for a limited number of count locations. The data has been reviewed and analysed. Table 3-2 presents data from the SRA count program with results from automated traffic counts in the week commencing 21.12.2006 along M3 and R3/R34. Average Daily Traffic Count Stations at Road M3 km 109 (Count Station No. 203) for April 2008 are shown in Figure 3-3. Figure 3-4 displays the average daily traffic stratified by speed categories at the same location.

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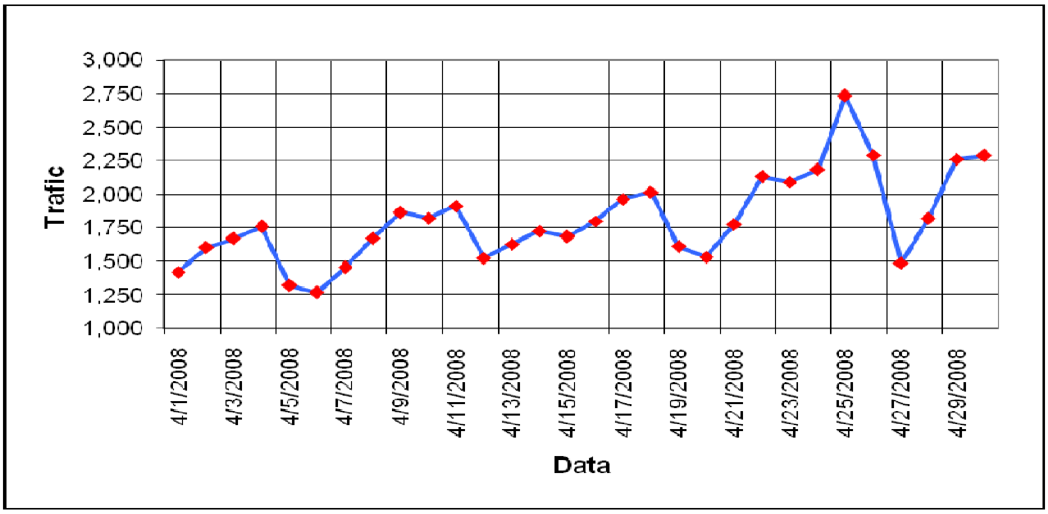
Table 3-2. Existing Traffic Counts (21.12.06 until 27.12.06 - 06:00-22:00)

			Thu	Fri	Sat	Sun	Mon	Tue	Wed	Aver.
Route	**SRA Ref**	**KM**	**21.12**	**22.12.**	**23.12.**	**24.12.**	**25.12.**	**26.12.**	**27.12**	**Week**
R3 Chisinau-Basarabeasca	321	66	3,205	3,628	2,751	2,357	3,052	3,525	3,797	3,188
M3 Chisinau-Giurgiulesti	322	63	1,935	2,315	1,712	1,403	1,785	2,253	2,225	1,947
M3 Chisinau-Giurgiulesti	323	98	2,164	2,387	1,719	2,064	2,338	2,912	2,649	2,319
R34 Hincesti-Leova-Cahul-Slobozia Mare	325	124	2,914	2,932	2,655	2,584	2,723	3,045	3,302	2,879
M3 Chisinau-Giurgiulesti	324	137	791	821	1,220	550	1,321	870	795	910

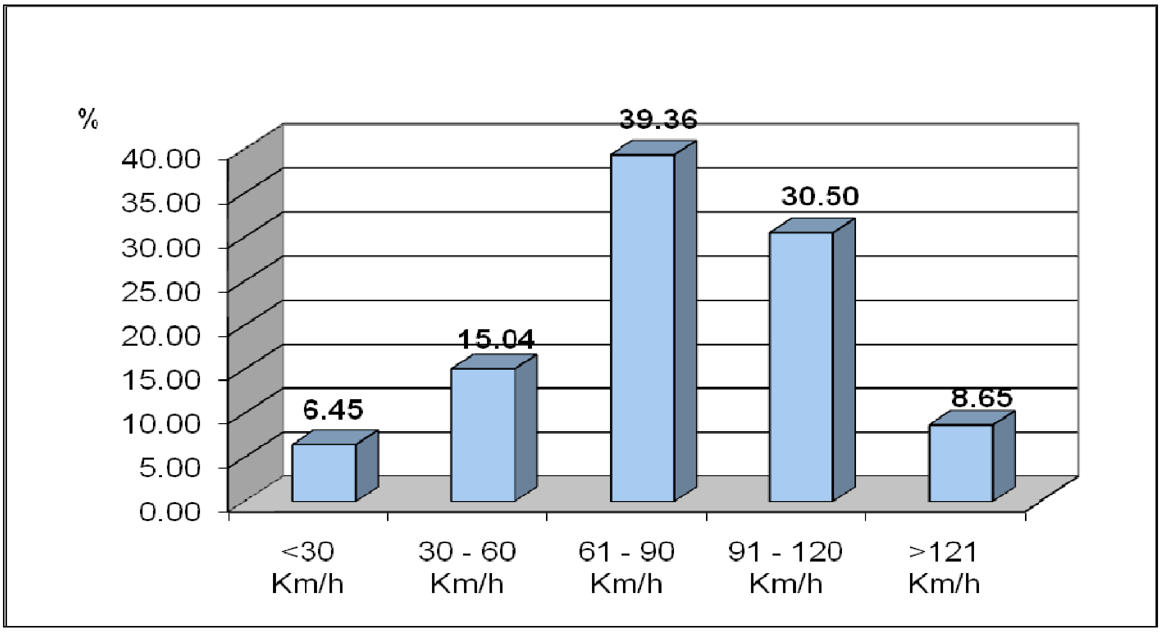
Source: State Road Administration

Figure 3-2. Average Daily Traffic Count at M3 km 109: Weekly Traffic April 2008



Source: State Road Administration, 2008

Figure 3-3. Traffic Classified by Speed at M3 km 109: Weekly Traffic April 2008



Source: State Road Administration, 2008

Additionally, some historical information is available regarding vehicle classification, daily, weekly and seasonal traffic volume variations. Table 3-5 lists the known automatic traffic count stations of relevance to the current study and their years of operation.

Table 3-3. Automatic Traffic Count Stations

Road No.	from	to	District	km	ref(s)		Data			
							from	to	from	to
M3	Chisinau	Porumbrei	Cainari	23	3.14.04		1993	1996		
	Chisinau	Cimislia	Cimislia	63	2.09.01	322	1991	1994	2006	2006
	Cimislia	Comrat	Comrat	84	2.05.01		1991	1996		
	Comrat	R38 jct	Comrat	98	323		2006			
	Comrat	R38 jct	Comrat	99	2.05.02		1991	1996		
	Comrat	R38 jct	Comrat	109	203		2007	2008		
	R38 jct	Vulcanesti	Taraclia	137	2.07.03	324	1991	1996	2006	2006
	R38 jct	Vulcanesti	Taraclia	153	2.07.04		1991*	1996*		
	Vulcanesti	Giurgiulesti	Vulcanesti	183	2.02.04		1991	1996		
	Vulcanesti	Giurgiulesti	Vulcanesti	200	2.02.06		1991	1996		
	Vulcanesti	Giurgiulesti	Vulcanesti	206	2.02.03		1993	1996		
	Vulcanesti	Giurgiulesti	Vulcanesti	216	2.02.05		1994	1996		
R3	Chisinau	Hincesti	Ialoveni	23	102		2004	2008		
	Hincesti	Cimislia	Cimislia	48	106		2007	2008		
	Chisinau	Cimislia	Cimislia	65	2.09.02		1991	1996		
	Chisinau	Cimislia	Cimislia	66	321		2006			
R34	Hincesti	Leova	Hincesti	17	303		2007	2008		
	Cantemir	Cahul	Cantemir	85	108		2007	2008		

Source: SRA atc data

Tables 3-4 and 3-5 summarise the daily and monthly traffic variation observed at the historic traffic count locations. Since traffic flow is not uniform throughout the day or year factors for the daily and monthly variations were calculated and will be applied to the sample data set collected for the M3 study to arrive at Annual Average Daily Traffic figures for each study count station.

Table 3-4. Daily Traffic Variation from ATC data, R3/M3/R34

Factor	Mon	Tues	Wed	Thurs	Fri	Sat	Sun
5-day	0.940	1.056	1.070	0.922	1.012	-	-
Factor to be applied	1.064	0.947	0.935	1.084	0.988	-	-
7-day	0.959	1.077	1.091	0.941	1.032	0.859	0.765
Factor to be applied	1.043	0.929	0.917	1.063	0.969	1.164	1.307

Source: SRA atc data, 2006

Table 3-5. Monthly Traffic Variation from ATC data, R3/R1

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Factor = 0.752	0.737	0.850	1.032	1.068	1.070	1.124	1.244	1.143	1.067	0.981	0.931
Applied factor = 1.329	1.356	1.177	0.969	0.936	0.934	0.890	0.804	0.875	0.938	1.020	1.074

Source: SRA atc data, 2004-7

3.3. Establish Base Year Traffic

Traffic Survey Programme

Traffic surveys were conducted late July through the end of August 2008. The survey programme is summarised in Table 3-6 and consists of Manual Classification Counts (MCC), a Turning Movement Count (TMC), and Origin Destination Surveys (O-D). The duration of the surveys is presented in Table 3-7. Figure 3-4 presents the location of the traffic count stations.

Table 3-6. Traffic Survey Programme

Survey No.	Road No.	Km	from	to	Location	Type of Survey(s)	
MCC1	M3	22	Chisinau	Porumbrei	Razeni	MCC*	
OD1	R3	57	Hincesti	Cimislia	N. Cimislia	MCC	OD
MCC2	M3	62	Cimislia	Comrat	S. Cimislia	MCC	
OD2	M3	82	Cimislia	Comrat	Bugeac	MCC	OD
MCC3	M3	96	Comrat	Vulcanesti	S. Comrat	MCC	
TMC1	M3	135	Comrat	Vulcanesti	R38 junction	TMC	
OD3	M3	172	Comrat	Vulcanesti	E. Vulcanesti	MCC	OD
MCC4	M3	176	Vulcanesti	Slobodzia Mare	W. Vulcanesti	MCC	
OD4	M3	204	Slobodzia Mare	Giurgiulesti	S. Slobozia Mare	MCC*	OD

* 24-hour count
Source: The Consultant

Table 3-7. Survey Durations

Counts:	*Number*	*Number of Days*	*Duration*	*Days*	*Time of day*
MCCs	*6 no.*	*2 days*	*2 x 16 hr*	*not Sat/Sun*	*0600-2200*
*MCCs**	*2 no.*	*2 days*	*1 x 16 hr* *1 x 24 hr*	*not Sat/Sun*	*0600-2200* *0600-0600*
TMCs	*1 no.*	*2 days*	*2 x 16 hr*	*not Sat/Sun*	*0600-2200*
O/Ds:	*4 no.*	*2 days*	*2 x 12 hr*	*not Sat/Sun*	*0700-1900*

Source: The Consultant

Manual Classification Counts

A total of 8 Manual Classification Counts over a two day period were undertaken by survey staff. The purpose of the MCC programme was to confirm existing traffic volumes and vehicle composition along the various corridor sections. In order to confirm daily variations in traffic flow two 24 hour counts were conducted at the northern and southern ends of the corridor. The following vehicle types were categorized:

Car/4x4 - This includes private cars, and all other small vehicles such as 4 wheel drive vehicles, passenger vans etc. which are being used as private vehicles. Taxis were also included in this category.

Minibus - This includes minibuses and small buses of up to 15 seats being used for the transport of fare paying passengers.

Medium/Large bus - This includes all standard and large buses with more than 15 seats being used for the transport of passengers.

Light goods vehicle (4-wheel) - Vans and pick-ups are small four-wheel vehicles used predominantly for the transport of goods.

Light goods vehicle (6-wheel) - Six-wheel vans used for the transport of goods.

2 axle goods vehicle - Trucks with a total of two axles and six wheels.

3 axle goods vehicle - 3 axle trucks with a single axle at the front and two axles at the rear.

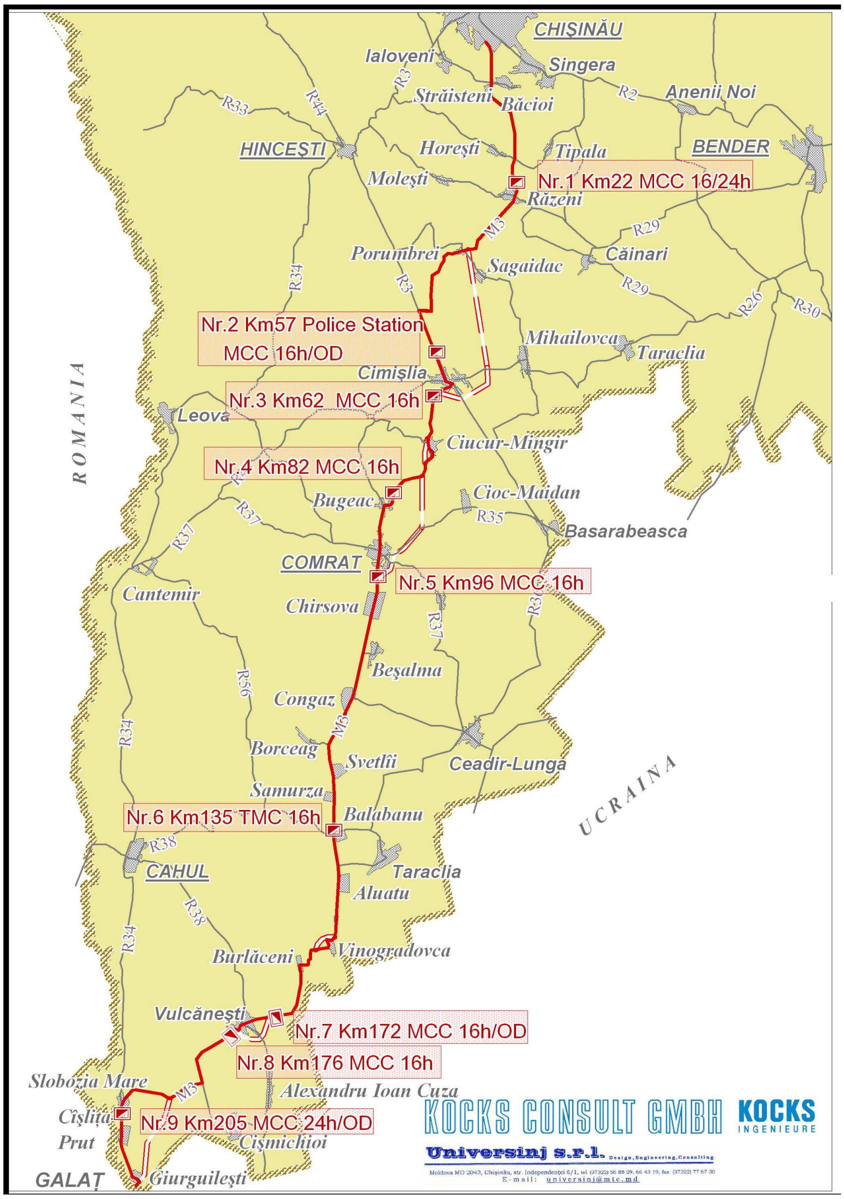
4 + axle goods vehicle - 4+ axle trucks or truck - trailer combinations with 4 or more axles in any formation.

In addition, motorcycle, bicycles, and animal carts were counted. For all vehicle it was recorded whether the vehicles were registered nationally or internationally.

Origin Destination Survey

Origin-destination surveys were conducted north Cimislia, at Bugeac, east of Vulcanesti, and between Cislita Prut and Slobozia Mare. The purpose of the O-D surveys was to gain knowledge regarding journey origins and destinations, journey purpose and the potential for diversion to the rehabilitated M3 corridor. Each O-D survey was accompanied by manual classification counts. The surveys were conducted by

Figure 3-4. Location of Traffic Survey Stations



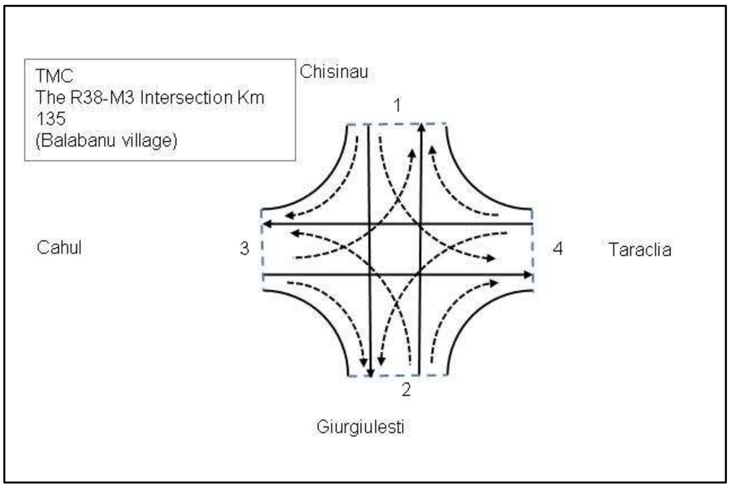
Source: The Consultant

a team of interviewers and traffic directed by a police officer. A total of 2,149 interviews were conducted at the four locations. The following information was collected and questions asked:

- Vehicle class
- Nationality of vehicle
- No. of occupants
- Where are you coming from? (Origin)
- Where are you going? (Destination)
- Why were you there? / What is that place?
- Why are you going there? / What is that place?
- Frequency of Journey
- Type of Goods Carried
- Routeing

Turning Movement Count

A Turning movement count was conducted at the intersection of M3 and R38 in the vicinity of the village of Balabanu. This count location was identified in regard to possible diversion movements to and from the M3 corridor from and to the City of Cahul .



Axle Load Survey Programme

As in many other countries the paved road network carries the bulk of national and international freight traffic. Over time roads deteriorate due to two primary reasons: traffic volumes and induced loading, as well as the environment (climate). Traffic is therefore regarded as the key parameter in road deterioration. For this reason it is essential to know its composition in terms of:

- total traffic volume (AADT)
- magnitude of the loads (axle load)
- axle configuration
- contact pressure from the loads (mainly from tyre pressure)
- number of load repetitions

In order to assess axle loads as well as axle configurations on trucks axle load surveys were conducted at the former police station north of Cimislia and at the intersection of M3 and R 38. Two survey teams supported by local police used portable axle weights to conduct the surveys.

3.4. Traffic Survey Results

As OD and MCC survey data was collected it was returned to the project office for processing. The data was transferred to EXCEL using filters and conditional checks to verify variable ranges and logic. This allowed any error in data collection or data entry to be identified and corrected.

Base Year Traffic Volumes

The absolute number of vehicles per day ranges from 4,197 north of Chimislia, where M3 shares the alignment with R3 Cimislia – Hincesti, to 674 vehicle between Vulcanesti and Slobozia Mare. The raw counts were expanded to 24 hour values using a factor of 1.075 derived from SRA data for the R3 from 2006 and 2007. Seasonal factors were then applied from Table 3-5 to calculate Average Annual Daily Traffic (AADT) for each count location. Since July and August are months with higher than average traffic volumes, the raw counts were factored down to represent an Average Annual Daily Traffic. Table 3-8 presents 24 hour equivalents together with AADT for 2008. Figure 3-5 presents the traffic distribution along the study corridor. The first obvious trend is the decline of traffic intensity from north to south, secondly traffic peaks occur in the major localities along the study corridor - Cimislia, Comrat, Vulcanesti, and Slobozia-Mare/Giurgiulesti.

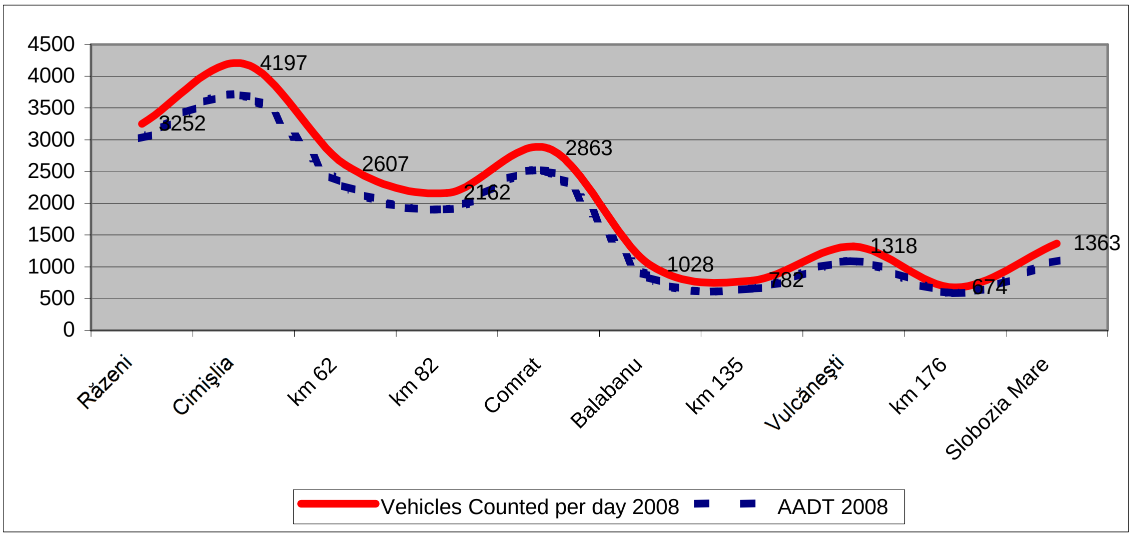
Figure 3-6 shows the daily distribution of traffic at the location of 24 hour counts in Razeni and Cislita Prut. Razeni, located closest to the Chisinau urbanized area presents a distinct commuting pattern with peak flows in the morning hours towards Chisinau and an afternoon/evening peak in the southern direction. The daily distribution of traffic in Cislita Prut shows a much more equal distribution of directional trips. It has to be noted that overall the south to north movement from Giurgiulesti is slightly higher than the opposite direction; A possible explanation might be cross-border vacation related travel.

Table 3-8. 2008 AADT at Selected Locations

Nr.	Station	Location km	Vehicles Counted	AADT 2008
1.	Răzeni	22	3252	3021
2.	North of Cimişlia	57	4197	3700
3.	South of Cimişlia	62	2607	2272
4.	S. Bugeac	82	2162	1905
5.	South of Comrat	96	2863	2495
6.a	N. of intersect R 38	135	1028	829
6.b	S. of intersect R 38	135	782	653
7.	East of Vulcăneşti	172	1318	1091
8.	West of Vulcăneşti	176	674	587
9.	Slobozia Mare	205	1363	1098

Source: Consultant's surveys

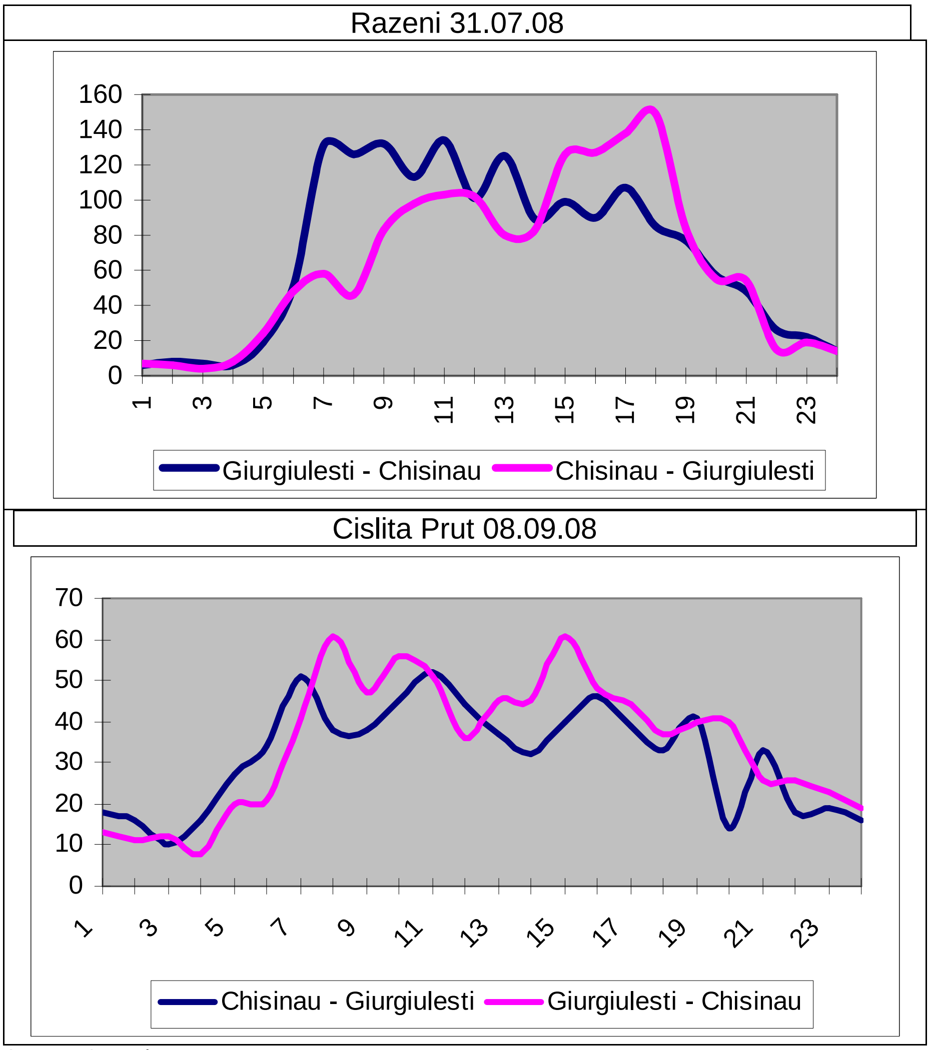
Figure 3-5. Study Corridor Traffic Distribution



Source: Consultant's surveys

Table 3-9 presents the vehicle categories as percentage of total traffic. The majority of vehicles counted are cars with over 67%, followed by 11% Light Goods Vehicles, Trucks with more than 4 axles make up about 5% of traffic. Non-motorized vehicles make up almost 2 percent of the average traffic flow, in certain locations such as Vulcanesti west 3.2 % of traffic is non-motorized.

Figure 3-6. Hourly Traffic Distribution Razeni and Cislita Prut



Source: Consultant's surveys

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Table 3-9. AADT per Vehicles Categories

Location	Car& 4x4	Mini-bus	Medium & Large Bus	4 wheels LGV	6 wheels LGV	2 axles truck	3 axles truck	4+ axles truck	Motor-cycles	Bi-cycles	Animal cart	Total veh./ day
Razeni	66.8%	7.7%	1.3%	9.8%	5.2%	3.5%	0.8%	3.8%	0.4%	0.6%	0.1%	100.0%
Cimislia Nord	70.9%	4.5%	1.6%	11.0%	3.3%	3.2%	0.8%	3.9%	0.2%	0.4%	0.1%	100.0%
Cimislia South	70.3%	2.6%	1.9%	7.5%	5.4%	3.1%	0.9%	7.1%	0.8%	0.3%	0.1%	100.0%
Bugeac	65.9%	3.7%	2.8%	11.9%	6.2%	2.4%	1.0%	5.7%	0.2%	0.2%	0.0%	100.0%
Comrat South	68.7%	5.6%	3.7%	9.0%	3.9%	2.9%	1.0%	2.9%	1.0%	0.7%	0.5%	100.0%
North of M3 / R38	61.8%	4.5%	2.3%	12.8%	1.9%	3.9%	2.2%	7.5%	1.2%	0.9%	0.8%	100.0%
South of M3 / R38	63.2%	4.2%	1.9%	11.9%	1.8%	3.2%	2.1%	6.8%	2.5%	0.9%	1.6%	100.0%
Vulcanesti East	70.5%	4.2%	3.7%	8.3%	2.8%	1.7%	0.7%	3.8%	2.3%	0.7%	1.3%	100.0%
Vulcanesti West	63.3%	2.4%	1.6%	12.0%	1.5%	6.8%	1.7%	5.9%	1.6%	1.2%	2.0%	100.0%
Slobozia Mare	79.0%	2.0%	2.1%	5.0%	1.6%	1.0%	0.6%	4.2%	2.7%	0.8%	1.1%	100.0%
Average	67.5%	3.7%	2.1%	10.8%	3.1%	3.1%	1.3%	5.1%	1.7%	0.8%	0.9%	100.0%

Source: Consultant's surveys

3.5. Travel Characteristics of Study Corridor

Origin-Destination Sample Size and Factors

During the O-D survey period of 12 hours, the drivers of a sample of vehicles were interviewed. At each location MCCs were undertaken concurrently, to allow the calculation of a sample factor for the interview period. A summary of the number of vehicles counted and interviewed is shown in Table 3-10 below. The sample rate ranges from 25.5% in Cimislia to over 58% in Cislita Prut which in all cases is well above the minimum required 20% sample size.

Table 3-10. Origin - Destination Survey Sample

Number	Location	Count	Interviews	Sample
4	Bugeac	1579	485	30.7%
2	Cimislia	3319	846	25.5%
7	Vulcanesti	1044	271	26.0%
9	Cislita Prut	939	547	58.3%

Source: Consultant's surveys

Table 3-11 presents vehicle occupancy by vehicle class for all survey stations. Average vehicle occupancy for all vehicle categories combined is 3.3, for cars alone the vehicle occupancy rate is 2.5 passengers per vehicle.

Table 3-11. Vehicle Occupancy by vehicle class – all stations

	Cars & 4x4	LGV 4 wheels	LGV 6 wheels	Mini-bus	Medium & large bus	Truck 2 axle	Truck 3 axle	Truck 4 + axle	Average
Occupancy/ Vehicle	2.5	2.1	1.9	6.4	18.8	1.4	1.4	1.4	3.3

Source: Consultant's surveys

Tables 3-12 through 3-15 present the major origin-destination pairs for each of the survey stations. At the Cimislia station (Table 3-12) it is apparent that most trips have Chisinau as their origin and destination, followed by Cimislia and Gagauzia. Interestingly, more trips originating in Chisinau have the Gagauzia territory (147) than Cimislia (72) as a destination.

Table 3-12. Origin-Destination Pairs - Survey Station Cimislia

Cimislia	Destination										
Origin	Basar-abeasca	Cahul	Cantemir	Chisinau	Cimislia	Gagauzia	Hincesti	Ialoveni	Taraclia	Trans-nistria	Total
Basar-abeasca				28			4				32
Cahul				8			1	1			10
Causeni				1	4						5
Chisinau	52	22	7		73	147			29		330
Cimislia				72	120		18	1		3	214
Gagauzia				117	1		2			2	122
Hincesti	1	1			13	3					18
Ialoveni					2	1					3
Taraclia				17	1						18
Total	53	23	7	243	214	151	25	2	29	5	752

Source: Consultant's surveys

Major traffic movements in Bugeac (Table 3-13) are between Gagauzia territory and Chisinau, to a far lesser degree to Cimislia or Cahul. At the Vulcanesti survey station (Table 3-14) most trips are within the Gagauzia territory with an additional strong east-west movement between Cahul and Ukraine. In Cislita Prut (Table 3-15) a significant number of trips originate in Romania, while Cahul is the dominant destination with about 74% of trip ends.

Table 3-13. Origin-destination Pairs - Survey Station Bugeac

Bugeac	Destination										
Origin district	Basara-beasca	Cahul	Cantemir	Chisinau	Cimislia	Gagauzia	Hincesti	Taraclia	Trans-nistria	UA	Total
Cahul				11	2					1	14
Chisinau	1	25	1		2	108		7		8	152
Cimislia		3	1	1		23		1			29
Gagauzia	1			115	21	1	5		9	3	155
Hincesti			2			3					5
Taraclia				21	1						22
Transnistria		1				8					9
UA/south				6							6
Total	2	29	4	154	26	143	5	8	9	12	392

Source: Consultant's surveys

Table 3-14. Origin-destination Pairs - Survey Station Vulcanesti

Vulcanesti	Destination					
Origin district	Cahul	Chisinau	Gagauzia	Taraclia	UA	Total
Cahul	9	5	27	1	13	55
Chisinau	6		12			18
Cimislia			2			2
Gagauzia	29	3	83	7	17	139
Transnistria			1			1
UA	4		5			9
Total	48	8	130	8	30	224

Source: Consultant's surveys

Asked about their journey purpose, as presented in Table 3-16, the majority of drivers responded with commuting trips (51%), followed by non-work related trips (30%) and work related trips (19%).

Table 3-15. Origin-destination Pairs - Survey Station Cislita Prut

Cislita Prut	Destination					
Origin	Cahul	Chisinau	Gagauzia	RO	UA	Total
Cahul	322	21	27	24	9	403
Chisinau	19			6	2	27
Gagauzia	39			5		44
RO	35	4	2		2	43
Taraclia	1					1
UA	8		1	1		10
Total	424	25	30	36	13	528

Source: Consultant's surveys

Table 3-17 presents the overall approach volumes at the intersection of M3 and R34 in the vicinity of Balabanu. The counts indicate a distinct drop of the M3 volumes south of the intersection indicating a diversion of traffic to and from the east-west axis Taraclia – Cahul. While absolute numbers of counted vehicles are small, almost 20% of M3 traffic moves either east or west.

Table 3-16. All OD Stations Journey Purpose

From / To	Home	Work	Business	Education	Store	Social/ Rec	Other	Grand Total
Home		552	225	3	50	344	88	1262
Work	254		406	1	3	6	3	673
Business	68	7			1	2	6	84
Education	2							2
Store	26	1	1		2			30
Social/ Rec	58		1					59
Other	27	3	1				8	39
Grand Total	435	563	634	4	56	352	105	2149

Type of Trip

Commute	Work	Non-work
1099	413	637
51.1%	19.2%	29.6%

Source: Consultant's surveys

Table 3-17. Results of Turning Movement Count

Intersection M3 – R34 Approaches	18/08/08	19/08/08
Chisinau (M3)	923	989
Giurgiulesti (M3)	744	760
Cahul (R38)	913	961
Taraclia (R38)	694	730

Source: Consultant's surveys

In summary, the M3 corridor from Chisinau to Giurgiulesti traverses half of the expanse of the Republic of Moldova from its centre to the very south. The northern portion of the corridor is characterized by its proximity to the Chisinau urbanized area, displaying high traffic volumes as well as distinct commuting patterns. The middle portion of the corridor displays a mixture of interregional trips primarily between Cimislia, Comrat and Cahul. The southern portion serves as an international linkage to Romania as well as Ukraine and connects the smaller localities with the regional centres in Cimislia, Comrat and Cahul.

3.6. Axle-Loadings

The axle-load data from the two survey stations, at Cimislia and Balabanu, has been processed to produce values of Equivalent Standard Axles (ESA) by medium and heavy vehicle class. ESA is a measure of the "potential damage factor" of each axle and by extension each vehicle. ESA is calculated as follows:

$$ESA = (\text{measured axle weight (tonnes)}/8.16)^{4.5}$$

The total ESA of a vehicle is the total of the individually calculated ESA values for each of the vehicle axles.

The ESA formula emphasises the damage to road pavements resulting from very heavily loaded vehicles. In contrast, light vehicles produce negligible ESA values and are conventionally excluded from the analysis.

A summary of the results of the axle-load survey analysis, in terms of ESA by vehicle type, is provided in Table 3-18 below. These results include both survey stations.

In general, the ESA values obtained are relatively modest indicating that overloading of vehicles is not a major problem on the M3 corridor. Only 4.5% of the surveyed vehicles had one or more axles loaded with 11.5 tones or more. However, it should be noted that a small number of highly overloaded vehicles can still destroy a conventional paved road.

Table 3-18. Summary of ESA Values by Vehicle Class

Vehicle Class	Sample		ESA/vehicle	
	Total	Edited*		
Minibus	14	14	0.0019	
Large Bus	141	140	0.2002	
LGV	50	50	0.0021	
2-ax MGV	310	310	0.3331	
3-ax HGV	74	68	1.1381	
4-ax HGV	57	57	5.0404	
5-ax HGV	401	289	3.7423	3.9717
6-ax HGV	6	6	4.8704	
	1053	934		
Average			1.7204	

* excludes inconsistent or incomplete entries - Source: Consultant's survey

The Cimislia survey site generally produced higher ESA values than the Balabanu site. However, it is conventional to reflect any such variation by combining the datasets to produce an overall average for the study, as in Table 3-18, to be used in both the pavement design and the economic evaluation. The survey results also showed a marked directional imbalance in axle-loadings. At both locations, and for the majority of medium-heavy vehicle classes, southbound vehicles produced higher ESA values than their northbound counterparts. This may, in part, be attributable to the current importation of many materials to the region of the corridor from Chisinau and northern Moldova. The imbalance in loadings has been taken into account in the pavement design.

3.7. Traffic Forecasts

Traffic forecasts have been made on the basis of available data, including:

- existing time series traffic count data
- available study reports such as the study in preparation of the National Transport Strategy
- statistical data published in the Statistical Yearbook of Moldova.
- past and predicted GDP figures from World Bank, EBRD and International Monetary Fund.
- recent traffic counts and OD survey results carried out on the study corridor

There are four main components of future traffic growth in the M3 corridor:

- "normal" traffic growth, deriving from national and regional economic development
- "diverted" traffic from alternative routes and corridors following upgrade of the M3
- "generated" traffic resulting from local and regional improvements in accessibility
- traffic generated by the development of Giurgiulesti Freeport

The traffic forecasts have taken each of these four components into account to produce future flows for each of the traffic sections, taking cognisance of the particular characteristics pertinent to each section. It has been assumed that the date of opening of the improved/rehabilitated road corridor will be the beginning of year 2011. The forecasts cover the period 2008 – 2030, respectively representing the traffic survey base year and the twentieth operational year following implementation of the project.

High and low traffic growth scenarios have been developed to reflect the inherent uncertainty of traffic forecasting. High growth represents an optimistic scenario in which national, regional and local economic development factors contribute to a rapid growth in vehicle ownership and usage in the M3 corridor over a sustained period. Alternatively, low growth represents a contrastingly pessimistic combination of factors leading to sluggish growth in traffic on the M3 corridor.

3.7.1. Normal Traffic Growth

Normal growth, with very few exceptions, is independent of specific highway projects. It is driven by economic development and reflects the increasing prosperity of society and the attendant increases in vehicle ownership and vehicle usage.

National economic growth is best represented by growth in real Gross Domestic Product (GDP). The IMF's latest forecasts of real GDP growth for Moldova are compared with other recent forecasts in Table 3-19 below.

Table 3-19. Real GDP Growth Rate Forecasts for Moldova (% per annum)

	imf	getinsa (low)	getinsa (high)
2008	6.5	4.0	8.0
2009	6.5	4.0	8.0
2010	7.0	4.0	8.0
2011	7.0	4.0	8.0
2012	6.5	4.0	8.0
2013	6.0	4.0	8.0
2014-27	-	4.0	8.0

Sources: as indicated

A set of national economic growth forecasts has been developed for the study to reflect the expected growth in the national economy of Moldova. In a country the size of Moldova regional differences in economic development can be assumed to be limited and can effectively be covered by the assessment of generated traffic. The IMF's forecasts for Moldova over the period to 2013 have been used as starting point for the development of central, or best estimate, growth forecasts for the national economy.

The IMF forecasts only extend to 2013. For the remainder of the evaluation period to 2030 reference has been made to work carried out by Scott Wilson relating to the prospective development of Central and Eastern European countries. This bases GDP forecasts on specific long-term objectives, for example joining the EU and the consequent convergence of levels of economic development with established EU members with assumed "catch-up" periods and realistic growth profiles.

Profiles for 30 year, 50 year and 70 year catch-up periods have been developed. The best fit with the IMF forecasts for Moldova is provided by the 30 year catch-up period and this has been adopted for the purposes of the current study. The resulting GDP growth forecasts for Moldova are provided in Table 3-20 below.

Table 3-20. Moldova National Economic Growth Forecasts

GDP growth: Central Forecast					
from	to	% p.a.	from	to	% p.a.
2007	2008	6.50	2019	2020	5.50
2008	2009	6.50	2020	2021	5.20
2009	2010	7.00	2021	2022	4.90
2010	2011	7.00	2022	2023	4.60
2011	2012	6.50	2023	2024	4.30
2012	2013	6.00	2024	2025	4.00
2013	2014	6.00	2025	2026	3.70
2014	2015	6.00	2026	2027	3.40
2015	2016	6.00	2027	2028	3.10
2016	2017	6.00	2028	2029	2.90
2017	2018	5.90	2029	2030	2.80
2018	2019	5.50			

Source: The Consultant

3.7.2. Normal Traffic Growth Forecasts

The strong relationship between economic growth and traffic growth is widely recognised and, in the developing stage of an economy, cars and other light passenger vehicle traffic are generally considered to grow slightly faster than GDP while goods vehicle traffic, being driven directly by the economy, is commonly in line with GDP growth.

Vehicle registration figures indicate that low elasticity values for vehicle ownership/usage in relation to national economic development are currently appropriate for Moldova. Accordingly, 1.05 for car and passenger traffic has been adopted together with a conventional value of 1.0 for goods vehicles.

The resulting traffic growth rates have been smoothed to produce three growth periods, short term up to 2013, medium term from 2014 to 2020 and long term on to 2030. The growth rates are summarised in Table 3-20 below and shown in Figure 3-7. Low growth takes 75%, and high growth 120%, of central growth.

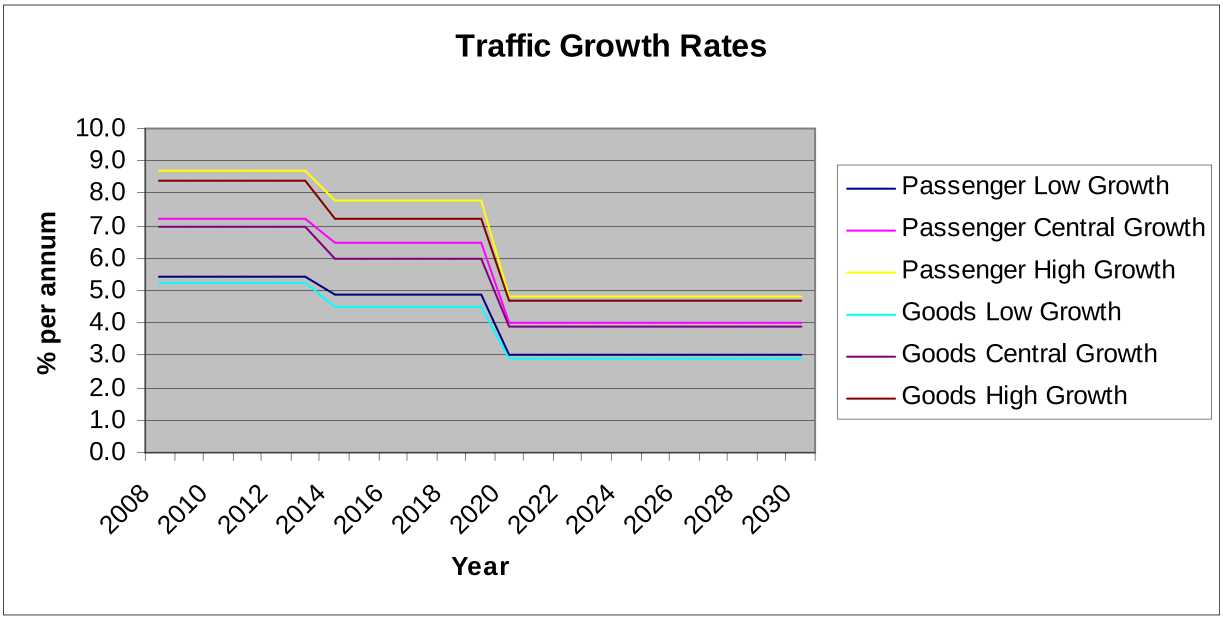
Table 3-21. Normal Traffic Growth Rates

Traffic Growth Rates (% per annum)							
		Passenger			Goods		
From	To	Low	Central	High	Low	Central	High
2008	2013	5.4	7.3	8.7	5.3	7.0	8.4
2014	2019	4.9	6.5	7.8	4.5	6.0	7.2
2020	2030	3.0	4.0	4.8	2.9	3.9	4.7

Source: The Consultant

These growth rates have been applied to all of the motorised vehicle classes. Non-motorised transport (nmt) will be affected by improvements in prosperity and accessibility and reduced growth rates have been assumed, taking half the rate of passenger vehicles until 2013 with zero growth subsequently to reflect increasing motorisation and the stagnation of non-motorised traffic.

Figure 3-7. Traffic Growth Rates



Source: The Consultant

3.7.3. Diverted Traffic

In relation to the rehabilitation and upgrading of the M3 corridor there are two potential components of traffic diversion:

- Localised diversion from the existing M3 to the various proposed bypasses and sections of new alignment
- Strategic diversion from other corridors or routes, notably the R34, to the M3 corridor

A dual approach has been adopted to model this potential diversion of traffic to the upgraded M3, using spreadsheet-based diversion curves in conjunction with the travel demand software QRSII to calculate the diversion to the bypass and other offline sections and QRSII alone to forecast the strategic traffic diversion from other corridors or routes. The results of the two approaches have then been compared and assessed before arriving at diversion forecasts for each section of the M3 corridor.

3.7.4. Local Diversion of Traffic

The proposals for the M3 corridor include nine offline improvements, covering bypasses and both longer and shorter sections of realignment. Of these, the most significant are:

- Cimislia Bypass/M3 Extension
- Comrat Bypass
- Vulcanesti Bypass
- South Corridor Realignment (including Slobozia Mare - Giurgiulesti Bypasse)

Spreadsheet-based diversion curves have been used to forecast the switch of traffic from the existing M3 alignment to each of these four principal offline sections. The diversion curves apply values of time and distance appropriate to Moldova to the existing traffic flow, categorised into light and heavy vehicle classes. The respective lengths of the alternative routes are input together with existing travel times, from surveys, and the anticipated travel times on the proposed improvements. The diversion coefficients are different for the two vehicle classes reflecting different routeing criteria. The proportion of each class diverting to the new alignment is calculated. Each of the four principal offline sections has been modelled separately

3.7.5. Strategic Diversion of Traffic

Rehabilitation and or upgrading of the M3 corridor has the potential to attract traffic from alternative routes. An assessment of existing traffic data relating to southern Moldova in combination with field reconnaissance visits which were not confined exclusively to the study corridor indicated the following major potential sources of diverted traffic:

- R3 Chisinau – Hincesti – Cimislia
- R47/R46/R34 Cimislia – Cantemir – Cahul
- R3/R34 Chisinau – Leova – Cahul – Giurgiulesti

The first named could be expected to lose traffic to an extended M3 in conjunction with the Cimislia bypass. Cimislia – Cahul traffic would predominantly travel via the R38 and Balabanu in the event of M3 rehabilitation and upgrading, in particular provision of the Comrat bypass. Traffic from one end of the corridor to the other is currently limited but can be expected to use the M3 throughout in the case of project implementation.

3.7.6. Sketch Plan Travel Demand Model

A Sketch Plan Travel Demand Model using the *Quick Response System II* (QRS II) software was developed to model traffic diversion from outside the M3 corridor. This computer program is generally used for forecasting impacts of urban developments on roadway traffic and for forecasting impacts of roadway improvement projects on travel patterns. In light of the absence of developed socio-economic data sets, as well as time series determining trip generation factors by socio-economic activities the application of the computerized travel demand model was limited to the forecast of major travel demand trends. However, it does provide the benefit of testing the effects of the corridor improvements in a wider network of highways, and helped to determine the potential diversion effects to and from other corridors.

In an initial step available socio-economic data (i.e. number of households, car-ownership per HH, retail and non-retail employment) was associated with a series of centroids (representing a zone) or external station (representing border crossing traffic or the special traffic generator of Giurgiulesti Freeport). Trip generation rates for productions and attractions were then calibrated to replicate current 2008 traffic conditions in the subsequent assignment process. This enabled the replication of current (2008) study area traffic flows on the network based on the AADT by section derived from the M3 survey programme. The following zones and external stations were represented in the sketch plan model:

- Cimislia
- Chisinau
- Hincesti
- Basarabesca
- Cantemir
- Comrat
- Taraclia
- Cahul
- Vulcanesti
- Giurgiulesti Free Port
- External Station Galati
- External Station Reni

Figure 3-8 presents the model network with 2008 replicated traffic flows. Primarily, the relationship of speed and distance in the sketch plan model was used to test variations between the primary corridors in the study area M3, R3 and R34.

3.7.7. Results of Traffic Diversion Modelling

The results of the local traffic diversion modelling using both the diversion curves and the travel demand model are summarised in table 3-21 below.

The comparison of the two methods shows that generally the travel demand model predicts a higher level of diversion than the diversion curves. Accordingly, to minimise any overestimation in the forecasting of diverted traffic and acknowledging the relative coarseness of the travel demand model the average produced by the two methods has been adopted for the purposes of traffic forecasting. The results of the strategic traffic diversion from the traffic demand model are summarised in Table 3-22 below

Table 3-22. Local Traffic Diversion Modelling Results

Principal Bypassable Sections	Diverted AADT		
	Diversion Curves	Travel Demand Model	Average
Cimislia Bypass + M3 extension	1,605	1,489	1,547
Comrat Bypass	1,333	3,227	2,280
Vulcanesti Bypass	298	652	475
South Corridor Realignment*	457	844	651

*(including village bypasses)
Source: The Consultant

.

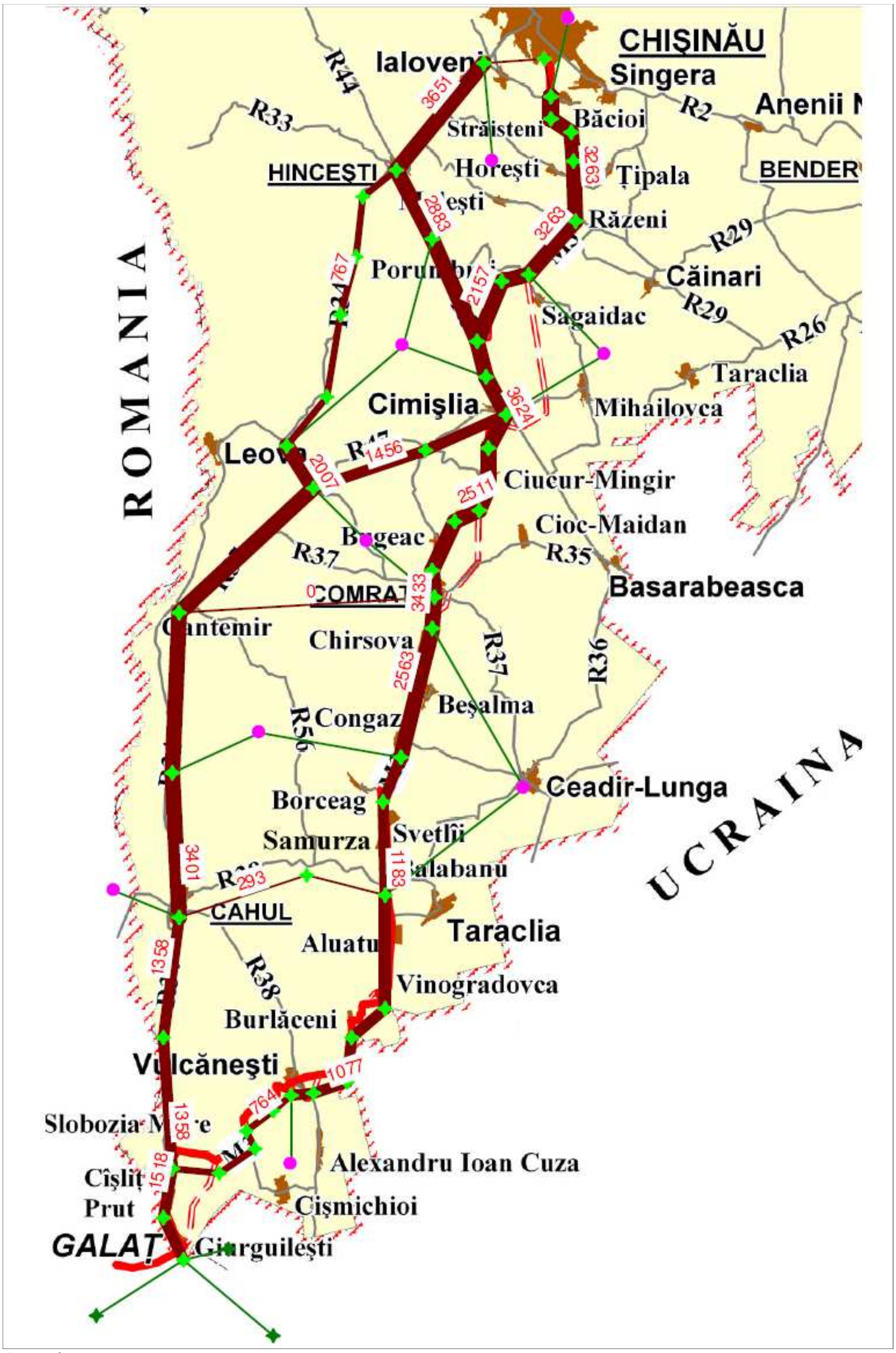
Table 3-23. Strategic Traffic Diversion Modelling Results

From	To	Flow (vehicles/day)
Cahul	Chisinau (via M3)	360
Cahul	Chisinau (via R3/Hincesti)	370
Cahul	Cimislia	1,140
Cahul	Comrat	1,096
Giurgiulesti/Slobozia Mare	Comrat/Cimislia/Chisinau	280

Source: Consultant's traffic model (QRSII)

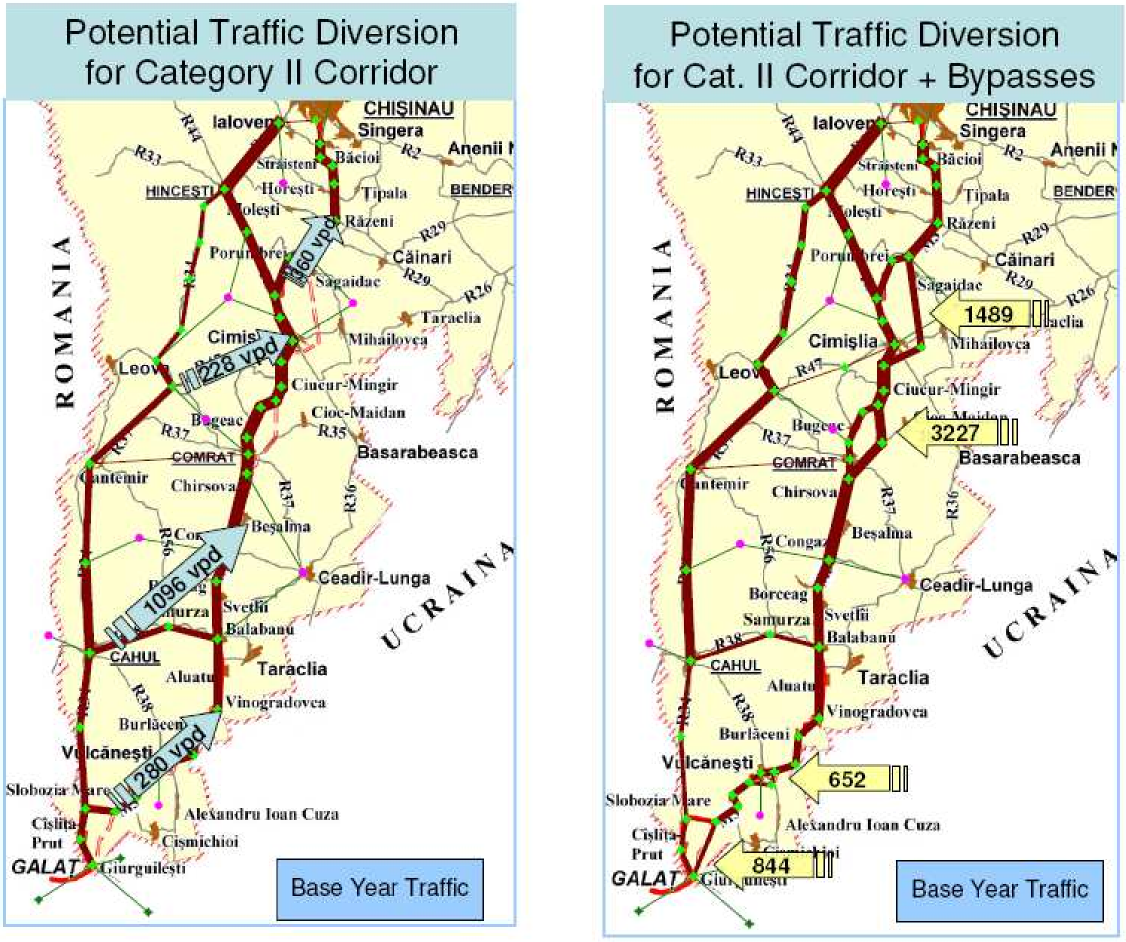
The results in Table 3-22 have come directly from the QRSII modelling and reflect the different components of strategic traffic diversion following upgrading of the M3 corridor. The Cahul to Chisinau traffic comprises two, almost equal, elements, one using the M3 from Cimislia northwards, the other using the R3 via Hincesti.

Figure 3-8. Travel Demand Model Base Year Traffic



Source: The Consultant

Figure 3-9. Travel Demand Model Potential Traffic Diversion



Source: The Consultant

3.7.8. Local and Regional Generated Traffic

The increased accessibility provided by the proposed improvements to the M3 corridor can be expected to generate traffic at both local and regional levels. Given that the existing M3 corridor, although of inconsistent standard and having sections of poor alignment and condition, enables light vehicles to comfortably travel from one end to the other at an average speed in excess of 60kph, the potential for accessibility-based traffic generation based is modest.

Accordingly, a value of 0.7% of total traffic has been adopted for each of local and regional traffic generation. This value has been assumed to apply for each of the first ten years of operation of the improved M3, that is, from 2011 to 2020 inclusive.

3.7.9. Special Traffic Generator: Giurgiulesti International Free Port

One of the objectives of improving the M3 corridor is to provide a direct link between Chisinau and Giurgiulesti, the most southern village in Moldova. Giurgiulesti is located at the confluence of the Prut and Danube rivers between Romania to the west and Ukraine to the east. Border Crossings to each country exist for road as well as rail traffic.

Between the international border of Romania and Ukraine the Republic of Moldova owns 800 m of shore line on the Danube, providing for the only access to international waters for the otherwise landlocked country. In addition, railways linking Ukraine, Moldova and Romania pass through Giurgiulesti since the city of Reni was a part of Romania prior to 1947.
Galati, Romania, is located approximately 25 km to the west of Giurgiulesti. The city has a population of 295,000 people, making it Romania's seventh largest city. The largest iron and steel plant in Romania, the Mittal Steel Galați is located in Galati. In addition, the country's largest shipyard is located here, profiting from the good access Galați has to the Black Sea through the Danube and the short distance between its facilities and the Mittal Plant. Reni, Ukraine, is situated approximately 5 km to the east of Giurgiulesti and is estimated to have a population of around 20,000.

In summary, Giurgiulesti, lies at the convergence of rail, road and maritime transportation corridors, linking western with Eastern Europe. M3 Chisinau to Giurgiulesti is designated European Corridor E584 providing this linkage on an international level.

Development of Giurgiulesti Free Port
Danube Logistics SRL, a Moldovan limited liability company, is the general investor, owner and operator of Giurgiulesti International Free Port (GIFP). In December 2004 Danube Logistics signed an investment agreement with the Government of Moldova for the construction of Giurgiulesti International Free Port. Danube Logistics' shareholders are the Dutch EASEUR Holding BV and the European Bank for Reconstruction and Development, holding 80% and 20% of Danube Logistics shares respectively. The investment agreement includes the subsidiaries of EASEUR: Danube Logistics SRL, BEMOL Retail SRL, BEMOL Refinery SRL, and BEMOL Trading SRL.

The Dutch EASEUR Holding took over the Giurgiulesti investment project from the Azeri Azerpetrol in mid-2006. According to the investment agreement, investments in the project should amount to 250 million dollars. In addition to constructing the port the investment agreement specifies to put into operation 50 fuel filling stations across Moldova. Overall the port will provide tri-modal transport infrastructure consisting of up to six berths, road access and railway links to Russian and European standard railway systems. The water depth at the six berths will vary – one berth with a water depth of 7m will be dedicated to sea vessels and the other five berths with a water depth of 3-5m will be dedicated to river vessels. Once completed, GIFP will consist of:

- Oil Terminal
- Dry Cargo-Terminal and Storage
- Industrial Free Zone
- Administration Centre

In addition, current plans for the Port Development include the construction of a Passenger Port by the Government, and possibly a Bio-ethanol production site.

According to Danube Logistics SRL a host investment agreement between the Republic of Moldova (approved by the Moldovan Parliament) and EASEUR Holding specifies the following obligations by the Government in regard to road infrastructure to the port:

- Maintenance of asphalt road from Chisinau to the International Free Port "Giurgiulesti"
- Repair of asphalt road from the International Free Port "Giurgiulesti" to Cahul;
- Granting the entire asphalt road between Chisinau and the International Free Port "Giurgiulesti" Status "M"

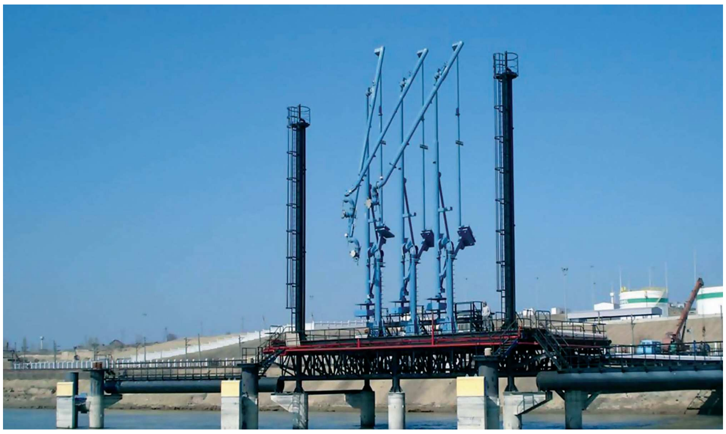
Details of Port Development
Several meetings and visits to Giurgiulesti Port were undertaken by the study team to learn about the ongoing activities as well as current and future developments. The following information was gathered in respect to the development, as well as the future traffic generation of the port activities:

- In 2006 Danube Logistics completed the construction of the oil terminal - First shipment of Oil Products August 2007 - 3 shipments since then
- In 2007 specialized equipment to load grain onto vessels as well as grain cargo storage facilities with a total storage capacity of 45,000 tonnes have been installed by Danube Logistics' business partner Trans Cargo.
- In August 2008 opening of the Cahul-Giurgiulesti Railway
- In 2008, 10 of the 50 planned gas filling stations are operational. Completion of gas station network anticipated by 2010. Gas Stations being supplied by tanker trucks.
- In 2008 Danube Logistics will complete the first phase of the dry cargo terminal and the construction of the infrastructure for the industrial free zone of the port.
- In 2009 Danube Logistics plans to complete the dry cargo terminal, including a dedicated small container terminal. Apart from the port facilities that provide direct access to the Danube and the Black Sea, GIFP benefits from connections to the Russian and European standard railway systems as well as to the international road network.
- In 2008-2010 Danube Logistics plans to construct the multi-purpose dry cargo terminal, consisting of up to six berths, capable of handling typical bulk cargo such as grain and construction material as well as containers. For the transhipment of bulk cargo and containers gantry cranes will be used.
- Bemol Trading SRL, a trading company for refined oil products, currently has contracts with Ronpetrol and with Tirex (both maintaining networks of gas stations in Moldova). Discussions are underway with Lukoil (largest distributor of gasoline products in Moldova)
- Port also provides fuel for railway
- Currently oil products are imported by train and truck. Border clearance is an issue in terms of cost and time; port offers economy of scale through customs clearance of large volumes (one customs procedure for 4,000 t of product versus 30t per tanker truck).
- According to Danube Logistics 1 ship with 4,000t oil product per month is expected from early 2009 and one ship (5,000t) every two days during harvest time.
- Austrian Company is building port, anticipated completion by 2010.
- Grain will be exported through Trans Grain Terminal, which has 37,000t grain silos (Danube logistics provides services); weigh-bridge is installed for grain delivery to port, direct delivery from farmers to port for export.

- Since the port in Reni does not have container services it is foreseen to establish a barge service for containers from Constanza, Romania; Customs clearance time is high (takes 7 to 10 days for container to clear customs in Romania) per individual container. It is expected to process 750 TEU (Twenty feet Equivalent Unit) containers per month. Distribution within Moldova primarily by truck.
- The Republic of Moldova is currently constructing a Passenger Terminal. Since the Danube is an international waterway Moldovans can go to Bulgaria and other destinations via the Danube. Approximately 200 passengers are expected a day. Access primarily by bus and car. Opening is planned for the first quarter of 2009.
- Sand and Gravel will be important commodities for the port, with one dedicated berth. Distribution of materials primarily by truck.
- The Ministry of Transportation estimate the short term need for construction materials for road rehabilitation at 500,000t for southern Moldova. Because of the absence of natural resources much of the building materials will need to be imported through Romania and or Ukraine.
- Currently there are 18 companies registered in the Economic Free Zone with a total of 380 employees as of September 2008.
- Plans exist for a Bio-ethanol refinery (1000t of material need a day).

Anticipated Development and Throughput of Port Activities

In 2006, Dorsch Consult, completed a Due Diligence Report for the Giurgiulesti Freeport assessing the ports competitiveness as well as its future level of activity and throughput. In terms of competitiveness the report states: “Oil products come from Romania with trucks and from Russia and Ukraine (via Trans-Nistria) with rail. Due to the current interferences (political situation in Trans-Nistria, high prices for truck transport from Romania) of oil import Giurgiulesti Port could be a competitive alternative for oil transport. Most relevant for Giurgiulesti port, however, are bulk products like grain, gravel, sand, fertilizer, cement and gypsum.” Dorsch Consult estimated a potential cargo throughput of around 1 million tons for 2008 for the port. The volume of the bulk cargo throughput is determined by the available storage space in the port. ISO-container traffic will be an exception because the total volume is too low for regular container traffic per ship. Figure 3-10 presents the Giurgiulesti Free Port Master plan, which forms the basis and guideline for the further planning as well as development of the non-oil cargo related area of the future “Giurgiulesti International Free Port”.



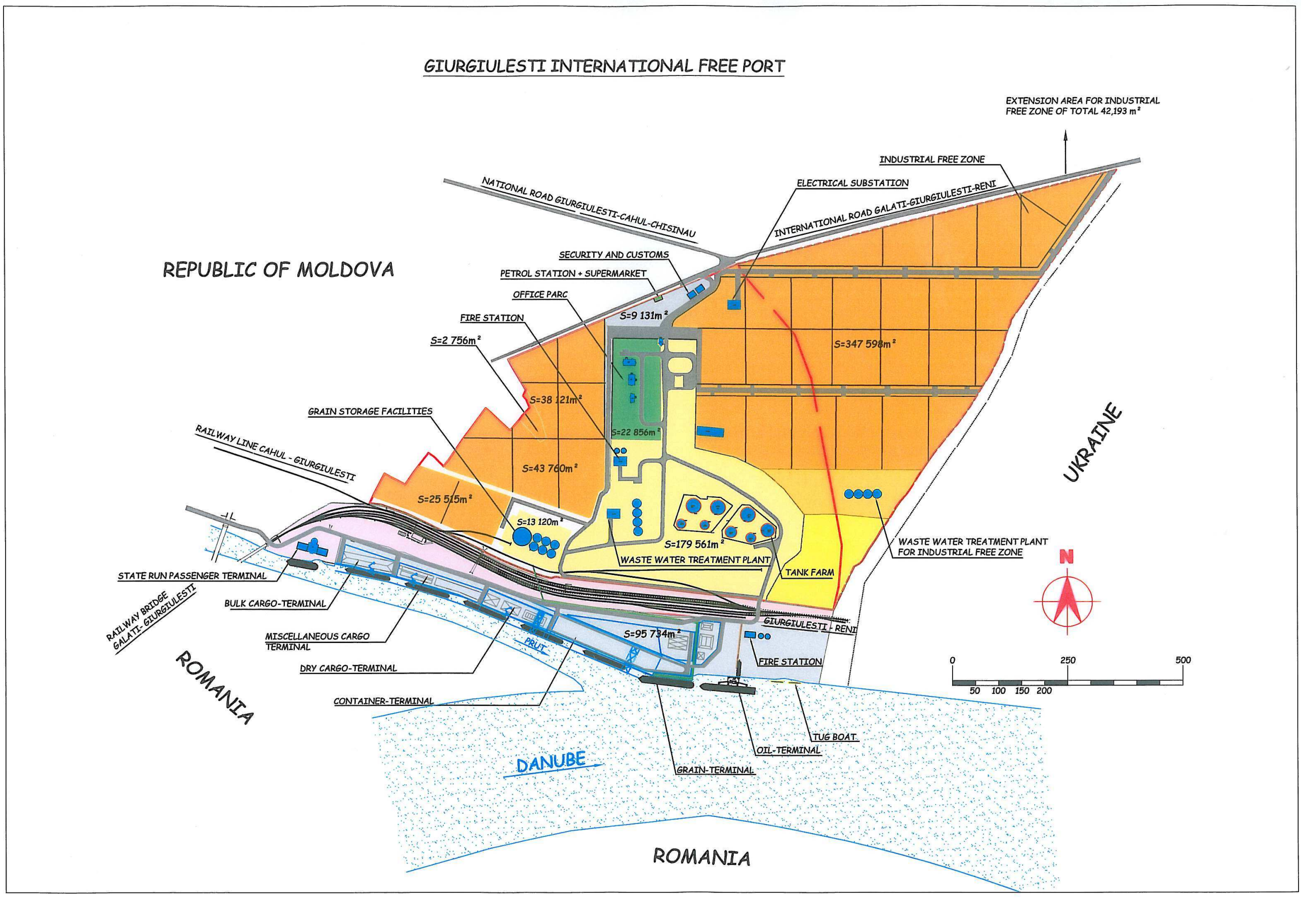
3.7.10. Trip Generation of Port Activities

With little data available on the generation of truck trips from a inland river port in a transition economy the following approach was taken to estimate the number of trips generated by the Giurgiulesti Freeport:

1. identify the estimated tonnage of throughput at the port by activity
2. estimate mode share between rail and truck distribution
3. apply average load factor for each truck trip
4. divide identified number of annual truck trips by working days

The same methodology was applied for the anticipated oil product distribution - only with larger truck loads. Anticipated trip generation of the commercial and industrial activities was estimated based on a trip generation factor per employee – representing both the commute of the employee to and from work as well as trips attracted and produced by the economic activity the employee is serving. Again in the absence of developed data sets for transition economies a trip generation factor of 2.5 trips/employee was applied. Trip generation for the passenger port was based on proposed staffing schedules obtained from the Ministry of Transport.

Figure 3-10. Giurgiulesti International Free Port



Source: Danube Logistics

Assignment of Port Generated Trips to Study Corridor

Further assignment of trips on the study corridor was based on results of the Origin-Destination survey, particularly from the survey station in Cislita Brut. Data from this station indicated that approximately 25% of trips, today, currently use the M3 corridor while 75% continue north along the R3 corridor towards the city of Cahul. It is assumed that with the development of the port activities a larger percentage of trips will go to “market” destinations in Chisinau and the northern portion of Moldova, therefore a percentage of 36% of future trips generated at the port are assigned to the M3 corrdior.

The central growth estimate projects 2583 trips generated by the port activities, including 553 truck trips. This represents a conservative estimate of generated trips primarily reflective of the uncertainties in trip generation rates. See Table 3-22 and Table 3-23 for rationale.

Table 3-24. Forecasted Import and export Commodities in Giurgiulesti Free Port

Import Commodity	Forecast	Remarks
Gravel/Sand	250,000 t	- Demand for storage space limits throughput.
Fertilizers	70,000 t	- Storage silos are required.
Cement/Asbestos Cement	70,000 t	- Storage silos or warehouses are required.
Frozen Meat/Fish	40,000 t/a	- Refrigerated warehouses are required. - Relevant as general cargo (possible in ISO-containers)
Bricks, Construction Material	30,000 t/a	-Demand for storage space limits throughput. -Relevant as general cargo (possible in ISO-containers)
Containers of Glass	30,000 t/a	- Relevant as general cargo (possible in ISO-containers)
Export Commodity	**Forecast**	**Remarks**
Grain	300,000 t	- Volume is contracted.
Gypsum	120,000 t	- Demand for storage space
Wine	20,000 t	- Relevant as general cargo (possible in ISO-containers)
Containers of Glass	10,000 t	- Relevant as general cargo (possible in ISO-containers)
Total	**940,000 t**	

Source: Dorsch Consult Due Diligence 2006

Table 3-25. Estimated Traffic Generation Giurgiulesti Free Port

Giurgiulesti Free Port - Traffic Generation	Growth Scenario		
Dry Cargo	**Low**	**Central**	**High**
Annual Forecasted Throughput Dry Cargo Terminal w/o oil products	250,000	940,000	940,000
Truck Mode Share	80%	80%	80%
Annual Tonnage on Truck	200,000	752,000	752,000
Average Number of trucks based on 10t* load per vehicle	20,000	75,200	75,200
Daily Trucks (LGV & HGV) per working day (Mo - Fr)	**77**	**289**	**289**
Oil product delivery			
Forecasted Throughput oil products, annual tonnes	200,000	500,000	500,000
Tanker truck trips (return trip) 30t load per vehicle	6,667	16,667	16,667
Daily Truck Trips per working day	**26**	**64**	**64**
Bio-ethanol production site			
Needed material per day	0 t	1000 t	1000 t
10 t trucks daily - return trip	0	200	200
Economic Free Zone			
Port trip generation based on number employees (all activities)	400	800	1,600
Vehicle trips per Employee (commute & business generated trips)	2.5	2.5	2.5
Trips	**1,000**	**2,000**	**4,000**
Passenger Port			
Passengers/day	250	250	250
Work Force	21	21	21
Buses/cars trips	**30**	**30**	**30**
Total vehicle trips	**1,133**	**2,583**	**4,583**

* (Dorsch Consult Due Diligence 2006)

3.7.11. Traffic Forecast Summary

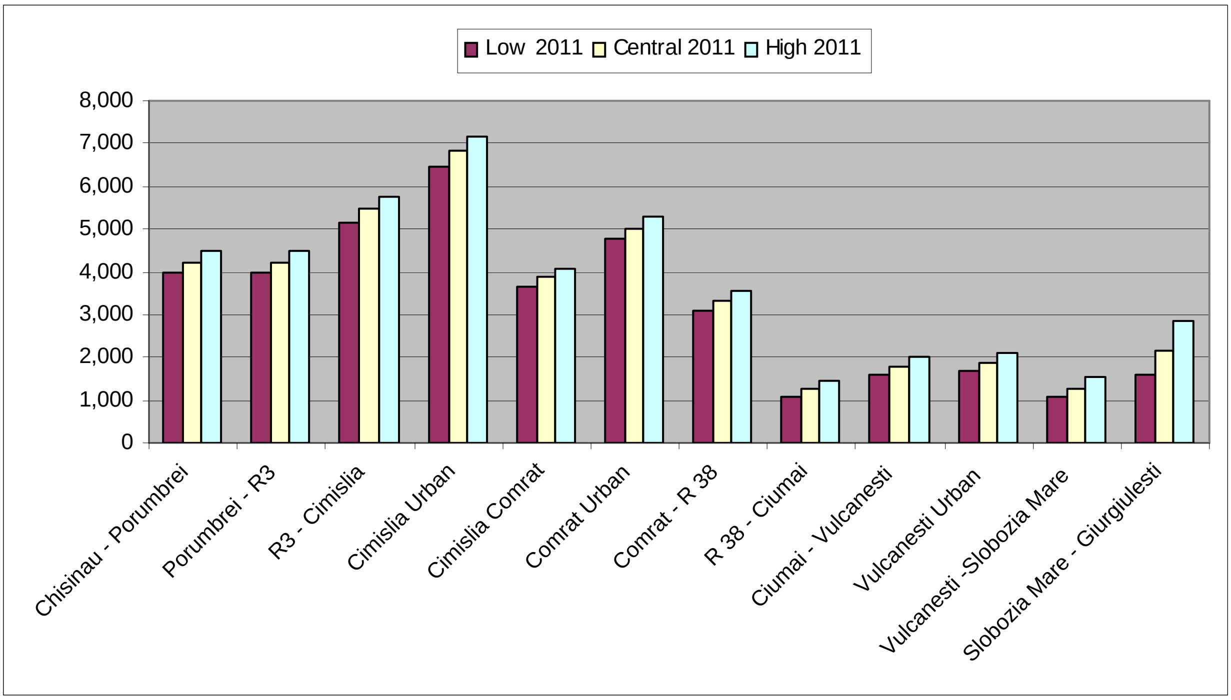
The composite traffic forecasts produced by the methodology described above are summarised in Tables 3-24, 3-25 and 3-26 below, for central, low and high growth respectively. These are summary tables, showing AADT (excluding two-wheelers and non-motorised vehicles) for scheme opening year, 2011, and final evaluation year, 2030. Forecasts are provided for both online and offline variants of the project. Figures 3-11 presents the 2011 forecast by individual corridor section, Figure 3-12 illustrates forecasted volumes by 2030.

Table 3-26. Summary of Traffic Forecasts: Low, Central, High Growth

Online Scheme			Low Growth		Central Growth		High Growth	
			2011	2030	2011	2030	2011	2030
Sect. No.	From	To	AADT	AADT	AADT	AADT	AADT	AADT
1	Chisinau	Porumbrei	3,962	9,007	4,228	12,356	4,494	16,184
2	Porumbrei	R3 junction	3,962	9,007	4,228	12,356	4,494	16,184
3	R3 junction	Cimislia	5,149	11,592	5,458	15,721	5,759	20,331
4	Cimislia urban area		6,461	14,445	6,818	19,432	7,157	24,904
5	Cimislia	Comrat	3,651	8,158	3,860	11,146	4,079	14,592
6	Comrat urban area		4,750	10,629	5,019	14,409	5,287	18,659
7	Comrat	R38	3,091	7,018	3,306	9,869	3,549	13,361
8	R38	Ciumai	1,088	2,693	1,240	4,261	1,432	6,471
9	Ciumai	Vulcanesti	1,602	3,849	1,782	5,789	1,996	8,374
10	Vulcanesti urban area		1,693	4,049	1,877	6,050	2,095	8,698
11	Vulcanesti	Slobozia Mare	1,067	2,803	1,273	4,779	1,543	7,714
12	Slobozia Mare	Giurgiulesti	1,603	4,914	2,147	9,586	2,872	16,928
Offline Scheme			**Low Growth**		**Central Growth**		**High Growth**	
			2011	**2030**	**2011**	**2030**	**2011**	**2030**
Sect. No.	From	To	AADT	AADT	AADT	AADT	AADT	AADT
1	Chisinau	Porumbrei	3,962	9,007	4,228	12,356	4,494	16,184
234bp	Cimislia bypass + M3 extension		2,279	5,731	2,451	7,970	2,633	10,647
56bp	Comrat bypass		3,839	8,658	4,055	11,787	4,273	15,356
7	Comrat	R38 Intersection	3,091	7,018	3,306	9,869	3,549	13,361
8	R38	Ciumai	1,088	2,693	1,240	4,261	1,432	6,471
9	Ciumai	Vulcanesti	1,602	3,849	1,782	5,789	1,996	8,374
10bp	Vulcanesti bypass		919	2,464	1,054	3,921	1,223	5,986
1112bp	Slobozia Mare bp + Southern Corridor realignment		1,154	3,059	1,353	5,104	1,605	8,084

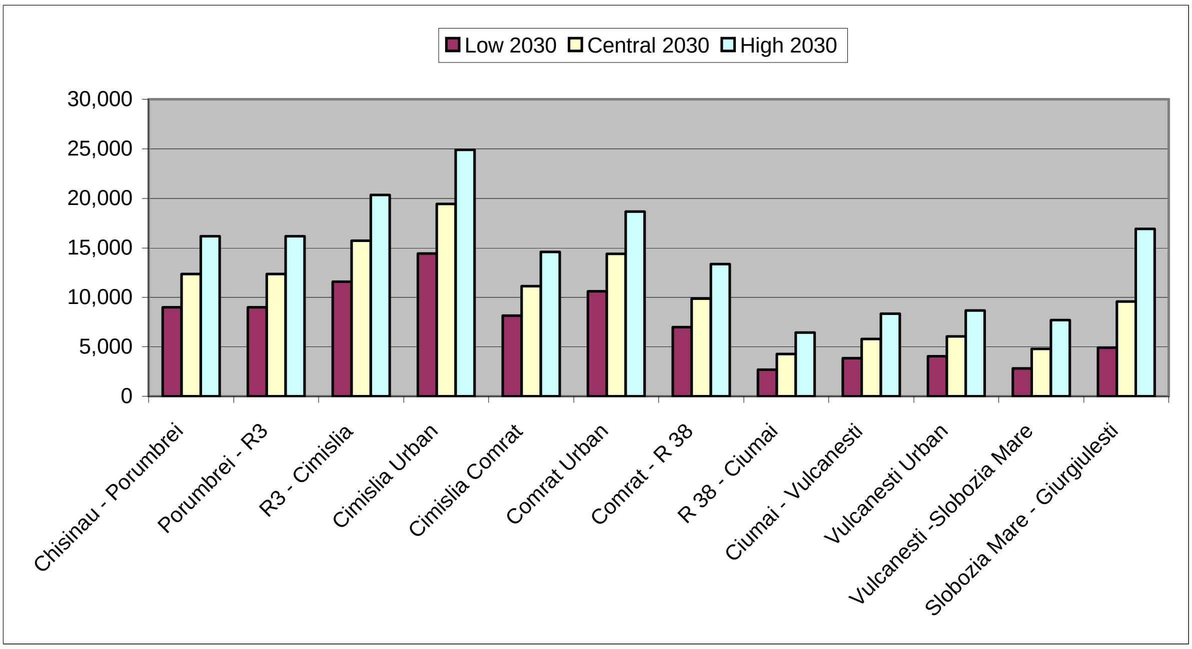
Source: The Consultant

Figure 3-11. 2011 Traffic Forecast (AADT)



Source: The Consultant

Figure 3-12. 2030 Traffic Forecast (AADT)



Source: The Consultant

3.8. Road Safety Analysis

Traffic safety conditions in Moldova are characterized by a still low motorization index (vehicles available relative to population) and a high level of traffic accidents resulting in a high rate of fatalities. As presented in Table 1, the number of fatalities per 1000 registered vehicles is almost eight times higher in Moldova if compared to the situation in a Western European country like France:

Table 3-27. Fatalities per 1000 Registered Vehicles

Country	Registered vehicles	Population	Accidents/year (2007)	Fatalities	Fatalities/ 1000 Registered vehicles
France	37,150,988	63,392,000	81,272	4620	0,1
Moldova	586,015	3,581,100	2437	464	0,8

A study "*Joint OECD / ECMT Transport Research Centre, Working Group on Achieving Ambitious Road Safety Targets, Moldova Country Report on Road Safety Performance July 2006"* summarizes traffic safety issues on a national level for Moldova[1]:

- A high level of fatalities
- Drivers account for 25-30% of road fatalities, vehicle passengers for 25%, pedestrians for 40-45% and cyclists for 3-5%.
- The high level of fatalities in Moldavia is due largely to the lack of separation between road users, especially on high speed roads. This in turn is due to deficiencies in land use planning.
- Important infrastructure improvement is required to reduce this high fatality rate, with measures such as pedestrian crossings and central islands introduced in built-up areas.
- Excessive speeds are also responsible for the high number of fatalities.
- Since 1995, vehicle occupants constitute the user group with the biggest increase (+171%) in the number of fatalities. One reason for this is speeding and the non-utilisation of passive safety devices, such as seatbelts.
- A key issue is also the high rate of pedestrians killed, which is far above the European average: collisions with pedestrians represent 46% of all accidents.

In the Republic of Moldova, traffic accident data are collected and recorded by the Road Police Division of the General Department of Public Police and Internal Affairs. Statistics are collected on accidents resulting in injuries or fatalities. Non-injury accidents are not included in the statistics.

The Ministry of Internal Affairs communicated recently the following information:

- In 2007, 2,437 road accidents occurred in total, resulting in 464 fatalities and 2,984 injuries.

[1] The data used in the Joint OECD/ECMT study varies from the data provided by the site of the Ministry of the Informational Development of Moldova. Following the study, at the end of 2004 there were 649,910 registered vehicles in Moldova. The MID counted 586,015 registered vehicles by the 01/09/2008.

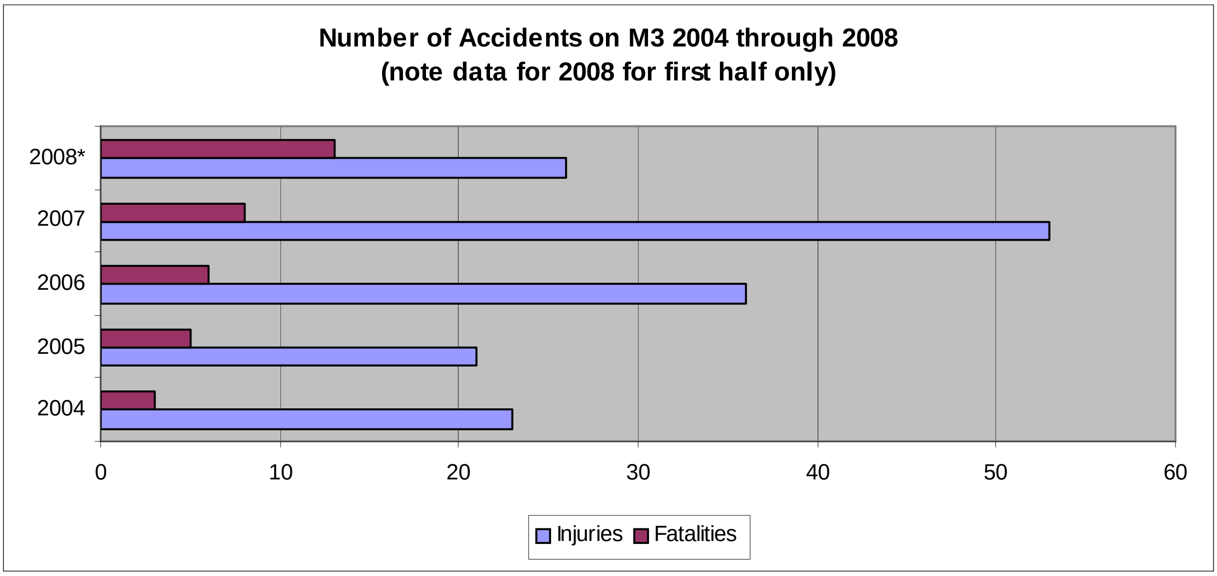
- 279 road accidents, which constitute 11.4% of the total, were due to unsatisfactory road conditions resulting in 62 people dead and 358 injured.
- Subsequent analysis identified 80 road sections with a high frequency of accidents. (244 road accidents, 102 fatalities, 340 injuries).
- A major problem, needing an urgent solution, is the reduction of the road sections with a high frequency of road accidents. Therefore it is of high urgency to develop measures to ensure the road safety of the public on these dangerous sections. In order to address the problem the Ministry of Internal Affairs together with the State Road Administration carried out an examination of the identified sections and proposed counter measures.

3.8.1. M3 Chisinau - Giurgiulesti Traffic Accident Data

Traffic Accident Data for the study corridor was requested from the Road Police Division and received for the years 2004 through 2007. In addition, summarized data for the first half of 2008 was also obtained.

Corridor Specific Information
Between 1st of January.2004 and June 31st 2008 a total of 106 accidents (injury and fatalities) occurred along the study corridor. The recorded accidents resulted in 159 injuries and 35 fatalities. Figure 3-12 presents the number of injuries and fatalities by year. After a short decline between 2004 and 2005 absolute numbers of injuries as well as fatalities increased dramatically. Note that data for 2008 represents only first half of the year. Between 2004 and 2007 injury accidents increased by 130% and fatalities by 160%. The number of fatalities in the first half of 2008 (13) are almost as high as the total of 2006 and 2007 combined. It is also noted that traffic volume increased in the range of 3 to 5 percent annually). The maps in Appendix present the location of accidents on the M3 corridor.

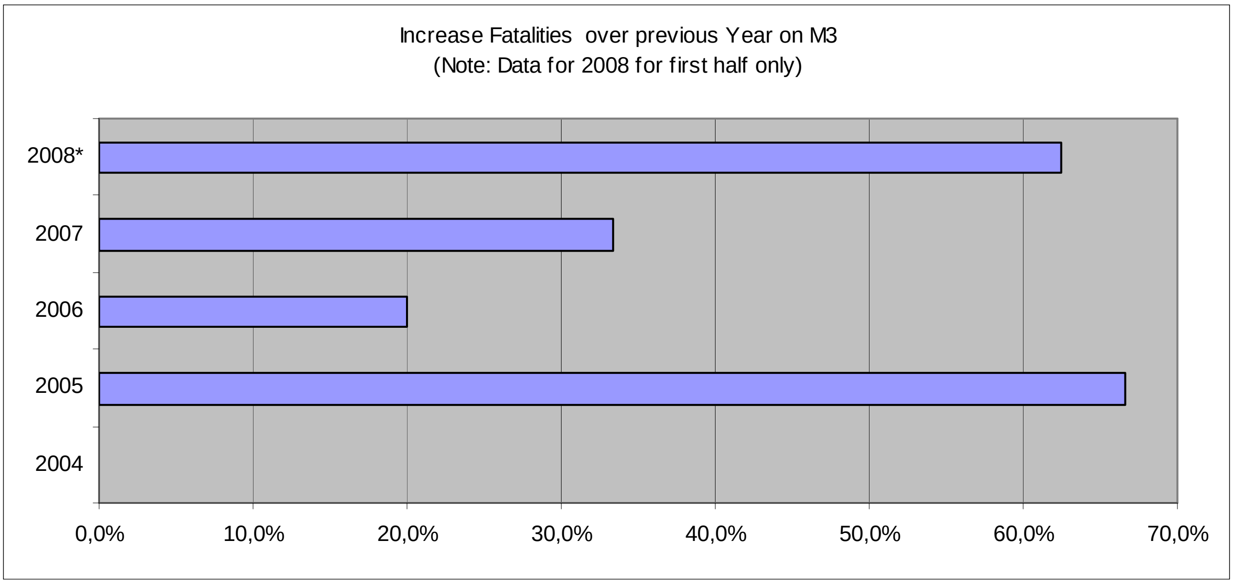
Figure 3-13. Number of accidents on M3 January 2004 – June 2008



Source: Consultant, data Ministry of Internal Affairs

What is noticeable is the continuous increase of fatalities relative to the previous years. Figure 3-14 presents the relative increase of fatalities over the previous year. In the first half of 2008 7.4% of all fatalities in Moldova occurred on the M3 corridor.

Figure 3-14. Increase of Fatalities over Previous Year



Source: Consultant, data Ministry of Internal Affairs

The data received from the Road Police Division contained some data items regarding type and cause of the recorded accidents. Table 3-28 presents the type of accidents. From all accidents 56 % were vehicle with vehicle collisions, followed by a combined 31% of single vehicle accidents (inversion, obstacle, stationary vehicle), and approximately 11 % involving pedestrian and cyclists.

The majority of accidents were caused by either speeding (45%) or drunk driving (14%). More than 10% involved pedestrians and cyclists.

Table 3-28. Types of Accidents on M3

Type of accident	Number	Percent of Total
Collision	47	57.3%
Inversion (roll-over)	12	14.6%
Stationary vehicle	5	6.1%
Obstacle	9	11.0%
Pedestrian	2	2.4%
Cyclist	7	8.5%
Non-motorized vehicle	0	0.0%
Total	**82**	**100.00%**

Source: Consultant, data Ministry of Internal Affairs

3.8.2. M3 Accident Patterns – Black Spots

The maps displayed in Appendix I-5 show the location of accidents along the M3 corridor. The analysis of the accident locations revealed five distinct "black spots" with a high frequency of accidents. The identified locations correspond with the locations identified by the Ministry of Internal Affairs. Table 3-29 lists the location together with possible causes, identified issues, and suggested improvements.

Table 3-29. M3 Accident "Black Spots"

Location	From Km	To Km	Comment
Razeni	21	23	4 lane concrete section, in the vicinity of the village of Razeni; horizontal curve **Issues:** high speed traffic in conflict with other road users, i.e. pedestrians, non-motorized vehicles, **Suggested improvements**: Improvement of carriageway; speed enforcement, signage lighting
North of Sagaidacul Nou	27	29	4 lane concrete section, hilly terrain **Issues:** high-speed traffic, steep curves, **Suggested improvements:** rehabilitation of carriageway including renewal of road markings, speed enforcement,
	75	78	2 lane section, normal visibility, horizontal curve section **Suggested improvements**: rehabilitation of carriageway including renewal of road markings, speed enforcement
Between Chirsova and Congaz	100	115	2 lane section between the villages of Chirsova and Congaz, straight alignment, high visibility; **Issues:** speed differential, high speed, mix of traffic modes, **Suggested improvements:** rehabilitate the carriageway, renew the road markings and ensure lighting during night time
Vulcanesti	174	179	Vulcanesti; high concentration of accidents within town limits as well as western entry to town **Issues:** hilly terrain, steep grades, mix of traffic modes, speed differential **Suggested improvements:** rehabilitation of carriageway including renewal of road markings, speed enforcement

Source: Consultant, Data Ministry of Internal Affairs

Meeting at the Road Police Department Of Moldova – 03/09/2008
In order to identify general as well as specific safety improvements the study team met with representatives of the Moldova Road Police Department:

- Mr. Valentin Zubic, Police Chief of the RPD
- Mr. Dan Chirita, Statistics Department RPD
- Mr. Sergey Capatina, Road Engineer at the RPD

The following main Safety issues were identified by Moldova Road Police Department:

- There is a dramatic increase in the number of accidents – 70% more than for the same period of 2007 ;
- About 5-6 deaths every day in road accidents all over the country ;
- The main factor leading to the accidents is excess speed, often very much over the limits

- There is not sufficient police staff to survey the traffic and to limit the excesses on the roads; still a low culture among local drivers, not respecting road rules and the other participants in the traffic. The road police staff has recently been reduced by 50% and the department has 150 vacant places at present ;
- It would be good to start implementing the modern traffic survey technologies in order to improve the safety on the roads and to replace as much as possible the human factor by these technologies ;
- The Department is working on some projects in this sense. Thus, it would be good to use the M3 road as a pilot road (project) in implementing some technologies of traffic survey ;
- About the statistics on the accidents: since the beginning of 2008, the Department is using a new methodology (and software) of getting information about the accidents. There is collected a detailed information about each accident : how many persons involved, their ages, how many adults, children, teenagers etc., the sex of the persons, their driving experience etc. ;
- A critical factor which leads to serious accidents is trees planted on both sides of the road, present on most of the Moldovan roads. In the Soviet period, it was basically a tradition to plant trees on the roadside and the consequences are dramatic today. Most of the accidents with four or more dead happened because the vehicles hit a tree on the roadside;
- Classification of high accident risk sections: if there are two or more accidents/km/year, this section is considered as high risk. Also, if there was only one accident during a year and another one the next year, the section is also considered as a high risk one.

The following safety improvement was suggested by the Road Police Department of Moldova for the M3 corridor:

- The implementation of modern traffic survey technologies which would transmit the images and information directly to the control stations in Chisinau and to the respective police units in the districts;
- To supplement the police staff for the survey and monitoring of the dangerous and high risk sections;
- European standard road signing and marking. For example, the indicators which show the four lane section is ending will become a two lane section, should be placed at 500, 300, 200 m, etc from the point of lane reduction;
- On the sections with trees planted on the roadside: to plan some crash barriers in order to avoid the impact with the trees. It should be done at least on the high risk sections first;
- Not to plant any tree on the new road sections (on the extensions);
- To make a meticulous examination of the soil in the land sliding risk sectors, to reconstruct and reinforce the road in these sectors and limit the future consequences of the road sliding, as much as possible.

3.8.3. General Safety Strategies

Roll-over Accidents at Bends

The apparent cause of these accidents is usually the driver entering the bend at excessive speed. The reason for this can be because the driver was willfully traveling at a high speed, was paying insufficient attention or because he misjudged the severity of the bend. Such misjudgments can be caused because of the bend's visual configuration, poor delineation or because it was unexpectedly sharp. Therefore for all bends below the desirable minimum standard, warning signs should be provided to give the driver an idea of the severity of the bend. This should ideally follow a standard whereby the most dangerous bends have the highest level of signing and marking.

Hazardous bend signs placed in front of the bend inform the driver of how the horizontal road alignment changes. Edging the signs with fluorescent strips will improve conspicuity. Advisory information can be written on the road or placed on speed limit signs. The information should inform the driver of how severe the hazard is and provide readily understandable advice on how to navigate the hazard safely.

Overtaking and Head-on Collisions
Another major problem occurs when drivers sometimes ignore the no-overtaking enforcement. Where head-on accidents are a problem, double white lines should be enhanced. Since line markings are widely ignored in Moldova, more physical deterrents to crossing the centre line are required. A variety of traffic engineering devices have been developed that could be used in similar circumstances, from rumple strips (profiled line marking) to heavy duty road studs.
Accidents at Entry and Exit of Villages and Municipalities
The differential between the speed limits inside and outside a village can be large. If drivers have been travelling along rural roads subject to the national speed limit for an appreciable distance, they may not recognize the need for greater care and lower speeds. They may be unaware of a lower speed limit or of their own speed and may respond late to the lower limit. In particular they may be unaware of the increased risk of an accident, especially with a vulnerable road user. Speeds observed through villages are often high compared to what is appropriate for the conditions.

Although village name signs together with speed limit signs have been conventionally used to mark the entry to a village these are largely ignored by the drivers. Other features within the village, respectively at the entrances, should be considered, if appropriate, to urge the driver to keep an appropriate speed. These may include reductions in road width, traffic islands and mini-roundabouts.
Rehabilitation and Enforcement
Unfortunately it is likely that accidents will increase as a result of the road rehabilitation improvements as it will be much easier for drivers to travel at greater speeds. From the engineering point only limited possibilities exist to oppose this tendency to higher speeds, and Police action to enforce speed limits is probably the only effective way to limit accidents.

3.8.4. Safety Features to be Considered In the Design

However, the following work items should be considered, where appropriate, in the detailed design phase of the project to enhance traffic safety:

- Install and replace delineation
- Install rumble strips
- Install crash barriers
- Replace deficient signing, as needed, using current standards
- Separate traffic modes, i.e. provision of sidewalks
- Install traffic islands and pedestrian refuges
- Restore sight distance at public road junctions and the inside of curves through low cost measures if they are available such as removal or relocation of signs and other obstructions, and cutting back of vegetation

Safety and Miscellaneous Design Items
In addition to the requirements on the road geometry, junction design, road furniture and markings, International Design Manuals include recommendations for safety and miscellaneous design items, which are considered in the design review of the project as follows:

- Safety Rest Areas and Scenic Viewing Points
- Bus Lay-bys and Parking Bays/Lanes
- Public Utilities
- Safety Barriers
- Emergency Escape Ramps

Road Furniture and Markings
Adequate road furniture and markings in conformity with international standards and/or improved project standards are included in the design to provide for the road users suitable:

- Signalization
- Orientation
- Safety.

Road Markings and Marker Posts
For appropriate guidance during the day and especially at night or during adverse weather conditions (e.g. rain, fog) road markings are considered in the design.

General Notes on Road and Traffic Safety
Recent studies showed that the road/traffic safety situation all over South-East Europe including Moldova is among the worst in the world. A general problem is poor driving skills (e.g. speeding, cutting curves, risky overtaking) associated with a lack of discipline (e.g. neglecting traffic regulations) as well as inadequate technical condition of the vehicles (e.g. non functioning brakes).

The improved alignment together with the new pavement and the much higher design speed of the upgraded M3 Road will provide a smooth road which may lead to drivers using excessive speed. Unfortunately, it is very likely that the higher driving speed will entail an increasing number of accidents due to the above-mentioned general problem in the area.

In order to avoid and control potential problems in the operation of the upgraded road maximum attention has been paid to adequate road and traffic safety. Road and traffic safety is based on the three 'E's which can be described as:

Engineering	(e.g. standards for road/highway design and traffic engineering, control of quality in implementation, supervision of works for and maintenance of a good/safe road condition)
Education	(e.g. education of pedestrians and motorists, training, public promotion)
Enforcement	(e.g. laws and regulations, police, justice)

and is a complex process where dynamic, visual, geometric, drainage and psychological requirements need to be optimized.

Engineering Design Component for Road and Traffic Safety
The main items of traffic safety which will be considered in the present engineering road/highway design can be summarized as follows.

Road Geometry
The requirements of the geometric design standard on road cross section (width of carriageway + shoulders), the horizontal & vertical alignment and the junctions will be described in detail as well as the route selection for the determined improvement alignment and the resulting engineering design for the upgrading of the M3 Road.

Traffic Signs
For signalization danger warning and regulatory signs (e.g. speed limit, curve warning, give way) will be considered as well as standard 1.6m x 1.5m destination signs according to international practice. In order to provide an optimum signalization and orientation during darkness all road signs will be specified to be retro-reflective.

Road Markings
For appropriate guidance during the day and especially at night or during adverse weather conditions (e.g. rain, fog) road markings with surface reflectorisation and road studs should be used.

For the centerline and other markings, which are often crossed by vehicles (e.g. at lay-bys or junctions), thermoplastic material should be specified, which has a long service life and reduces maintenance requirements. All other markings, which are usually not crossed by vehicles, will be provided in ‘ordinary’ road marking paint due to economic reasons. All road markings will be specified with surface reflectorisation by the application of ballotini beads.

Kilometer and Guide Posts
The kilometer and guide posts should be upgraded. Therefore an improved type of guide post should be developed and used for the present project.

Guard Rails
Galvanized steel guard rails will be considered at high embankments, at bridge approaches, etc. They will exclusively be installed with beveled/buried end sections, because these provide a higher safety than the ordinary end pieces.

Populated Areas

Speed Calming System (SCS)
As observed during the site inspection and as pointed out by town officials during our visit, a major concern is the high speed of vehicles entering or passing through sensitive areas. Consequently, an appropriate Speed Calming System (SCS) should be developed to increase road safety.

Pedestrian Walkways
Where the site conditions (space) allow, pedestrian walkways will be considered which are separated from moving or stopping traffic (carriageway or parking bay/lanes) by a kerbstone for the best possible safety of pedestrians and their convenience as well.

4. SELECTION OF DESIGN AND CONSTRUCTION STANDARDS

4.1. Introduction and Background

General direction given in the Terms of Reference foresees a Category II Standard for the improvements on the M3 corridor. The following discussion is intended to highlight the differences between the locally applied SNIP standards and possible adjustments based on western standards.

Geometric road design standards in Moldova are still based on FSU standards, although initiatives are under way to introduce European norms. Therefore the Terms of Reference of the Road M3 Chisinau – Giurgiulesti/Romanian Border Extension and Rehabilitation Project emphasise that the applicable design and construction standards should be consistent with representative international design and construction standards. The following chapter discusses established FSU standards, recent Moldovan modifications to the FSU standards, as well as applicable international standards.

Experience in Western European countries has shown that more appropriate geometric and pavement design standards are just some of the areas where large savings in costs and increases in efficiency can be made.

Cost effective road design requires a thorough understanding of the complex interactions of soils, terrain, climate, and traffic. Moreover, creating sustainable solutions to the problems posed by these interactions requires a significant level of engineering judgment, technical skills, and local knowledge. Standard solutions are often insufficient. Terrain conditions can vary considerably within countries and between regions. Traffic types and needs depend on the circumstances of individual communities. To achieve cost-effective solutions, it is important to tailor interventions to the specific situation and not to impose rigid designs.

One of the principal objectives of this chapter is to make recommendations about the geometric design and construction standards for the Chisinau - Giurgiulesti Road Rehabilitation Project such that the optimum balance between road construction cost and road user cost is obtained, considering road safety issues and natural and human environmental aspects.

4.2. Geometric Design Standards

Geometric design is the process whereby the layout of the road in the terrain is designed to meet the needs of the road users. The principal geometric features are the road cross-section and horizontal and vertical alignment. Geometric design standards are not more than a first approximation to design needs, since it should be accepted that design must be site specific. The optimal design for a given traffic flow will depend on terrain and other characteristics.

The use of geometric design standards fulfills three inter-related objectives. Firstly, standards are intended to provide minimum levels of safety and comfort for drivers by the provision of adequate sight distances, coefficients of friction and road space for vehicle manoeuvres; secondly, they provide the framework for economic design; and thirdly, they ensure a consistency of alignment. The design standards applied must take also into account the environmental road conditions, traffic characteristics, and driver behaviour.

During recent years, an emphasis has been placed on flexibility in design guidelines and the use of creative design in addressing the site-specific project needs has been encouraged. This philosophy was coined in the USA as context-sensitive design and represents an approach in which balance is sought between safety, environmental, economic and mobility needs.

4.3. Geometric Design Standards in Moldova

The design, construction, improvement and maintenance of roads in Moldova are still carried out according to the provisions of various technical standards of the former Soviet Union (FSU).

According to the Soviet Union Standard (SNIP) 2.05.02-85 roads are classified into five categories. The category of the road is determined according to its importance for the national economy and administrative value of the road. At the same time future traffic volumes are considered. Table 4-1 presents the road categories in the former Soviet Union. The traffic volume indicated is the projected figure at the end of the design period.

Table 4-1. Road Categories in the former Soviet Union

Road Category	Traffic volume (ADT)		Economic and administrative value of roads
	PCU	Vehicles	
I-a	14,000	7,000	Highways of state value (including international connection)
I-b II	> 14,000 6,000 – 14,000	> 7,000 3,000 – 7,000	Highways of state (not referred to I-a cat.), republican and regional value
III	6,000 – 14,000	1,000 – 3,000	Roads of state, republican, regional value (not referred to I-b and II cat.), roads of local importance
IV	200 – 6,000	100- 1,000	Roads of republican, regional and local value
V	> 200	> 100	Roads of local value

Source: Soviet Union Standard (SNIP) 2.05.02-85, 1986

Notes: PCU – Passenger Car Units

Cars	PCU value = 1.0
Truck, 2 tonnes	PCU value = 1.5
Truck, 6 tonnes	PCU value = 2.0
Truck, 8 tonnes	PCU value = 2.5
Truck, 14 tonnes	PCU value = 3.0
Truck, > 14 tonnes	PCU value = 3.5
Bus	PCU value = 2.5

The combination of two parameters of different nature in classifying a road, i.e. administrative value and traffic volumes, leads to confusions about an adequate classification of roads and a technically unjustified mix of levels of service and recommendations for upgrading. In addition, the traffic volume ranges indicative for each of the roadway categories are, from a western perspective, generous in terms of when a higher roadway category should be applied.

Based on the selected road category the geometrical elements are defined. The main parameters are summarised in Table 4-2.

According to SNIP 2.05.02-85 standard the project roads are classified from category I to IV road. The proposed main determinants for the project corridor according to SNIP standards are summarised in Table 4-3.

Table 4-2. Geometrical Design Standard SNIP Categories

Road category	Design Speed (km/h)			No. of lanes	Lane width	Carriage-way	Width of Shoulder		Width of Median		Total Road
	normal	rolling terrain	difficult terrain		(m)	(m)	total (m)	paved (m)	total (m)	paved (m)	Width (m)
I-a	150	120	80	4, 6 or 8	3.75	2 x 7.50 or 2 x 11.25 or 2 x 15.00	3.75	0.75	6.00	1.00	28.50 or 38.00 or 43.50
I-b	120	100	60	4, 6 or 8	3.75	2 x 7.50 or 2 x 11.25 or 2 x 15.00	3.75	0.75	5.00	1.00	27.50 or 35.00 or 42.50
II	120	100	60	2	3.75	7.50	3.75	0.75	-	-	15.00
III	100	80	50	2	3.50	7.00	2.50	0.50	-	-	12.00
IV	80	60	40	2	3.00	6.00	2.00	0.50	-	-	10.00
V	60	40	30	1	-	4.50	1.75	-	-	-	8.00

Source: SNIP 2.05.02-85, 1986

Table 4-3. Existing M 3 Segment Classification

Section	Existing		Proposed				
	Length	Existing Road Cat.	Design Speed (1)	Paved Roadway Width (2)	Gravel Shoulder Width (3)	Minimum Horizontal Curves (4)	Max. Grade
	(km)		(km/h)	(m)	(m)	(m)	(%)
Chişinău- Porumbrei	34	I	80-100	15.0	3.0	400	6,0
Porumbrei- R 3 (5)	14	IV	30-60-80	8,0	1,0	30	7,0
R 3 – Cimislia	9	III	60-100	8.0	1,0	150	1,5
Cimişlia -Comrat	31	III	60-100	8.0	1,0	60	7,0
Comrat -Ciumai	63	III	60-100	8.0	1,0	200	3,0
Ciumai – Vulcaneşti	21	IV	60-80	8.0	0,5	60-100	7,0
Vulcaneşti town	5	III	60-80	8.0	0,5	150	6,0
Vulcaneşti - Giurgiuleşti	37	IV	60-80	8.0	0,5	40	7,0

Notes: (1) Maximum speed pertains to normal terrain, minimum to difficult terrain
(2) Including width of paved shoulder
(3) In difficult terrain the shoulder width can be reduced to 1.0 m
(4) The minimum radius for serpentines is 20 m
(5) On an existing section of 400m the maximum grade reaches 10.5%

4.4. Selection and Application of Standards

In order to comment on the consistency of applicable design and construction standards in Moldova with representative international standards, the main parameters of geometrical design standards have been compared with various internationally recognised modern standards.

However, it should be noted that the application of design standards for a rehabilitation project is usual inherently different from a new construction project, especially considering that the project roads are expected to follow the existing road alignments. It is widespread practice that for these projects, the existing design elements are maintained at their existing values, with the possible exception of limited improvements of geometric characteristics to eliminate safety hazards.

4.4.1. Overview of Cross Section Design Parameters

Cross-section parameters are related to traffic flows and will vary with the requirements of vehicular traffic. The road cross-section incorporates all elements between the road boundaries including carriageways, shoulders, and verges, including cutting or embankment slopes. The cross-section elements serve several purposes and have a significant impact on construction costs and road operation and safety. The cross section in combination with the alignment will determine the earthwork quantities. Lane and shoulder width greatly impact traffic operations and safety. Therefore, the road width should be minimised so as to reduce the costs of construction and maintenance whilst being sufficient to carry traffic loading efficiently and safely.

Lane Width
A fundamental feature of roadway cross section is the width of a travel lane, which must be sufficient to accommodate the design traffic, allow for imprecise steering manoeuvres, and provide clearance for opposing flow in adjacent lanes. Table 4-4 below shows typical lane width design values for various countries. In order to compare the values of different countries, the road categories/classification are summarised into three categories.

Table 4-4. Typical Lane Width Design Values

Country	Road Category / Classification		
	Freeway	Arterial	Local
Brazil	3.75 m	3.75 m	3.00 m
France	3.50 m	3.50 m	3.50 m
FSU / Moldova	**3.75 m**	**3.50 to 3.75 m**	**3.00 to 3.50 m**
Germany	3.50 to 3.75 m	3.25 to 3.50 m	2.75 to 3.25 m
Japan	3.50 to 3.75 m	3.25 to 3.50 m	3.00 to 3.25 m
United Kingdom	3.65 m	3.65 m	3.00 to 3.65 m
USA	3.60 m	3.60 m	2.70 to 3.60 m

Source: International Symposium on Highway Geometric Design Practices
Overview of cross section design elements; L.E. Hall, R.D. Powers, D.S. Turner, W. Brilon, & J.W. Hall

Lane widths vary between the countries, but with reasonably narrow ranges. Typical lane widths for freeways are 3.50 to 3.75 m, for arterial 3.25 m to 3.75 m, and for local roads 2.75 m to 3.60 m.

Shoulders
Shoulders are used for emergency stopping, for parking of disabled vehicles, and for lateral support of the subbase, base, and surface courses of the travel lanes. Shoulders should be wide enough to adequately fulfil their purpose, but excessive width encourages drivers to use them as an additional travel lane.

The lateral clearance outside the paved carriageway provides a safety margin which has to be kept clear of solid obstacles. But the lateral clearance is not only a safety reserve; it is also needed due to the human senses of perception. For the approaching driver, obstacles situated beside the roadway occur under a certain angle. Due to the vehicle speed, this lateral angle increases by a certain rate. Research studies[2] have shown that this rate must be above a certain threshold in order to be perceived by the driver. Stress-free driving is only provided when all lateral obstacles are perceived above this threshold. The German 'Guidelines for Cross Sections'[3], the relations between allowed maximum speed and minimum lateral clearance are presented in Table 4-5. Typical shoulder width design values for selected countries are presented in Table 4-6 below.

Table 4-5. Relations between Maximum Speed and Minimum Lateral Clearance

Maximum allowed speed	Minimum lateral clearance
≤ 50 km/h	0.75 m
≤ 70 km/h	1.00 m
> 70 km/h	1.25 m

Source: RAS-Q, Richtlinien fuer die Anlage von Strassen, Teil Querschnitte, 1982

Table 4-6. Typical Shoulder Width Design Values

Country	Road Category / Classification		
	Freeway	Arterial	Local
Brazil	3.00 m	3.50 m	1.50 to 2.50 m
France	3.00 m + 0.75 m unpaved	2.50 m + 0.75 m unpaved	2.50 m + 0.75 m unpaved
FSU / Moldova	**0.75 m + 3.00 m unpaved**	**0.50 to 0.75 m +2.0 to 3.0 m unpaved**	**0.50 m +1.5 to 2.0 m unpaved**
Germany	2.50 m + 1.50 m unpaved	0.25 m + 1.50 m unpaved	0.25 m + 1.50 m unpaved
Japan	> 2.50 m	> 1.75 m	> 0.50 m
United Kingdom	3.30 m	1.00 m	no shoulders
USA	3.00 to 3.60 m	1.20 to 2.40 m	0.60 to 2.40 m

Source: International Symposium on Highway Geometric Design Practices
Overview of cross section design elements; L.E. Hall, R.D. Powers, D.S. Turner, W. Brilon, & J.W. Hall

There is no international consensus on appropriate shoulder width. However, it should be noted that shoulders in Moldova are in comparison with western standards wider and unpaved. Road category I and II have shoulder width of 3.75 m, whereas lower road categories have 1.75 m – 2.50 m shoulders. Roads with even moderate traffic volumes do need shoulders, especially if there is a high occurrence of disabled vehicles, but it is recommended to pave the shoulders to a recent width in order to provide for emergency parking and support of the road pavement.

Cross Slope

A cross slope is used on traffic lanes to promote drainage of surface water. Divided highways can be treated as two separate roadways. Table 4-7 below contains typical values of standard lane cross slope.

It appears that a 2.0 to 2.5 % cross slope is most widely accepted value for design and there is little or no variation by road classification.

[2] R.M. Michaels, Perceptual Factors in Car Following; International Symposium on Theory of Traffic Flow, Paris, 1993
[3] RAS-Q, Richtlinien fuer die Anlage von Strassen, Teil Querschnitte, 1982

Table 4-7. Typical Lane Slope Design Values

Country	Road Category / Classification		
	Freeway	Arterial	Local
Brazil	2.0 % concrete 2.5 % asphalt	2.0 % concrete 2.5 % asphalt	2.0 % concrete 2.5 % asphalt
France	2.5 %	2.5 %	2.5 %
FSU / Moldova	**1.5 to 2.5 %**	**1.5 to 2.0 %**	**1.5 to 2.0 %**
Germany	2.5 %	2.5 %	2.5 %
Japan	2.0 %	1.5 to 2.0 %	1.5 to 2.0 %
United Kingdom	2.5 %	2.5 %	2.5 %
USA	1.5 to 2.0 %	1.5 to 3.0 %	1.5 to 6.0 %

Source: International Symposium on Highway Geometric Design Practices
Overview of cross section design elements; L.E. Hall, R.D. Powers, D.S. Turner, W. Brilon, & J.W. Hall

Shoulder Slopes
Cross slopes should be used on shoulders to provide adequate drainage, but care must be taken to keep the slope small enough to accommodate proper vehicular use of the shoulder. In some countries shoulders are sloped at the same rate as the adjacent travelled lane, while in others the shoulder slope can be much as 2 % greater than the adjoining lane. The Table 4-8 below shows typical design value from selected countries.

Table 4-8. Typical Shoulder Slope Design Values

Country	Road Category / Classification		
	Freeway	Arterial	Local
Brazil	2.5 to 4.0 %	2.5 to 4.0 %	2.5 to 4.0 %
Denmark	1.5 %	1.5 %	1.5 %
FSU / Moldova	**3.0 to 6.0 %**	**3.0 to 6.0 %**	**3.0 to 6.0 %**
Germany	6.0 %	6.0 %	6.0 %
Japan	> 2.0 %	> 2.0 %	> 2.0 %
United Kingdom	same as lane	same as lane	same as lane
USA	2.0 to 6.0 %	2.0 to 6.0 %	2.0 to 8.0 %

Source: International Symposium on Highway Geometric Design Practices
Overview of cross section design elements; L.E. Hall, R.D. Powers, D.S. Turner, W. Brilon, & J.W. Hall;
The Consultant

The cross slopes of the shoulder are also dependent from the shoulder material. Unpaved shoulders have in general higher slope values than paved shoulders.

4.4.2. Overview of Alignment Design Parameters

Design Speed
Design speed is used as an index which links road function, traffic flow and terrain to the design parameters of sight distance and curvature to ensure that a driver is presented with a reasonably consistent speed environment.

Even though most of the countries used a different term to describe their design speed, it is usual to use a guiding speed for designing roads that ties the various roadway elements. All countries use design speed as basis for establishing limits for basic parameters (e.g. minimum horizontal curve, maximum vertical grade). A fundamental difference among countries is the speed used to establish other alignment parameters, including superelevation rates, sight distance and radius of vertical curvature.

The French, British, German and Australian geometric design standards introduce operating speed (V_o), which usually matches the speed exceeded only by 15 % of the users (V_{85}), so as to consider the conditioning users experience while driving and how the latter react to external circumstances. Other countries, including Switzerland, Spain, Canada and USA, have geometric design standards which contemplate the determination of limits just on the basis of design speed, thus neglecting the known considerations about deviations between the latter and actual speed on the road.

The following synoptic Table 4-8 shows how design speed (V_P) and operating speed (V_o) have a part in the geometric design of selected countries.

Table 4-9. Dimensioning of the Elements of the Road Depending on Speed

Country	Horizontal Elements					Vertical Elements		
	R_H	A	D_{S1}	D_{S2}	Q	I_{grade}	$R_{V,sag}$	$R_{V,crest}$
Australia	V_o	V_o	V_o	V_o	V_o	V_o	V_o	V_o
Canada	V_P	V_P	V_P	V_P	V_P	V_P	V_P	V_P
FSU / Moldova	**VP**	**VP**	**VP**	**VP**	**VP**	**VP**	**VP**	**VP**
Germany	V_P	V_P	V_o	V_o	V_o	V_P	V_P	V_P
United Kingdom	V_o	V_o	V_o	V_o	V_o	-	V_o	V_o
USA	V_P	V_P	V_P	V_P	V_P	V_P	V_P	V_P

Source: An Experimental Investigation on the Relationship between Speed and Road Geometry, A.Bevilacqua, G.DiMino, J.Nigrelli & the Consultant

Note:
R_H – horizontal radius
A – parameter of transition curve
D_{S1} – stopping sight distance
D_{S2} – passing sight distance
Q – superelevation rate
I_{grade} – gradient slope
$R_{V,sag}$ – radius of sag curve
$R_{V,crest}$ – radius of crest curve
" – " indicates an element independent of speed

The establishment of operating speed backgrounds is an important assumption that must be regarded when establishing modern highway geometric design guidelines. Nowadays, a speed parameter capable of better interpreting users' behaviour is more and more used, thus replacing the traditional design speed. Therefore the operating speed is the more modern parameter of the design speed definition for dimensioning of horizontal and vertical alignment elements.

Due to the differing approaches in defining the design speed, values for individual alignment parameters must be evaluated within the context of a country's overall design policy, which demands considerable care in making comparison.

Horizontal Curvature

The table below summarizes the minimum radius of horizontal curvatures as a function of design speed for various countries. These values are a product of maximum superelevation rates and maximum coefficients of side friction. Table 4-9 presents minimum radius of horizontal curves. It should be noted that in mountainous terrain reduced values for horizontal curves are provided in certain design standards.

Minimum radius of horizontal curvature for a given design speed varies considerably among countries. This range results from differences in maximum superelevation rates and maximum side friction coefficients.

Table 4-10. Minimum Radius of Horizontal Curves

Design Speed (km/h)	Minimum Radius (m) of Horizontal Curves						
	Australia	France	**FSU/Moldova**	Germany	Japan	UK	USA
50	45		**100**		100	127	80
60	70	120	**150**	135	150	180	125
70	95			200		255	175
80	140	240	**300**	280	280		230
85						360	
90	230			380			305
100	360	425	**600**	500	460	510	395
110	435						500
120			**800**	800	710	720	665

Source: International Symposium on Highway Geometric Design Practices & Worldwide review of alignment design policies; R.A. Krammes & M.A. Garnham

Maximum Gradient

Maximum gradient guidelines range in complexity, with various countries considering some or all of the following factors: road classification, design speed and terrain. For example in the UK, desirable maximum gradient values are specified for road types: motorway (3 %), dual carriageway (4 %), and single carriageway (6 %). In Switzerland, maximum gradient is a function of design speed (from 10 % for a 60 km/h to 4 % for 120 km/h design speed). In Germany, maximum gradient is a function of road type and design speed. For main rural roads, values range from 8 % for 60 km/h to 4 % for 120 km/h design speed. In the USA maximum gradients are based upon road type, topography and design speed.

The FSU standard for the maximum gradient is dependent on the design speed, and ranges from 4 % for 120 km/h design speed to 10 % for 30 km/h design speed. Usually gradients in more rolling and mountainous terrain may be 1 to 2 % steeper, particularly where traffic volumes are at the lower end of the range.

Minimum Radius of Crest (Convex) Vertical Curves

Minimum radii of crest curves are established to satisfy stopping sight distance requirements, whereas most of the countries specify the use of parabolic vertical curves. According to AASHTO the radius corresponds to the K-value, or rate of vertical curvature which is used in several countries. The design is based on minimum allowable ‘K-values’, as defined by the formula:

$K = L/A$

Where K = rate of vertical curvature per change in grade given as metres per percent grade change
L = Minimum length of vertical curve
A = algebraic difference in approach and exist grades (%)

In order to compare values for vertical curves, the AASHTO ‘K-values’ have been converted to the approximate corresponding radii values. Minimum radii for various design speeds of selected countries are presented in the table below.

Table 4-11. Minimum Radius of Crest Curves

Design Speed (km/h)	Minimum Radius (m) of Crest Curves						
	Australia	France	**FSU/Moldova**	Germany	Japan	UK	USA
50	540		**1,500**		800	1,100	1,000
60	920	1,500	**2,500**	2,700	1,400	1,900	1,800
70	1,570			3,500		3,300	3,100
80	2,400	3,000	**5,000**	5,000	3,000		4,900
85						5,900	
90	4,200			7,000			7,100
100	6,300	6,000	**10,000**	10,000	6,500	10,500	10,500
110	9,500						15,100
120	13,500	10,000	**15,000**	20,000	11,000	18,500	20,200

Source: International Symposium on Highway Geometric Design Practices & Worldwide review of alignment design policies; R.A. Krammes & M.A. Garnham

Minimum Radius of Sag (Concave) Vertical Curves

Sag vertical curves are generally considered as less critical from the safety point of view than crest curves. Several countries (see Table 4-11) base their values for minimum sag curves on headlight illumination distances to satisfy stopping sight distance requirements on unlit roadways at night. Other countries base their design values on driver comfort. In Germany, the minimum radius of sag curves is one half the minimum radius of crest curves at a given design speed. Minimum radii of sag curves for various design speeds of selected countries are presented in the table below.

Table 4-12. Minimum Radius of Sag Curves

Design Speed (km/h)	Minimum Radius (m) of Sag Curves						
	Australia	France	**FSU/Moldova**	Germany	Japan	UK	USA
50			**1,200**		700	1,300	1,200
60	600	1,500	**1,500**	1,500	1,000	2,000	1,800
70				2,000		2,000	2,500
80	1,000	2,200	**2,000**	2,500	2,000		3,200
85						2,000	
90				3,500			4,000
100	1,600	3,000	**3,000**	5,000	3,000	2,600	5,100
110							6,200
120	2,300	4,200	**5,000**	10,000	4,000	3,700	7,300

Source: International Symposium on Highway Geometric Design Practices
Worldwide review of alignment design policies; R.A. Krammes & M.A. Garnham

Note: In order to compare values for vertical curves, the AASHTO 'K-values' have been converted to the approximate corresponding radii values.

It should be noted that SNIP allows using reduced radii of sag curves in mountainous terrain, but for comparison of the values these are not considered.

4.5. Recommendation for Application of Geometric Design Standards

Designs should be justified economically, and the optimum choice will vary with both construction and road user costs. Construction costs will be related to terrain type and choice of pavement construction, whereas road user costs will be related to level and composition of traffic, journey time, vehicle operation and road accident costs. To achieve cost-effective solutions, it is important to tailor interventions to the specific situation and not to impose rigid designs.

Currently, the geometric road design standards in Moldova are those which were used throughout the former Soviet Union. Since the last edition of the SNIP for road design was introduced in 1984, this standard is not in keeping with the times, and modern developments and practices are not considered.

Design speeds and the resulting geometric road characteristics according to SNIP are slightly higher than in Western Europe or North America for certain parameters. This indicated a lesser consideration given to economic justification at the design stage and makes these standards expensive.

Drainage, traffic safety, and continuity of road design are not explicit considerations in the SNIP design standard, which leads to inappropriate design solutions. The shortcomings of the current geometric standards are apparent on the project roads and due to inadequate maintenance the effects are getting worse. In particular the lack of drainage has resulted in excessive potholing, leading to deterioration of the existing pavement.

Within this Project we recommend that while SNIP standards will be applied, design and constructions standards shall be representative of international best practice and standards, for the geometrical elements, for pavement, drainage and structures.

It should also be noted that the application of design standards for a rehabilitation project is usual inherently different from a new construction project, especially considering that the project roads are expected to follow the existing road alignments. It is widespread practice that for these projects, the existing design elements are maintained at their existing values, with the possible exception of limited improvements of geometric characteristics to eliminate safety hazards.

Overall, the Consultant supports the revision of the current Moldovan design standards and norms, with special reference to international standards, economic feasibility and construction costs.

Feasibility Study Recommendations *„Road M3 Chisinau-Giurgiulesti/Romanian Border Extension and Rehabilitation Project"* will follow where it is possible, on the existing alignment to minimize excessive excavation, new agriculture land acquisition, demolition, and realignment of the road on the deteriorated sections and in urban areas.

Resulting from the above mentioned, and taking into account the specific conditions of every road section, Table 4-13, proposes parameters for carriageway and shoulders.

4.6. Relaxation of Standards

The proposed design values of the geometric design standards are usually intended to provide guidance for the design rather than to be considered as rigid minima. It should be realized that information and values presented in the design guidelines are considered as a 'design standard', but more appropriately described as good engineering practice that should be strived to achieve. But the justification for construction of a particular road will always be based on a detailed technical and economic appraisal, and relaxations of standards may be essential in order to achieve an acceptable level of return on investment. However, the safety implications of a substandard road section need serious consideration.

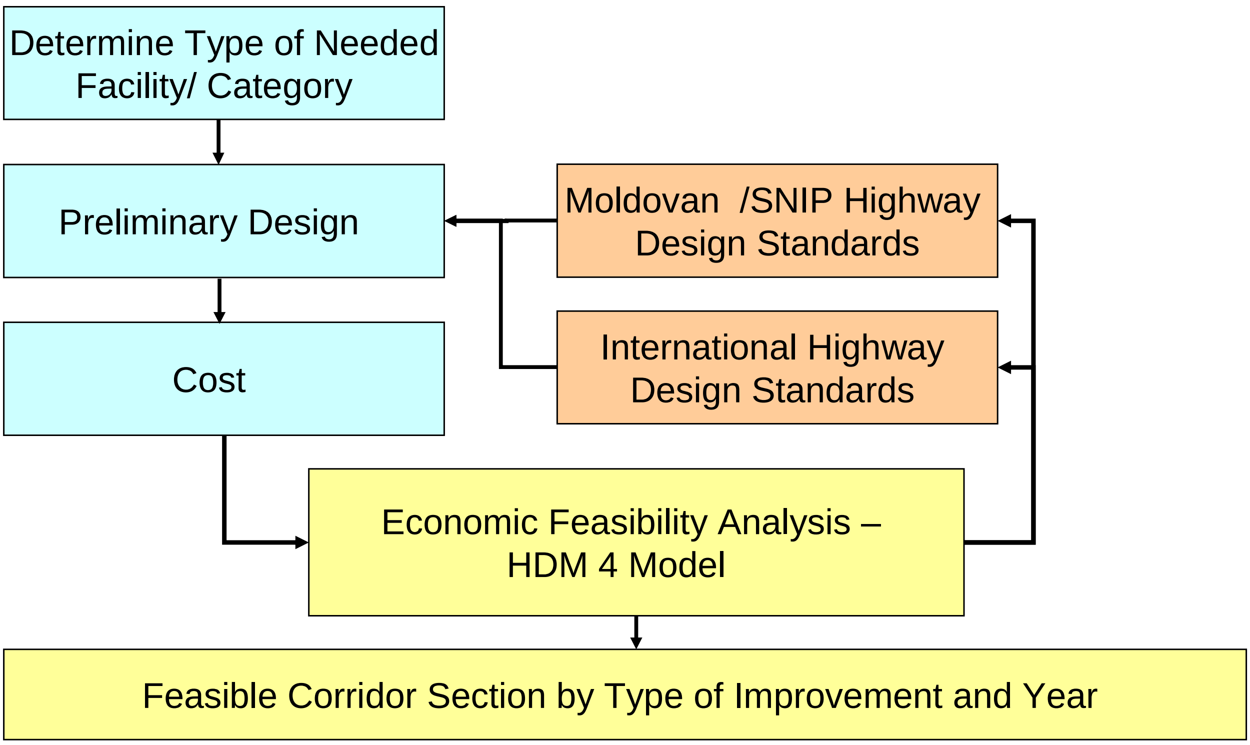
Table 4-13. Proposed M3 Roadway And Shoulder Width

Existent road sections	Paved Roadway Width (1) (m)	Gravel Shoulder Width (2) (m)
Chişinău- Porumbrei	15.0+(2x0,75+2x1,0)	Existing
Porumbrei- Intersection withR 3	8,0	1,0
Intersection with R 3 – Cimislia	8.0	1,0
Cimişlia - Comrat	8.0	1,0
Comrat - Ciumai	8.0	1,0
Ciumai –Vulcaneşti	8.0	0,5
Vulcaneşti town	8.0	0,5
Vulcaneşti town - Giurgiuleşti	8.0	0,5

Notes: (1) Including width of paved shoulder
(2) Where existing roadbed is insufficient, shoulders could be narrower

During the recent years, an emphasis has been placed on flexibility in design guidelines and the use of creative design in addressing site-specific project needs has been encouraged. This philosophy was coined in the USA as context-sensitive design and represents an approach in which balance is sought between safety, environmental, economic and mobility needs. Experience in the UK[4] has shown that r eduction of design parameters by one design class step, equivalent to a 15 % speed reduction, is likely to have little effect on safety. Figure 4-1 presents the process of refining the design standards through an iterative process under the application of the HDM-4 economic feasibility model.

Figure 4-1. Refinement Process of Design Standards



Source: The Consultant

[4] Overseas Road Note 6, A guide to geometric design, Overseas Unit Transport and Road Research Laboratory, UK, 1988

A relaxation of two steps, equivalent to a 30 % speed reduction, should not significantly increase risks where appropriate signing and/or other warning measures are provided. High speeds on rural roads are also a safety issue and attempts are ongoing to control and reduce speeds. A study on speed, speed limits and accidents[5] concluded that a reduction of 1.6 km/h (1 mph) in the average speed reduces the incidence of injuries by about 5%. To achieve this objective, higher speeds are discouraged to preserve safety. A common approach for improving safety on these roads is the use of narrower lane width, which requires drivers to slow down.

5. PAVEMENT DESIGN STANDARDS

Prior to the review and selection of standards for the road pavement design the general design principles, design philosophies and parameters are discussed in the following section.

5.1. General Design Principles

Pavement design is a process of selection of appropriate pavement and surfacing materials to ensure that the pavement performs adequately and requires minimal maintenance under the anticipated traffic loading for the design period adopted. This selection process involves adoption of material types, thicknesses and configurations of the pavement layers to meet the design objectives.

Performance objectives are to:

- provide safe and comfortable riding conditions to all road users, being motor vehicles, cyclists and pedestrians, optimised for the road's intended function and the level of use;
- provide low cost of ownership (ie minimum whole of life cost) to the State Road Authorities (Government);
- comply with the Pavement Standards and other relevant State Road Authorities' Guidelines and/or Standards.

Pavement types
The Pavement Design Standards set out procedures for the design of the following pavement types:

- flexible pavements consisting of granular pavement materials with thin bituminous surfacing ("granular pavements");
- flexible pavements that include one or more lightly bound layers, either in situ or in a plant ("stabilised pavements");
- flexible pavements consisting of predominantly asphalt concrete layers;
- rigid pavements ("concrete pavements").

Flexible pavements consisting of granular pavement materials without dust free surfacing ("gravel pavements") should be considered only for remote rural roads, minor access roads or temporary roads.

[5] Speed, Speed Limits and Accidents, D.J.Finch, PR58, Transportation Research Laboratory, 1994

Design Parameters
When designing or selecting pavement, there are three fundamental external design parameters to consider:

- the characteristic of the subgrade upon which the pavement is placed,
- the applied loads, and
- the environment

The basic input data for pavement design are design life to be specified, the traffic to be carried and the strength of the subgrade.

Design life: Design life is defined in terms of the cumulative traffic that can be carried before strengthening of the pavement is necessary. In this context, design life does not mean that at the end of the period the pavement will be completely worn out and in need of reconstruction; it means that towards the end of the period the pavement will need to be strengthened so that it can continue to carry traffic satisfactorily for a further period.

Traffic: The traffic loads are expressed in terms of accumulated equivalent standard axle loads (ESAL) per direction, passing the road during the scheduled design life.

Subgrade strength: The strength of road subgrade is commonly assessed in terms of the California Bearing Ratio (CBR) and this is dependent on the type of soil, its density, and its moisture content.

5.2. Discussion and Review of Pavement Design Standards

For the pavement design of the project road the selection of standards has been limited to standards which have been proposed by the Client or have been used before in Moldova. These are the Russian/Former Soviet Union standards. The European Standards were not introduced officially and at the moment they are not applied in road design.

Further, we will present a short comparative description of the American standard (AASHTO Design Guide for Pavement Structures) and the pavement design standard used in the Republic of Moldova. The American standard is used to represent western standards as it has a major influence on design methods not only in the USA but worldwide.

Russia /Former Soviet Union (FSU)
The Russian/FSU standards for the design of flexible pavements, is the norm *„ODN 218.046-01 Non-rigid road systems design".*

In the design practice of the non-rigid road systems, the local designers are using ODN 218.046-01, and the results of application of this standard shows that the road complex calculated according to the last instruction, results with a smaller load capacity than with former standard VSN 46-83 for the same calculation conditions (traffic, thickness of pavement layers, type of earth at the road base). To ensure the necessary load capacity, (modulus of elasticity E) from calculation ODN 218.046-01 results in a road system with a bigger total thickness compared to the VSN result.

The governing factor for pavement design is the so-called stiffness modulus of the pavement structure. The stiffness modulus is calculated under consideration of E-moduli of the respective pavement layers. The weak point of the method is however that the foundation support (the subgrade) is based on definition of subgrade type only (without any further verification on site), and not on measurable in situ values of the subgrade.

USA

The major influence on design methods in the USA and even worldwide is the design method developed by the ‘American Association of State Highway and Transportation Officials’ (AASHTO). This design method the ‘AASHTO Guide for Design of Pavement Structures’ is taken here as representing the USA.

The AASHTO Design Method is an empirical method and empirical equations have been built into the design method. Major factors are the time of use until first maintenance is required, the reliability and the structural number (layer coefficient) of the pavement layers. For the subgrade the relevant material parameters are determined by field and laboratory tests.

In the AASHTO design the layer coefficients are basic characteristics of the pavement materials which are required for the dimensioning of the pavement layers based on the structural number. Relations between CBR value and layer coefficient are shown in diagrams or can be calculated using simple equations. Different drainage conditions are taken into consideration by modified layer coefficients. The final pavement design and dimensioning is done using design charts and monographs or the relevant software programs.

European standards

In most international recognised European standards the pavement design is based on tolerable stresses induced in the subgrade by traffic load. The different subgrade materials and their behaviour are considered with the respective subgrade bearing capacity (e.g. CBR, plate load test) leading to the total pavement thickness. The total pavement thicknesses result from standardised pavement layer thicknesses which have been empirically determined. In addition, the material requirements are specified and have to be verified on site by regular testing to ensure the required bearing capacity of each layer. The criteria for determination of asphalt layer thickness is to provide a satisfactory service over the planned design life period of the pavement, taking into consideration the effects (climate, traffic) on the road surface.

It is recommended to use a pavement design method more based on values of experience and empirical studies than a purely theoretical design approach where almost all relevant parameters for variable actual conditions can be included. The Russian/FSU standard has its weak point in not verifying the in-situ subgrade condition and dimensioning is based on the tensile strength at the bottom of the asphalt layer not the actual subgrade strength. For the actual project it is therefore recommended to use the AASHTO design standard, but make comparative calculations according to the Russian standard.

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6. BRIDGE DESIGN STANDARDS

The bridge design standard in Moldova is based on the former Soviet Union standards. All structures are classified according to the standards valid during the time of their design/construction. Bridges are divided into classes according to design loads. The design load requirements changed over the years (see Table 6-1.) to follow the technical development of trucks. Standard truck loads have increased from 18 t to 30 t and heavy loads from 60t to 80t.

The load N 18 is a truck of 18 t with two axles (distance between the axles 4.00 m). The distance between the back axle of the first truck and the front axle of the next truck is 10 m.

The load N 30 is a truck of 30 t with 3 axles. The truck has a front axle of 6 t, after a space of 6 m a second axle of 12 t and a third axle of 12 t at a distance of 1.6 m after the second axle. The distance between the back axle of the first truck and the front axle of the next truck is 10 m.

The load A 11 is a uniform load which includes one 2-axle truck with a weight of 11 t, or a uniform load on spans (0.1 x 11 t) t/m.   For road category IV and V and local roads the A load is reduced to 8 t and called A 8.

**Table 6-1.	Design Load**

Year	Design Standard	Road Category I, II		Road Category III - V	
		Truck	Overweight load	Truck	Overweight load
1943 - 1953	SNIP 11	N 13	NK 60	N 10	NG 60
1953 – 1962	SNIP 11-A.8-54	N 18	NK 60	N 13	NK 60
1962 – 1984	SNIP 11-A.7-62	N 30	NK 80	N 30	NK 80
Since 1984	SNIP 2-05.03-84	A 11	NK 80	Road cat. III: A 11 Road cat. IV - V: A 8	NK 80 NK 60

The overweight load NK 80 is composed of four single axle loads of 20 t each, total weight 80 t, with 1.20 m distance between the axles.   The overweight load NK 60 is designed for A 8 load. This load of 60 t is distributed from a tracked vehicle of 5 m length and 3.30 m width, wheel width 0.70 m.

## 6.1.	Review of Existing Bridge Design Standard

For a detailed assessment of the bridge classes and their bearing capacity respectively, a comparison with a Western European standard was made. For this purpose it was used the German standard DIN 1072 and the relevant data are summarised in Table 6-2 below.

**Table 6-2.	Bending Moments**

Span	Bending Moments (KNM)					
(meter)	Germany Cl. 60/30 (DIN 1072) only main lane	Germany Cl. 60/30 (DIN 1072) carriageway width 7m	Germany Cl. 30/30 (DIN 1072) only main lane	Germany Cl. 30/30 (DIN 1072) carriageway width 7m	FSU SNIP 2.05.03-84 NK-80	FSU SNIP 2.05.03-84 NG-60
5	612.0	846.4	306.0	504.4	520.0	375.0
10	1,623.0	2,279.1	891.0	1,487.1	1,520.0	1,125.0
15	2,690.0	3,841.0	1,442.4	2,592.9	2,520.0	1,875.0
20	3,794.0	5,524.2	2,129.7	3,850.2	3,520.0	2,625.0
25	4,952.0	7,318.0	2,882.3	5,247.8	4,520.0	3,375.0
30	6,125.0	9,210.0	3,688.8	6,774.3	5,520.0	4,125.0

The bending moments from the loads of the main lane of the bridge classes 60/30 and 30/30 of DIN 1072 as well as the bending moments from the loads of the bridge deck with a width of 7 m of the bridge classes 60/30 and 30/30 of DIN 1072 were analysed, as well as the bending moments of the bridge classes NK-80 and NG-60 corresponding to SNIP standard 2.05.03-84.

A comparison of the results shows that the bridge classes NK-60 corresponds closely to the bridge class 30/30 according to DIN 1072. Structures which can be classified into this or a higher class of bearing capacity comply with present bridge requirements as far as the bearing capacity is concerned.

However, the review and comparison of SNIP with the German standard DIN shows:

(a) Contrary to DIN for reinforced and pre-stressed concrete (safety factors 1.75 generally) SNIP is based on a partial safety concept. In iteration comparison of the opposing concepts can be estimated by multiplication of load with material safety factors. The bending reinforcement is calculated to SNIP for dead load at 1.1x1.15=1.27, for total load 1.5x1.15=1.73, for 30 t truck groups 1.4x1.15=1.61, and for the 80 t heavy goods vehicle (HGV) 1.1x1.15=1.27. With the HGV applicable for short spans, the highest applicable safety factor is approximately 1.3.

(b) the safety concept provided by SNIP is substantially lower than provided by DIN. This applies also to the comparison calculation done in accordance with the British Standard BS for the British standard HA- and HB traffic loads.

(c) The small difference between working loads and ultimate loads implies that the dynamic cyclic loading component is relatively larger than the yield point strength load of the reinforcement, increasing fatigue of the reinforcement. In this connection it is important to note that pre-cast bridge deck elements are made using welded reinforcement cages.

6.1.1. Structural Principles According to Standard Drawings

The standard drawings for pre-cast slab bridges (spans of 6 – 9m) and for pre-cast slab-beam-bridges (spans of 12, 15 and 18 m) revealed the structural principles of these bridges in so far as being relevant to the appropriate designs of rehabilitation measures suggested for the project. The structural principles are:

(a) Reinforcement made of welded (part-) cages in mats, where horizontal lower and upper mats do not seem to be welded onto the stirrup, and were anchors as solely provided by the welded joints

(b) Pre-cast elements are bedded on mortar only on the capping beams, fixed with grouted dowels, with additional concrete stops in the transverse direction

(c) Pre-cast superstructure elements are shear profiled along longitudinal joints, and according to the drawing filled with concrete for providing transverse distribution of wheel loads onto adjacent pre-cast slabs;

(d) Transverse joints are without continuation plates, but only with hooks for the sealing, continued asphalt layer

(e) Capping beams in situ concrete or as precast elements; precast parts are welded to piles and jointed to the beams by penetration pockets to be closed finally with concrete/mortar

(f) The details provided for bridges equipment (side walks, sealing, drainage, bearings, joints etc.) are not comparable to international standard, and have been identified as major causes for damages. Improvement is required to avoid continued deterioration.

6.1.2. Assessment of Bridge Design Standards and Recommendations

The assessment concludes that construction in accordance with SNIP and its typical drawings does not provide from the technical point of view bridges of a satisfactory quality compared with today's accepted state-of-the-art standards, which provides long service life. This is even more important when noting that the minimal structural requirements were often not observed during construction.

Considering that international standards specify the latest state-of-the-art standards in terms of concrete technology and reinforcement arrangement, an advanced standard should be considered for reasons of extended service life and reduced maintenance and repair costs.

However, since SNIP standards are still officially used in Moldova at this point in time the Consultant proposes the rehabilitation of existing to the established SNIP Standrads. In the medium term the Consultant supports the ongoing efforts to revise the current standards to incorporate state-of-the-art approaches and designs in bridge Design.

6.2. General Description of Bridges on Study Corridor

Along the study corridor 41 bridges and overpasses of the vaulted type exist, generally of reinforced concrete precast beams, simply supported. The bridges and the overpasses have been constructed during the years 1945-1991, according to the designs developed by «Moldghiproavtodor», The State Road Design Institute from Chisinau. The normal load category of the bridges ranges between N-13 and NG - N-30 and NA-80 .

The infrastructure of the bridges is composed of abutment and piers, with elevation of reinforced concrete piles and a collar beam, or structure of stone or concrete. The abutment of all bridges is burried into the embankment at the approach to the bridge, with elevation of reinforced concrete piles and beams. Safety (guard) rails and wing walls are mounted on the beams of the precast units. The joints of the access aproaches with the lateral sides of the abutment is provided through cone quarters of a circular section. For a smooth movement of the vehicles, from the access aproach to the bridge, are used joining slabs, supported on the abutment by hinges (articulated joint).

6.2.1. Deficencies

The bridge survey conducted during the fall of 2008, assesed all bridges along the corridor. Detailed information is presented in the following chapter as well as in the Appendix.II-1,2,3 The following, lists a series of deficencies found on most of the bridges. Not applicable to each individual bridge, the listed deficencies give a general impression of the current condition of the bridge structures:

- The existing bituminous pavement on the bridge deck, both on the carriageway and on the walkways, is generally degrading, having many transversal and longitudinal fissures which are progressively opening. The rough surface, corrugated closer to the parapet, has many potholes filled with accumulated dirt.

- The expansion joints are often disturbed (distroyed), not providing continous riding quality of the carriageway and not providing waterproofing against leaking and ingress of the water.

- The waterproofing of the main supporting structure is often in the phase of progressive degradation.

- The reinforced concrete precast units of the existing walkways are also degrading on the surface, with significant lossess of sections of the safety barriers (parapets) - with deterioration of the concrete and with exposed re-bars, rusted and with significant loss of their cross-section.

- The height of the existing safety parapet of (0,45-0,5m) is often not sufficient and does not comply with the applicable technical standard requirements.

- The protection cover against corrosion of the existing metallic guard-rais is degrading, corrosion progressing both on the guardrails, and on the mettalic units connecting the gurdrails with the precast units of the walkways.

- Existing bearing pads are affected by corrosion and need to be repaired.

In order to remove the defects and drawbacks revealed on site, the supporting structure of the bridge needs to be brought to a technical condition compliant with the permanently increasing traffic, therefore repair works are required. A detailed description of the defects and drawbacks of the supporting elements of all bridges and overpasses is contained in Appendix II-2

6.2.2. The Design Option - Repair works

The study corridor is a highway of general importance with traffic in both directions. The SNiP 2.05.03-84* “Bridges and Culverts” and SNiP.02.03-85 “Foundations of Piles” standards were appplied for the proposed design solutions. The basic feasibility indices for bridges and overpasses are**:**

- Normative Loading Category - A-11, SC-80.
- Clearances min – 11,5+2x1,0

The repair works on the carriageway of bridges and overpasses will be performed with traffic disruption during the whole period of works. The diversion of traffic will be performed according to a Traffic Management Plan approved by the Traffic Police in accordance with the applicable legislation.

6.2.3. Anticipated repair work items: The Bridge Deck, Gullies, Sideways, Safety Parapets

The replacement of **waterproofing on the deck** and on the sideways, as follows:

- Removal of the bituminous pavement on the sideways;
- Milling of the bituminous pavement on the deck up to the level of the waterproof protection;
- Removal of the protection waterproofing cover and basecourse;
- Dismantling of the existing precast units of the walkways, including the metallic parapet;
- Execution of an overlay of reinforced concrete of B30 F200 W6;

- Waterproofing on the whole surface of the supporting structure (including the sidewalks);
- Performing the protection cover (capping layer) of waterproof;
- Performing the sideways – using the option of concrete for backfilling with gaps for cable pipes of the Type PVC 110;
- Mounting of the safety parapet;
- Laying of bituminous pavement on the deck in two layers, using asphalt concrete Type B I of a total thickness of 7cm;
- Laying of bituminous pavement on the sidewalks, one single layer, using fine grained asphalt Type Г I, of 4cm-thick.

The surface level and the cross-fall of the concrete, used as an overlay, will be a support for waterproofing layer. The concrete will be cast according to the SNiP 3.06.04-91 «Bridges and Culverts», Chapter 4. Trafficking of vehicles and of the opperational equipment on top of the cast concrete will be only allowed when the concrete achieves a minimum strength of 20 MPa of the concrete type strength provided by the design.

The transverse and longitudinal profile of the carriageway on the bridge deck will be in accordance with the design, providing the required slopes for water run-off the bridge deck.

The materials used for the asphalt mixture will be specified according to the data from Table 2 and 3 of the GOST 9128-97 and the quality of materials will be that, which is required by the relevant standards for materials.

Gullies
Replacement of gullies, as follows:

- Removal of concrete around the gully;
- Location of a new gully according to the design levels;
- Formwork in the area of the replaced gully for casting the concrete on the carriageway;
- Concrete casting using concrete Type B30 F200 W6 and its compulsory vibration;
- Extension of the gullies up to the undenearth side level of the supporting beams;
- The extension will be a gutter of a brass type protected against corrosion, with a mettallic collar.

Existing precast units of the sidewalks
Replacement of the existing precast units of the sidewalks by sidewalks of the option – an in-situ concrete slab, a bracket type, using concrete for backfilling with gaps for cable pipes Type PVC 110.

Metallic parapet
Replacement of metallic parapet as follows:
- Dismantling of the existing safety guardrails;
- Manufacturing of parapets panels at the plant, including the system of anticorrosion coat;
- Mounting of new panels;
- Painting of parapets.

Sealing Elements
Replacement of sealing elements of the existing expansion joints will be performed using sealing elements of the Type „Algaflex T” in accordance with the design and the proprietory instructions for installation procedure.

Protection of Pedestrians
For protection of pedestrians, for safety and optical guidance of vehicles on the bridge deck, the carriageway will be framed with a metallic safety parapet, performed according to the design and according to the GOST 26804-86 «Metallic Road Parapets of Barrier Type».

Repairing of Degradated Concrete Using Special Mortars
This work item refers to repair works of the degradated layer of concrete (low strength (poor) concrete, stratified concrete, exposed bars not covered by concrete, loosely spread concrete, segregation, ect.) by casting a special concrete or a mortar. The works will be performed according to the design and the technical conditions stipulated in chapter 9 of VSN 24-88 «Technical Norms of Road Repairing and Maintenance».

The degradated concrete will be removed, and the surface of the concrete after removal will be sprayed, will be scrubbed by a wire brush, will be cleaned by an air injector and treated with a spraying solution of the Type LATEX CKC-65ГП. The exposed bars will be scrubbed with a wire brush up to the steel glitter. A special mortar will be applied using a trowel, and the surface of the mortar will be treated using an ironing-board. The surfaces repaired using a special mortar, will be treated with a special solution, of a colour as the element making part of it.

Repairing of bearings

- Cleaning the metallic surface of rust, dust, solid materials, ect.;
- Performing of anti-corrosive protective layer on top of metallic surface, using a paint based on tixotrop-alchidic extracts;
- Lubrication of the sliding surface of the bearings with vaseline;

As for the advanced displacement of the metallic pivots, actual permanent monitoring is recommended during operational (maintenance) period, in view of duely time required interventions.

Repairing of the access aproach to the bridge

- This work item provides for repair works of the cone quarters, as follows:
- Milling of the bituminous pavement on the carriageway;
- Dismantling of the existing sidewalk of precast units and of the existing parapets of reinforced concrete;
- Performing the sidewalks– the option of using concrete for backfilling with gaps for cable pipes of type pvc 110;
- Casting of leveling layer of reinforced concrete type b30 f200 w6 on top of the existing approach slab;
- Mounting of the safety parapet;
- Isolated backfilling of the embankment using draining material;
- Mechanized compaction of the backfill material;
- Performing of a 10cm-thick foundation of crushed stone of a strength type not less than m600;
- Casting of concrete type B22.5 F200 W6 on the slope of 8cm thickness, reinforced with a steel grid 4Cp $\frac{6AI - 200}{6AI - 200}$ according to the GOST 23279-85*, including the chutes on the slope for water drainage;
- Performing of acces stairs on the slope of reinforced concrete, cast-in-situ, and of the steel rails.

7. ROAD INVENTORY AND SURFACE CONDITION SURVEY

The applied roadway category, type as well as the condition of the pavement along the corridor is subject to large variations. The first section of M3, for example, from Chisinau to the village of Porumbrei was designed and build as a four lane Category I motorway with a road surface build from jointed Portland cement concrete slabs. The remaining portion of the corridor varies in applied design standard and is surfaced with asphalt.

A road inventory and condition survey was conducted along the study corridor between September and November 2008. The survey recorded the parameters needed for the economic appraisal by HDM-4, and the information on existing condition required for the designs. Before carrying out a detailed visual condition survey a windscreen survey has been done in order to divide the project road into lengths of similar construction and condition. For each uniform section the road condition has been recorded separately. Road Inventory as well as surface conditions, including surface distress, are significantly different between the sections.

The first section of this chapter reports on the road inventory, while the second section presents data and findings regarding the pavement condition of the corridor.

7.1. Road Inventory

Road Width
Table 7-1 presents the total width of carriageway including travel lanes and paved shoulders. The widths were obtained by site measurement and average values were applied to each of the project sections. Based on applied design standards road width varies from 19.3 metres in the north of the corridor to 6.6 metres on Category IV cross-section in the southern portion of the corridor. Similarly shoulder width varies considerably from 6.6 meters to under 2 meters.

Rise and Fall, and Curvature
Table 7-2 presents corridor section rise and fall, and curvature values. Rise and fall is defined as the sum of the absolute values, in meters, of all ascents and all descents along the road, divided by the length of the road in kilometres. The data were determined based on GPS survey data.

The data of the horizontal curvature characteristic of the road were extracted from the topographical maps and data from the GPS survey of the existing alignment. The curvature is defined as the sum of the absolute values of angular deviation (in degrees) of successive tangent lines of the road alignment when travelling in one direction, divided by the road length in km.

Some sections of the M3 corridor traverse rolling to hilly terrain, while the majority is located in relatively flat terrain. Similarly, curvature of the sections varies with long straight alignments as well as sections with more curvature.

Table 7-1. Corridor Section Road Width

No.	Section	From km	To km	(km)	Width (m)	Shoulder (m)
1	Chisinau - Porumbrei	0.00	34.34	34.34	19.33	6.66
2	Porumbrei - R3 junction	34.34	48.80	14.46	8.51	1.80
3	R3 junction - Cimislia	48.80	57.30	8.50	9.72	1.73
4	Cimislia urban	57.30	62.40	5.10	9.45	1.79
5	Cimislia - Comrat	62.40	88.40	26.00	*7.00*	*2.50*
6	Comrat urban	88.40	96.76	8.36	*7.00*	*1.80*
7	Comrat - R38 Intersection	96.76	135.80	39.04	8.23	2.38
8	R38 Intersection - Ciumai	135.80	151.35	15.55	8.06	2.55
9	Ciumai - Vulcanesti	151.35	172.76	21.41	6.62	2.34
10	Vulcanesti urban	172.76	178.10	5.34	7.05	2.15
11	Vulcanesti - Slobozia Mare	178.10	202.00	23.90	6.74	3.09
12	Slobozia Mare - Giurgiulesti	202.00	215.16	13.16	6.73	1.96

Source: Consultant

Table 7-2. Corrdior Section Raise and Fall and Curvature

No.	Section	Start km	End km	(km)	Rise/Fall m/km	Curvature deg/km
1	Chisinau - Porumbrei	0.00	34.34	34.34	27.33	27.10
2	Porumbrei - R3 junction	34.34	48.80	14.46	22.87	46.43
3	R3 junction - Cimislia	48.80	57.30	8.50	5.62	14.15
4	Cimislia urban	57.30	62.40	5.10	5.60	84.31
5	Cimislia - Comrat	62.40	88.40	26.00	34.26	30.12
6	Comrat urban	88.40	96.76	8.36	9.77	88.68
7	Comrat - R38 Intersection	96.76	135.80	39.04	7.53	6.53
8	R38 Intersection - Ciumai	135.80	151.35	15.55	9.77	11.20
9	Ciumai - Vulcanesti	151.35	172.76	21.41	25.54	57.01
10	Vulcanesti urban	172.76	178.10	5.34	20.00	55.75
11	Vulcanesti - Slobozia Mare	178.10	202.00	23.90	25.68	33.93
12	Slobozia Mare - Giurgiulesti	202.00	215.16	13.16	24.30	58.43

Source: Consultant

7.2. Distresses For Pavement With Jointed Portland Cement Concrete Surfaces

Several types of distresses affect the structural and/or functional capacity of concrete pavements. The following types of deteriorations have been recorded:

- Cracking
- Spalling
- Faulting

Figure 7-1 presents typical types of cracking in concrete pavements. Cracks can be distinguished in transverse, longitudinal, and corner breaks, in addition to a series of durability cracks. In addition, the spalling of joints as well as faulting were recorded. Table 7-3 presents average deficiencies for the concrete section of M3.

7.3. Asphalt Pavement Distress

The surface distress survey for the asphalt portion of the project road was carried out by visual inspection and measurement. The surveys were conducted September through October 2008. The measurement method and distress type was taken from the suggested inputs described in the HDM Manual. The field team measured the distress data for every one km section in the field. The definitions of the recorded data are as follows:

Cracks in m

Cracks were recorded as number of metres per kilometre. Traverse cracks occur relatively perpendicular to the centreline and are often regularly spaced. The cause of traverse cracks is movement due to temperature changes and hardening of the asphalt with aging. Cracks running in the direction of traffic are longitudinal cracks. Centre line or lane cracks are caused by inadequate bonding during construction or reflect cracks in the underlying pavement. Longitudinal cracks in the wheel path indicate fatigue failure from heavy vehicle loads. Cracks near the asphalt edge are caused by insufficient shoulder support, poor drainage, or frost action.

Alligator cracks in m²

Alligator cracking is associated with loads and is usually limited to areas of repeated traffic loading. The cracks surface initially as a series of parallel longitudinal cracks within the wheel path that progresses with time and loads to a more branched pattern that begins to interconnect. The stage, at which several discontinuous longitudinal cracks begin to interconnect, is defined as alligator cracking. Eventually the cracks interconnect sufficiently to form many pieces, resembling the pattern of an alligator.

Potholes in m²

Potholes are holes of various sizes in the pavement surface which are usually caused by weak base or subgrade layers. The loss of surface by de-bonding is also including in this distress category and describes the removal of the asphalt surface from the underlying layer. The problem is most common with thin asphalt surface layers and is caused by freeze-thaw action or poor bonding of the two layers during construction. The areas of open cavities in the road surface with at least 150 mm diameter and at least 25 mm depth are measured.

Patched area in m²

A patch is an area of pavement which has been replaced with new material to repair the existing pavement or access the utility. A patch is considered a defect no matter how well it is performing (a patched area or adjacent area usually does not perform as well as an original pavement section). Generally, some roughness is associated with this distress. Temporary patches, as well as localized permanent repairs (dig-out repair), are included in this distress category. Utility cut patches are also included as part of the patching values.

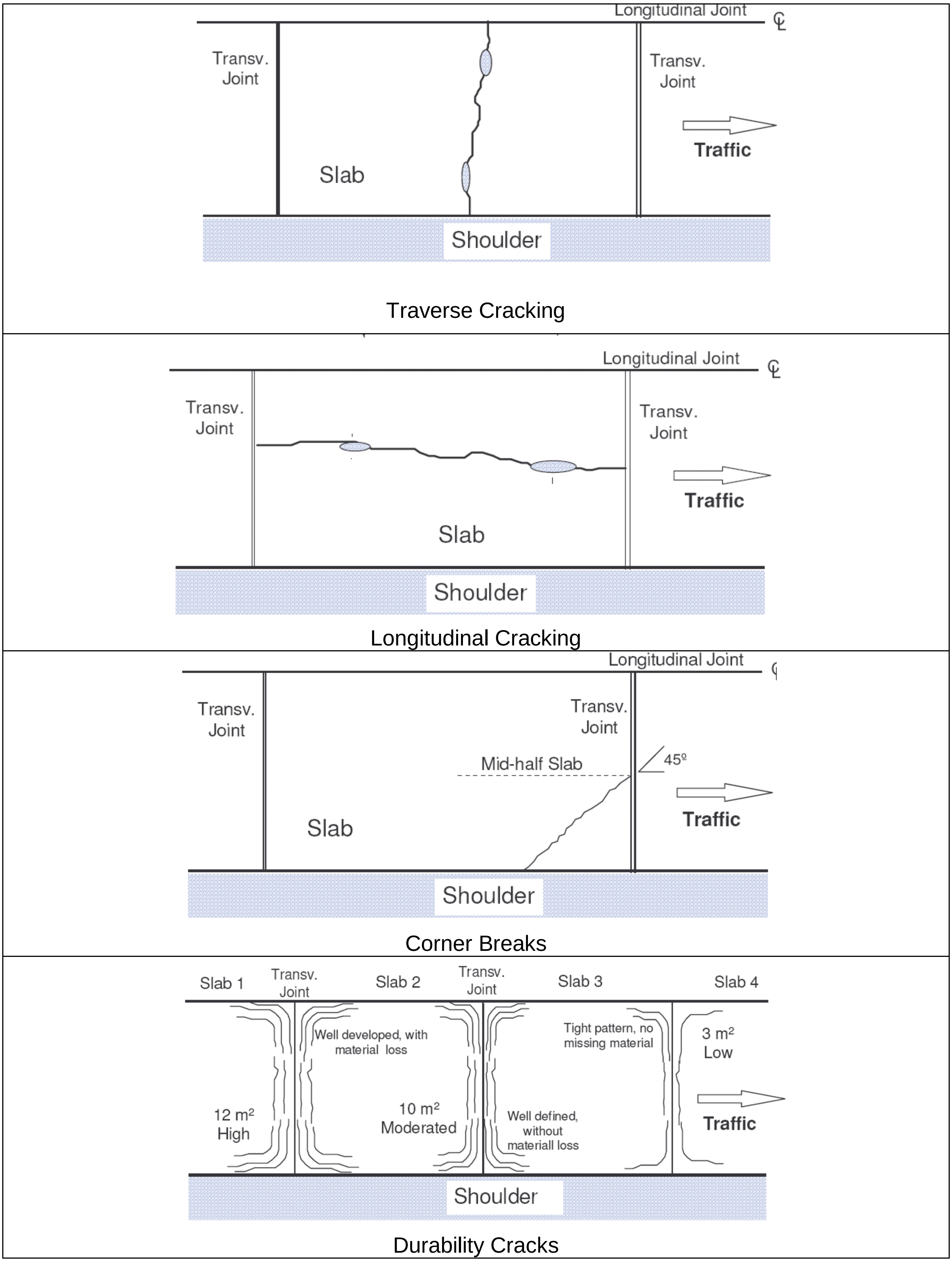
Settlements/deformations in m²

This distress category also covers forms of surface distress that are not limited to the wheel path, although they generally include the wheel paths. The distress usually occurs in isolated areas of the roadway surface. Settlements and deformations are localized depressions or elevated areas of the pavement that result from settlement, pavement shoving, displacement due to subgrade swelling, or displacement due to tree roots.

Edge-break in m²

Edge break is defined as the loss of surface and base materials at the pavement edge, caused by shear failure and attrition. This commonly arises on narrow roads with unsealed shoulders, where vehicles wheels pass on or close to a pavement edge.

Figure 7-1. Types of Cracking in Concrete Slaps



Source: http://www.lpcb.org/lpcb-downloads/isohdm_pdwe/1997_concrete_pavement_modelling.pdf

Ravelling in m²
Ravelling is a pavement surface deterioration that occurs when aggregate particles are dislodged (ravelling). An asphalt concrete pavement loses its smooth surface and begins to appear very open and rough. Ravelling is caused by stripping of the bituminous film from the aggregate, asphalt hardening due to ageing, poor compaction especially in cold weather construction, or insufficient asphalt content.

Bleeding in m²
Bleeding is indicated by an excess of bituminous material on the pavement surface which presents a shiny, glass-like reflective surface that may become sticky in hot temperatures. Bleeding is caused by a poor initial asphalt mix design or by paving or seal coating over a flushed surface.

Rutting in m² incl. rut depth average and rut depth deviation
Rutting is a surface depression within the wheel path. Rutting is caused by traffic compaction or displacement of unstable material. When the upper pavement layers are severely rutted, the pavement along the edges of the rutted area may be raised. The severity level of rutting is also defined through the rut depth and rut depth standard deviation. Rut depth is the average of the measures of maximum depth under a 2 m straight edge placed transversely across a wheel path, in mm. Rut depth standard deviation is the standard deviation of rut depth measures (across both wheel paths), in mm.

The area of any distress (cracks, ravelling and potholes) is the sum of rectangular area circumscribing the manifest distress and for line cracks a width dimension of 0.1 m is assigned. The distresses are expressed as a percentage of the total carriageway area. The surface deficiencies of the project road sections are summarised in Table 7-4. Surface distress data for each km are presented in Appendix II-3

7.4. Road Roughness

Road roughness is gaining increasing importance as an indicator of road condition and as a major determinant of road user costs. The roughness of a road means the surface elevation along a road that causes vibration in traversing vehicles. HDM defines roughness as deviation of a surface from a true planar surface with characteristic dimensions that effect vehicle dynamics, ride quality, dynamic loads and drainage. The IRI (International Roughness Index), is the reference measure expressing roughness as a dimensionless average rectified slope statistic of the longitudinal profile in m/km. Suggested values based on a qualitative evaluation of the ride quality of the road (and respective condition rating):

- Smooth paved road 2 m/km
- Reasonably smooth paved road 4 m/km
- Medium rough paved road 6 m/km
- Rough paved road 8 m/km
- Very rough paved road 10 m/km

Using a vehicle equipped with Bump Integrator (BIU) developed by the United Kingdom Transport Research Laboratory (TRL) the State Road Administration crew measured the roughness along the corridor during November of 2008. The bump integrator system measures the road roughness by recording the cumulative displacement of the vehicle axle relative to its body. Table 7-5 displays the averaged measurements by corridor segments.

Table 7-3. Concrete Pavement Section Deficiencies

Section 1. Chisinau - Porumbrei												
		Average	Average			Cracking		Joint deficiencies		Distresses		
		Road Width	Shoulder Width	Paved Area	Slab length	Cracked slabs	Deteriorated cracks	Spalling of long. Joints	Spalling of trans.Joints	Average faulting		Failures
from km	to km	M	m	m2	m	%	no.	%	%	mm	%	no.
0.0	34.13	19.33	6.66	657,300	5.00	21.76	307	4.18	0.91	2,270.00	66.76	125

Source: Consultant

Table 7-4. Asphalt Pavement Section Deficiencies

Section				**Width**	**Shoulder**	**Structural**	**Ravelling**	**Potholes**	**Edge break**	**Mean rut depth**	
No.	from	To	(km)	(m)	(m)	Cracks %	%	no.	m^2 per km	(mm)	sd
2	Porumbrei	R3 junction	14.86	8.51	1.80	0.09	0.38	0.13	1.35	61.80	59.27
3	R3 junction	Cimislia	8.50	9.72	1.73	2.29	0.86	2.29	28.73	20.00	36.06
4	Cimislia urban		5.10	9.45	1.79	0.32	0.00	7.75	14.65	0.00	0.00
5	Cimislia	Comrat	26.00	*7.00*	*2.50*	*No data collected since section under rehabilitation*					
6	Comrat urban*		8.36	*7.00*	*1.80*						
7	Comrat	R38	39.07	8.23	2.38	2.41	0.33	3.30	39.47	12.55	26.43
8	R38	Ciumai	15.99	8.06	2.55	1.00	0.03	3.50	37.19	15.63	34.00
9	Ciumai	Vulcanesti	21.40	6.62	2.34	2.02	0.00	2.38	14.50	25.29	41.71
10	Vulcanesti urban		5.37	7.05	2.15	0.57	0.00	9.00	0.00	0.00	0.00
11	Vulcanesti	Slobozia Mare	23.90	6.74	3.09	0.22	0.00	5.16	9.99	16.00	34.03
12	Slobozia Mare	Giurgiulesti	13.16	6.73	1.96	0.58	0.62	3.36	2.83	0.00	0.00

Source: Consultant

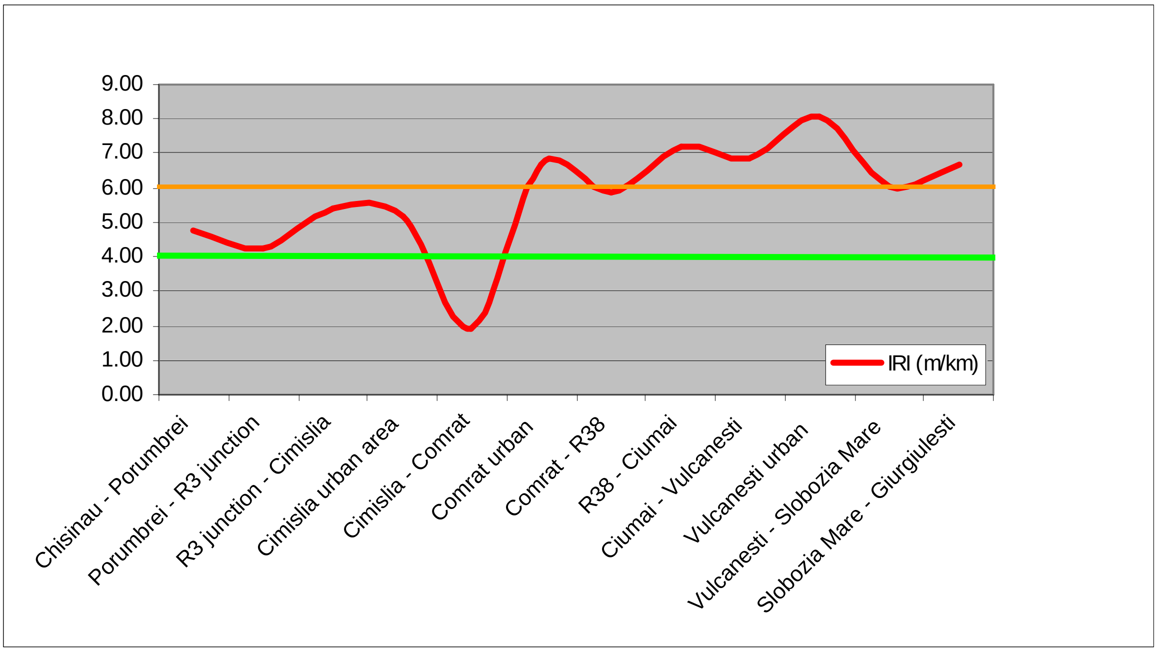
Table 7-5. Average Road Roughness M3

No.	Section	From km	End km	(km)	Roughness IRI (m/km)
1	Chisinau - Porumbrei	0.00	34.34	34.34	4.74
2	Porumbrei - R3 junction	34.34	48.80	14.46	4.24
3	R3 junction - Cimislia	48.80	57.30	8.50	5.42
4	Cimislia urban	57.30	62.40	5.10	5.18
5	Cimislia - Comrat	62.40	88.40	26.00	1.91
6	Comrat urban	88.40	96.76	8.36	6.67
7	Comrat - R38 Intersection	96.76	135.80	39.04	5.89
8	R38 Intersection - Ciumai	135.80	151.35	15.55	7.19
9	Ciumai - Vulcanesti	151.35	172.76	21.41	6.87
10	Vulcanesti urban	172.76	178.10	5.34	8.10
11	Vulcanesti - Slobozia Mare	178.10	202.00	23.90	6.06
12	Slobozia Mare - Giurgiulesti	202.00	215.16	13.16	6.67

Source: Consultant

The detailed records of the measurements for each kilometre and the resulting road roughness are presented in the road inventory and condition summary sheets, Appendix xx. Table 7-5 presents the average measured Road roughness by study corridor sections. Figure 7-2 displays the same data in graphical form. The green line in the graphic indicates the threshold of good condition, orange delineating medium roughness. The graphic shows that south of Comrat the roughness of the road lies well in the rough to very rough range. Individual kilometre segments, particularly south of Ciumai displayed very high roughness readings.

Figure 7-2. Average Road Roughness M3



Source: Consultant

8. GEOTECHNICAL INVESTIGATIONS

8.1. General

For the preparation of the Feasibility study and preliminary design of the M3 Chisinau-Giurgiulesti Road Rehabilitation geotechnical and materials investigation had to be carried out to provide the design team with the required reliable geotechnical and material information. The M3 road from Chisinau to Giurgiulesti with a total length of about 215km is mainly a two lane road with the exception of the first 35km which have four lanes.

Within the M3 route there are two sections which are scheduled to be already rehabilitated in 2009 or have been resurfaced in 2008. These are the road sections from the junction of the M3 with R3 (km48.1) to Cimislia (km61.3), including the town passage, where rehabilitation measures are scheduled for 2009, and the road section from Cimislia to Comrat. The asphalt pavement from Cimislia to Comrat has been rehabilitated during 2008. The rehabilitation works were almost complete at the time of the field investigations in November 2008.

This chapter details the characteristics of the terrain and foreseen difficulties during the rehabilitation works for the M3 Chisinau-Giurgiulesti road. It describes the general methodology that was used to conduct the geological and geotechnical studies and investigations and studies undertaken to assess the geomorphologic and geotechnical characteristics along the project road, identify potential critical areas and determine the requirements of appropriate slope stabilization and erosion protection.

Information obtained from geological maps and available reports was used to set up the geological outline of the project area and determine the geomorphological and geotechnical characteristics along the project road**.**

8.1.1. Geological overview

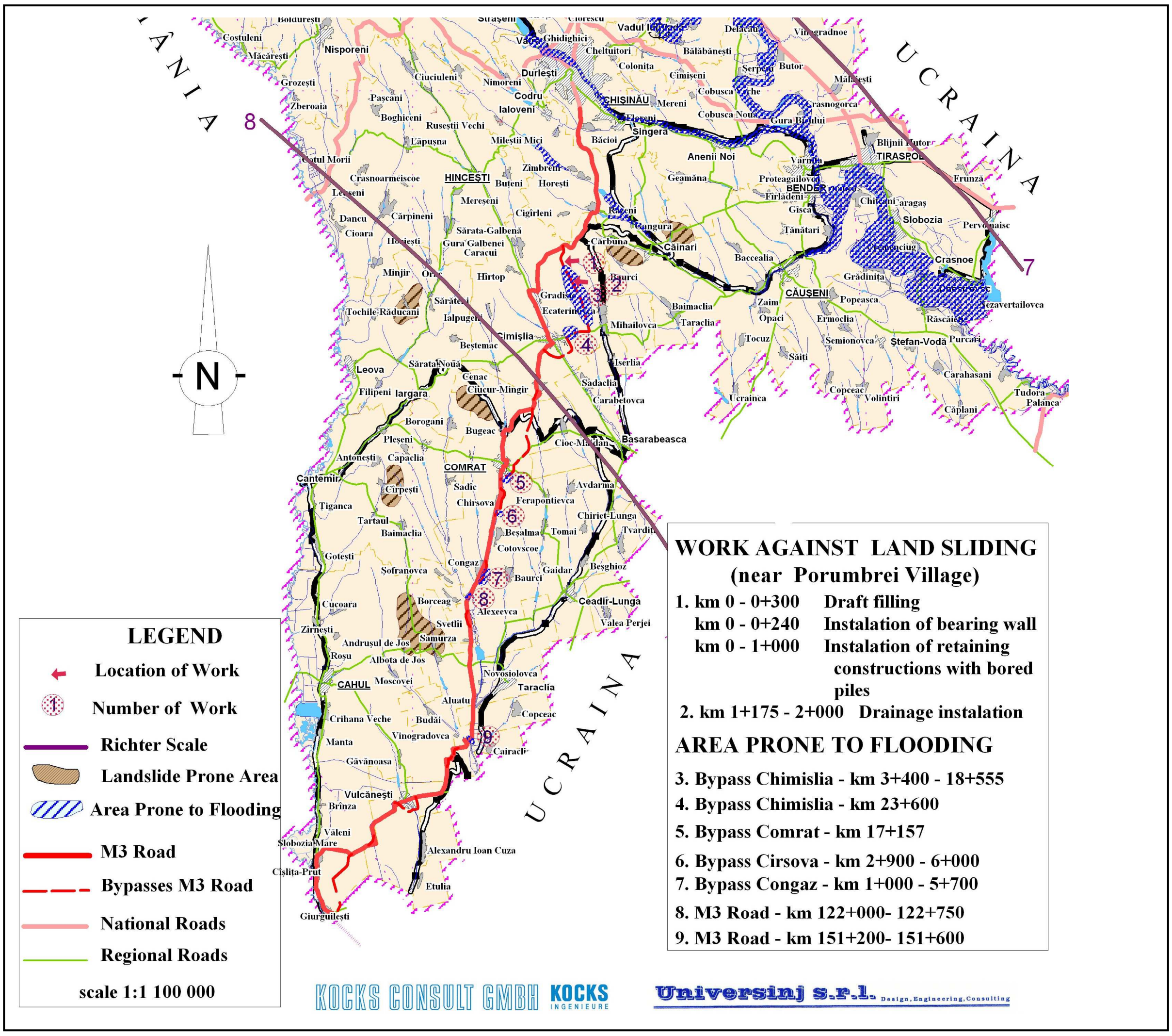
In the geological structure of the Republic of Moldova the Neogene, Quaternary and contemporary deposits are prevalent. Most ground water bearing stratums are related to the depths of Neogene deposits.

The project area is located within the limits of the central part of Moldova. The relief of this area is considerably cut with ravines and has high seismicity magnitude. The area is formed of middle Sarmate, upper Sarmate and Quaternary age soils. The middle Sarmate is exposed in the valleys of rivers Isnovat, Botna, Botnisoara and is represented by loams, sands and limestones.

8.1.2. Seismic Activity and Geo-hazards

The Republic of Moldova is situated in a seismic zone where the earthquakes can reach the magnitude of 8-9. During the last 200 years Moldova has been affected by 18 earthquakes of magnitude 7-9. It is reported that there are about 16,000 areas affected by landslides in the Republic of Moldova. The highest intensity thereof is registered in the central region of the country and the Tigheci plateau, where over 1500 areas at risk are located within the settlements. Figure 8-1 presents an overview geo-hazards in the study area. The whole length of the M3 road is situated in seismic zone 7 and 8.

Figure 8-1. Geo-Hazards in Study Area



Source: Consultant

The landslide activity is influenced by the landscape, the geological structure, the quantity and dynamics of precipitation. Within the project area direct affecting the existing alignment and new designed bypass sections at this stage only the potential landslide near Porumbrei village has been detected. This area has been surveyed and investigated previously during the time of the former Soviet Union. From the historic investigation and tests results it has been concluded that in this section of the new bypass technical measures to stabilize the landslide are required.

8.1.3. Climate

The climate of the Republic of Moldova is moderately continental. It is characterized by a lengthy frost-free period, short mild winters, lengthy hot summers, modest precipitation, and long dry periods in the south.

Considering the cohesive subgrade and embankment fill along the project road attention has to be paid to the influence of freezing temperatures to the pavement layers and subgrade.

Based on long-term meteorological data the maximum depth of frost penetration has been recorded in the range from 600mm in the Cahul and Vulcanesti area to 700mm in the region around Cimislia and Comrat. The subgrade material is considered frost-susceptible.

8.2. Geotechnical Field Investigations

The scope of the geotechnical study at this stage relates primarily to the assessment of the subgrade strength, the type and structure of the existing pavement, the location of suitable construction material and provision of parameters for the elaboration of rehabilitation measures and a preliminary pavement design.

Geotechnical field work for the feasibility study and preliminary design commenced in November 2008 and was completed during December 2008. The field surveys were carried out by the Consultant's Geotechnical Engineer assisted by a team from Universinj Ltd in Chisinau.

For the preparation of the preliminary design the field studies for the material and site investigations included the following:

- Excavation of Trial pits along the existing road alternating between right and left lanes

- Execution of Dynamic Cone Penetration Tests (DCP) carried out at 2.0km intervals at the same locations as the core samples

- Drilling and extraction of asphalt cores have been executed at 2.0km intervals
- Benkelman tests have been carried out along the road

For the design, surveys and investigations the project road has been subdivided into twelve (12) distinctive road sections. In the following investigations, tests and results for each of the road sections have been recorded and evaluated separately.

The proposed bypass sections had all already been investigated during the previous design phases at the time of the former Soviet Union. At this stage of the project no additional investigation and testing had therefore been scheduled along the bypass and realignment sections.

8.3. Laboratory Tests

Laboratory tests were performed on soil and asphalt samples extracted during the field investigations to determine the main parameters.

Samples from each type of subgrade soil encountered, existing base and sub-base course and from potential construction material sources were collected from site and brought to the Soils- and Materials Laboratory “State Organization Institute INGEOCAD” in Chisinau for testing.

Analyses of samples from existing asphalt were done by the Testing Laboratory of the “State Road Administration” of the Republic of Moldova in Chisinau.

The following laboratory testing has been executed on soil samples for the preliminary design:

- determination of grain size distribution
- determination of natural moisture content
- determination of Atterberg limits
- execution of Proctor tests (moisture density relation, MDD/OMC)
- determination of salinity

On samples from the existing asphalt pavement, consisting of the top asphalt layer and the second asphalt layer, the following laboratory tests have been performed:

- determination of bitumen content
- determination of aggregate grading

Laboratory tests at this stage of investigation were mostly carried out according to Russian Standards as the available and existing laboratory equipment complies with GOST and other Russian Standards.

8.4. Evaluation and Recommendation

The existing pavement of the M3 road sections Chisinau-Giurgiulesti has for the major length an asphalt surfacing consisting of two layers, locally only one layer. Exceptions are the first 35km with a cement concrete pavement. This section of the road is over the greater part of its length constructed on an embankment of varying height. Remaining sections are at or near natural ground level. Road sections within a cut of shorter length are located mainly at the north and south ends of the road.

Most the existing roads sections are in fair to poor, and only locally very poor, condition. However the existing bituminous road surface on some road sections is widely in a condition which needs major maintenance and repair where rutting, depressions, alligator cracking and frequent transverse cracks have been recorded.

Evaluation of each road section has been done based on all available information and results for the existing bituminous layer (actual condition, re-use), existing base course (grading, bearing capacity) and subgrade condition (determination of design subgrade strength).

The existing pavement consists mainly of two asphalt layers, locally one to three layers have been recorded. The asphalt is generally underlain by a layer of crushed limestone which is considered the base course. A subbase layer has not been detected during the investigations. The subgrade material either natural ground or embankment fill has a over the full length a cohesive characteristic, ranging from silty sand to fat clay.

The subgrade material along all road sections contains material aggressive to cement concrete. Appropriate protective or other measures have to be taken for all concrete structures in contact with subgrade material to avoid damage to concrete structures due to the saline content of the subgrade

At this stage for design purposes it is important that the strength of the subgrade is not seriously underestimated for large areas of pavement or overestimated to such an extent that there is a risk of local failures. Based on field and laboratory tests the preliminary subgrade design CBR has been determined in the range from 5 to 8% for the various road sections. This includes the bypass sections.

Table 8-1. Summary of Preliminary Subgrade Design CBR Values

Road section		**subgrade CBR design values**
From (km)	To (km)	%
Porumbrei 34.3	Junction with R3 48.8	7
Bypass M3 extension and bypass Cimislia		7
Comrat 88.4	Junction with R38 135.8	7
Bypass M3 extension and bypass Comrat		7
Junction with R3 135.8	Ciumai 151.4	6
Ciumai 151.4	Vulcanesti 172.8	8
New alignment and bypass Ciumai-Burlaceni		6
Vulcanesti 172.8	Slobozia Mare 202.0	5
Bypass Vulcanesti		5
New alignment and bypasses of Slobozia Mare, Cislita-Prut, Giurguilesti		5
Slobozia Mare 202.0	Giurguilesti 215.2	5

Source: The Consultant

In selecting the design CBR value for the subgrade, consideration has been given to the likely moisture conditions applying during construction, assuming that appropriate precautions are taken against excessive disturbance, as shall be demanded by the Specification. Also the likely long-term equilibrium moisture condition has been considered, making reasonable allowance for moisture ingress through the pavement, but assuming drainage is correctly installed as designed.

Most of the existing roads sections are in fair to poor, and only locally very poor condition. However the existing bituminous road surface on some road sections is widely in a condition which needs major maintenance and repair where rutting, depressions, alligator cracking and frequent transverse cracks have been recorded

For the rehabilitation of the M3 road from Chisinau to Giurgiulesti it is recommended to construct a new pavement over the entire length. This shall include the removal, reuse and recycling of the existing pavement layers. It is recommended to reuse the existing asphalt in a cold recycling process with or without the addition stabilising agents. The existing crushed limestone base may be left in place where the design permits as a capping, improved subgrade layer or part of the subbase. In other sections with considerable change in the vertical or horizontal alignment the crushed material should be reused and incorporated as part of the new pavement structure where ever feasible

Considering the very limited availability of high quality aggregates for road construction, reuse and recycling of existing pavement material has to be a priority during any rehabilitation works.

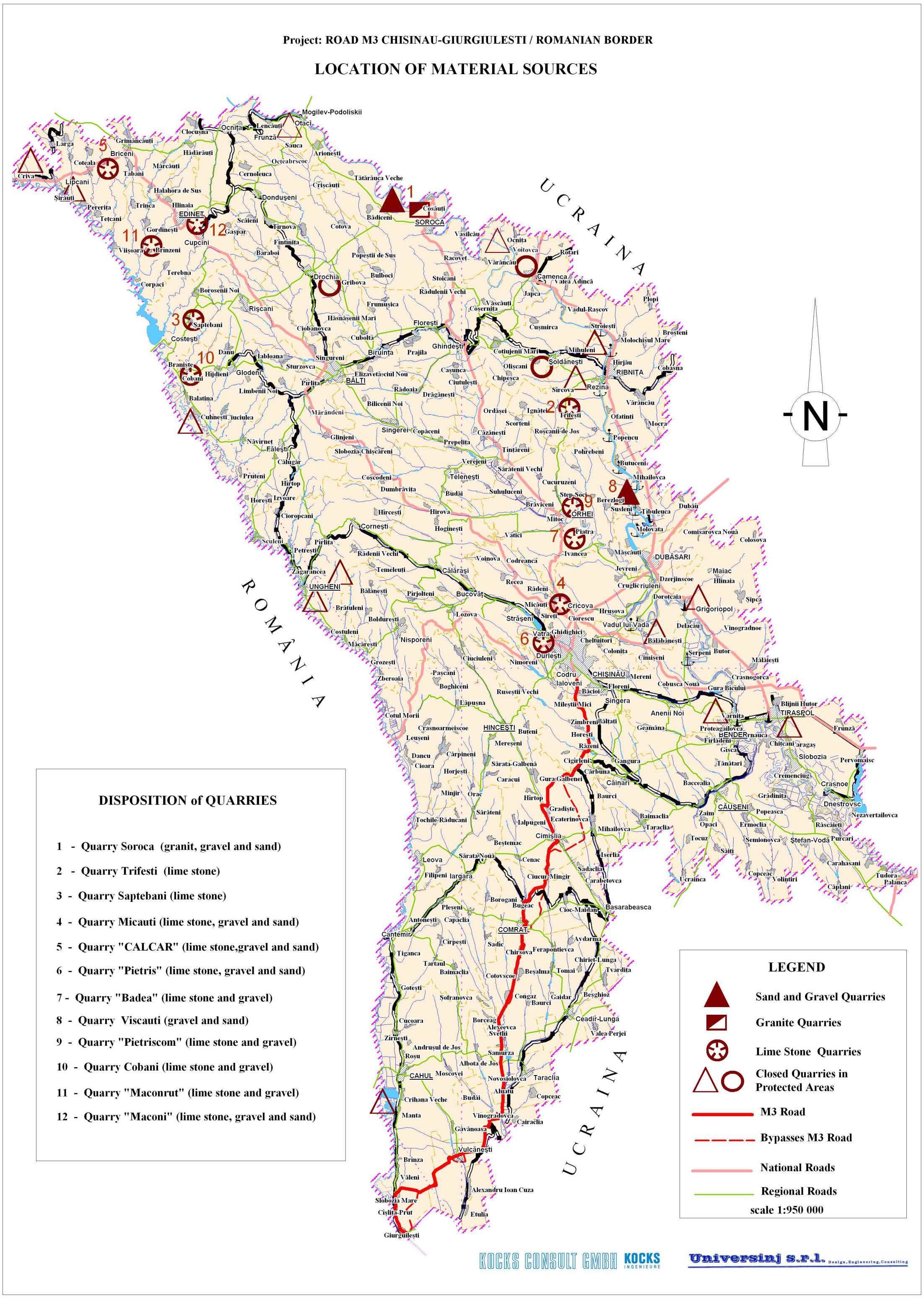
8.5. Construction material sources

Natural sources for high quality aggregates for road construction and purposes are very rare in Moldova. The only existing and operating rock quarry in the country which is the main if not only source of high quality aggregates near Soroca is located at the northern border to the Ukraine.

Granular deposits exist along rivers at the western and eastern border of the country. However most of these old borrow areas are closed and do no longer operate as they are located in environmentally protected areas. The locations of main material sources in the republic of Moldova are shown on the attached map (see Figure 8-2). In the central and northern part of the Republic of Moldova there are several locations where limestone is extracted and processed. For the most southern section of the project road the import of high quality aggregates from neighbouring countries as Romania may be an option.

Other construction materials needed for the road pavement construction such as bitumen and cement are also not available or not in the required quantity in Moldova. For the asphalt pavement construction besides aggregates, bitumen is required as the main component and binder. Bitumen products for road construction are not produced in Moldova and have to be imported. Cement is locally produced, but the demand exceeds current production. It has therefore to be expected that part or all of the cement for construction of structures and road works has to be imported.

Figure 8-2. Location of Materials Sources



Source: Consultant

9. HYDROLOGY AND DRAINAGE

9.1. Overview

The study road crosses a numerous permanent and temporary watercourses. From the beginning of the corridor to km 32 the watercourses are tributaries of Nistru River, located to the east. From km 32 to km 195, general drainage is toward the Black Sea to the southeast and from km 195 on to the end of the corridor, drainage regime is to the river Prut in westerly direction.

The hydrologic conditions are characterized by high waters in spring and by short, but intensive flash floods as a result summer rains. The vast majority of watercourses are falling dry during summer. Only the rivers Cogilnic, Ialpug and Ialpugel have established year-around stable low water flows

During years with insignificant snowfalls there are no high waters in spring. During summer there can be 2-6 flash floods as a result of torrential rain falls. Rainfall contributes more to the year-around water flow in the rivers than snow fall.

Climatic conditions in the study area not homogeneous. From the beginning to km 33, the hydrological basins, where the surface waterway is formed, are referred to as a zone of unstable and insufficient moisture, and the extreme southern regions, from Comrat on to the end of the road, - is a draught (arid) zone. The precipitation occurs mainly in the form of rains during summer, especially in June and July.

Heavy showers, are the main factor of high waters from rainfalls for the artificial structures, and are not uniformly distributed. They are significantly different from the annual summarized amount of precipitation distribution, and having a zonal character. The annual summarized amount of precipitations is decreasing in southern direction with Chisinau at 443 mm, Giurgiulesti with 300 mm of precipitation a year.

9.2 Carrying capacity of the drainage structures

To determine the carrying capacity of the drainage structures (the aperture of the structure) necessary for the road, the following approach is applied. In compliance with МСП 3.04–101-2005 “Determination of the main design hydrological characteristics”, it is obtained the maximal flow rate of surface waters within the surface area of the drainage basin. For areas with less than 100km^2, the carrying capacity is determined according to the equation of marginal intensity of the surface drainage area. For areas with more than 100km^2, it is applied the equation of empirical reduction and equation of analogy.

The design levels of the high waters are determined through a morphological-metrical method, according to the function Q = f(H) depending on the roughness of the flood-lands, of the waterway (bed) and of the longitudinal profile of the watercourse. If the road alignment crosses the watercourses perpendicularly, then the embankment slope on the upper watercourse is being shortly flooded by the backwaters of the artificial structures.

9.3 Location specific characteristics

At Cimislia Bypass, from km 3+400 to km 18+955, the alignment of the design road runs through the thalweg and the flood-lands of the gorge Casim. During the short flash floods the slopes of the embankment are flooded from both sides. The level of the earthworks margin is set from the level of the backwaters of the artificial structures, for the Casim gorge itself, as well as for the other separate tributaries, crossed by the road, taking into account the design level of the water flowing between the road embankment and the slope.

The following areas might be subject to flooding during disastrous flash floods events:

- Cimislia Bypass, km 23+600
- Comrat Bypass, km 17 +157
- Cirsova Bypass, km 2+900 – km 6+00,
- Congaz Bypass km 1+00 – km 5+700,
- M3 km 122+00 – km 122+750,
- M3 km 151+200 – km 151+600

9.4 Evaluation of Current Conditions on the Existing M-3 Road Sections

Chisinau - Valea Perjei
The Chisinau – Gurgiuleşti, M3 Road, from km 0 to km 32, is crossed by the rivers: Isnovat, Botna, Botnisoara and by some dry gorges. The carrying capacity of the existing bridges and culverts (the apreture) on this sector is enough to take the design debit of water flow.

At the river Schinoasa, km 32+126, exists a reinforced concrete culvert of 2m x 2m. The culvert is 60% silty. If the structure is not cleaned during a design flash flood event it is possible that a high level of water will accumulate at the inlet of the structure.

The Porumbrei – Valea Perjei section at km 38+235, could have overflows on the road, due to insufficient carrying capacity of the culvert.

At km 42+793, the existing Chisinau – Gurgiulesti road section, is crossed by the river Cogilnic, by bridge passage of 5 spans by 6 m each. The carrying capacity of the structure is enough to take the design debit of the water, provided the section under the bridge is cleaned. The height of the embankment at the access approaches to the bridge from the side of Valea Perjii village reaches 0,5 m, during high waters, an overflow on the road is possible.

According to inquiries, several years ago the high level of water was reaching in places of the earthworks margins.

Valea Perjei-Cimislia
On the Valea Perjei-Cimislia road section overflows were observed on the road due to insufficient carrying capacity of the culvets, which could not take the design flow, due to low embankments of the earthworks and due to silty road side ditches from the hilly side of the road alignment:

- at km 49+445 – the carrying capacity of the culvert is not sufficient;
- at km 51+000 – overflow due to low embankment of the earthworks and to the silty ditch;
- at km 56 + 011 and km 56+350 – the carrying capacity of the culverts is not sufficient.

Cimislia
In Cimislia town, due to the fact that there is no water drainage at km 59+000 to km 60+083, the water stays on the carriageway for a long duration. The reason for that is the lack of ditches and a low embankment in the urban conditions.

Cimislia - Comrat
On the section from Cimislia town to km 86+000 in Comrat town, the carrying capacity of all the existing structures allows taking the design flow.

Comrat
In Comrat town, on the section from km 86+000 to km 88+000 the waters stays on the carriageway for a long time, due to siltied ditches from the hilly side of the road. In Comrat town, near km 88+000 of Chisinau – Gurgiulesti road, there is a collector of an aperture of 2 (2,5m x 2m), taking the drainge waters from the slope. The collector is currently silted up and full of garbage. The poor technical condition of this structure, results into a partial flood of the town, as well as of the Chisinau – Gurgiulesti road, from km 88+000 up to km 91+200.

The carrying capacity of the box culvert of 2 (2,5 x 2,0), located at km 91+345 on the river Ialpug is not sufficient to take the design flow. Due to the fact that a canal was cut for the river Ialpug, later after the construction of this structure, the bottom of the culvert now is higher than the bottom of the canal.

From km 91+500 to km 92+925 in Comrat town, the road runs along the foot of the LHS slope of the Ialpug River valley. The longitudinal profile of the road is nearly zero. Due to the missing water drainage on this section, the water stays on the carriageway for a long tme.

From km 94+000 to km 95+505, in Comrat town the road runs along the RHS slope of the river Ialpug valley. The drainage from the slope causes flooding of the carriageway. At the street intersections: km 95+119, km 95+335 and km 95+505 the rapid water flows cause the silting up of the culvert, and as a result overflow on the road, and deteriorate the pavement.

Chirsova
Through Chirsova village on the section from km 99+400 to km 103+000, the existing culverts are getting silted after each flash flood, and after recurrent flash floods there are overflows. The surface waterway is being formed on the RHS arable slope of the river Ialpug valley. During showers, intensive erosion of the top soil occurs.

The longitudinal profile of the road is nearly zero. There are ponds of water standing a long the carriageway and deposits of silt, causing deterioration of the pavement. The problem with the surface drainage in the village is not addressed. To take the water and to divert it towards the structure, a lined concrete chute is required along the whole village.

Chirsova to Congaz
From Chirsova to Congaz village, on some sections of the road overflows occur due to insufficient carrying capacity of the culverts for the designed flow of water at:

- km 105+094
- km 105+571
- km 107+509
- km 108+116
- km 108+428
- km 112+740

Through Congaz village, from km 114+500 to km 117+676, the longitudinal profile of the road is nearly zero. The village is situated at the foot of the RHS slope of the river Ialpug valley. During intensive precipitations the topsoil is washed off the slope, overflowing the culvert on the street intersections. Overflows of the road in Congaz village occur on seven street intersections. On the sections between the structures, there are ponds of water standing long on the carriageway, resulting in deterioration of the road pavement.

Congaz Village to Svetlii

From the suburbs of Congaz village to Svetlii village, on separate sections, there are overflows on the road, especially at km 118+812, km 123+802, where the carrying capacity of the culvert is not sufficient to take the design debit of water. Through Svetlii, village the longitudinal profile of the road is nearly zero.

Through the village, the road Chisinau – Gurgiulesti runs on the 'bed', resulted from deposits of sediments, washed off from the slope. The problem with the water drainage is not addressed. Due to permanent ponds of water, the pavement of the road completely deteriorated.

Svetlii to Chirilovca

From Svetlii village, km 126+500 to Chirilovca village, km 147+833, the water drainage is provided sufficiently, except for the culverts at km 133+487, km 140+253, km 140+500, km 146+719. Through Chirilovca village, km 148+000 – km 149+500, the problem with the water drainage can be resolved replacing the culvert at km 148+209 by a structure of a large aperture (opening) and constructing a ford chute at km 148+746.

At km 148+746 from the slope there is concentrated a strong flow of water, which together with the moving roots, causes the silting up of the culvert. There overflows of the road occur. It is necessary to provide a ford chute.

Chirilovca to Vulcanesti

From Chirilovca village, km 149+500 to Vulcanesti village, km 174+000, the water drainage is provided, except for two sections, where overflows happen on the road: at km 156+465 and km 161+040, where the carrying capacity of which is not enough to take the design flow.

Vulcanesti

On the M3 road section, in Vulcanesti town, km 174+00 to km 176+00 water is draining on the street. No gulleys or other draining systems exist. The carrying capacity of the bridges, located within the boundaries of the town, is sufficient to take the design flow.

Vulcanesti to Slobozia Mare

From the Vulcanesti boundary, km 177+00 to Slobozia Mare, km 201+00, the problem with the water drainage is generally being resolved. An exception is the several sections, where the carrying capacity of the culverts is insufficient to take the design flow, resulting in overflows on the road. These are namely: the structure at km 177+303, km 193+533, km 194+157, km 195+923.

Slobozia Mare - Giurgiulesti

On the section at km 201+00 to km 202+00, the problem with the water drainage through the Sloboziaa Mare village is not adressed and there are ponds of water standing long on the carriageway. The asphalt concrete is transformed into crushed stone.

Further, along the Slobozia Mare village, after the junction of the Chisinau – Gurgiulesti road with the Cahul – Giurgiulesti road, the concrete chutes alongside the road provide the water run-off from the carriageway.

On the section of the road from Slobozia Mare village, km 204+200 to Cislita Prut village, km 206+000, water drainage is provided. Through Cislita Prut village up to the bridge at km 207+194 and the culvert at km 207+236 there is a problem with water drainage. The water flows on the carriageway, the pavement is getting destroyed.

From km 207+351 to km 208+145 through Cislita Prut village there are ford chutes on the road, in the form of depressions (bowls) of the carriageway at the street intersections, which are a solution for the water drainage.

From Cislita Prut boundary up to watershed on the LHS of the road, there are no lined concrete chutes. The waters are running on the carriageway. From the watershed to the Giurgiulesti boundary, on two sections there are overflows on the road: the structures at km 209+600 and km 210+578, due to insufficient carrying capacity of the culvert to take the design debit of water.

Through Giurgiulesti village to km 214+000 no water drainage provided. In fact, overflows are happening through-out the whole village.

Summary
In summary, drainage regiment and current condition of exiting drainage structures are of concern. Particularly, the lack of functioning drainage features led to the deterioration of the current road and especially the pavement.

The following chapter describes the structural investigations that have been carried out to survey the location and condition of existing culverts and bridges. A detailed description of all the structures and their hydrological characteristics are presented in Appendix II-1, Appendix II-2, Appendix II-3.

10. STRUCTURAL INVESTIGATIONS

10.1 Culverts

There are many similarities between bridges and culverts, and they perform similar tasks. Bridges however, usually accommodate longer spans; they consist of free-standing abutments and a separate articulated superstructure which carries the traffic. Culverts are often made of pre-fabricated pipes or boxes, or are cast in one or two pieces; they are usually set low in an embankment and less often bear the direct weight of traffic where the waterway opening is less than about 15 m^2, and particularly where the road crosses the waterway on a relatively high embankment, a culvert will usually be cheaper than a bridge.

Single pre-cast concrete pipe culverts are commonly used for small openings up to 2 m^2, while multiple concrete pipes with common headwalls or corrugated steel pipes cater for larger areas. Alternatively, reinforced concrete box culverts are used with internal box sizes up to 4 m x 3.5 m. Twin or multiple boxes may be required for larger waterway openings.

In difficult ground conditions a flexible steel pipe has an advantage over a rigid concrete culvert through its ability to accommodate a certain amount of differential settlement over the length of the culvert without overstressing the material. A culvert of rigid concrete sections will not be tolerant to differential settlement unless it is specifically designed for such condition either by increasing its structural strength or by segmenting the culvert along its length to allow it to flex.

If properly constructed, a reinforced concrete culvert is likely to have a service life in excess of 60 years and will almost certainly be more durable and require less maintenance than a steel pipe. By comparison, a corrugated steel pipe culvert, well protected against corrosion, can be expected to have a working life in the order of 30 to 40 years in a non-aggressive environment. It is usual to design culverts to last the life of the highway.

It must be expected that some culverts will become silted or obstructed by debris. For this reason, pipes of internal diameter less than 1.0 m are not recommended since they are difficult to clean.

10.1.1. Culvert Condition Survey

In total, 194 culverts are located along the existing project roads. In fall of 2008 a survey of all culverts was undertaken, together with an assessment of the culvert condition. Table 9-1 presents the number of culverts by roadway segment. Appendix II-3 shows the location, types, size and length of existing culverts.

Table 10-1. Number of Culverts by Road Section

Road Section	Name	Total Number of Culverts
1a	Chisinau - Sagaidacul Nou	13
1b	Sagaidacul Nou to Porumbrei	2
2	Porumbrei to R 3	16
3	R3 to Cimislia	9
4	Cimislia urban section	7
5	Cimislia - Comrat	10
6	Comrat urban section	13
7	Comrat - R38	62
8	R38 - Ciumai	26
9	Ciumai - Vulcanesti	10
10	Vulcanesti urban section	1
11	Vulcanesti - Slobozia Mare	19
12	Slobozia Mare - Giurguilesti	6
	Total	**194**

Source: Consultant

Visual inspections were performed to verify the existing culvert condition. Inspection standard report forms were used to record geometrical information and condition data. Photographs were taken to document problems and provide an overall picture of the structure.

10.1.2. Summary of Structural Damages to Culverts

All recorded structural damages are listed in the Appendix III-3, together with rehabilitation measures and estimated cost for all culverts. The main structural information is included and details are shown in the investigation forms. The conditions of existing culverts are summarized as follows:

- Majority of culverts are of reinforced concrete with an average length of 17.2 m
- Generally in need of major maintenance and repair
- 30% of the culverts need to be replaced due to failure or insufficient capacity

- Average cost of rehabilitation measures is just over 9,000€ per culvert
- Lack of maintenance of drainage system is of concern

10.1.3 Culvert Design

Culverts are designed according to standard types preliminarily developed for this project. Each standard type is designed for a defined discharge range.

The standards were developed in order to limit the type of structures to be used and thus minimising the works to be carried out. In order to adapt the structures to a wider range of discharges and, at the same time, limit the height of the required structures, single, double or triple culverts with either circular or rectangular cross sections will be used depending on the required discharge capacity and the topography.

The use of standard design types means, that drawings for each individual culvert are not required. On each of the standard drawings there will be a list indicating the culverts for which it is applicable, including variables such as length, up- and downstream invert levels, earth cover etc. related to each culvert listed. For each culvert the required standard type is chosen according to the calculated runoff from the related catchment area.

10.2. Bridges

Bridges start ageing and deteriorating from the day they are built due to the natural weathering of materials, environment and traffic. Bridge inspection aims at following up this ageing and deterioration process and recording which components have changed since the last inspection and to what extent.

10.2.1. Structures' Condition

Information concerning existing bridges has been obtained from the bridge passports, but the information is often incomplete or even insufficient or not comprehensive or not in accordance with the as-built condition on site. There are many reasons for incomplete documentation, partly the long period of time since the bridges were built, partly there are no as-built drawings available, and organisational problems and understaffing in the years following independence and financial difficulties in the years of an emerging economy. The available documentation was thus taken as orientation, and comprehensive field surveys had to be done for the assessment of the bridge condition.

The visible inspection consists of visual control and assessment of all bridge elements. It involves a thorough check of all bridge elements, e.g. approaches for potholes and related damage, settlement of the pavement, erosion, excessive vegetation, any obstruction, or missing bridge signs; checking the superstructure from above and underneath for damage caused by traffic, cracks, spalling and similar damage, deflections etc; examining whether the bearings are functioning well, and for any blockage, rust, change of shape etc; checking the substructure for cracks, settlement, bulging, wearing of pointing, under scouring etc, and waterway for erosion, scour, widening or narrowing of the river, silting up, obstructions, etc.

Typical types of routine maintenance works to be checked are the cleaning of bearings, vegetation control around the bridge, removal of debris from the wearing course, the opening of drain pipes, removal of debris from the waterway, etc.

The seriousness of the damage which is required to be recorded will be based on the estimated extent of damage. The locations of the damage, however, have to be accurately shown.

10.2.2. Bridge Condition Survey

During September 2008 the bridges along the study route were evaluated according to the guidance outlined in the Bridge Inspection Manual (see Appendix II-2). A total of 41 bridge structures were examined. Initially, general dimension data for each structure was recorded including:

- Year of Construction
- Design Load Class
- Total Bridge Length (m)
- Roadway Width (m)
- Number of Lanes On and Under the Bridge
- Curb or Sidewalk Width (m)
- Approach Roadway Width (m)
- Vertical Clearance (m)
- Type of Wearing Surface (m)
- Thickness of Surface Layer (mm)
- Structure Type
- No of Spans in Main Unit
- No. of Approach Spans

Structure Evaluation
In addition the structure's system components were recorded and evaluated. For each bridge the following components were assessed:

- Slab
- Longitudinal Beams
- Cross Beam
- Abutment
- Bearings
- Joints
- Piles

Condition Rating
These basic units are divided into structural members or components. The general procedure for evaluating the structure was to assign a numerical rating to the condition of each element or component of the main units.

The condition rating is based on the AASHTO Manual for the Condition Evaluation of Bridges. Condition ratings based on the field inspections can be considered as "snapshots in time" and cannot be used to predict future condition or behaviour of the structure. However, the condition ratings based on the inspections along with the written comments by the field inspector act as the major source of information on the status of the bridge. Condition ratings are a measure of the deterioration or damage and are not a measure of design deficiency. For instance, an old bridge designed to lower load capacity but with little or no deterioration may have excellent condition ratings, while a newer bridge designed to modern loads but with deterioration will have lower condition ratings.

Each element or component of the bridge was then rated using a scale of 0 through 9, with 9 representing a new condition and 0 a failed condition. Separate bridge assessment forms were compiled for each structure, accompanied by notes and photographs describing the condition.

The location of existing bridges along the project road alignments and the main geometrical data of these bridges are presented in Table 9-5 below.

Table 10-2. Existing Bridges

Nr. Ctr.	Chainage	Corridor Section	Road Category	Crossed River	Closest Locality	Year Built	Length (m)	Carriageway Width (m)	Technical Class	Restriction*	Rating	Rehab. cost, € (000) current condition	Additional cost, € (000) to upgrade to Cat II
1001.	0+672	1A	IV		Bacioi	1988	57	8.15	2	No	5	92.3	N/A
1002.	0+872	1A	IV		Bacioi	1988	57	8.35	2	No	5	95.7	N/A
1003.	4+036	1A	I		Bacioi	1988	63	30.35	2	No	4	205.4	N/A
1004.	4+470	1A	I	Işnoveţ	Bacioi	1987	84.2	26.3	2	No	5	286.6	N/A
1005.	16+403	1A	I		Horeşti	1987	63.2	20.8	2	S	5	171.3	N/A
1006.	17+227	1A	I	Botna	Horeşti	1987	45.2	21	2	S	4	111.7	N/A
1007.	20+894	1A	I		Rezeni	1988	45	21	2	S	5	98.2	N/A
1008.	23+378	1A	I	Botnişoara	Rezeni	1988	54	21	2	S	5	159.3	N/A
1009.	23+616	1A	I		Rezeni	1989	54	33.2	2	No	5	186.1	N/A
1010.	31+964	1A	I		Sagaidacul	1990	42	25.15	2	S	4	179.2	N/A
1011.	47+793	3	IV	Cogîlnic	Gradişte	1984	30.2	9	4	S & T	4	50.3	50.3
1012.	50+445	4	IV		Ecaterinovca	1955	17.5	7.4	4	S & T	5	11.0	5.5
1013.	57+617	5	II		Cimişlia	1958	12	13	4	T	4	47.5	23.7
1014.	59+214	5	II		Cimişlia	new	6	11.5	2	No	N	35.0	N/A
1015.	60+636	5	II		Cimişlia	1968	17.8	11.7	4	T	5	49.3	24.7
1016.	84+195	6	IV	Ialpug	Bugeac	1966	31.4	7.5	4	S & T	5	92.8	92.8
1017.	84+837	6	II	Mussa	Comrat	1975	24	12.8	4	T	4	82.5	41.3
1018.	91+345	8	II	Ialpug	Comrat	new	36.2	17.5	2	No	N	99.3	N/A
1019.	91+941	8	III		Comrat	1970	6	10	4	S & T	4	23.5	11.7
1020.	93+128	8	II	Ialpug	Comrat	1976	36.2	16.6	2	No	4	103.0	103.0
1021.	97+593	8	II		Comrat	1972	12	13.5	4	T	5	37.7	18.8

"T" – tonnage, "S" – Size
Source. Consultant

Table 10-2. Existing Bridges (continued)

Nr. Ctr.	Chainage	Corridor Section	Road Category	Crossed River	Closest Locality	Year Built	Length (m)	Carriageway Width (m)	Technical Class	Restriction*	Rating	Rehab. cost, € (000) current condition	Additional cost, € (000) to upgrade to Cat II
1022.	98+100	8	IV		Chirsovo	1971	6	9.6	4	S & T	4	12.0	6.0
1023.	114+160	8	V		Congaz	1968	18	7.6	4	S	5	41.1	20.6
1024.	118+356	8	II		Congaz	1961	18	12.8	4	No	4	46.4	23.2
1025.	122+212	8	IV	Ialpujel	Congaz	1961	42.3	8	4	S & T	3	56.1	56.1
1026.	127+881	8	III		Svetlîi	1964	8	10.1	4	T	4	24.0	12.0
1027.	130+729	8	II		Samurza	1964	21	11.6	4	No	4	28.2	14.1
1028.	134+987	8	V		Samurza	1964	20	7	4	S	5	26.7	13.4
1029.	145+663	9	V		Ciumai	1960	5	7	4	S & T	5	23.3	11.6
1030.	151+297	9	V		Ciumai	1958	40	7.4	4	S & T	4	103.2	103.2
1031.	151+597	10	III		Ciumai	1954	7	10	4	T	4	24.8	12.4
1032.	158+070	10	III		Vulcăneşti	1952	5	9.8	4	S & T	4	19.7	9.9
1033.	172+100	10	II		Vulcăneşti	1952	15.4	Nov-65	3	T	4	50.9	25.5
1034.	174+890	11	IV	Cagul	Vulcăneşti	1948	37.8	8.6	2	S & T	4	56.8	56.8
1035.	175+812	11	IV		Vulcăneşti	1989	36	9.5	3	S	4	117.4	117.4
1036.	176+353	12	V		Vulcăneşti	1953	26	7.3	4	S	4	65.9	65.9
1037.	180+703	12	III		Vulcăneşti	1953	6	10	4	T	4	17.9	9.0
1038.	194+157	12	III		Slobozia	new	6	10	2	No	N	61.4	N/A
1039.	203+633	13	V		Slobozia	1958	26.3	7.4	4	S & T	4	40.7	40.7
1040.	207+194	13	IV		Cîştliţa Prut	1963	17.3	8.8	4	T	4	88.1	44.0
1041.	212+905	13	IV		Giurgiuleşti	1960	12.8	9.2	4	T	4	46.6	22.6

"T" – tonnage, "S" – Size
Source: Consultant

11. PRELIMINARY PAVEMENT DESIGN

11.1 General

This chapter covers the pavement design for the M3 Chisinau-Giurgiulesti/Romanian border road. Extending over a total length of around 216km the preliminary Design chainages start at Chisinau with km0.0 and ends at Giurgiulesti with km215.8.

Traffic counts and axle load weighing have been carried out to determine the existing traffic volumes and establish the base year traffic. Forecasts of future traffic have been prepared in terms of vehicles per day for each year over the evaluation period of the project.

The design of pavement rehabilitation works should consider in accordance with the Terms of Reference a limit of 11.5 ton axle load for the determination of the bearing capacity and a 20 year performance period.

The road section from the junction of the M3 with the R3 (km48.1) to Cimislia (km57.3) will be rehabilitated in 2009 and the section from Cimislia (km61.3) to Comrat (km88.4) is currently rehabilitated. Therefore this report does not include these two sections for the pavement design.

11.2 Pavement rehabilitation options

Pavement rehabilitation measures are usually defined as a combination of repair and preventive treatments performed over a defined period of time to restore the ability of an existing pavement to carry expected future traffic with adequate functional performance. Pavement rehabilitation usually includes a combination of individual rehabilitation treatments that are required to repair existing deterioration and minimize future deterioration.

Only cosmetic treatment on a deteriorated pavement should be avoided as the effort and funds spent on such superficial repairs are essentially wasted. If the mechanisms that cause the distress in the pavement are not halted as part of the rehabilitation, the distresses will continue to appear with increasing severity, leading to more repairs and costs.

Minor rehabilitation measures without overlay include a series of repair and preventive treatments such as patching, pothole repairs, and crack sealing and surface treatments.

Major rehabilitation measures applicable to the actual project are:

- Non-structural overlay
- Structural overlay
- Reconstruction with/without lane widening
- Restoration without overlay (rigid pavements)

11.2.1 Non-structural overlay

Non-structural overlays may be placed on existing pavements to improve ride quality and /or surface friction. They are also placed to minimize the effects of aging of flexible pavements and minor surface irregularities. Non-structural overlays should not be placed where pavements show extensive signs of fatigue such as longitudinal or alligator cracking, transverse cracking, faulting and pumping. Non-structural overlays are only effective if the existing pavement is structurally adequate with no or little signs of fatigue related distress or durability problems.

Structural overlay

Structural overlays represent a wide variety of treatments to rehabilitate a pavement. They are used when a pavement has medium to high level distress which would make preventive maintenance/repair treatments too expensive or ineffective. However structural overlay should not be used in the following cases:

- severe alligator cracking which will require complete removal and replacement of the pavement,
- severe rutting indicates that the existing material lacks sufficient stability,
- base course shows sign of serious deterioration and must be removed and replaced.

11.2.2. Reconstruction with/without lane widening

Reconstruction is the most invasive rehabilitation option; however it may be the most cost-effective if life cycle costs are considered. Reconstruction is most suitable for flexible pavements with high severity distress such as fatigue cracking or rutting or material durability problems. Reconstruction usually involves the removal and replacement of the entire pavement or larger parts of it, followed by the construction of new pavement layers.

Recycled material from the existing pavement and special recycling techniques may be used in reconstruction of the pavement layers. Recycling of existing asphalt and other materials has become very common with the increase of costs for new materials and increased costs of disposal. The cost effectiveness of reconstruction measures could be enhanced greatly by the application of recycled pavement materials.

There are two fundamental methods of asphalt recycling:

- Hot Mix Recycling (HMR) with or without new materials

- Cold Mix Recycling (CMR) of existing asphalt, bound and unbound material with or without new materials

Mixing of the recycled and new materials can be done in-situ, on-site or off-site.

Recovered materials should be used in such a manner that the expected performance of the pavement will not be compromised. Recycled materials differ vastly in their type and properties and certain limitations may be associated with their use.

11.2.3. Restoration without overlay (rigid pavement)

For the existing concrete pavement a non-overlay rehabilitation treatment seems the most adequate restoration method. This restoration includes

- Preventive treatments (clean and reseal joints, restore drainage)

- Repair treatments (crack sealing, slab replacement, joint/edge repair, surface repair)

These measures are designed to restore functionality and structural capacity of the concrete pavement to an adequate level and limit further deterioration.

11.3. Selection of Rehabilitation Measures

At the actual stage of investigations and testing the selection and proposal of pavement rehabilitation measures in this report is mainly based on technical reasons.

It must be noted that the selection of the rehabilitation measures are highly influenced by the amount of future traffic expected on the pavement and the effect of climate. Future traffic is a key consideration, because traffic direct influences rehabilitated pavement structural capacity and performance for the anticipated design life. Along with future traffic climatic condition can also cause premature failure of rehabilitation especially if non-durable materials are used.

The existing asphalt pavement has nearly reached the end of its design life but has due to lack of regular maintenance along several sections experience premature failure. The geotechnical investigations have shown that the asphalt is placed on a granular base consisting of crushed limestone over a cohesive mostly clayey subgrade. Locally deficiencies obviously related to improper drainage have been observed. The limestone used for the base of the road is relatively soft and might not withstand increased load cycles by higher future traffic loads.

Considering the following major factors:

- severe deterioration of the asphalt on longer sections of the road,
- locally inadequate drainage
- relatively soft limestone base and
- weak subgrade
- future traffic load in the range between 6.1msa and 15.9msa

a reconstruction of the pavement is recommended.

Overlay options are at this stage not considered a technically sound solution for the actual situation with severe deterioration of the existing asphalt pavement.

The rehabilitated pavement shall withstand deterioration caused by expected future traffic by using materials that are durable enough to last through the anticipated design life and shall include recycling techniques to make optimal use of the existing materials.

The rehabilitation measures will be based on a pavement design which includes pavement layers of recycled materials and relevant recycling techniques.

For the pavement design of the project road sections the selection of standards has been undertaken during the inception phase to include established and well known design methods from different areas. These are the Russian/Former Soviet Union standard and European/Western standards. The British standard as representing a European standard, the Russian standard previously used in The Republic of Moldova and an American standard as general western standard has been reviewed and commented on.

For the project road it is recommended to use the AASHTO Design Method as the data collection and compilation of required input values as traffic load and subgrade condition have been determined on the basis and method according to the AASHTO method.

11.3.1 General Design Principles

As discussed in Chapter 5 Pavement Design Standards, the pavement design is a process of selecting the appropriate pavement and surfacing materials to ensure that the pavement performs adequately and requires minimal maintenance under the anticipated traffic loading for the design period adopted. This selection process involves adoption of material types, thicknesses and configurations of the pavement layers to meet the design and performance objectives.

Pavement Design Procedure

The major influence on pavement design methods worldwide has the design method developed by the *„American Association of State Highway and Transportation Officials“(*AASHTO). The *ASHTO Guide for Design of Pavement Structures*, *1993, Volume 1,* provides Design Procedures for new construction or reconstruction. It is recommended to use the AASHTO Design Method for the pavement design of the project road as it is widely used.

The AASHTO Guide for Design of Pavement Structures is based on precise input numbers for material properties, performance, reliability and traffic. The main input parameters required by the design method are:

- Traffic load
- Reliability
- Serviceability
- Subgrade Strength

In the following section these parameters will be discussed and applied for the project road Chisinau – Giurgiulesti/Romanian Border.

Design Life

Design life is defined in terms of the cumulative traffic that can be carried before strengthening of the pavement is necessary. In this context, design life does not mean that at the end of the period the pavement will be completely worn out and in need of reconstruction; it means that towards the end of the period the pavement will need to be strengthened so that it can continue to carry traffic satisfactorily for a further period.

For the road Chisinau – Giurgiulesti/Romanian Border.a design life of 20 years has to be considered according to the TOR and will be applied for the pavement design.

Traffic

The traffic load is based on the forecasts of future traffic, vehicle damage factors and cumulative standard axles for a period of 20 years. Traffic counts have been performed which are used as the basic input figures for the determination of the traffic load.

The traffic counts to confirm existing traffic volumes and vehicle composition along the length of the project road have been conducted during August and September 2008. As traffic flows are not constant throughout the year a seasonal variation factor has been used to adjust the data from the month of survey to an “average” month.
Traffic growth forecasts have been developed with regard to the existing traffic volumes on the project road, as revealed by the traffic surveys, and anticipated national and regional economic development and its subsequent impact on the demand for highway transport, also considering the effect of improved accessibility and connectivity resulting from project implementation.

The total forecasts volume of traffic during the design life is a two-way traffic. It is usually assumed that 50% of the total traffic goes into each direction. However, the traffic flow surveys have shown that the number of loaded trucks going south is considerably greater than in the opposite direction. The lane distribution factor for the design lane has therefore be taken as 0.6 (60%) instead of the usually 0.5 (50%).

The Chisinau – Giurgiulesti/Romanian Border road has with regard to traffic load been divided into eight sections. This includes town passages through Comrat and Vulcanesti.

For the pavement design the cumulative equivalent standard axles (ESAL) for each road section for a 20 year (2011-2031) design life are used. Detailed information regarding traffic is presented in the relevant chapter.

For easier reference the summary of the cumulative standard axles for each road section is presented in the Table 11-1 below:

Table 11-1. Cumulative ESAL for 20 year design life

Road section		**Cumulative ESAL (2011-2031)**	
From (km)	To (km)	Total	In design lane
Porumbrei 34.3	Junction with R3 48.8	12.64×10^6	7.58×10^6
Comrat town passage 88.4	96.8	15.92×10^6	9.55×10^6
Comrat 96.8	Junction with R38 135.8	11.12×10^6	6.67×10^6
Junction with R3 135.4	Ciumai 151.4	7.05×10^6	4.23×10^6
Ciumai 151.4	Vulcanesti 172.8	6.13×10^6	3.68×10^6
Vulcanesti town passage 172.8	178.1	7.40×10^6	4.44×10^6
Vulcanesti 178.1	Slobozia Mare 202.0	6.90×10^6	4.14×10^6
Slobozia Mare 202.0	Giurguilesti 215.2	12.59×10^6	7.56×10^6

The lane distribution factor for the design lane has been taken as 0.6 (60%) instead of the usual 0.5 (50%).

The rehabilitation project for the M3 also shows a number of proposed bypasses. Traffic forecasts and Esal numbers for the anticipated bypasses are shown in the following table 11-2.

Table 11-2. Cumulative ESAL in Bypass Sections for 20 year Design Life

Road / Bypass section	Cumulative ESAL (2011-2031) msa	
	Total	In design lane
M3 Extension and Cimislia bypass	9.203×10^6	5.522×10^6
Comrat bypass	14.593×10^6	8.756×10^6
Ciumai – Burlaceni realignment	6.134×10^6	3.680×10^6
Vulcanesti bypass	6.630×10^6	3.978×10^6
Slobozia Mare bypass + Southern Corridor realignment	6.427×10^6	3.856×10^6

The lane distribution factor for the design lane has been taken as 0.6 (60%) instead of the usual 0.5 (50%).

Detailed traffic data are presented in the corresponding chapter.

Subgrade Strength

The subgrade forms the foundation of the road. The main purpose of the foundation is to distribute the applied vehicle loads to the deeper ground without causing distress in the foundation itself or in the overlying layers. This is required both during construction and during the service life of the pavement.

During the life of a pavement, its foundation has to be able to withstand large numbers of repeated loads from traffic. It is also likely to experience ingress of water, particularly as the upper pavement materials begin to deteriorate towards the end of their design lives.

The materials which represent the subgrade can be either natural ground or compacted fill. It is essential to investigate and evaluate the existing subgrade condition to determine the subgrade strength. The California Bearing Ratio (CBR) is traditionally used as an index test for subgrade strength.

For the Chisinau – Giurgiulesti/Romanian Border road subgrade strength has been evaluated compiling the results of geotechnical investigations and testing. The subgrade assessment for this project is based on the California Bearing Ratio (CBR). The subgrade design CBR has been evaluated for the road and is presented in the "Geotechnical Investigations Report". Based on the geotechnical determination the following subgrade CBR values will be used for the preliminary pavement design, as presented in Table 11-3 and Table 11-4. Areas of locally weak subgrade with a lower CBR value which might require additional measure will be determined during the second investigation phase.

Table 11-3. Subgrade Design CBR values

Road Section		Subgrade CBR design values
From (km)	To (km)	%
Porumbrei 34.3	Junction with R3 48.8	7
Bypass M3 extension and bypass Cimislia		7
Comrat 88.4	Junction with R38 135.8	7
Bypass M3 extension and bypass Comrat		7
Junction with R3 135.8	Ciumai 151.4	6
Ciumai 151.4	Vulcanesti 172.8	8
New alignment and bypass Ciumai-Burlaceni		6
Vulcanesti 172.8	Slobozia Mare 202.0	5
Bypass Vulcanesti		5
New alignment and bypasses of Slobozia Mare, Cislita-Prut, Giurguilsti		5
Slobozia Mare 202.0	Giurguilesti 215.2	5

Table 11-4. Preliminary design CBR and Resilient Modulus

Road Section		Subgrade CBR design values	Resilient Modulus
From (km)	To (km)	%	kpa
Porumbrei 34.3	Junction with R3 48.8	7	61200
Bypass M3 extension and bypass Cimislia		7	61200
Comrat town passage 88.4	96.8	7	61200
Comrat 96.8	Junction with R38 135.8	7	61200
Bypass M3 extension and bypass Comrat		7	61200
Junction with R3 135.8	Ciumai 151.4	6	55450
Ciumai 151.4	Vulcanesti 172.8	8	66650
New alignment and bypass Ciumai-Burlaceni		6	55450
Vulcanesti town passage 172.8	178.1	5	49350
Bypass Vulcanesti		5	49350
Vulcanesti 178.1	Slobozia Mare 202.0	5	49350
New alignment and bypasses of Slobozia Mare, Cislita-Prut, Giurguilsti		5	49350
Slobozia Mare 202.0	Giurguilesti 215.2	5	49350

In addition to the subgrade strength and traffic load the AASHTO Pavement Design procedure requires a number of input parameters such as reliability and serviceability which are used to determine the required structural number.

The structural number is an abstract number expressing the structural strength of a pavement required for given combinations of soil support, total traffic expressed in equivalent standard axle loads (18kip), terminal serviceability and environment. The required structural number will be converted to actual thickness of pavement layers.

For the road sections with different traffic loads and a 20 year design life the total required structural numbers (metric) have been determined as follows:

Table 11-5. Required Structural Number (SN)

Road section		Cumulative ESAL (2011-2031) in design lane	Required Structural Number S_N (metric)
From (km)	To (km)		
Porumbrei 34.3	Junction with R3 48.8	7.58 x 10^6	121
Comrat town passage 88.4	96.8	9.55 x 10^6	125
Comrat 96.8	Junction with R38 135.8	6.67 x 10^6	118
Junction with R3 135.8	Ciumai 151.4	4.23 x 10^6	114
Ciumai 151.4	Vulcanesti 172.8	3.68 x 10^6	105
Vulcanesti town passage 172.8	178.1	4.44 x 10^6	120
Vulcanesti 178.1	Slobozia Mare 202.0	4.14 x 10^6	119
Slobozia Mare 202.0	Giurguilesti 215.2	7.56 x 10^6	129
Road / Bypass section		Cumulative ESAL (2011-2031) in design lane	Required Structural Number S_N (metric)
M3 Extension and Cimislia bypass		5.522 x 10^6	115
Comrat bypass		8.756 x 10^6	123
New alignment and bypass Ciumai-Burlaceni		3.680 x 10^6	112
Vulcanesti bypass		3.978 x 10^6	118
Slobozia Mare bypass + Southern Corridor realignment		3.856 x 10^6	117

Based on the above input parameters and calculations a pavement structure will be determined.

11.3.2 Determination of Pavement Structure

Determination of pavement layer thickness is done using AASHTO Ware Software program DARWin 3.1. Based on the above input parameters and calculations the layer thickness will be determined for two alternative pavement structures:

Option 1: Full depth asphalt pavement

- Asphalt surface course
- Binder course
- Bituminous base course
- Subbase containing recycled asphalt, stabilised with bitumen emulsion and cement

Option 2: Asphalt pavement with cold recycled base

- Asphalt surface course
- Binder course
- Base containing recycled asphalt, stabilised with bitumen emulsion and cement
- Subbase, cement stabilised
- Capping layer, existing limestone base

For both pavement options the pavement layer thicknesses have been determined separately for all road sections based on the relevant parameters for each section. In addition, similar pavement structures have been chosen for the bypass sections. As along the bypass sections no old pavement exists, the use of recycled material has not been taken into consideration.

11.3.4 Recommended Thickness of Pavement Layers

For both pavement options the reuse of existing suitable pavement materials is essential. The cement stabilised, hydraulic bound subbase course in pavement option 1 shall contain reclaimed asphalt pavement (RAP) material of the existing asphalt as well as the existing limestone layer. To improve the strength of the mix of cold recycled material it is recommended to add cement in the range of 3 to 5%. The subbase material shall have an unconfined compressive strength of >3.0 Mpa after 7 days. Exact mix proportions and cement content have to be determined based on laboratory testing.

The pavement option 2 takes more account of the availability of materials within the country and has therefore a reduced asphalt thickness. The base course shall be constructed of recycled asphalt and granular material with the addition of bitumen emulsions (2.5-5%) and cement (about 1 to 1.5%). Exact mix proportions and bitumen emulsion and cement content have to be determined based on laboratory testing. The cement stabilised subbase layer is considered to be constructed from lower quality material and shall have an unconfined compressive strength of >1.5 to 3.0 Mpa after 7days. Exact mix proportions and cement content have to be determined based on laboratory testing.

A summary of the recommended pavement structures for the existing alignment and bypass sections for both options is shown in Tables 11-6 to 11-9.

Taking into consideration the type of materials available in the Republic of Moldova it is recommended to use the pavement option 2. Less asphalt thickness will require less high quality aggregates which are rare and have to be transported over greater distance from

Soroca or imported. Less asphalt thickness also requires less bitumen which has to be imported. Limestone and cement is available locally and can be utilised in the pavement rehabilitation at lower rates than imported materials.

11.3.4. Comparison of Russian and AASHTO Pavement Structure

In the Republic of Moldova for pavement design the Russian based Design Standard is commonly used. For the proposed pavement structure option 2 a calculation has been done according the Russian Standard using the software "RADON-2 CREDO/DIALOGUE Pavement Design and Analysis System". At this stage of the project only the results of the calculation in the form of the pavement structure with layer thicknesses is shown in Table 11-10 in comparison with the AASHTO Design method. The differences in layer thickness result from a number of differences in input parameters which are summarised below.

One of the major differences is the way in which the traffic data is evaluated and the required input data determined. As the AASHTO design is mainly based on the number of standard axles the Russian method relies on the number of heavy (trucks) vehicles split into certain categories.

The second major difference relates to the determination of subgrade strength. The Russian design method mainly relies on predetermined soil parameters for a certain region; the adaptation of actual values is limited, whereas the American method makes full use of the actual values determined by field and laboratory tests.

Another difference relates to the material parameters of the different pavement layer according to the relevant standards and requirements. This is the case to a lesser extent regarding the parameter of the standard asphalt layers but leads to greater differences with regard to pavement layers which require the relatively new recycling and stabilising technology.

At this preliminary design stage it is recommended to use the American pavement structure because it shows thicker base and subbase layers and has mostly a greater total pavement thickness. During the detailed design phase the American pavement design will be reviewed and adjusted according to detailed investigation results. A change of the Russian pavement design is expected only in relation to adjusted material parameters for the recycled and stabilised pavement layers. A more detailed comparison of the parameters and calculations will be done during the detailed design phase.

Table 11-6. Flexible Pavement Design– Option 1

Flexible Pavement Design according AASHTO Guide for Design of Pavement Structures 1993
Calculation by software: DARWin Pavement Design and Analysis System

Option 1: Full depth asphalt pavement
Proposed preliminary pavement layer thickness along **existing alignment**
Design life 20 years

M3 Chisinau - Giurgiulesti/Romanian Border	ESAL Carriageway msa	ESAL Design Lane msa	Design CBR %	Resilient Modulus kpa	Total Asphalt Thickness mm	Asphalt Concrete mm	Bituminous Binder mm	Bituminous Base mm	Subbase Cold recycled mm	Total Pavement mm
Porumbrei - R3 Junction km 34.5 to km 48.1	12.637	7.582	7	61200	260	40	70	150	200	460
Comrat town passage km 88.4 to km 95.3	15.924	9.554	7	61200	270	40	70	160	200	470
Comrat - R38 Junction km 95.3 to km 135.4	11.122	6.673	7	61200	250	40	70	140	200	450
R38 Junction - Ciumai km 135.4 to km 151.2	7.051	4.231	6	55450	230	40	70	120	200	430
Ciumai - Vulcanesti km 151.2 to km 172.7	6.134	3.680	8	66650	210	40	70	100	180	390
Vulcanesti town passage km 172.7 to km 176.2	7.397	4.438	5	49350	290	40	70	180	200	490
Vulcanesti - Slobozia Mare km 176.2 to km 201.9	6.895	4.137	5	49350	250	40	70	140	200	450
Slobozia Mare - Giurgiulesti km 201.9 to km 215.8	12.591	7.555	5	49350	290	40	70	180	200	490

Recommendations:

Wearing Course:	Asphalt concrete 0/16mm (0/11mm)	Bitumen:	Penetration Grade Bitumen 50/70 (EN 12591)
Binder Course:	Bituminous binder course 0/22mm (0/16mm)		
Base Course:	Bitumninous treated base course 0/32mm (0/22mm)		
Subbase:	Cold recycled asphalt with new aggregates and stabilised with bit. emulsion		

The existing asphalt pavement (thickness 60mm to 280mm) has to be removed or milled and processed for reuse/ recycling.

Following the removal of the existing pavement layers as required by the design in sections without in-place recycling the existing subgrade (road bed) has to be shaped to line and level and compacted to at least 95% MDD (AASHTO T180).

Table 11-7. Flexible Pavement Design– Option 1 (Bypass sections)

Flexible Pavement Design according AASHTO Guide for Design of Pavement Structures 1993
Calculation by software: DARWin Pavement Design and Analysis System
Option 1: Full depth asphalt pavement with cement stabilised subbase
Proposed preliminary pavement layer thickness **BYPASS SECTIONS**
Design life 20 years

M3 Chisinau - Giurgiulesti/Romanian Border	ESAL Carriageway msa	ESAL Design Lane msa	Design CBR %	Resilient Modulus kpa	Total Asphalt Thickness mm	Asphalt Concrete mm	Bituminous Binder mm	Bituminous Base mm	Cement stabilised Subbase /base mm	Total Pavement mm
M3 Extension and Cimislia bypass	9,203	5,522	7	61200	110	40	70	160	200	470
Comrat bypass	14,593	8,756	7	61200	110	40	70	180	220	510
New alignment and bypass Ciumai-Burlaceni	6,134	3,680	6	55450	110	40	70	150	200	460
Vulcanesti bypass	6,630	3,978	5	49350	110	40	70	170	200	480
Slobozia Mare bypass + Southern Corridor realignment	6,427	3,856	5	49350	110	40	70	170	200	480

Recommendations:
Wearing Course: Asphalt concrete 0/16mm (0/11mm) Bitumen: Penetration Grade Bitumen 50/70 (EN 12591)
Binder Course: Bituminous binder course 0/22mm (0/16mm)
Base Course: Bitumninous treated base course 0/32mm (0/22mm)

Subbase: Cement stabilised crushed limestone base with recycled asphalt , unconfined compessive strength 3.0 Mpa

Following the shaping of the road formation, the subgrade has to be compacted to at least 150mm below formation level to not less than 95% MDD (AASHTO T180 or similar)

Table 11-8. Flexible Pavement Design– Option 2

Flexible Pavement Design according AASHTO Guide for Design of Pavement Structures 1993
Calculation by software: DARWin Pavement Design and Analysis System

Option 2: Asphalt pavement with cold recycled base
Proposed preliminary pavement layer thickness along **existing alignment**
Design life 20 years

M3 Chisinau - Giurgiulesti/Romanian Border	ESAL Carriageway msa	ESAL Design Lane msa	Design CBR %	Resilient Modulus kpa	Total Asphalt Thickness mm	Asphalt Concrete mm	Bituminous Binder mm	Base Cold recycled mm	Subbase cement stabilised mm	Capping existing mm	Total Pavement mm *)
Porumbrei - R3 Junction km 34.5 to km 48.1	12,637	7,582	7	61200	310	40	70	200	200	120	630
Comrat town passage km 88.4 to km 95.3	15,924	9,554	7	61200	310	40	70	200	200	170	680
Comrat - R38 Junction km 95.3 to km 135.4	11,122	6,673	7	61200	310	40	70	200	200	100	610
R38 Junction - Ciumai km 135.4 to km 151.2	7,051	4,231	6	55450	310	40	70	200	200	100	610
Ciumai - Vulcanesti km 151.2 to km 172.7	6,134	3,680	8	66650	290	40	70	180	180	0	470
Vulcanesti town passage km 172.7 to km 176.2	7,397	4,438	5	49350	310	40	70	200	200	100	610
Vulcanesti - Slobozia Mare km 176.2 to km 201.9	6,895	4,137	5	49350	310	40	70	200	200	100	610
Slobozia Mare - Giurgiulesti km 201.9 to km 215.8	12,591	7,555	5	49350	330	40	70	220	200	170	700

Recommendations:

Wearing Course:	Asphalt concrete 0/16mm (0/11mm)	Bitumen:	Penetration Grade Bitumen 50/70 (EN 12591)	*) includin cappin
Binder Course:	Bituminous binder course 0/22mm (0/16mm)			
Base Course:	Cold recycled asphalt with new aggregates and stabilised with bit. emulsion			
Subbase:	Cement stabilised, unconfined compessive strength 1.5 to 3.0 Mpa			
Capping layer;	Existing crushed limestone material, CBR > 15%			

The existing asphalt pavement (thickness 60mm to 280mm) has to be removed or milled and processed for reuse/ recycling.

Following the removal of the existing pavement layers as required by the design in sections without in-place recycling the existing subgrade (road bed) has to be shaped to line and level and compacted to at least 95% MDD (AASHTO T180).

Table 11-9. Flexible Pavement Design– Option 2 (Bypass sections)

Flexible Pavement Design according AASHTO Guide for Design of Pavement Structures 1993
Calculation by software: DARWin Pavement Design and Analysis System
Option 2: Asphalt pavement with cement stabilised base
Proposed preliminary pavement layer thickness **BYPASS SECTIONS**
Design life 20 years

M3 Chisinau - Giurgiulesti/Romanian Border	ESAL Carriageway msa	ESAL Design Lane msa	Design CBR %	Resilient Modulus kpa	Total Asphalt Thickness mm	Asphalt Concrete mm	Bituminous Binder mm	Cement stabilised Base mm	Capping limestone mm	Total Pavement mm
M3 Extension and Cimislia bypass	9.203	5.522	7	61200	170	40	130	200	200	570
Comrat bypass	14.593	8.756	7	61200	180	40	140	200	240	620
New alignment and bypass Ciumai-Burlaceni	6.134	3.680	6	55450	160	40	120	200	200	560
Vulcanesti bypass	6.630	3.978	5	49350	180	40	140	200	200	580
Slobozia Mare bypass + Southern Corridor realignment	6.427	3.856	5	49350	180	40	140	200	200	580

<u>Recommendations:</u>

Wearing Course: Asphalt concrete 0/16mm (0/11mm)

Binder Course: Bituminous binder course 0/22mm (0/16mm)

Base Course: Cement stabilised, unconfined compessive strength ≥ 3.0 Mpa

Subbase: crushed limestone, CBR > 15%

Bitumen: Penetration Grade Bitumen 50/70 (EN 12591)

Following the shaping of the road formation, the subgrade/ capping has to be compacted to not less than 95% MDD (AASHTO T180 or similar) to a depth of 200mm

Table 11-10. Flexible Pavement Design Comparison

Comparison of pavement structures determined by Russian and Amercan design procedures

Option 2: Asphalt pavement with cold recycled base
Proposed preliminary pavement layer thickness along **existing alignment**
Design life 20 years

	Flexible Pavement Design according ODN 218.046-01 2001 Calculation by software: RADON-2 CREDO/DIALOGUE Pavement Design and Analysis System							**Flexible Pavement Design according AASHTO Guide for Design of Pavement Structures 1993** Calculation by software: DARWin Pavement Design and Analysis System						
M3 Chisinau - Giurgiulesti/Romanian Border	Total Asphalt thickness mm	Asphalt Concrete mm	Bituminous Binder mm	Base cold recycled mm	Subbase cement stabilised mm	Capping existing mm	Total Pavement mm *)	Total Asphalt thickness mm	Asphalt Concrete mm	Bituminous Binder mm	Base cold recycled mm	Subbase cement stabilised mm	Capping existing mm	Total Pavement mm *)
Porumbrei - R3 Junction km 34.5 to km 48.1	210	40	70	100	200	150	560	310	40	70	200	200	120	630
Comrat town passage km 88.4 to km 95.3	250	40	70	140	200	170	620	310	40	70	200	200	170	680
Comrat - R38 Junction km 95.3 to km 135.4	230	40	70	120	160	240	630	310	40	70	200	200	100	610
R38 Junction - Ciumai km 135.4 to km 151.2	230	40	70	120	200	150	580	310	40	70	200	200	100	610
Ciumai - Vulcanesti km 151.2 to km 172.7	230	40	70	120	180	150	560	290	40	70	180	180	0	470
Vulcanesti town passage km 172.7 to km 176.2	250	40	70	140	200	150	600	310	40	70	200	200	100	610
Vulcanesti - Slobozia Mare km 176.2 to km 201.9	210	40	70	100	200	150	560	310	40	70	200	200	100	610
Slobozia Mare - Giurgiulesti km 201.9 to km 215.8	250	40	70	140	200	150	600	330	40	70	220	200	170	700

*) including existing capping layer

Bitumen: Penetration Grade Bitumen 60/90 (GOST 22245)

*) including existing capping layer

Bitumen: Penetration Grade Bitumen 50/70 (EN 12591)

Base Course : Cold recycled existing asphalt stabilsed with bitumen emulsion and cement, new aggregates added as required based on laboratory tests

11.3.5. Frost Protection

Considering the cohesive subgrade and embankment fill along the project road attention has to be paid to the influence of freezing temperatures on the pavement layers and subgrade.

Based on long-term meteorological data the maximum depth of frost penetration has been recorded in the range from 600mm in the Cahul and Vulcanesti area to 700mm in the region around Cimislia and Comrat. The total thickness of the pavement structure which is considered non frost-susceptible has a thickness 480 to 600mm. The subgrade is considered frost-susceptible.

Taking full consideration of the frost penetration depth requires pavement thickness to be increased by adding granular material to reach the frost penetration depth. Granular material which qualifies as non frost-susceptible is very rare in Moldova. For this reason a limited subgrade frost penetration approach is adapted for this road. This approach allows some frost penetration into the subgrade but enough to prevent unacceptable surface roughness to developing.

11.4. Pavement Materials

All materials to be used shall comply with the requirements listed in the pavement design report, in the geotechnical report and in the relevant standards. The main properties of the proposed pavement layers, materials and of the bituminous mixes are presented in the pavement design report including the recommended grading, bitumen content and other relevant material characteristics.

Bitumen
For the bituminous mixes of the new pavement layers for the Chisinau – Giurgiulesti/Romanian Border road the use of penetration grade bitumen 50/70 according European standard EN12591 is recommended. The interaction of the bitumen with the aggregates to be used shall be tested especially with regard to adhesion. Depending on the test results it might become necessary to use additives to modify the properties of the bitumen and meet the requirements.

Asphalt Surface Course
A continuously graded asphalt concrete based on Marshall Test criteria is recommended for the construction of the structural surfacing. Aggregates for asphalt concrete shall be entirely crushed material and provided from approved sources and shall be free from elongated, soft or decomposed pieces, excess dust and any dirt, acids or other deleterious substances.

Asphalt binder course
A continuously graded bituminous binder course based on Marshall Test criteria is recommended. Crushed material from approved borrow areas with natural river gravel will meet the main requirements for aggregate production. Aggregates for asphalt binder shall be entirely crushed material and shall be free from elongated, soft or decomposed pieces, excess dust and any dirt, acids or other deleterious substances.

Bituminous base course
The material for base course shall consist of crushed stone, roughly cubical in shape, free from elongated, soft or decomposed pieces, excess dust and any dirt, acids or other deleterious substances. Crushed river gravel will be suitable material for the production of the coarse aggregates. For the fine aggregate material like crushed stone or sand or a blend of these may be used.

Prime Coat
All non–bituminous road bases shall be primed. The most appropriate binders for priming are medium curing fluid cut-backs MC 30 and MC 70. MC 30 is suitable for practically all types of materials. MC 70 is suitable only for open textured materials, such as crushed stone. The rate of application of 1.0 litre/m² is proposed for cost calculation purposes

The use of emulsions for priming is not recommended. If the use of emulsion is proposed by the contractor the suitability of the material has to be demonstrated on a test section.

Tack Coat
A tack coat has to be applied on all bituminous surfaces, e.g. bituminous base course, existing bituminous surface for overlaying, widening of existing bituminous pavement layers. Tack coats shall be bitumen emulsions complying with the relevant standards. For cost calculation purposes a rate of spray of 0.6litres/m² is proposed.

Base /subbase stabilised with bitumen emulsion (containing recycled asphalt and natural material)
Bitumen emulsions were developed as a means of reducing the difficulties of working with hot bitumen mixing with damp material at ambient temperatures.

Cement is normally used in conjunction with bitumen emulsion for stabilising material mixes. The sole reason for using emulsified bitumen as a stabilising agent is to make it possible to mix bitumen with cold moist material.

When bitumen emulsion is used as a stabilising agent in the recycling process the emulsion has to be chosen according to the specific conditions. Bitumen emulsions are susceptible to temperature and pressure.

Cement Stabilised Base Course (containing recycled asphalt and natural material)
For the provision of material and construction of the cement stabilised base it can be possible to use the existing asphalt construction as recycled construction material from the whole road section. In this case the existing asphalt construction is to be milled and to be transported to special collecting stations. Then this asphalt material is to be mixed with natural crushed limestone material. This process can also occur direct in place. The recommended proportion of milled asphalt material and crushed limestone material is 1:1. The crushed limestone should have a grading as a sand-gravel material.

Granular Subbase
Granular sub-base material can be selected from road excavation and/or from borrow areas. Selection within the material sources will be required in some cases. The material may consist of natural sands, gravels, crushed rock, crushed slag, and crushed concrete and recycled aggregates. The material shall not contain more than 50% asphalt arising.

Capping Layer
Soils for capping layer or soil replacement can be obtained from areas of cut, or from borrow pits. Road way excavation will virtually also yield material suitable for the construction of the capping layer.

Recommended grading or plasticity criteria are not given for these materials; the content of fine material passing the 0.063mm sieve shall be less than 10%. It is also desirable to select reasonably homogeneous materials since overall pavement behaviour is often enhanced by this. The selection of materials which show the least change in bearing capacity from dry to wet is also beneficial.

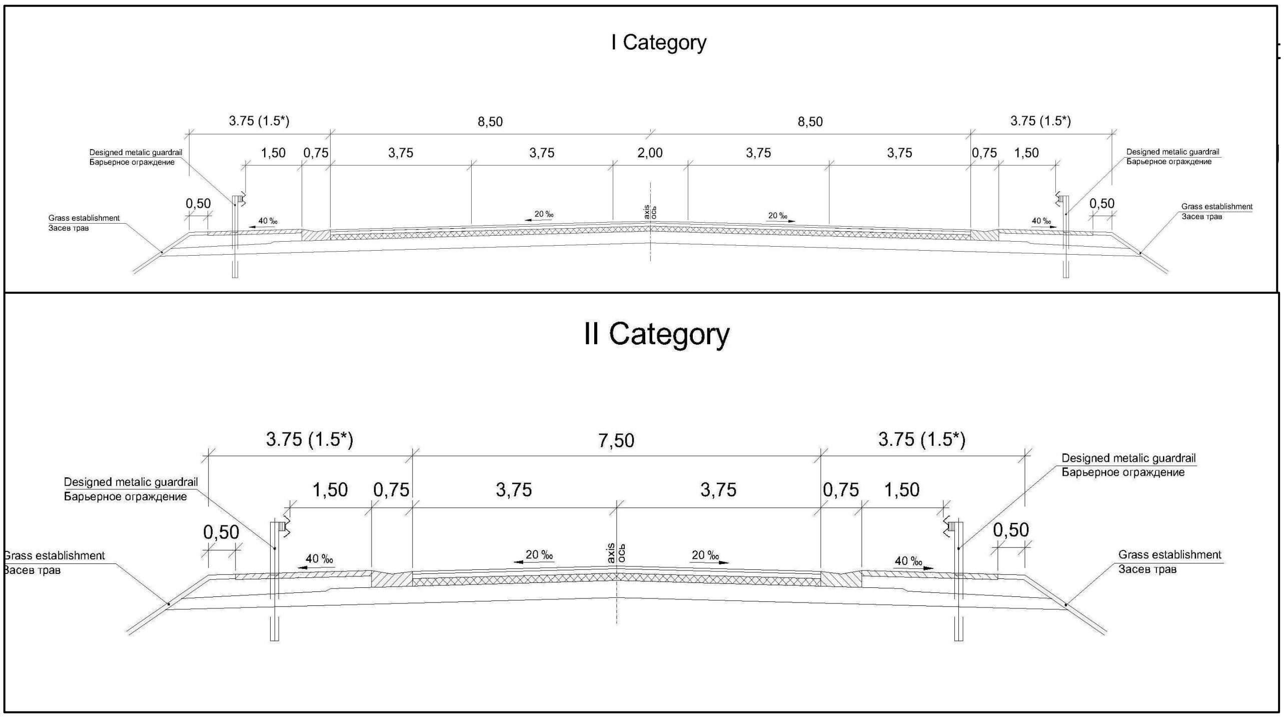
12. ROAD DESIGN

12.1. Preliminary Engineering Design

Road Design Standard
The geometric design was carried out according to the Former Soviet Union Standard (SNIP) 2.05.02-85, which is in use in Moldova.

Preliminary road/bridge designs
The recommendations on the geometrical elements for designing the road are included in the chapter 4 “Selection of Design and Construction Standards” presented earlier in the document. The standards and possible modifications are currently being discussed and will be further evaluated with the Ministry of Construction and Territorial Development, as well as with the State Road Administration, taking into account other highway designs in Moldova and international standards.

Figure 12-1. Schematic Cross-section Category I and II



Source: SNIP

12.2. Preliminary Design Drawings

Two sets of Plan and Profile sheets have been developed:

- Plan and Profile for the existing alignment
- Plan and Profile for bypass section

Table 12-1 presents a listing of preliminary design drawings for improvements to the existing alignment, including the number of sheets per section. Table 12-2 presents the preliminary design drawings for the bypass section. Table 12-3 presents typical design drawings for selected features.

Table 12-1. Preliminary Design – Improvementy to Existing Alignment

Nr.	From – To	Km	Sheet
1	Chisinau - Sagaidacul Nou	Km 0+000-km 32+000	1- 5
2	Sagaidacul Nou to Porumbrei	Km 32+000- km 34+500	6
3	Porumbrei to R 3	Km 34+500- km 48+800	7- 8
4.	R3 to Cimislia	km 48+800- km 57+300	9-10
5.	Cimislia urban section	km 57+300- km 62+400	11
6.	Cimislia – Comrat	km 62+400- km 88+400	12-15
7.	Comrat urban section	km 88+400- km 96+000	16
8.	Comrat - R38	km 96+000- km 135+800	17-22
9.	R38 - Ciumai	km 135+800- km 151+600	23-25
10.	Ciumai - Vulcanesti	km 151+600- km 173+000	26-28
11.	Vulcanesti urban section	km 173+000- km 176+300	29
12.	Vulcanesti - Slobozia Mare	km 176+300- km 202+000	30-33
13	Slobozia Mare – Giurguilesti	km 202+000- km 216+000	34-35

Source: Consultant

Table 12-2. Preliminary Design – Extension and Bypasses

Nr.	From – To	Km	Sheet
B 1a.	M3 extension		1-4
B 1b.	Cimislia Bypass		4-6
B 2.	Realignment Ciucur-Minjir		1
B 3.	Bypass Comrat		3
B 4.	Bypass Chirsova		1
B 5.	Bypass Congaz		1
B 6.	Bypass Svetlii		1
B 7.	New alignment and bypass Ciumai – Burlaceni	See exist alignment 9. Ciumai – Vulcanesti	
B 8	Bypass Vulcanesti		2
B 9.	New alignment and bypasses of Slobozia Mare, Caslita-Prut, Giurgiulesti		3

Source: Consultant

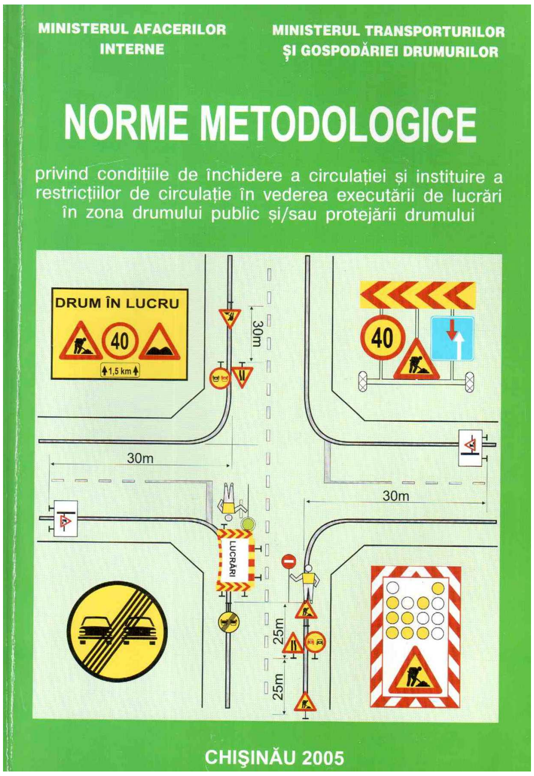
Table 12-3. Preliminary Design – Typical

Nr.	Object	Sheet
1	Typical Pipe Culvert	1
2	Typical Culvert	1
3	Chute and roadside ditch	1
4	Road signs	1
5	Guardrails	1
6	Pedestrian rails	1

Source: Consultant

12.3. Traffic Management During Construction

Traffic management during construction will be conducted according to the methodology established by the manual *Methodological Standards Regarding the conditions of stopping the traffic and implementing the restrictions for works execution in the public area road and/or road safety,* elaborated by the Ministry of Internal Affairs, and the Ministry of Transport and Road Administration, Chisinau 2005.



13. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

13.1. Introduction and General Study Approach

The following chapter presents the key findings of the environmental and social assessment. Individual documents for the Environmental and the Social Assessment have been prepared (see Appendix III-5) as separate reports.

Two main issues in the ToR for this project determine the conduct of the M3 FS and subsequently the conduct of this Environmental and Social Assessment:

> **First,** no particular donor/lender has been identified for the needed improvements on M3. This means that the procedures and guidelines from the various IFIs need to be taken into consideration to the extent possible. While the general guidelines of each of the institutions are similar in approach detailed analysis might vary. Therefore, a generalized approach will be applied to satisfy overarching requirements.
>
> **Secondly,** individual roadway segments are currently being evaluated in regards to their economic feasibility, based primarily of current and future traffic volumes and estimated cost of the needed improvements. This iterative process will identify specific sections ranked by their need and priority of implementation. Once the particular sections are identified, the impacts of the chosen projects will be analyzed and assessed.

Therefore the EA will be two-phased. First, a corridor-level EA is being carried out, and secondly, once individual projects are identified, detailed EIA will be conducted for the selected sections, taking into consideration scope and extent of the Project as well as its expected environmental impact.

13.2. Objective and Scope of the Environmental Assessment

Given the situation outlined under the section ‘General Study Approach’ the present EA has been conducted in phases with different respective objectives and scope:

Project Categorization
The first step within the EA process is the determination of the level of environmental assessment required in accordance with national and IFI requirements:

- A ‘Category A’ would be assigned to such sections where ‘significant’ impacts may be expected and alternatives (e.g. different alignments for proposed bypasses and the ‘non-project option’) are considered.
- A Category B would be assigned to sections where no significant impacts are expected.

The categorization would either trigger an Environmental Management Plan (EMP) to be prepared or an Environmental Impact Assessment (EIA) to be conducted for defined sections of the overall Project.

EMPs for Rehabilitation Reconstruction-Only Sections
For sections where only rehabilitation or reconstruction are proposed within the existing RoW and where the proposed interventions would not affect environmentally sensitive locations or areas, environmental impacts are not normally significant and can generally be managed by proper construction management and appropriate, up to standard construction. Such measures would be compiled in an EMP to subsequently become binding elements of the contract documents.

Potential Off-Line Improvements
Where new bypasses are suggested based on economic and environmental considerations or where the proposed interventions would potentially affect environmentally sensitive locations / areas more significant and irreversible environmental and / or socio-economic impacts may result. For such sections an EIA would be conducted including the assessment of options and preparation of EMPs.

13.3. Approach and Methodology

Since the ultimate International Funding Institution (IFI) for the implementation of the Project or potential sub-projects has not yet been identified, the various environmental and social guidelines have been considered to the extent possible. A series of meetings with the MCC environmental team took place to coordinate the process and study effort. The Consultant's study team, comprising of both Moldovan and international environmental and social experts, carried out the following activities:

- Conduct of several field visits to the study corridor between June and December 2008;
- Review of relevant national environmental legislation and procedures and IFI policies;
- Review of existing baseline data (literature and internet publications);

Study coordination has been an on-going process throughout the process, including various individual or group meetings with Project stakeholders, e.g.:

- Rep. of Moldova State Road Administration;
- Ministry of Construction and Territorial Development;
- International Financial Institutions (WB, EBRD);
- Millennium Challenge Account (MCA) Moldova;
- Millennium Challenge Corporation (MCC) Delegation;
- Danube Logistics;
- Steering Committee Meeting;
- and others.

Coordination with MCC and the local MCA continued throughout the study[1]. Scoping meetings were organized at 3 strategic locations in coordination with the local and state administration and the active support of the Ministry of Construction and Territorial Development. In total 93 elected officials, citizens, stakeholders and NGO representatives participated in these meetings.

13.4. Policy, Legal and Administrative Framework

13.4.1. National Environmental Policy

The foundation of the environmental policy of the Republic of Moldova was laid by the Law on Environmental Protection (1993), the Concept of Protection of the Environment (1995), the National Strategic Program of Actions for the Environment (1996) and the National Action Plan for Environmental Health (2001). By 2003, Moldova had signed 17 international agreements, and

[1] Note: While National Transport Strategy projects are currently funded or underway, the MCC is in the process of finalizing a compact agreement with the Government of Moldova. In preparation of the compact agreement MCC has selected five corridors from the National Transport Strategy for potential funding. The section of M3 from Cimislia to Giurgiulesti is one of the candidate projects identified by MCC for funding.

ratified 15, adopted 25 laws and approved more than 50 regulations, instructions etc., which also form the normative framework for environmental protection.

The Concept for the Environmental Policy of the Republic of Moldova (2001), substituted the action plans and the concepts that were used until the mid 90's. This policy paper tries to adjust the main objectives of the national environmental policy taking the social and economic changes in the country and also recent regional and global trends into account. Another key document is the Action Plan EU-Moldova which addresses sustainable development and proposes measures to be taken to better integrate the environmental dimension into the policies of other sectors. Transport is being given particular attention in this context. The Strategy for Economic Growth and Poverty Reduction also contains a chapter on environmental protection and the sustainable use of natural resources, emphasizing the need to integrate these principles into all sectors of socio-economic activities.

13.4.2. National Environmental Legislation and Institutional Framework

The following summary on the Environmental Assessment Procedures of Moldova and related institutional aspects has been extracted from the Sectoral Environmental Assessment carried out in 2007 under the Moldova Road Sector Program Support Project[2]. More comprehensive information on these regulatory provisions and other relevant environmental policy and the legal and institutional framework was extracted from the same source and is provided in Appendix x.

13.4.3. National Environmental Assessment Procedures

Moldova has its own relatively well-developed legal and institutional framework for Environmental Assessment. This framework is in line with the existing WB EA rules and procedures as well as with the EU EIA Directives. The national legal basis for Environmental assessment is presented in two main laws: Law on Environmental Protection (1993) and the Law on Ecological Expertise and Environment Impact Assessment (1996). These laws introduce the concept of state ecological review (literally, state ecological "expertise" – SEE) which seeks to examine the compliance of proposed activities and projects with the requirements of national environmental legislation and standards. The SEE precedes decision-making about activities that may have an adverse impact on the environment. Financing of programs and projects is allowed only after a positive SEE conclusion has been issued. Procedures for conducting SEE are contained in the Guidelines on Performing SEE (2002). They define, in detail, the goals, objectives, and principles of the SEE, and specify the procedures for submitting project documentation, as well as reviewing procedures.

According to the applicable national legislation project documents must describe and assess the expected direct/indirect impacts of the proposed project, in particular for such proposed projects that may impact on air quality, surface water and soils, on the integrity and stability of ecosystems and on people and settlements. The EIA/SEE documents also need to include:

- A comparison of alternatives and justification for the selected alternative,
- Mitigation measures to avoid or minimize impacts to acceptable levels.
- Generally, the Impact Assessment needs to address both the construction and operational phase of the project.

For the road sector, the Ministry of Transport and Roads Industry (MTRI) issued specific "Guidelines Concerning Environmental Protection for Road and Bridges Design, Construction,

[2] Moldova Road Sector Programme Support Project: Sectoral Environmental Assessment, Ministry of Road Transport and Road Industry; State Road Administration. Chisinau, February 2007

Rehabilitation and Maintenance Activities" in 1997, which define environmental requirements for designing, constructing and maintaining different types of roads and bridges in Moldova. This document also contains relevant provisions and standards with regard to traffic noise. In recent practice traffic noise issues are not being consistently followed up. For the present Project however, compliance of proposed solutions with these traffic noise regulations will definitely have to be considered in the decision making process.

Further national pieces of legislation that are relevant in the context of the EIA process are: the Water Code (1993, amended in 2003), the Land Code (1991 as revised), the Forest Code (1996), the Law on Air Protection (1997), the Law on Regime of Harmful Products and Substances (1997, amended in 2002), the Law on Wastes of Production and Consumption (1997), the Law on Payment for Pollution of the Environment (1998), the Law on Sanitary-Epidemiological Protection of the Population (1993, as amended), the Regulation on Access to Information, Public Participation in decision making and Access to Justice in Environmental Matters (2000). More details about each of these pieces of legislation is provided in Appendix x.

13.4.4. International Environmental Conventions

A catalogue with a comprehensive list of environmental legislation of the Republic of Moldova has been published in 2008. Besides the national environmental legislation this list also indicates the 27 International Environmental Conventions that Moldova is a party to. Of these the following have been considered in the organization of the EIA process for the M3 Project or considered in the assessment of potential impacts or the design of mitigation measures.

- The Espoo Convention on Environmental Impact Assessment in a Transboundary Context;
- The Aarhus Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters;
- The Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat; and
- The Bonn Convention on the Conservation of Migratory Species of Wild Animals.

13.4.5. Institutional Aspects

The national authority responsible for SEE in Moldova is the Division on SEE within the State Ecological Inspectorate (IES), which is a subdivision of the Ministry of Ecology and Natural Resources (MENR)3. The earlier mentioned Sector Assessment of 2007 concluded that these institutions do have relevant capacities to perform their duties in reviewing EA studies and enforcing EMP provisions. However, the Ministry of Construction and Technical Development (MCTD, formerly MTRI) and the State Road Administration (SRA) have no special unit and/or especially designated staff responsible for environmental issues in the road sector, nor are there appropriate laboratories that may assist in ensuring compliance with the applicable legislation, regulations and ecological norms. The Sector Assessment thus concluded that TA would need to be provided to the MCTD to strengthen its capacity and ensure the environmental requirements will be fully integrated into sectoral policies, and program design, as well as into design and implementation of the EIAs for subprojects. With the support of MCC and as a first step in that direction an environmental consultant has been recently appointed to the SRA.
Other governmental institutions that will be involved in the EIA process of the Project and its future sub-projects are:

[3] The IES has a special division in charge for performing SEE. For major projects (i.e. projects exceeding investment of 1 Mio Lei) it is the responsibility of the MENR's Institute of Ecology and Geography to perform the SEE.

- The Ministry of Economy and Commerce;
- The Ministry of Construction and Territorial Development.
- The Ministry of Agriculture and Food Industry
- The Agency “Apele Moldovei”.

13.4.6. IFI-Environmental Policies

European Bank for Reconstruction and Development – Environmental and Social Policy
The European Bank for Reconstruction and Development (EBRD) financed projects are expected to meet good international practice related to sustainable development. To help clients and/or their projects achieve this, the Bank has defined specific Performance Requirements (PRs) for key areas of environmental and social issues and impacts as follows:

- PR1 – Environmental and Social Appraisal and Management
- PR2 – Labour and Working Conditions
- PR3 – Pollution Prevention and Abatement
- PR4 – Community Health, Safety and Security
- PR5 – Involuntary Resettlement and Displacement
- PR6 – Biodiversity Conservation and Sustainable Natural Resources Management
- PR7 – Indigenous People
- PR8 – Cultural Heritage
- PR9 – Financial Intermediaries
- PR10 – Information Disclosure and Stakeholder Engagement

PRs 1 through 8 and 10 include the requirements for direct investment operations; PR2 and PR9 those for financial intermediary operations. Each PR defines, in its objectives, the desired outcomes. Compliances with relevant national laws are integral parts of the PRs.

Categorization of projects by EBRD will depend on the nature and extent of any actual or potential adverse environmental or social impacts as determined by the specifics of the project design, operation and location. EBRD Environmental and Social Policy lists samples of projects which could be considered Category A. Examples and descriptions indicated in the EBRD Policy which may be applicable to the Project are:

- Construction of motorways, express roads and lines for long distance railway traffic; airports with a basic runway of 2,100 metres or more; new roads of four or more lanes, or realignment and/or widening of existing roads to provide four or more lanes, where such new roads, or realigned and/or widened sections of road would be 10 km or more in a continuous length;
- Projects which are planned to be carried out in sensitive locations or are likely to have a perceptible impact on such locations, even if the project category does not appear in the EBRD list. Such sensitive locations include, inter alia, national parks and other protected areas identified by national or international law, and other sensitive locations of international, national or regional importance, such as wetlands, forests with high biodiversity value, areas of archeological or cultural significance, and areas of importance for indigenous peoples or other vulnerable groups;
- Projects which may result in significant adverse social impacts to local communities or other project affected parties;
- Projects which may involve significant involuntary resettlement or economic displacement.

World Bank Safeguard Policies

WB has a series of safeguards policies and procedures that address different issues. WB safeguards policies that may be triggered by the current Project are the following: (a) Environmental Assessment (OP 4.01), (b) Natural Habitats (4.04), and (c) Involuntary Resettlement (OP4.12). At current stage only policy related to the Environmental and Social Assessments (OP4.01 and OP4.12) are considered to be applicable, however, as the project is implemented, other policies may be potentially triggered, as well.

Environmental Assessment - World Bank requires environmental assessment (EA) of projects proposed for financing by Bank to ensure their environmental soundness and sustainability, and thus to improve decision making (OP 4.01, January 1999). EA is a process whose profundity and type of analysis depends on nature, scale, and potential environmental impact of the proposed project. EA evaluates a project's potential environmental risks and impacts; examines project alternatives; identifies ways of improving project selection, sitting, planning, design and implementation by prevention, minimization, mitigation or compensation of adverse environmental impacts and enhancing positive ones. It also includes mitigation and management of adverse environmental impacts during project implementation. Generally, the Bank favours preventive measures rather than mitigation or compensatory ones, whenever feasible.

EA takes into consideration the natural (air, water, and land), social (human health and safety, and such social aspects as involuntary resettlement, indigenous peoples) and cultural environments, as well as trans-boundary and global environmental aspects. It also takes into account the variations in project and country conditions, findings of country environmental studies, national environmental action plans, the country's overall policy framework, national legislation, and institutional capabilities related to the environmental and social aspects, and obligations of the country to be met under relevant international environmental conventions and agreements. The Bank does not finance projects that would not comply with these obligations, if these are identified during EA.

WB OP 4.12 on Involuntary Resettlement - The requirement of the World Bank's Policy (WB OP4.12) is to avoid involuntary resettlement whenever possible. The details of this specific Policy are presented in the Social Impact Assessment Report prepared as an integral part of this FS.
Information Disclosure and Consultation - For (i) A and B projects and (ii) sub-projects categorized as A and B, the borrower consults project-affected groups and local non-governmental organizations (NGO's) about the project's environmental and social aspects and takes their views into account. The borrower initiates such consultations as early as possible. For Category A projects, the borrower consults these groups at least twice: (a) shortly after environmental and social screening and before the terms of reference for the EA are finalized; and (b) once a draft EA/Resettlement Action Plan (RAP) reports are prepared. In addition, the borrower consults with such groups throughout project implementation as necessary to address SEA-related issues that affect them. The Borrower provides relevant information in a timely manner prior to consultation and in a form and language accessible to the groups being consulted.

The Borrower makes the Draft EA (for category A projects) or any separate EA report (for category B projects) available in country in a local language and at a public place accessible to project-affected groups and local NGOs prior to appraisal. The final EA report should be sent to the InfoShop prior to appraisal for all Category A and Category B projects. For Category A projects, the task team sends a summary of the EA report to the Board of Directors as soon as it is received.

Where in accordance with World Bank Safeguard Policies (OP/BP/GP 4.01 Environmental Assessment) a project is rated environmental Category B (limited and reversible environmental impact) EIAs and an Environmental Management Plan (EMP) would nevertheless have to be carried out as part of project preparation and design. The EMPs would address the moderate adverse environmental effects of the physical rehabilitation activities of the project, would provide mitigation and monitoring plans to ensure appropriate attention to environmental and social issues, and would monitor management practices.

Millennium Challenge Corporation – Guidelines for Environment and Social Assessment
The Millennium Challenge Corporation (MCC) is cognizant of the fact that pursuit of sustainable economic growth is highly associated to a healthy environment. Accordingly, to ensure that MCC funded programs are environmentally sound, compliance with certain regulatory requirements and policies promulgated is required. The guidelines provide the principles of EIA by which the Compact eligible countries are expected to apply. The application of these guidelines to specific projects and the scope of environmental and social impact review depend on the nature, scale and potential environmental and social impacts of proposed projects. As part of its review of Compact proposals, MCC funding decisions will be informed by the results of environmental screening and where needed, an Environmental Impact Assessment or other environmental and social impact analysis. Screening will result into project categorization based on scope and magnitude of impacts. Projects which are deemed to have significant adverse environmental and social impacts, considered to be sensitive, diverse and unprecedented are classified as Category A and will be the subject of a full EIA based on the guidelines. Project classified as Category B (less adverse impacts than A) will require specific environmental and social analysis including an Environmental Management Plan (EMP). Category C projects on the other hand are considered unlikely to have adverse environmental and social impacts but where MCC reserves the right to require specific impact studies as the case maybe.

13.5. Project Related Activities

As had been recommended in the Terms of Reference for the Project, the road rehabilitation will generally follow the existing alignment to minimize extensive excavation and avoid realignment in difficult sections and land acquisition in urban areas and agricultural areas. The proposed carriageway and shoulder width are shown in Chapter 4. However, there will be sections where pavement and shoulders will be narrower depending on the local conditions. As part of the improvement works the following types of interventions are envisaged:

- Rehabilitation and widening of some existing road sections;
- Resurfacing or rehabilitation of existing bitumen and concrete surfaced roads;
- Upgrading of some existing sections to Category II standard or construction of new alignments, including bridges.

The proposed rehabilitation and construction works will involve the following activities:

- General activities (survey/preliminary works)
- Establishment and operation of work camps, equipment mobilization and operation, contractors yard and possibly crushing plants;
- Site Clearance;
- Earth works;
- Establishment of quarries and borrow pits;
- Stockpiling and dumping of spoil/debris;
- Construction of culverts and drainage works;

- Road formation (gravel road shaping, sub-base and base preparation, shoulder and sidewalk construction);
- Road surfacing (use of bitumen for prime coat and surface dressing and/or concrete);
- Potential relocation of some public utilities like electric posts, telephone lines, irrigation and drainage ditches, gas pipes etc.;
- Provision of sidewalks and new drainage in the villages;
- Replacement, repair and rehabilitation of existing bridges[4];
- Provision of new rest areas at selected sites;
- Provision of road furniture and markings in accordance with international standards;
- Provision of protective devices for sensitive animal habitats; and
- Potential land acquisition for the road right of way.

Off-site Works
Off-site works will mainly relate to the extraction of construction materials from already existing and / or new borrow pits and quarries. However, findings so far indicate the absence of quarries and borrow sites in the close vicinity of the study corridor. Therefore, hauling of construction materials to the work sites, and its associated traffic will be of concern.

Construction
Construction activities will normally take place within the existing RoW, unless bypasses and extensions are determined feasible. Through the provisions contained in the contract documents the Contractors will be generally requested to plan their operations such as to minimize the physical impact on the adjoining human and natural environment. In addition the EMP will provide indications on where and how construction organization shall be adapted to the conditions of a specific site / road section so as to avoid or to minimize potential adverse impact on the human, the physical or the biological environment.

Implementation Schedule and Staffing
Since the IFI(s) for the Project have not been identified at this point in time implementation schedule and staffing are unknown. However the M3 FS's final product will be a prioritized list of projects indicating the timeframe of implementation.

Lifespan of the Project
The proposed Project is designed for a lifespan of 20 years provided that routine and periodic maintenance is carried out.

13.6. Environmental Baseline

The following information on the environmental baseline is mainly drawn from existing sources, such as official thematic maps, literature and official internet documents. This information was complemented by data obtained during the field visits and the public consultation process.

13.6.1. General Topography and Landscapes

The topography of the country is generally characterized by hills and plains, with the plateaus being mainly located in the Central part, which is slightly inclined from the North-West to South-

[4] Note: in total there are 41 bridges on the existing route. Out of these some will need to be replaced, repaired or may not require any interventions if they are in a satisfactory technical condition.

East. Overall, the country is relatively low-lying, with semi-arid steppe developed in the in the plains in the southern parts. The hills in the Central part of the country are densely forested, while arable fields replaced the natural grass cover of the plains and steppes in the North and South. Absolute elevations hardly exceed 400 m, the absolute maximum (429 m) is reached in the Central part of the country. The relief altitudes vary from 5 m (Giurgiulesti and the end point of the study corridor) to 429 m (Balanesti).

As is shown in the following Figure 13-1 the territory of the country is divided into two natural zones and five landscape regions:

Forest Steppe Zone

This occupies the northern and central parts of the country and is characterized by alternating plains and plateaus. The flora of this zone is rich with characteristic forest, steppe and meadows formations. Soils are mainly composed of normal and leached chernozems, as well as dark chestnut and brown soils in the oak and beech forests and under the hayfields. According to the physico-geographical conditions the forest steppe zone can be distinguished into three landscape regions

- Region of plateaus and forest steppe plateaus in the North of the country;
- The region of plateaus and plains with meadows (grasslands) of the Baltic Steppe;
- The plateaus of the Codri forests are in the central part of Moldova.

The Steppe Zone

This is located in the South and Southeast of Modova. It comprises elements of the steppe and forest steppe but has a lower biodiversity than the latter. Within this zone normal carbonic and leached chernozems as well as regularly flooded meadow soils prevail. The landscape regions of the Steppe Zone are:

- The steppe plains of the lower Nistru River terrace, situated in the South-East of Moldova;
- Fragmented plains of the Bugeac Steppe in the Southwest and South of the country.

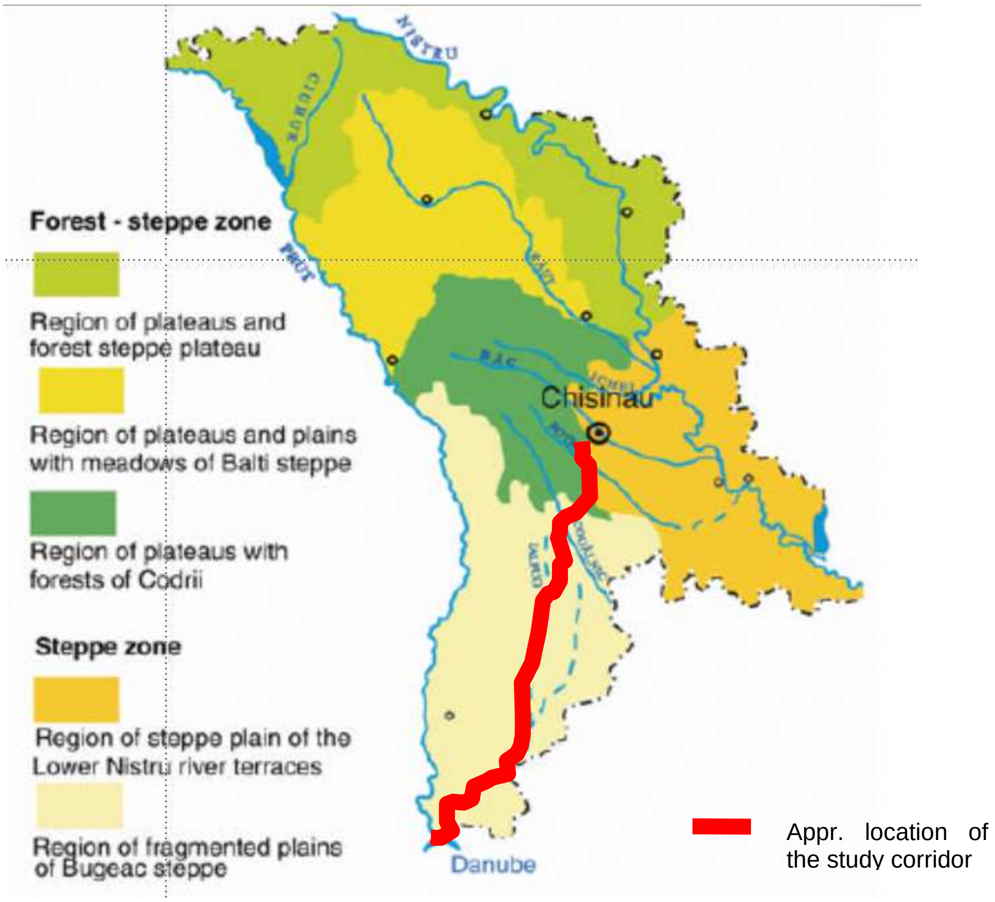
As can be seen from Figure 13-1 only a short northern section of the road runs through a region that was initially covered by forest (Codri Forest region). Further south the route then runs through landscapes that are naturally occupied by steppes (Balti and Bugeac Steppes).

The level of degradation of the natural landscapes of Moldova is high due to intensive agriculture and high population density. Agricultural lands occupy 75.14% of the territory of the country, forests – 9.6%, swamps – 0.16%, steppes and wet meadows are preserved as grazing fields – 11.23%. Of the latter only about 5% have preserved their high natural value; about 30% are still capable of self regeneration, the rest is degraded due to overexploitation. Seriously degraded soils occupy more than 13% of the country territory.

General Topography

The territory between Prut and Nistru Rivers is a part of a plateau that extends from the Bucovina Mountains and the Moldavian Sub-Carpathians in the West to the Nistru River in the East. On the left bank of Nistru River are the South-Western branches of the Podolia Plateau. The relief is rather fragmented, with the highest fragmentation density in the Center and the South-Western part of the country (Ialpug Plain). Relatively reduced values of the fragmentary density are in the Northern Moldova Plateau and in the Lower Nistru Plain. The relief, along with other geo-ecological, biotic and socio-human elements contributed to the formation and geographical landscape and eco-systems evolution. The genesis of the geo-ecological complex took place at the end of the Upper Pleistocene and in the first half of the Holocene. The biotic complex (vegetation and fauna) and soils were formed in the second half of the Holocene. Moldova does not have any major mineral deposits but natural resources include deposits of limestone, sandstone and gypsum.

Figure 13-1. Natural Zones and Landscape Regions of Moldova

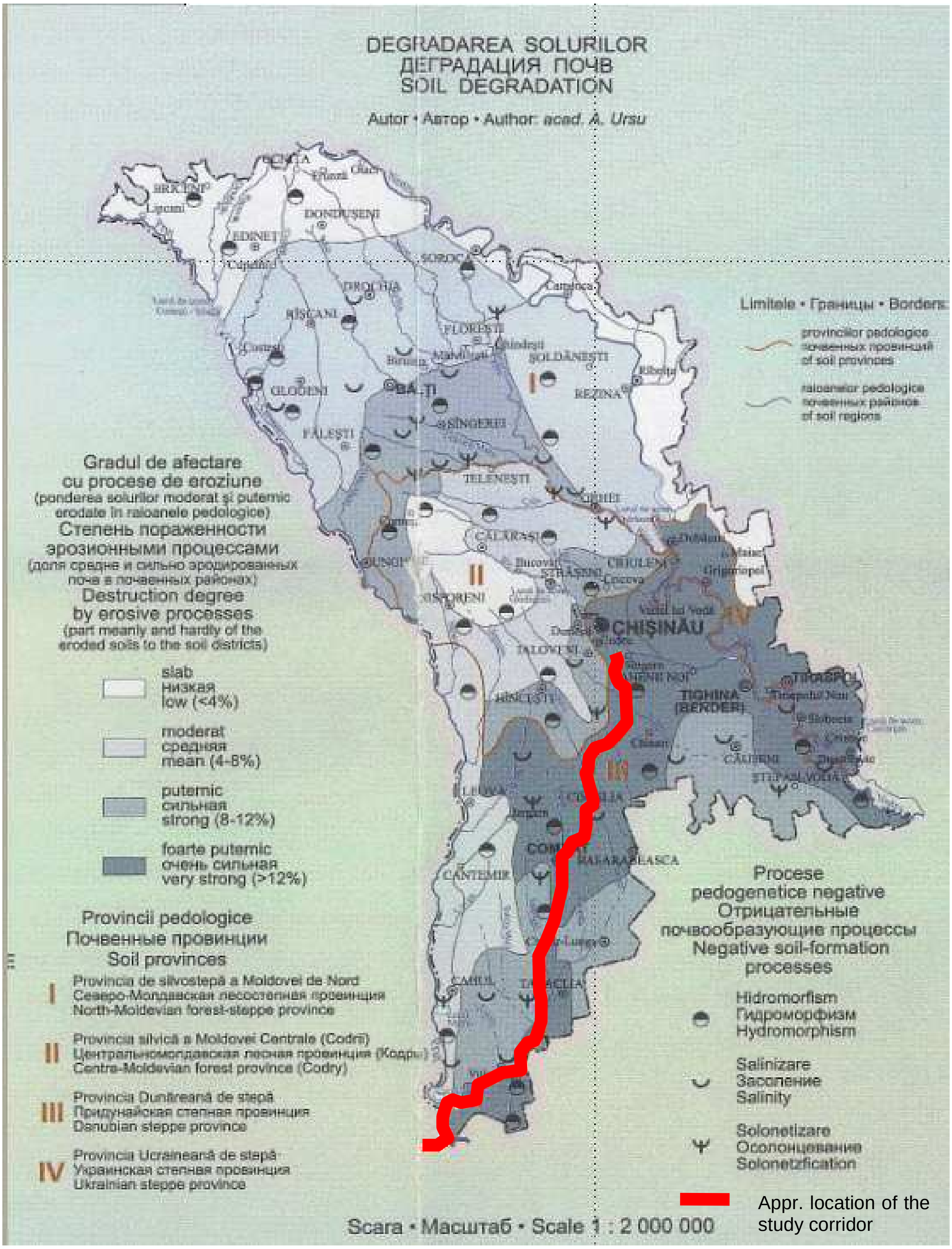


Source: Third National report on the implementation of the CBD. Chisinau, 2005

13.6.2. Soils

Three-quarters of the country are covered with fertile Chernozem soils which is the main natural resource in Moldova. The naturally productive soils and favourable climatic conditions support substantial and diverse agricultural production such as wheat, corn, barley, tobacco, sugar beets, soybeans, sunflower, fruits and vineyards. Beef and dairy cattle, as well as pigs, sheep and poultry are raised on a family farm scale. In the south of the country the prevailing soil type is simple Chernozem, one of the most fertile types of soils. Alluvial soils characterize the floodplains, while the lower reaches of the Prut and southern river valleys have saline and marshland soils. The excessive use of chemical fertilizers, pesticides, and herbicides during the Soviet period has generally resulted in significant contamination of the soil and groundwater. Figure 13-2 overleaf shows that the study corridor is located in a zone where the soils are classified as heavily degraded, mainly by erosive and negative soil formation processes (salinization).

Figure 13-2. Soil Degradation



Source: Republic of Moldova Ecological State. Extract of a map produced by the Institute of Geography of the Academy of Sciences of the Republic of Moldova and IC 'Regionica' under a fund from the Ecological Fund of the Republic of Moldova and the WB/GEF Project No. TF051208. 2004

13.6.3. Hydrology and Drainage

The country has a well-developed network of rivers and streams, all draining south towards the Black Sea lowlands, and eventually into the Black Sea. Of the more than 3600 rivers and streams only 8 rivers and streams exceed 100 km in length. In fact, many of these are small, shallow streams that dry up during the summer. The Dniester (Nistru), Moldova's main river, is navigable throughout almost the entire country, and in warmer winters it does not freeze.
The River Prut is a tributary of the Danube, which it joins at the far southwestern tip of the country (close to the end of the Project road). Over 95% of the surface water in Moldova drains into Prut or Dniester. The main rivers in the southern part of the country (where the M3 is located) are **Cogîlnic** and **Ialpug**, both around 100 km long. Oher smaller streams that are crossed by the road are (from North to South) Isnovat, Botna, Botnisoara, Ialpujeli, Cirsova Mare, Cerac, Salcea Mare and Cahul. Numerous other streams that are crossed are unnamed. Ialpug, Cogâlnic, and other small southern rivers largely drain into the Danubian estuary in nearby Ukraine. Most of the smaller water courses are fed by precipitation, the contribution of groundwater is limited. Maximum water level are mainly in spring, following the snow melt, and in summer, when torrential rains may cause catastrophic flooding. During the rest of the year such small streams generally fall dry.

Moldova only has a few ***natural lakes***, most of them in the Prut and Dniester river floodplains. Water reservoirs were created for various purposes, e.g. irrigation, fish-farming, leisure, industrial and domestic needs, and flood protection.

Groundwater resources are limited in Moldova, especially in the southern part of the country, which is classified as a water scarcity area. Groundwater is the major source of potable water supply for the majority of the rural population.

The general characteristics of the shallow aquifers are high salt contents of over 1.000 mg/l (in the belt between Comrat and Cahul even exceeding 3.000 mg/l) and nitrate contents. In the EU, the permissible limit of Nitrate content for potable water supply is 50 mg/l. This value is apparently exceeded almost everywhere in the south of Moldova, except in the area between Cimislia and Comrat, Balabanu and Vulcanesti and in a small area in the southernmost part of the country.

While high salt contents are mainly due to natural factors, high nitrate contents are caused by agriculture through inappropriate use of organic fertilizers. An overview of the situation of groundwater pollution for selected parameters is shown in Figure 13-3**.**

13.6.4. Climate

The Climate of Moldova is moderately continental and characterized by a lengthy frost-free period, a comparatively mild winter, considerable temperature fluctuations and erratic rainfall, and, in the south, extended droughts. Average temperatures are -3.5℃ in January and +21.4℃ in July. The warm period of the year lasts about 193 days. Average annual rainfall decreases from from 711 mm in the North-West to 600 mm in the South-East.

Extreme lows - near −36 ℃ in the north and excessi ve highs of about 41 ℃ in the south have been recorded. The country receives highly variable amounts of precipitation, usually averaging 500 mm annually, with totals a little lower in the south, but these figures conceal variations that may double the quantity in some years and result in prolonged dry spells in others. Most precipitation occurs as rain in the warmer months, and heavy summer showers, coupled with the irregular terrain, cause erosion problems and river silting. Winter snow cover is thin. Winds tend to come from either the Northwest or Southeast.

Figure 13-3. Groundwater Pollution

Source: Republic of Moldova Ecological State. Extract of a map produced by the Institute of Geography of the Academy of Sciences of the Republic of Moldova and IC 'Regionica' under a fund from the Ecological Fund of the Republic of Moldova and the WB/GEF Project No. TF051208. 2004

13.6.5. Natural Hazards

The territory of the Republic is exposed to some unfavourable natural processes and phenomena, such as erosion, land slides, earthquakes, etc. Torrential rains, droughts, desertification processes, strong winds, tornadoes, hails, spring and autumn frosts are other common natural phenomena in the region. Figure 8-1 in chapter 8 presents the identified geo-hazards.

Natural calamities like droughts, heavy rains (often with hail), massive floods, hurricanes, snow storms, extremely cold winters and other destructive processes became increasingly frequent in the recent past. During the warm periods of 2004 and 2008 several heavy rains (often with hail) occurred during May, July and August, sometimes accompanied by storms and vortexes. During the warm period of 2007 heavy drought was recorded from May to September, causing high social and economic damage.

Moldovan landscapes are naturally susceptible to ***landslides***, a phenomenon that is often triggered by human activities such as construction on dangerous slopes resulting from poor physical planning. As regards the study corridor along the M3 the known areas susceptible to landslides are:

- northeast of Cimislia (close to one of the bypass alternatives that was assessed during the early planning stages); and
- South of the village Ciumai (~ km 151) where an improvement of the existing alignment is proposed.

As regards ***seismicity*** the Project route runs through two seismic regions:

Bacioiul - Cicur Minjir:	7 Richter on scale; and
Bugeac - Guirgiulesti:	8 on Richter scale.

13.6.6. Biological Environment

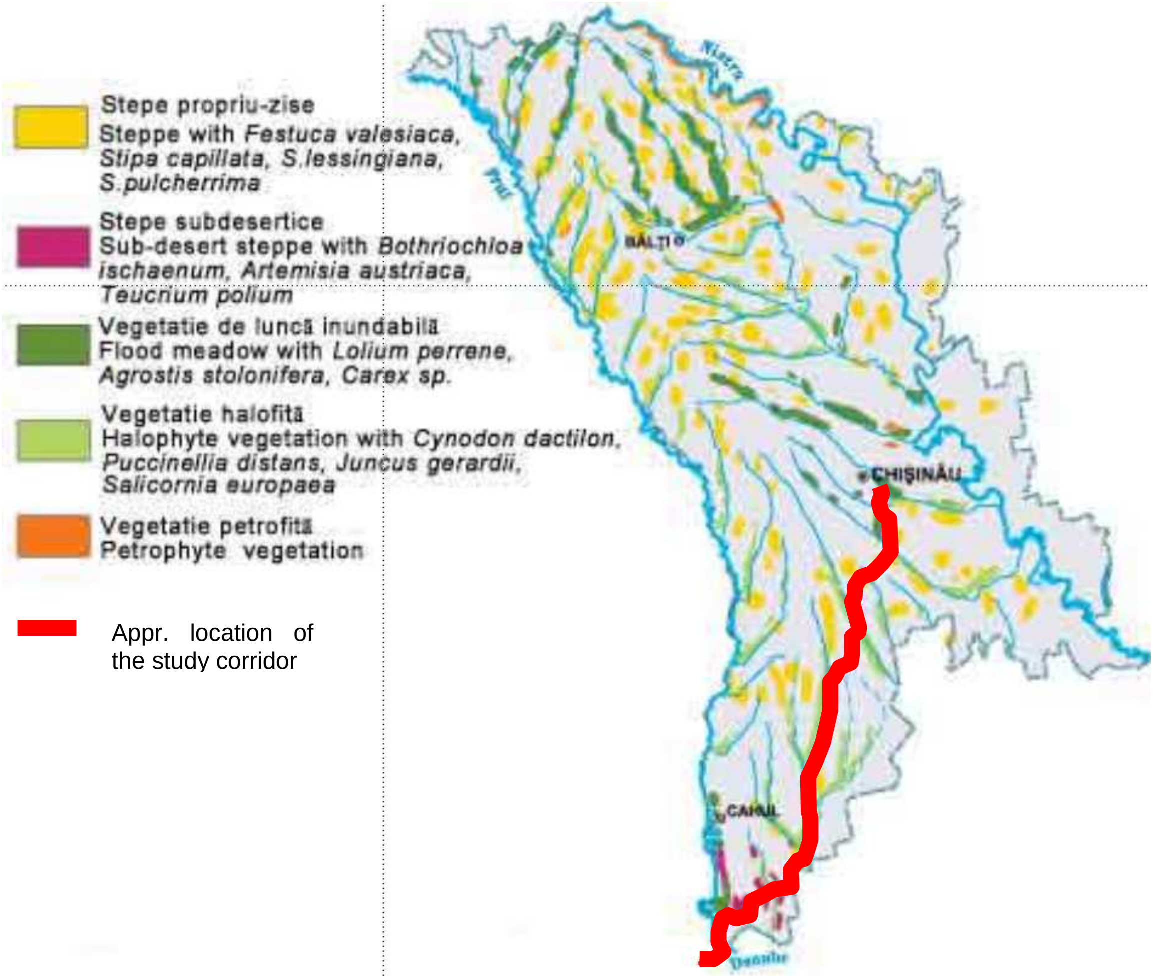
The geographic location, climate and landscape of Moldova provide favourable conditions for the development of a rich flora and fauna. The Red Book of the Republic of Moldova (2001) includes 126 species of flora and 116 species of rare and/or endangered animal species that are protected by law.

Flora

As was mentioned earlier in this report, the territory of the Republic of Moldova can be distinguished into two natural vegetation zones, forest steppe and steppe. The *steppe zone* covers the plains and highlands located South and East of the Central *Codrii Plateau* and the *Tigheci Hills*. In addition, steppe vegetation appears in the North of the country (the *Bălti steppe*). Almost all former steppe areas, and especially the *Bugeac Region* (through which most of the study corridor runs), are now being used for agriculture. As a result only fragments of natural steppe communities remain mainly on steep hillsides or areas affected by landslides. Such steppe fragments are mainly formed by xerophytic *Poaceae, Festuca valesiaca* and *Stipa* species, *Asteraceae* and *Lamiaceae* are also common (see **Figure 13-4**). In the very south of the country fragments of sub-desert steppes remain. These communities are sparsely vegetated, resistant to drought and high temperatures and have a short period of growth. They have a less diverse flora than other steppe communities and are dominated by *Andropogon sp, Artemisia sp.* and *Thymus sp.*

Steppe ecosystems include diverse and unqiue flora and fauna biodiversity, play an important role in soil stabilization and are important ecotonal habitat elements in the forest and agricultural landscape. The few remaining steppe communities are under constant pressure through the expansion of pastures and overgrazing.

Figure 13-4. Steppe and River Meadow Vegetation in the Republic of Moldova



Source: Republic of Moldova: Biodiversity Conservation National Strategy and Action Plan [5]

Lush meadows and reed growths occur in parts of the floodplains of River Prut, while salt-marsh grasslands flourish in the saline valleys of the rivers Cogâlnic, Ialpug, and lower Prut. Local larger stands of reed were also observed at around km 84 of the M3 in the immediate vicinity of the road and the River Ialpug.

The *forest steppe zone* located in the northern part of the country includes forest communities, mostly located in hilly areas alternating with steppe vegetation areas. Moldovan forests basically consist of communities of broad-leaved species (98%) dominated by oak and acacia. The dominant forest species are English oak and durmast oak (*Quercus petraea*), locally in association with beech (*Fagus sylvestris*). In the South, pubescent oak (*Quercus pubescens*) groves occur on the hillsides. Paludal forests are spread in the river floodplains and mainly consist of willow (*Salix spec.)* and poplar (*Populus spec.)*.

[5] Available at: http://bsapm.moldnet.md/Text/Pagina%20web%20Strategia/Englez/Cuprinstotal.html

At the beginning of the 19th century, forests covered about one-third of the country. However, a large increase in population severely reduced the forested areas. At the beginning of 2006 forests covered ~ 363 000 ha (10.7% of the country's territory). The extensive deforestation in the 19th century has resulted in soil erosion, wind damage, lowering of the water table, flooding, and loss of fauna. The current forestation level is considered insufficient for ensuring an effective ecological balance.

In the study corridor such forests are restricted to a relatively short section, approximately between km 5 and km 8 in the vicinity of the village Baclol, and between km 23 and km 30 south of the village Razeni.

Fauna

The occurrence and abundance of animal species mainly depends on the type and area of habitats that provide food resources and shelter and on the level of disturbance that these habitats may be exposed to. As most of the former natural steppes have been converted to arable lands many of the typical animal species have disappeared.

The current most common mammals of Moldovan ***forests*** are fallow deer, wild boar, fox, badger, squirrel, marten and wild cat. Bird species include orioles, magpies, hoopoes, nightingales, blackbirds, etc.

Typical s***teppe animals*** include several species of rodents like hare, hamster and shrew and birds such as skylark, quail and partridge[6].

The artificial **lakes, wetlands and marshes** provide ecological niches for many birds, including migratory species. As can be seen from the following **Figure 13-5** the study corridor is almost entirely located within the Eastern European migration corridor. In this context the lakes located along the Project road (e.g. km 18, km 87 - north of Comrat-, between km 126 – Svetii - and 134 – Balaban - may have important functions in the staging of feeding habitats for mirgratory species.

The same lakes (artificial reservoirs) also support abundant fish resources including carp and perch, bream, ruff and pike from the rivers.

Agricultural ecosystems occupy about 75,6% of the Republic and are also the prevailing type of land use along the study corridor. Among mammals rodents prevail. Common bird species breeding in these open anthropogenic habitats are skylark, tufted lark, quail, bunting, white wagtail and others.

As regards the protection of biodiversity the 1st National Report of 2001 indicates the following secondary habitats to be of major importance to flora and fauna which should thus be given special attention:

- Lakes;
- Swamps and riparian meadows along the rivers;
- Agricultural areas with perennial crops and mixed cultures;
- Areas with a well developed mosaic of arable lands and natural vegetation; and
- Animal migration corridors.

[6] Source: 3rd National Report on the Implementation of Biodiversity, December 2005

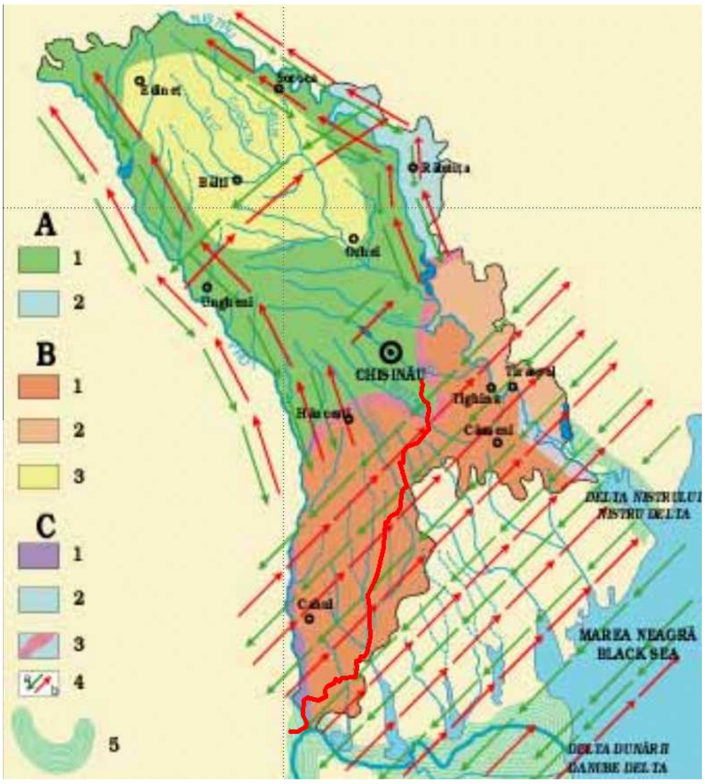
13.7. Protected Areas

Natural State Protected and Significant Areas

The Law on the Natural State Protected Areas Fund (NSPAF), approved in 1998, set the legal basis for creating and maintaining the NSPAF, the principles and mechanism of implementation, as well as the prerogatives of the central and local authorities, economic entities, NGOs and citizens on this matter.

The Law established 12 categories of natural protected areas, eight of which correspond to the IUCN classification: scientific reserve, national park, nature monument, natural reserve, landscape reserve, resource reserve, multifunctional management area, biosphere reserve; and four categories of national interest: botanical garden, dendrological garden, landscape architecture monument, zoological garden.

Figure 13-5. Zoogeographical division and bird migration routes in Moldova



A – Zona de silvostepă. Sectoare zoogeografice de pădure:
1 – Codrii; 2 – Râbniţa.
B – Zona stepelor. Sectoare zoogeografice de stepă:
1 – Bugeac; 2 – Tiraspol; 3 – Bălţi.
C – Sectoare zoogeografice interzonale:
1 – Prutul inferior; 2 – Nistrul inferior; 3 – limită interzonală;
4 – căile de migraţie a păsărilor: a) toamna, b) primăvara;
5 – Rezervaţii biosferice.

A - Forest steppe zone. Zoogeographical forest sectors:
1 - Codrii; 2 - Râbniţa
B - Steppe zone. Zoogeographical steppe zones:
1 - Bugeac; 2 - Tiraspol; 3 - Bălţi
C - Inter-zonal zoogeographical sectors:
1 - Lower Prut; 2 - Lower Nistru; 3 - Inter-zonal boundary;
4 - Bird migration routes:
a) autumn, b) spring;
5 - Biosphere reservse

Regionarea zoogeografică şi căile de migraţie a păsărilor pe teritoriul Republicii Moldova

Appr. location of the study corridor

Source: 1st National Biodiversity Report, 2001

The requirements of the Law on NSPAF have been detailed in the framework statutes for every category of natural protected area, as well as in specific statutes for every natural protected area. In early 2006, the NSPAF comprised 1225 objects totaling 66,467 ha or 1.96% of country's territory. In November 2006, the NSPAF Law was modified to include three wetland areas of international importance, one of which, the Lower Prut Lakes (19,152 ha) is located at the southern end of the study corridor. This area is also included in the site list of the Ramsar Convention. Today Moldova's protected areas total 157,227 ha , i.e. 4.65% of the territory.

Despite the measures taken to conserve and extend the natural protected areas, their current condition is poor. The NSPAF Law is not currently properly enforced and its requirements are often violated. Following the land reform, many of the protected areas are now managed by economic entities, mayoralties, schools, etc, which neither show interest nor have the capacity for maintaining them in good condition.

The State Ecological Inspectorate, in cooperation with the local authorities and the police, undertook a number of compliance checks and took action in order to enforce the Law on NSPAF. In 2006, the protection regime and status of 357 protected areas was checked. The main offenses revealed were related to the violation of the regime of protected areas through extraction of minerals (limestone, sand, gravel, etc.), grazing and other illegal activities on their territory.

13.7.1. Protected Areas of the Study Corridor

The following section provides an overview of the protected sites in the study corridor.

Ramsar Sites

'Lower Prut Lakes. *20/06/00*. Judet Cahul. 19,152 ha. 45º42'N 028º11'E. The River Prut forms the western border of the site as well as the state border with Romania, and the site extends to the river's confluence with the Danube. Consisting of Ramsar Wetland Types O (permanent freshwater lakes), M (permanent river), and 1 (fish ponds), the site is considered to fulfil Criteria 2 on vulnerable species and especially 3 on biodiversity. Lakes Beleu and Manta are unique ecosystems, described as the last natural floodplains in the lower Danube region. The system is important for groundwater recharge, flood control, and sediment trapping, and it supports an imposing list of rare and threatened species of flora and fauna. A number of heritage sites can be seen in the area, including some of Roman Emperor Trajan's wall (ca.100 A.D.). Fish harvests have been decreasing markedly in recent years, forests are generally seen to be deteriorating, and quite a few adverse conservation factors have been listed as requiring attention. A management plan is in preparation, particularly in hopes of creating a UNESCO Biosphere Reserve over more or less the same site'[7].

Legally Protected Areas

The protected areas are indicated according to the Law on State Protected Area no. 1538 (25.02.1998 and amendments until 2007). The following Table 13-1 shows the areas with official protection status within a corridor of approximately 1 km to either side of the M3.

[7] Source: The Annotated Ramsar Lst: Moldova

Table 13-1. Areas with Official Protection Status

Areas of Geological and Paleontological Importance

Nr. Crit.	Name	Area (ha)	Location	Land owner
5	Fossil settlement near	10	Between the villages Moscovei and Dermengi; village Moscovei parcel 18, sub-parcels 2,3 Cahul	State Forest Farm in Taraclia region, Moscovei Forest sector
6	Tartaul Steep	2	At km 2 North of Tartaul de Salcie village, on the left slope of the Salcia river	Agriculture Company “Taraclia de Salcie”
20	Baurci Cropping, Ceadir-Lunga Region	1	On the road Congaz-Baurci, at km 2 from the bridge over the river Iaplug, Forest sector Congaz, parcel 38, sub-parcel 12	State Forest farm Iargara
21	Ceadir-Lunga Steeps, Ceadir-Lunga Region	10	East of Ceadir- Lunga city, Forest sector Ceadir-Lunga, parcel 46, sub-parcel 2	State Forest Farm Cahul
20	Cotofana Steep, Cimislia Region	10	East of Gura Galbena village (forth from north, on the left gradient of Valea Cotofana vale) Forest sector Zloti, Cotofana, parcel 33, sub-parcel 3.5; parcel 34, sub-parcel 3,8,12.	State Forest Farm Cimislia
23	Geologic Section from the valley of Ialpug River; Comrat Region	5,6	Comrat city, left gradient of the river valley Ialpug, Forest sector Comrat, Comrat – IV, parcel 34, sub-parcel 11	State Forest Farm Iargara
80	Cropping near Taraclia city	4,1	South of Taraclia city, along the left gradient of the vale, Forest sector Taraclia, Taraclia-II, parcel 20, sub-parcel 1	State Forest Farm Cahul

FORESTS

Nr. Crit.	Name	Area (ha)	Location	Land owner
8	Molesti-Razeni, Cainari Region	250,7	Forest sector Razeni, villa Molesti-Razeni, parcels 30-32; sub-parcels 1,2,7; parcel 33, sub-parcels 1,5	State Forest Farm Cimislia
15	Moisei hollow, Cimislia Region	101	Mihailovka Forest Sector, Moisei hollow, parcel 15, Comrat Region	State Forest Farm Cimislia
16	Bolgrad High School; Cimislia Region	54	Near Frumusica village, Forest sector Congaz, Bolgrad High school, parcel 26, sub-parcel 2	State Forest Farm Iargara
50	Vadul lui Isac; Vulcanesti Region	68	Forest sector Slobozia, Vadul lui Isac, parcel 33	State Forest Farm Cahul
51	Flamanda; Vulcanesti Region	71	Forest sector Vulcanesti, Flamanda parcel 14, sub-parcel 3; parcel15, sub-parcel 4; parcel 22, sub-parcels 9,12; parcel 24, sub-parcels 2,7; parcel 26, sub-parcel 6,9; parcel 28, sub-parcel 3; parcel 32, sub-parcel 5	State Forest Farm Cahul

MEDICINE PLANTS

Nr. Crit.	Name	Area (ha)	Location	Land owner
2	Cahul	343	Forest sector Larga, Romini, parcels 28,29,31-33,39,40	Cahul State Forest Farm
4	Bugeac, Comra t Region	56	West of the head office of the nr 2 brigade	Agriculture company “Bugeac”

LANDSCAPE RESERVES (Geographical landscapes)

Nr. Crit.	Name	Area (ha)	Location	Land owner
16	Cimislia hollow, Cimislia Region	256	South of Cimislia city, on the road to Basarabeasca city, forest sector Ciucur-Mingir, Oziornoe, parcel 3, sub-parcels 11,13,15; Recea, parcel 7, sub-parcels 1,4,5,10; Bacanciu parcel 5, sub-parcel 5,9,11,13-15,17-19,22,23,25,27,29	State Forest Farm Cimislia

PROTECTED RESOURCES

Nr. Crit.	Name	Area (ha)	Location	Land owner
2	Micelar-carbonatated fat Chernozem of the steppe Danube area ; Cahul Region	4	Field nr.10 of the cropping system, at the south-east of Rosu village	Rosu village town hall
3	Forest xerophytic Chernozem of the steppe Danube area; Cahul Region	200	Forest sector Larga, Romani, parcels 27-29	Cahul State Forest Farm
5	Simple Chernozem of the Danube steppe area; Comrat Region	4	Tractor Brigade nr 2, field nr 7	Agriculture company “Maiac”

REPRESENTATIVE AREAS WITH STEPPE VEGETATION

Nr. Crit.	Name	Area (ha)	Location	Land owner
1	Steppe sector north of Bugeac, Comrat Region	4	Bugeac village, at the border with Cimislia region	Agro-industrial complex “Bugeac”
2	Steppe section north of Bugeac, Comrat Region	15	Dezghindea village, 3 km north of the animal complex	Agriculture Company “Rodina”
5	Steppe section south of Bugeac; Taraclia Region	50	Near Vinogradovka village	Agriculture Company “Ciumai”

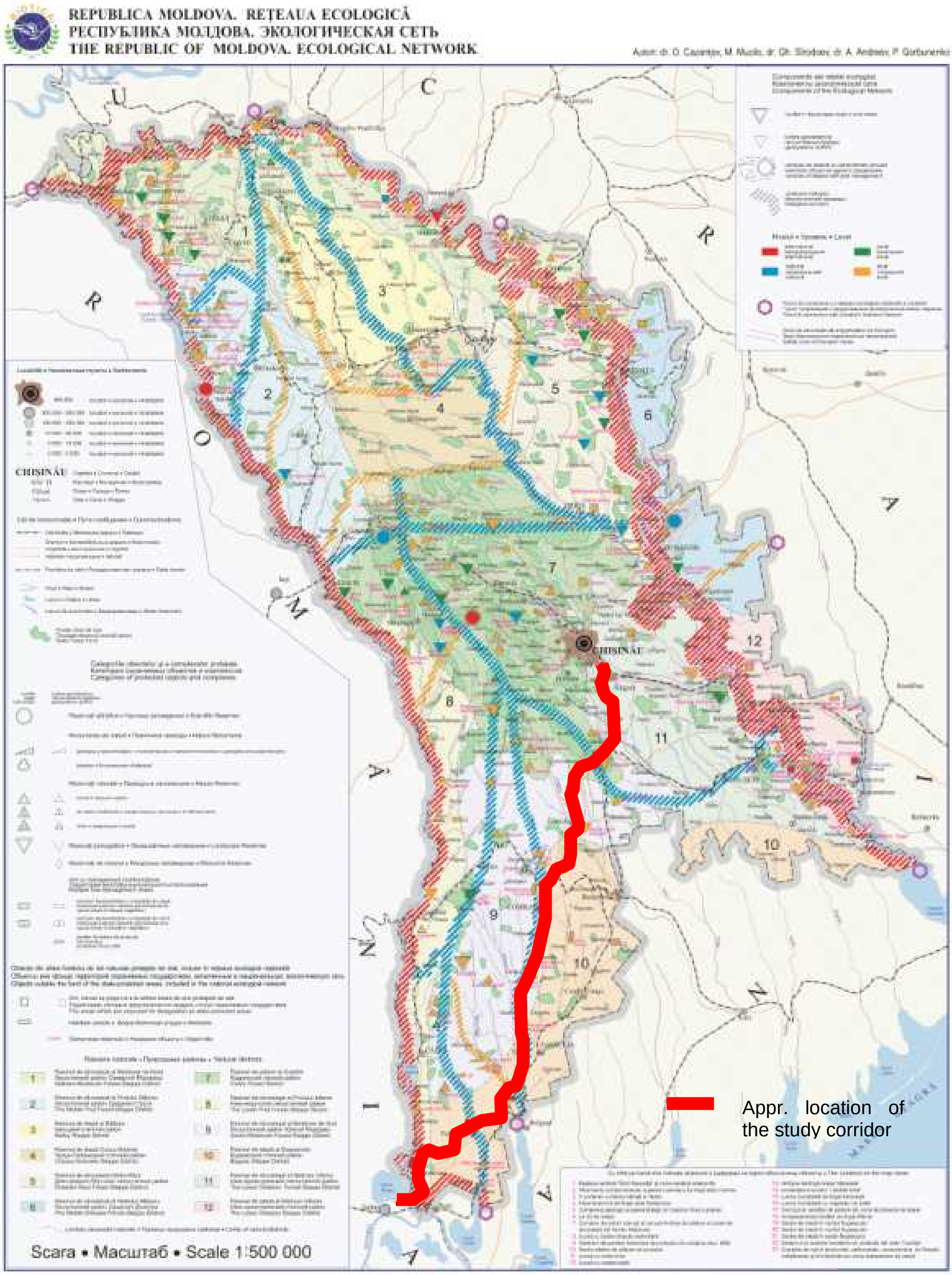
FOREST PROTECTION BELTS

Nr. Crit.	Name	Area (ha)	Location	Land owner
1	Forest protection curtains system in Tvardita village; Ciadir-Lunga Region	80,2	Tvardita village, number of the belts: 1-5 (7,1 ha), 8-22 (20,5 ha), 27 (1,7 ha), 39 (0,98 ha), 43 (1,1 ha), 49-50 (2,6 ha), 52 (1,4 ha), 54-59 (7,2 ha), 65 (1,3 ha), 68-69 (2,3 ha), 73-75 (3,7 ha), 77 (0,8 ha), 81-86 (5,3 ha), 88 (1,6 ha), 96-97 (2,7 ha), 99 (2 ha),100-108 (19,8 ha)	Agriculture Company “Lenin”

All protected areas form an integral part of the ‘National Ecological Network’ (NEN) as shown in the map Figure 13-6 overleaf.

As can be seen from this map parts of the M3 corridor (- section approximately between Bugeac and Burlaceni) have been classified as a ‘biological corridor’ of national importance.

Figure 13-6. Republic of Moldova Ecological Network



Source: Republic of Moldova: Third National Report on the Implementation of the CBD

Green Belts

Around all reservoirs and lakes as well as along rivers the 'Law regarding the protection of the waters, rivers and water basins" of 1995 establishes defined zones inside which only limited economic activities are permissible. These zones are as follows:

Major rivers (e.g. Prut)	100 m to either side
Rivers 100 – 200 km long (Ialpug, Cogilnic)	50 m to either side
Smaller rivers	20 m to either side.

Planned Protected Areas and other Significant Sites

Currently no other planned protected areas are proposed along the study corridor.

However, the ***planted avenues and shrubs*** that exist throughout the road corridor are assessed as significant elements of the landscape. In a predominantly anthropogenic environment these elements fulfill multiple functions such as providing

- food, shelter and bio-corridors for animals;
- windbreak and thus protection of arable lands against wind erosion;
- Shadow for non-motorized road users;
- Protection of adjacent arable land against accumulation of traffic-borne air pollutants;
- Fruit (mainly nuts).

In a predominantly open and rather 'empty' environment, these avenues also have a positive aesthetical effect on the landscape.

13.7.2. Rare and Endangered Species

According to the available official information the study corridor does not cross significant known habitats of rare or endangered animal species (see Figure 13-7). This statement, however, does not exclude that some local populations of rare or endangered species may exist.

According to the the available official information rare or endangered plant species occur in the valley of River Ialpug east and northeast of Comrat and in the south of the study corridor. Species indicated for the Ialpug valley are Polystichum aculeatum, Colchicum fominii Bordz, Ornithogalum oreoides Zahar, Koeleria moldavica, Serratula caput-najae and Cranbe tartaria. However, the scale of the map (of which an extract is provided in Figure 13-7) does not allow for the identification of the precise location of the respective habitats of these species.

Figure 13-7. Rare and endangered species

Source: Republic of Moldova Ecological State. Extract of a map produced by the Institute of Geography of the Academy of Sciences of the Republic of Moldova and IC 'Regionica' under a fund from the Ecological Fund of the Republic of Moldova and the WB/GEF Project No. TF051208. 2004

13.8. Existing Environmental Pollution

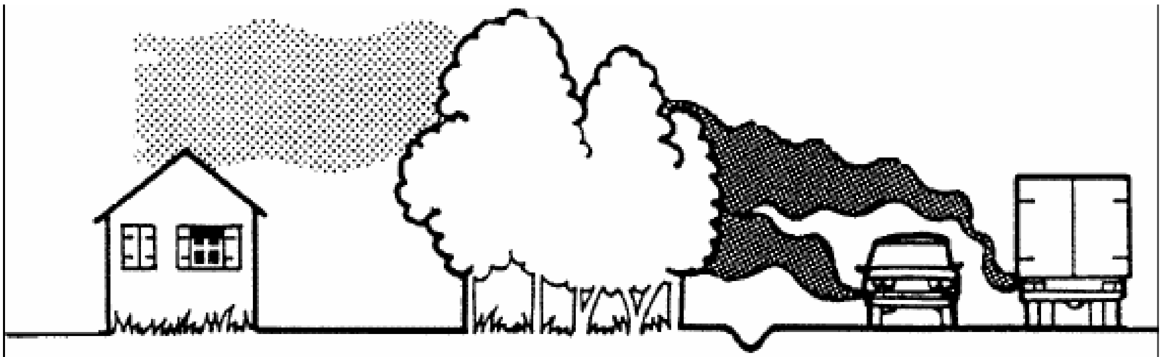
Air Pollution

While 15-20 years ago the industrial and energy sectors were the main polluters, road transport represents the current main source of emissions. According to the MENR, noxious emissions have increased by 10-15% p.a. during the last five years. By the end of 2005, the total of these emissions was of ≈ 155-160.000 t, which is 45.000 t more than in 2000. Due to the significant increase of imported second hand motor cars, road transport accounts for about 90% of total emissions. According to recent estimates emissions of every second diesel car and those of every third motor car with a carburettor engine exceed the applicable standards. Nevertheless, the number of vehicles controlled for their emissions decreased because of staff reductions in the regional units. Currently, only 20% of the motor cars are regularly controlled by the environmental inspectors each year.

While estimates of traffic borne emissions do exist for Chisinau, no such data are available for the rural areas, including the study corridor. However, given the lack of any significant stationary sources of emissions (e.g. industries), the current traffic volumes and the open character of the landscape it can be assumed that air quality is not currently an issue of significant environmental concern in the study corridor. As regards the existing road itself the stands of trees and / or bushes that are found along many sections of the M3 do play a role in protecting adjacent arable fields from the accumulation of traffic-borne pollutants. Within settlements avenue trees also have important functions in filtering pollutants, thereby contributing to the protection of air quality and thus the health of the local population (see illustration in Figure 12-8). Moreover, these trees and shrubs minimize the effects of wind erosion on the adjacent arable lands, provide food and shelter to a number of animals and, given the linear shape of these avenues, function as bio-corridors.

The beneficial effects resulting from the existence of these avenue trees and shrubs along the M3 will increase as traffic volumes grow and should thus be protected during design and implementation of the Project.

Figure 13-8. Filtering Role of Vegetation

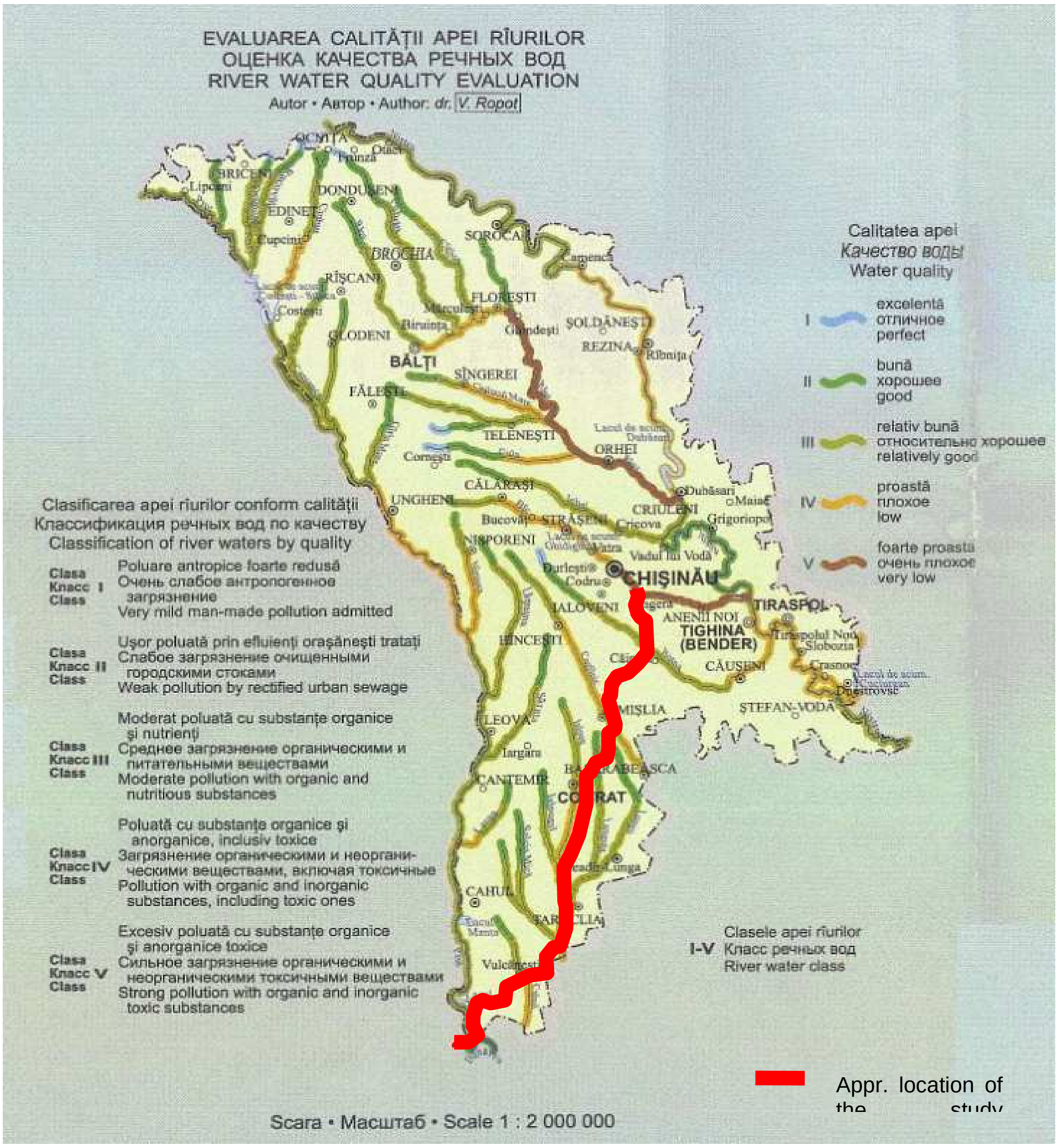


Source: The Word Bank; Roads and The Environment. A Handbook (Technical Paper No. 376). WB, Washington DC 1997

Surface Water Pollution

An overview of the situation of some selected rivers and streams is provided in Figure 13-9. According to this source water quality of streams generally deteriorates on their way to the south. While River Botna still has a class III water quality (= 'moderate pollution with organic substances and nutrients') over a relatively large distance, others like Cogilnic, Ialpug and Cahul deteriorate to class IV (= 'pollution with organic and anorganic substances, including toxic ones') downstream of larger towns / villages like Cimislia, Comrat and Vulcanesti. Rivers Iapugel and Salcia Mare (crossed by the Project Road at about km 121+350 and 150+410 respectively) have a class II water quality at these points.

Figure 13-9. River Water Quality



Source: Republic of Moldova Ecological State. Extract of a map produced by the Institute of Geography of the Academy of Sciences of the Republic of Moldova and IC ‘Regionica’ under a fund from the Ecological Fund of the Republic of Moldova and the WB/GEF Project No. TF051208. 2004

13.9. Cultural Heritage

Trajan's Wall (*Valul lui Traian* in Romanian) is a complex of walls in Eastern Europe (Romania, Moldova and Ukraine). Contrary to the name and popular belief, the ramparts were not built by Romans during Trajan’s reign.

The remnants in Moldova comprise earthen walls and palisades. There are two major fragments preserved in Moldova, both of which are crossed by the road under study, i.e. the Upper Trajan's Wall (crossed at about km 50 of the existing M3 and the proposed M3 extension/bypass Cimislia) and Lower Trajan's Wall (crossed by the M 3 in the area of km 164).

The ***Lower Trajan's Wall*** is thought to be dated from the 3rd century, and built by Antharc and stretches about 126 km from the village of Vadul in Cahul region by the Prut River into the Ukraine and ends at Lake Sasyk by Tartarbunar.

The ***Upper Trajan's Wall*** is thought to have been constructed in the 4th century by Greuthungi goths in order to defend the border against the Huns. It stretches 120 km from Dniester River by Kitkany in Teleneshty Region to the Prut River.

13.10. Environmental Impacts and Mitigation

As was explained earlier in this report the M3 road Project will consist of a series of relatively similar road improvement sections, the length and location of which had not been identified when this study was conducted. These future sub-projects will be most likely financed by different, however, not yet identified IFIs. Therefore the first issue of this section is a proposal of design options that would have environmental benefits in all proposed rehabilitation / upgrading sections along the existing route.

Issues that would generally be associated to construction and thus be common to the type of proposed interventions in all existing road sections will be discussed in a second step.

Where new bypasses are proposed the present assessment will screen out those alternatives that would only cause impacts of minor significance that can be managed by implementing generic environmental mitigation measures during construction. In these cases land acquisition and compensation issues would be dealt with separately in the SIA report. Other proposed bypasses may be located in more sensitive environments where design options may have to be considered to effectively mitigate potential impacts or require specific measures during construction or operation. For such cases the present study would recommend separate EIAs to be conducted during the detailed design phase.

Planning and Design Phase

The design of the Project will generally follow the existing Moldovan SNIP standards. Some local adjustment of these standards should however be taken into consideration during the decision making process to increase the potential benefits of the investment for beneficiaries. Based on the findings from the field trips, baseline analysis, feedback obtained during public consultation and discussions among the study team the following should be taken into consideration:

Existing village passages: Provide pedestrian walkways in every village, if possible on either side Provide lay bys for buses in both directions of the road;

Between neighbouring villages and sections with existing accident hot-spots: Provide paved shoulders for safe accommodation of non-motorized traffic.

Impacts Relating to the Construction Phase

In sections where only rehabilitation and upgrading of already existing road sections is proposed within the RoW no major environmental impacts are expected and land acquisition would not be required. In these cases most potential environmental impacts will be limited to the construction phase, such as dust and noise generation, odour nuisance resulting from the use of bitumen, traffic disruption caused by the temporary disposal or transport of construction materials or waste etc. Further issues may be erosion control, labour camp or traffic management. These impacts are common in road rehabilitation works and can be mitigated with existing management techniques. In order to minimize potential off-site impacts, materials (e.g. asphalt, stone, etc.) would be supplied only from sources with approved licenses, permits, and/or approvals for environment and worker safety. Construction equipment used during construction would meet internationally recognized standards for environment and worker health and safety.

Operational Phase
After completion, the Project will have positive indirect impacts on human health and safety through decreased number of accidents, reduced air pollution resulting from more constant rates of travel speeds on rehabilitated road sections, cleaning up of solid waste from roadside drains, and reduced water pollution resulting from rehabilitated drainage systems. Residents in the area of influence of the road subprojects will benefit from: (i) a reduction in travel times and in transport costs, (ii) improvements in the quality of road passenger and cargo transport; and, (iii) employment generation.

14. SOCIAL IMPACT ASSESSMENT

A stand alone report has been prepared presenting the initial Social Impact Assessment on a corridor level. Similar to the approach taken in the environmental assessment the following section provides an overview of corridor-level issues. Detailed social assessment will follow once feasible sections for improvements are identified;

14.1 Land Acquisition and Resettlement Planning

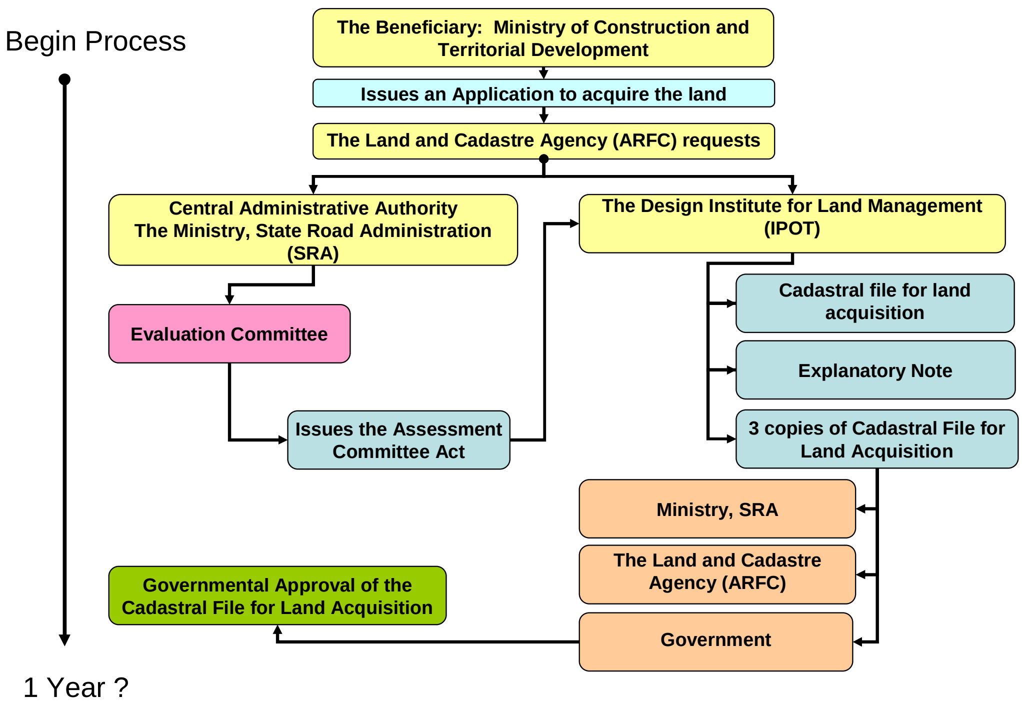
While the guidelines from the GRM and the EC and WB aim to avoid as much as possible the acquisition of additional private land during project implementation, the preliminary design will indicate whether there will be the need to make adjustments in certain technical details to ensure that the standard for Category II/III road is met including the design speed. Initial reconnaissance of the project road by the Consultant showed that there are certain sections where the curvature requires increase in radius to ensure meeting design speed requirements and the minimization of accidents, and where there might be the need, to pursue bypass options. But since the preliminary design has yet to be finalized, there is no basis for saying that additional land particularly private land will have to be acquired to accommodate the needed adjustment. In the meantime there will be a need to update the PSA and as the case maybe if required a need to prepare a RAP.

During the course of the study it became more apparent that current land acquisition process and practice in Moldova will be an issue to consider in the conduct of the engineering design as well as implementation of improvement projects. Figure 14-1 presents the current process of land acquisition in Moldova. In case of roadway improvements the Land Cadastre Agency, Design Institute for Land Management, and the State Road administration are the key agencies to conduct the land acquisition. After thorough examination of land ownership, determination of land value, and assessment for potential other losses such as economic activity the Government approves a cadastral file for land acquisition.

Through communication with the Design Institute for Land Management data was obtained regarding the land ownership and value of each plot of land potentially needed for the improvements defined in the preliminary design.

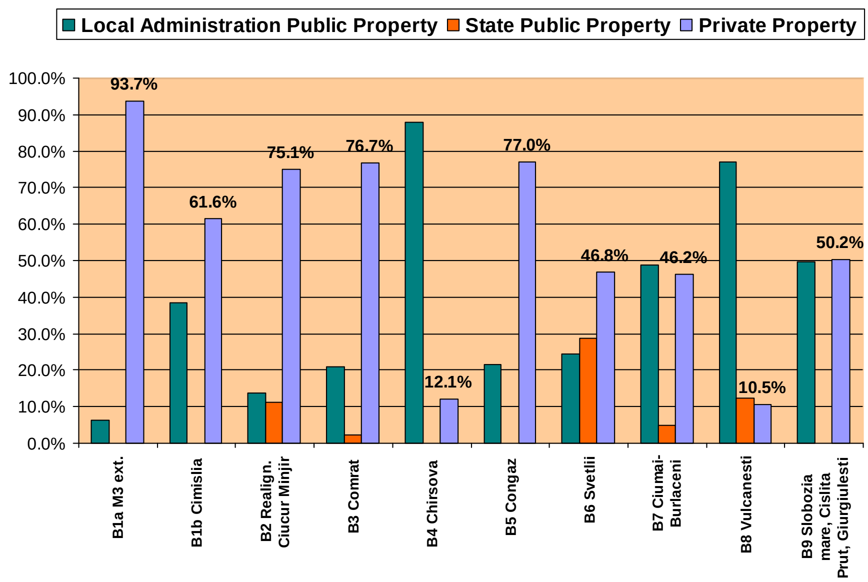
Land values are primarily based on a expropriation and or fair market base value. The base value is adjusted according a factor representative of the soil quality and potential changes in zoning category. The values received so far vary greatly and are subject to change.

Figure 14-1. Land Acquisition Process



Experience from other projects indicate that the conduct of the land acquisition process will require considerable time, especially considering that land ownership in the by-pass sections is primarily private. Figure 14-2 presents the distribution of land ownership in percent. Some of the by-pass sections are almost entirely in private ownership. Additionally, ownership is shared by many individuals, in some cases more than 170 owners per bypass section.

Figure 14-2 Land ownership for By-pass sections



14.2 Gender Development Plan

Like the other sections being reviewed, no significant gender impact is anticipated; thus no Gender Development Plan is required.

14.3. Participation Strategy

No special participation program will be devised but the project team will engage in full consultation activities that will encourage the participation of all local residents as well as people directly affected by rehabilitation. This consultation and participation program will be implemented by the Ministry of Construction and Territorial Development (MCTD) and its activities will cover (i) public discussion related to the design of facilities for pedestrians, bus users, road side vendors and/or animals; (ii) general publicity about the intended program, scope of the construction works, as well as environmental and health safety impacts particularly HIV/AIDS through information dissemination and printed brochures; (iii) establishing a mechanism for local people to raise concerns over the impacts of the construction works. The Supervision Consultant and the Civil Works Contractor will assist the Roads Administration staff to implement the participation program.

14.3.1. HIV/AIDS Awareness

The Project will adopt several activities similar to the program already in place in the country as coordinated under the National Program on Prevention and Control of HIV/AIDS and STIs and proposes its conduct in coordination with the MCTD and its project implementing arm to mitigate identified risks. These include HIV/AIDS mainstreaming of all project partners and adoption of an HIV/AIDS awareness raising policy, to ensure that all construction staff have appropriate information to enable them to adopt protective behaviours. The use of peer-counseling in the workplace would also strengthen the project’s role in HIV risk reduction and the response from construction workers, their families and partners.

The project will also adopt policies of non-discrimination of HIV positive workers and gender equity in project business. To reduce the risk of creating demand for transactional sex, the project should encourage the employment of local workers and facilitate their daily travel between their homes and construction sites through appropriate clauses in the construction works contracts. These approaches will be in line with the internationally agreed guidelines on results-based management of HIV.

Crucial interventions such as provision of an on-site Voluntary Counseling and Testing (VCT) centre at the border areas like Giurgiulesti, awareness-raising, wider condom distribution, strengthening local HIV/AIDS services, and sustainable and holistic HIV prevention strategies should all be conducted in a coordinated manner in partnership with the National Program on Prevention and Control of HIV/AIDS and STIs AIDS Center (NAC) and local and national partners. By scoping the expertise, funding availability, resources and materials of specialist organizations, the project will ensure low-cost and integrative support of a broad range of responses to the epidemic in project areas that will both support the Project development and optimize the national response to the epidemic.

The Supervision Consultant and Civil Works Contractor as well as the local government concerned will have the major responsibility in ensuring that the proposed measures are undertaken.

14.3.2. Indegenous People Plan

There will be no need to prepare a special IDP Plan for this road section as no specific impact for ethnic minorities is anticipated. The Government of the Republic of Moldova with the assistance of international aid community has an ongoing comprehensive program to address the needs of the ethnic minorities and the aim is to integrate these programmes within the overall development programme of the country. Accordingly, the road rehabilitation project will ensure that whatever benefits derived from it by the local population will benefit the ethnic minorities therein as well.

14.3.3. Internal Monitoring System

To track progress of, as well as, changes in civil works activities, and to monitor effects and impact of the road construction and rehabilitation on the households and communities along the road, an **internal monitoring system should be established**. Establishment of the monitoring system will be the responsibility of MCTD with the assistance of the Supervision Consultant and the Civil Works Contractor which will be specified in the terms of reference for the work contract. **Appendices 2** and **3** provide some broad basis for the selection of key indicators to monitor the effect and impact of the project on the overall well-being of the households and communities located along the road.

14.3.4. Applied Methods and Process

In accordance with EBRD/WB/MCC and GRM guidelines, participatory public consultations have been carried out with a wide range of stakeholders in the Project area. It is also expected that consultations will continue throughout the implementation phase. The basic objective of the consultation is to raise awareness, get feedback from the stakeholders and improve decision making by considering local knowledge and information among different individuals, groups and/or organizations with interests and stakes in the project.

Field investigations and surveys were conducted in the Chisinau-Giurgiulesti-Romanian Border Project road between June and October, 2008. The main objectives of the field surveys included:

- Assessment of the prevailing environmental and social conditions along the project corridor from Chisinau to Giurgiulesti; and
- Identification of key environmental and social attributes likely to be affected following the implementation of the proposed project and thereafter.

The field visits also provided a means of identifying stakeholders who have interests in the project. In order to adequately appreciate the views and concerns of stakeholders with regard to the project implementation, a number of persons, individuals and groups within the local communities were identified and consulted. The consultations were basically conducted in three formats as follows:

- Scoping meetings with a wide range of stakeholders held from 22-23 October 2008 in 3 strategic locations along the project corridor;
- Focused group discussions with a cross-section of men and women in the villages along the proposed road corridors; and
- Interviews with key informants including national government officials, local and municipal mayors; officials and staff of national and local development agencies, managers of utility/service companies, non-governmental organizations and other interested parties.

Scoping meetings

Recognizing that community involvement is of great importance to understand the nature and extent of potential impacts, especially socio-cultural impacts, and to assess the suitability and acceptability of mitigation measures associated with the Project a series of scoping meetings was conducted. Comments and suggestions received on the Project as far as it is technically and economically feasible will be incorporated in the implementation of the project.

In coordination with local and state administration, and with the active support of the Ministry of Construction and Territorial Development, the series of environmental and social scoping meetings were conducted by the project team. Three locations were identified and scoping meetings were held in Cimislia, Comrat and Giurgiulesti. A total of 93 elected officials, citizens, stakeholders, and members of NGOs participated. (See Table 14-1)

Table 14-1. Scoping Meetings

Time and Date	Location	Number of Participants
22 October 2008 – 10 AM	Cimislia	41
22 October 2008 – 3PM	Comrat	23
23 October 2008 – 10AM	Giurgiulesti	29
21 June 2009 – 3 PM	Cimislia	11

14.3.5. Stakeholders' Issues and Concerns

While almost all of the stakeholders expressed appreciation for the planned road rehabilitation, a number of concerns were also raised during the course of the discussions and consultations. These included the following:

- Fear that the planned rehabilitation will not result in beneficial impacts for local communities;
- Potential loss of land/plots and destruction of properties, landmarks and monuments, damage and destruction to crops, and felling of trees during road construction;
- Potential loss of access to agricultural lands or urban centres if the bypasses will not address the issue of connectivity;
- Increase in dust, noise and gaseous emissions along the road corridors;
- Influx of people including the Contractor's labour force in the project area with subsequent increase in social vices such as armed robberies, commercial sex, teenage pregnancies and spread of STDs and HIV/AIDS;
- Increase in child labor with students/pupils leaving school to take up employment;
- Potential damage to utilities including water pipes and telephone and electric power transmission lines along the ROW, damage to sidewalks and drainage system resulting in local flooding;
- Risks such as potential increase in siltation to valuable water bodies during road construction phase;
- Need for close coordination between the District Engineers and the Civil Work Contractors for work scheduling and technical details;
- Increased hazards and risk particularly to children along the constructed roads;
- Increase in water consumption leading to water shortages for the Contractor and local community;
- Increased law and order problems along the rehabilitated roads;
- Delayed and non payment for construction materials by the Contractors.

14.3.6. Project Appreciation

The expectations in the project area are extremely high. The perceived benefits of the proposed road projects are presented below as follows:

- Improve international trade and transport resulting in improved regional and local economic activities leading to better income opportunities;
- Increased trade and economic growth of the project area all leading to increased wealth, reduction of poverty and improvement of the living standards of the local community;
- Improvement of transport facilitating the farmers access to markets for their agricultural produce;
- Improvement in educational standards and school attendance in the project area;
- Improvement of health conditions including faster access to city and district hospitals for acute medical cases and complicated pregnancies;
- Increased availability of farm inputs and technology due to easier access to farm areas;
- Increased farmers' incomes due to improved access to markets for agricultural produce;
- Increases in employment opportunities especially for the manual laborers;
- Reduction in vehicle maintenance costs;
- Faster transportation of people and goods with reduction in time spent in waiting for vehicles;
- Increase in the number of vehicles plying the new roads and a possible reduction in transportation costs;

- Reduction in past harvest losses;
- Increased agricultural production leading to improvement of incomes and reduction of poverty levels;
- Higher incomes from the farmers and other members of the community will result in increased revenue for both national and local governments;
- Increased economic spin-off effects benefiting women sellers through provision of food, and services for the labor force;
- Improved access of agricultural produce to the markets; and
- Reduction of rural-urban migration within the Project districts.

14.3.7. Suggestions and Recommendations

The following is the summary of suggestions and recommendations generated during the stakeholders' consultations:

(i) There is the need to coordinate project development and implementation with the local authorities.

(ii) The project may only benefit international and national road users but not for the village population; the stakeholders should constantly be updated on the status of the project and the process and mechanism should be well defined.

(iii) Experience with the Giurgiulesti Port Project showed that because it was considered of international and national importance it was pursued without adequate consultations and participation of the local communities; as a result, a lot of of ill feelings and resentment about it particularly on the small communities around the area being left out of the largesse of development. The hope and wish is that the Project will not follow the course of the Port and Railway development experiences.

(iv) If the proposed alignment is considered part of the international route then the bypasses should be pursued and the design and construction of the road should conform to international standards.

(v) Impact of the proposed alignment and bypasses should also consider the villages and communities and there is the general belief that the road project and bypass construction will benefit the community as well and that the bypass construction through Giurgiulesti will have minimal negative environmental social impacts.

(vi) Choosing the bypass route will avoid densely populated areas and narrow road where expansion will have major social impacts; this option will also avoid impacts on private lands as municipal public land is already available.

(vii) The Project is considered vital and important to the development of areas like Comrat and the autonomous region. It is suggested that local people should be also hired during construction for employment purposes and that the Project should pursue a standard of excellence.

(viii) Lands along the route considered for the bypass are not economically useful and valuable. One benefit in pursuing the bypass is that the current area is being used as dumpsite for garbage. During construction of the bypass, cleaning up will be required and will benefit the community accordingly.

(ix) Comments on the process being pursued by the Project Consultant; that they expressed that this is the first time they could remember having been invited to scoping meetings for projects.

(x) Commented that in Cimislia, the Regional Authority has kept the area within the proposed bypass as public land; this has not been privatized.

(xi) Expressed the necessity for consultation with local communities and coordination on various concerns – traffic, design, environment, project scheduling- with local authorities.

15. COST ESTIMATES

The preliminary cost of the works was estimated based on the bills of quantities, calculated after the preliminary design for each studied section of the road.

Bills of quantities for the pavement and earthworks were developed with the resources method, using the IV quarter costs of 2008.

Other costs categories were determined based on costs of similar projects recently built in the area, as well as by updating the costs, applying the coefficients for the current costs (Statistic National Office of the Republic of Moldova, quarter IV of 2008), for some of bypass road sections,that where previously studied.

Initally the costs were developed as direct expenditures in Moldavien lei and include:

- Value Added Tax
- Additional costs for Preliminary works
- Incidental Expenditures
- Other Expenditures

The following categories were used in determining the preliminary cost:

EARTHWORKS
Site clearance
General excavation
Preparation of sub-grade
Embankments

ROADWORKS
Wearing course
Binder course
Base course
Sub-base

DRAINAGE
Pipe culverts
Drainage channels (including underground)
Manholes, chambers, catchpits, oil separators
Channels, chutes, rip rap protection

BRIDGE STRUCTURES

RETAINING WALLS

LANDSCAPING
PRELIMINARY AND GENERAL ITEMS

DAYWORKS
CONTINGENCIES

ANCILLARY WORKS
Slope protection / rockfall protection
Barriers and guardrails
Traffic signs
Pavement markings
Accesses / side and service roads
Junctions

Appendix II-7 presents the cost calculation data. Tables 15-1 presents cost estimates for online improvements, while Table 15-2 presents cost estimates for selected bypass-options. The tables are used as input to the economic feasibility analysis.

Reconstruction/rehabilitation cost for the improvements to a category II standard are on average €0.8 M per km. New construction cost are on average €1.2M per km.

Table 15-1. Capital Costs of Online Rehabilitation/Reconstruction

Section No.	Length (km)	Total Cost per section	Cost per kilometre
		€m	**€m**
1a*	32.00	2.672	0.084
1b*	2.34	0.098	0.042
2	14.46	14.531	1.005
3	8.50	8.956	1.054
4	5.10	4.984	0.977
5*	24.11	5.083	0.211
6	10.25	7.687	0.750
7	39.04	33.975	0.870
8	15.55	13.532	0.870
9	21.41	18.632	0.870
10	5.34	4.408	0.825
11	23.90	20.799	0.870
12	13.16	11.453	0.870
Total	215.16	159.202	0.740

Source: The Consultant
Notes: Economic costs
* Costs for sections 1&5 are for maintenance not reconstruction

Table 15-2. Capital Costs of M3 Corridor Major Offline Projects

Bypass/Extension		Length in km	Total Cost per section (€m)	Cost per kilometre (€m)
A	M3 extension/Cimislia Bypass	33.3	45.732	1.373
B	M3 extension II/Comrat Bypass	17.9	16.564	0.925
C	New alignment/bypass, Ciumai – Burlaceni	15.0	10.691	0.711
D	Vulcăneşti Bypass	8.4	11.026	1.306
E	New alignment/bypasses of Slobozia Mare, Câşliţa-Prut, Giurgiuleşti	20.7	25.645	1.236
	Total	95.3	109.658	1.152

Source: The Consultant

16. ECONOMIC EVALUATION

16.1. Introduction

This section of the report describes the economic assessment work carried out as part of the M3 Chisinau – Giurgiulesti feasibility study. In line with the Terms of Reference HDM-4 has been used to identify economically suitable sections for road improvement which can attract financing from IFIs.

16.1.1. Objectives of the Economic Evaluation

The objectives of the economic component of the study can be summarised as:

- conduct economic analysis of rehabilitation and or extension of each of the main segments of the M3 Chisinau – Giurgiulesti using an year evaluation period of 20 years and discount rate of 12% to produce indicators of economic viability;
- quantify and identify costs and benefits produced by each of the modelled road rehabilitation and improvement alternatives; costs to include capital, maintenance and institutional costs, benefits to include vehicle operating cost and time savings;
- conduct sensitivity tests on the key input variables, including capital costs;
- recommend preferred economic options for each road segment and sub-project;
- produce economic ranking of alternatives.

16.1.2. Overview of Economic Evaluation

The economic evaluation draws extensively on the output of other components of the study, notably the traffic analysis and the highway engineering investigations. These parts of the study have been described in detail in their respective parts of the report, traffic in section 3 and highway engineering in sections 7, 10 and 11. These elements of the study are only referred to in this section of the report where they directly relate, predominantly in terms of input, to the economic evaluation.

Together with the identification and quantification of traffic and engineering inputs the methodology of the economic evaluation modelling is confirmed and accompanied by a description of specific economic research and data collection. This is followed by output and results, including sensitivity tests, of the evaluation plus conclusions and recommendations.

16.1.3. Summary of Traffic Studies

The traffic work of the current study has been described in detail in section 3 of the report. It is recapitulated here only where it relates directly to the economic evaluation.

Derivation of Annual Average Daily Traffic
A series of manual classified counts (MCCs) was carried out during July and August 2008 in order to confirm existing traffic volumes and vehicle composition along the length of the study corridor. The traffic survey data was adjusted to take account of the precise time and period over which it was collected. Adjustment factors were applied to take account of the following:

- Expansion of 12 hour to 24 hour traffic flows
- Seasonal adjustment to give Annual Average Daily Traffic (AADT)

The estimates of Annual Average Daily Traffic (AADT) for 2008 produced by the adjusted traffic survey data were then used to confirm the road sections to be used within the HDM-4 economic evaluation modelling. Table 16-1 provides the details. A summary of classified AADT by road section is given in Table 16-2. For the economic modelling, HGVs have been grouped into two classes only, 3-axle and 4 or more axles. Other modelled road user classes are shown in Table 16-3.

Table 16-1. Road Sections for M3 Chisinau - Giurgiulesti Economic Modelling

Section	Chainage		Length
	from km	to km	in km
Chisinau – Porumbrei	0.00	34.34	34.34
Porumbrei – R3 junction	34.34	48.80	14.46
R3 junction – Cimislia	48.80	57.30	8.50
Cimislia urban area	57.30	62.40	5.10
Cimislia – Comrat	62.40	86.51	24.11
Comrat urban area	86.51	96.76	10.25
Comrat – R38 junction	96.76	135.80	39.04
R38 junction – Ciumai	135.80	151.35	15.55
Ciumai – Vulcanesti	151.35	172.76	21.41
Vulcanesti urban area	172.76	178.10	5.34
Vulcanesti – Slobozia Mare	178.10	202.00	23.90
Slobozia Mare – Giurgiulesti	202.00	215.16	13.16
Total M3 Corridor	0.00	215.16	215.16

Source: Consultant

Table 16-2. M3 Chisinau - Giurgiulesti 2008 AADT by section

Section		Car	Mini-bus	Bus	LGV	Light Truck	2-axle MGV	3-axle HGV	4+axle HGV	Total
1	Chisinau - Porumbrei	2,017	233	39	296	157	105	25	115	2,986
2	Porumbrei – R3 junction	2,017	233	39	296	157	105	25	115	2,986
3	R3 junction – Cimislia	2,624	166	59	409	124	117	31	146	3,675
4	Cimislia urban area	3,165	168	77	434	184	141	39	230	4,439
5	Cimislia – Comrat	1,426	64	49	199	120	58	20	134	2,070
6	Comrat urban area	2,079	147	103	317	150	83	31	125	3,035
7	Comrat – R38 junction	1,112	89	56	165	56	52	22	67	1,619
8	R38 junction – Ciumai	408	27	12	77	12	21	13	44	613
9	Ciumai – Vulcanesti	772	46	41	91	30	19	7	41	1,048
10	Vulcanesti urban area	801	42	35	113	27	41	12	53	1,125
11	Vulcanesti – Slobozia Mare	371	14	10	70	9	40	10	34	559
12	Slobozia Mare – Giurgiulesti	867	22	23	55	17	11	6	46	1,048

Source: Consultant

Table 16-3. M3 Chisinau - Giurgiulesti 2008 Daily Other Vehicle Classes by Section

Section		Motorcycle	Bicycle	Animal cart
1	Chisinau - Porumbrei	12	19	4
2	Porumbrei – R3 junction	12	19	4
3	R3 junction – Cimislia	6	16	2
4	Cimislia urban area	18	18	4
5	Cimislia – Comrat	11	6	2
6	Comrat urban area	20	15	9
7	Comrat – R38 junction	17	13	9
8	R38 junction – Ciumai	16	6	10
9	Ciumai – Vulcanesti	26	7	14
10	Vulcanesti urban area	25	10	18
11	Vulcanesti – Slobozia Mare	10	7	12
12	Slobozia Mare – Giurgiulesti	29	8	12

Source (all tables): The Consultant

Traffic Forecasts

The development of traffic forecasts for the current study is described in detail in section 3.6 of this report.

Normal traffic forecast growth rates for the study have been based on the prospects for national economic development and are summarised in Table 16-4 below.

Table 16-4. Traffic Forecast Growth Rates, 2008-2030, M3 (% change per annum)

Scenario	Low		Central		High	
Period	Passenger	Goods	Passenger	Goods	Passenger	Goods
2008-2013	5.4	5.3	7.3	7.0	8.7	8.4
2014-2019	4.9	4.5	6.5	6.0	7.8	7.2
2020-2030	3.0	2.9	4.0	3.9	4.8	4.7

Source: The Consultant

Four other elements contributed to the finalised future traffic forecasts for the M3 corridor:

- Traffic generation by the development of Giurgiulesti port
- Traffic generation from improved local and regional accessibility throughout the corridor
- Traffic diversion to the M3 corridor from other strategic routes, notably the R34
- Traffic diversion from the existing M3 corridor to the proposed offline improvements

Each of these components of future traffic on the M3 corridor is summarised within the components of Table 16-5.

Table 16-5. Traffic Generation from Giurgiulesti port at Full Development in 2018

Section of M3 Corridor	%	Vehicles/day
Total Port Traffic Assigned to M3 Corridor	100	2,583
Giurgiulesti - Slobozia Mare	100	2,583
Slobozia Mare – Vulcanesti	36	930
Vulcanesti - Comrat	24	620
Comrat – Chisinau	17	439

Source: The Consultant

It is anticipated that port traffic will develop to the maximum level shown in Table 16-5 over the period 2009-2018 inclusive to reflect progressive port development. For the purposes of HDM-4 modelling port traffic has not been treated as generated traffic but rather as an additional element of normal growth on the assumption that port development is already well underway and will continue irrespective of M3 corridor rehabilitation and improvement.

Traffic generation resulting from M3 corridor rehabilitation and improvement has been assumed to be modest, totalling 1.4% of AADT in 2008. This traffic generation has been spread evenly over the ten years from project opening, 2011-2020 inclusive. Table 16-6 and Table 16-7 present general traffic diversion and traffic diversion to off-line improvements.

Table 16-6. Traffic Forecasts: Strategic Diversion to M3

From	To	Flow (vehs/day) 2011
Giurgiulesti/Slobozia Mare	Comrat/Cimislia/Chisinau	280
Cahul	Comrat	1,096
Cahul	Cimislia	1,140
Cahul	Chisinau (via M3)	360
Cahul	Chisinau (via R3/Hincesti)	370

Source: The Consultant

Note that Cahul to Chisinau traffic is split almost evenly into two routes, one using the M3 corridor from Cimislia northwards, the other travelling via the R3 and Hincesti, so using the study corridor only over the short section between Cimislia and the M3/R3 junction.

Table 16-7. Traffic Forecasts: Diversion to Major Offline M3 Schemes

Principal Bypassable Sections	Diverted AADT (2011)
Cimislia Bypass + M3 extension	1,547
Comrat Bypass	2,280
Vulcanesti Bypass	475
South Corridor Realignment (including village bypasses)	651

Source (all tables): The Consultant

No distinction has been made for forecasting purposes between national and international traffic.

16.2. Road Network Data

16.2.1. Introduction to Economic Evaluation Methodology

The economic analysis has used HDM-4 (Highway Development and Management), originally developed by the World Bank and now accepted as the premier model for the economic evaluation of international road rehabilitation and improvement schemes.

In brief, the model compares the costs (capital and recurrent) of road investment with the resultant benefits to road users. These benefits primarily comprise vehicle operating cost and travel time savings, although reductions in accident costs and future maintenance expenditure can also be evaluated.

Time savings, vehicle operating costs and accident costs result from combinations of improvements in road standard/design, alignment and surface condition (notably roughness), future maintenance savings from improvements in road surface condition and structural strength. The improvement scheme is compared to a base or do minimum situation in which the unimproved road continues to be maintained in line with established procedures for appropriate roads in Moldova.

This analysis has used HDM-4 version 2.

16.2.2. Road Network: Engineering Input

HDM-4 bases its modelling on road sections of homogeneous traffic. Where traffic levels change significantly, for example at a major junction or in an urban area, it is necessary to have a change of section. A series of sections make up a link within HDM-4. The road sections for the M3 Chisinau – Giurgiulesti evaluation have been identified, on the basis of traffic, in Table 16-8 above which is recapitulated and expanded in Table 16-6 below.

Table 16-8. Road Sections for HDM-4

HDM-4 Section No.	Description	Length (km)
1a	Chisinau – Sagaidacul Nou	32.00
1b	Sagaidacul Nou - Porumbrei	2.34
2	Porumbrei – R3 junction	14.46
3	R3 junction - Cimislia	8.50
4	Cimislia urban area	5.10
5	Cimislia – Comrat	24.11
6	Comrat urban area	10.25
7	Comrat – R38 junction	39.04
8	R38 junction – Ciumai	15.55
9	Ciumai – Vulcanesti	21.41
10	Vulcanesti urban area	5.34
11	Vulcanesti – Slobozia Mare	23.90
12	Slobozia Mare – Giurgiulesti	13.16
	Total	215.16

Source: The Consultant

The subdivision of section no. 1 into two sub-sections reflects the change from a four lane to a two lane road for the southernmost 2.13 km of the concrete section of the M3. The two sub-sections are modelled to carry the same traffic volumes.

A series of sections or links comprise an HDM-4 road network and it is to the sections of the network that the extensive highway engineering data required by the program is assigned.
The input requirements of HDM-4 reflect its reliance on reliable highway engineering data, in particular regarding road construction, condition and maintenance. These engineering requirements, where they are included directly as part of the road network data can be summarised as follows:

- Road construction and maintenance history;
- Road inventory/geometric data;
- Road structure;
- Road condition.

16.2.3. Construction and Maintenance Histories

The M3 Chisinau – Giurgiulesti corridor consists of a series of component roads of varying history and standard as summarised in Table 16-9 below.

Table 16-9. Maintenance History of M3 Corridor

From	To	Section no.s	Standard	Year of Last Major Treatment
Chisinau	Porumbrei	1a,1b	D2 Concrete	1987
Porumbrei	R3 junction	2	S2 Asphalt	2006
R3	Cimislia	3	S2 Asphalt	2002
Cimislia	Comrat	4,5	S2 Asphalt	2008
Comrat	R38 junction	6,7	S2 Asphalt	2002
R38 junction	Vulcanesti	8,9,10	S2 Asphalt	2002
Vulcanesti	Giurgiulesti	11,12	S2 Asphalt	2002

Source: The Consultant

16.2.4. Road Inventory and Geometrics

A road inventory survey was conducted on the M3 corridor from August to October 2008. A summary of the results is provided in Table 16-10.

Table 16-10. Summary of Road Inventory: M3 Chisinau - Giurgiulesti

Section No.	Length	Width	No. lanes	Shoulder width	Rise and fall	Horizontal curvature	Speed limit	Altitude	Surface Type
	km	m		m	m/km	deg/km	kph	m	
1a	32.00	19.33	4	6.66	27.33	27.10	110	180	Concrete
1b	2.34	9.67	2	3.33	27.33	27.10	90	180	Concrete
2	14.46	8.51	2	1.80	22.87	44.52	60	150	Asphalt
3	8.50	9.72	2	1.73	5.62	14.15	70	100	Asphalt
4	5.10	9.45	2	1.79	5.60	84.31	50	100	Asphalt
5	24.11	7.00	2	2.50	34.26	30.12	90	150	Asphalt
6	10.25	7.00	2	1.80	9.77	88.68	50	50	Asphalt
7	39.04	8.23	2	2.38	7.53	6.53	90	40	Asphalt
8	15.55	8.06	2	2.55	9.77	11.20	90	50	Asphalt
9	21.41	6.62	2	2.34	25.54	57.01	90	100	Asphalt
10	5.34	7.05	2	2.15	20.00	55.75	50	50	Asphalt
11	23.90	6.74	2	3.09	25.68	33.93	90	100	Asphalt
12	13.16	6.73	2	1.96	24.30	58.43	90	40	Asphalt

Source: The Consultant

16.3. Existing Road Condition

Surveys of surface condition have been undertaken of the existing roads. These are described in full in the appropriate section of the engineering report. The surveys as relevant to the HDM analysis can be summarised as follows:

- Visual survey of surface condition (covering cracking, rutting, potholing/patching, ravelling, edge break)
- Road roughness survey using a rear-axle mounted bump integrator
- The visual survey was adjusted appropriately for the concrete section (no. 1) from km 0.0 to km 34.13.

Tables 16-11 and 16-12 summarise the results of the road condition investigations for the concrete and asphalt sections respectively of the M3 corridor.

Table 16-11. Summary of Road Condition: M3 Chisinau – Giurgiulesti: Concrete Section

Section No.	Roughness	Slab length (m)	Average faulting (mm)	Spalled joints %	Cracked slabs %	Deteriorated cracks/km	Failures per km
	m/km	%	%	%	no.	m^2	mm
1	4.74	5.00	66.76	5.09	21.76	9.00	3.66

Source: The Consultant

Table 16-12. Summary of Road Condition: M3 Chisinau – Giurgiulesti: Asphalt Sections

No.	Rough-ness	Area of All cracks	Area of wide cracks	Area of Ravelling	No. of Potholes	Edge break area	Mean rut depth	SD of rut depth
	m/km	%	%	%	no.	m^2	mm	Mm
2	6.00*	0.09	0.00	0.38	0.13	1.35	61.80	59.27
3	5.42	2.29	0.00	0.86	2.29	28.73	20.00	36.06
4	5.18	0.32	0.00	0.00	7.75	14.65	0.00	0.00
5	1.91	0.00	0.00	1.00	0.00	0.00	2.00	0.00
6	6.67	0.32	0.00	0.00	7.75	14.65	0.00	0.00
7	5.89	2.41	0.00	0.33	3.30	39.47	12.55	26.43
8	7.19	1.00	0.00	0.03	3.50	37.19	15.63	34.00
9	6.87	2.02	0.00	0.00	2.38	14.50	25.29	41.71
10	8.10	0.57	0.00	0.00	9.00	0.00	0.00	0.00
11	6.06	0.22	0.00	0.00	5.16	9.99	16.00	34.03
12	6.67	0.58	0.00	0.62	3.36	2.83	0.00	0.00

* measured = 4.42, but considered unreliable & inconsistent
Source: The Consultant

16.3.1. Surveys of Road Structure

Road structure surveys consisted of the investigation of the number, composition and depth of layers of pavement using Dynamic Cone Pentrometer (DCP) tests, trial pits and asphalt cores.

Table 16-13 below gives details of the structure of the existing road sections, including the concrete section (no. 1).

Table 16-13. Summary of Existing Road Structure: M3 Chisinau - Giurgiulesti

Section No.	Asphalt thickness	Surface Thickness	Granular Base course	Base Layer	Subgrade CBR
	mm	mm	mm	Mm	%
1	-	180	n/a	100	n/a
2	101	-	250	-	8
3	130	-	250	-	8
4	130	-	250	-	8
5	130	-	250	-	8
6	130	-	250	-	8
7	163	-	250	-	8
8	119	-	250	-	8
9	98	-	250	-	8
10	210	-	250	-	8
11	123	-	250	-	8
12	119	-	250	-	8

Source: The Consultant

Climatic Data

As part of the modelling of road deterioration HDM-4 requires a small set of climatic data to reflect the prevailing conditions in the vicinity of the study corridor. Data has been obtained from meteorological stations in Chisinau, Comrat and Cahul. Table 16-14 below details the climatic data input to HDM-4.

Table 16-14. Climatic Data for HDM-4

Moisture Class	-	Semi-arid
Moisture Index	MI	-40
Duration of dry season	months	9
Mean monthly precipitation	mm	37
Temperature class	-	Temperate – cool
Mean temperature	deg C	9.7
Average temperature range	deg C	45
Days higher than 32C	no.	15
Freeze index	FI	71
Days road snow covered	%	2.7%
Days road water covered	%	5.0%
Use of salt	Y/N	Yes
Use of studded tyres	Y/N	Yes

Source: Meteorological stations/HDM-4

16.3.2. HDM-4 Calibration

HDM-4 requires calibration to accurately represent local conditions, notably in the road deterioration and vehicle operating cost relationships within the model. Reference has been made to the work carried out by Finnroad and Roughton in the development of a Pavement Management System on behalf of the Ministry of Transport. The work provides a series of calibration factors for Moldova relating to the deterioration of paved roads.

Calibration factors from this work have been used, where appropriate, in the current analysis. The input values adopted are listed in Table 16-15 below.

Table 16-15. HDM-4 Calibration Factors applied to M3

Parameter	Ref.	Value
Roughness-age term	K_{ge}	1.52
Cracking initiation	K_{ci}	1.00
Cracking progression	K_{cp}	1.00
Ravelling initiation	K_{vi}	1.00
Rut progression	K_{pr}	1.50
Pothole progression	K_{pp}	1.00
Roughness progression	$K_{g..}$	1.00
IRI (m/km) after works	-	2.40

Source: Finnroad-Roughton/MoT

16.4. Vehicle Fleet and Operating Costs

Introduction
Vehicle operating cost (VOC) data for the main vehicle categories represented on Moldova national roads from previous studies, notably World Bank work from 2005, has been reviewed. Following observations of vehicle composition during the course of the study traffic surveys fresh data collection has been carried out at vehicle traders, importers and operators to obtain the latest values of VOCs in the light of rising prices in Moldova.

A single vehicle fleet with vocs has been developed for the M3 Chisinau – Giurgiulesti corridor.

16.4.1 Vehicle Classes and Characteristics

The choice of vehicle classes and their representative models was determined following observations made during the course of the study traffic surveys. These indicated the significant vehicle classes in the study corridor and the predominant models within each of those classes. For example, a single class of articulated goods vehicle was revealed as sufficient. This was represented by the 5-axle class which was shown to be the most significant by the study surveys. Table 16-16 shows the representative vehicle models selected and Table 16-17 their basic characteristics.

Information on equivalent standard axles (ESAs), vehicle occupancy and work/non-work time split has been provided by the study's own traffic surveys.

Table 16-16. Representative Vehicle Models for HDM-4

Vehicle Class for HDM-4	Make and Model
Car	Opel Vectra
Minibus	Mercedes Benz 210
LGV	Ford Transit
Large Bus	Mercedes Benz 410D
Light Truck	Mercedes Benz 412
2-axle MGV	MAN 8.163
3-axle HGV	Kamaz
5-axle Articulated	MAN 18-140

Source: The Consultant

Table 16-17. Basic Vehicle Characteristics

Vehicle Class	Operating weight (tonnes)	PCSE	No. of Axles	No. of Wheels	No. of ESAs	No. of Passengers	Work-related trips (%)
Car	1.50	1.0	2	4	0.0001	1.5	30
Minibus	2.80	1.0	2	4	0.0019	5.4	30
LGV	1.68	1.0	2	4	0.0021	1.1	30
Large Bus	4.60	1.8	2	6	0.2002	17.8	50
Light Truck	4.60	1.3	2	6	0.1000	0.9	30
2-axle MGV	8.80	1.5	2	6	0.3331	0.4	50
3-axle rigid HGV	17.10	1.8	3	10	1.1381	0.4	50
4+axle Artic HGV	28.00	2.2	5	18	3.9717	0.4	50

Source: The Consultant

16.4.2. Vehicle Operating Costs

The VOC data, as used and input to HDM-4, is summarised in Tables 16-18 and 16-19 below. Monetary values are in €uro.

Table 16-18. Vehicle Economic Unit Costs (in €uro)

Vehicle Class	New Vehicle Cost	Cost of New Tyre	Cost per hour of Repair/ Maint.	Cost per hour of Vehicle Crew	Passenger in work time delay cost per hour	Passenger in non-work time delay cost per hour	Annual Over-head
Car	9,460	143	1.43	7.16	1.46	0.48	859
Minibus	11,090	430	1.43	7.16	1.46	0.48	2,863
LGV	13,863	430	1.43	7.16	1.46	0.48	2,863
Large Bus	16.635	600	1.43	7.16	1.46	0.48	7,158
Light Truck	14,972	600	1.43	7.16	1.46	0.48	4,000
2-axle MGV	34,365	573	1.43	7.16	1.46	0.48	3,579
3-axle rigid HGV	38,940	859	1.43	7.16	1.46	0.48	4,295
4+axle Artic HGV	60,839	1,790	1.43	7.16	1.46	0.48	9,306

Source: The Consultant
Note: these are economic costs (i.e. exclusive of taxes and subsidies)

The average cost of cargo delay is €0.1/hour.

Table 16-19. Vehicle Utilisation

Vehicle Class	Annual vehicle km	Annual working hours	Vehicle life (years)	Annual Interest (%)
Car	12,700	550	13	15
Minibus	24,000	1,300	16.5	15
LGV	24,000	1,300	16.5	15
Large Bus	32,500	1,750	16.5	15
Light Truck	24,000	1,200	16.5	15
2-axle MGV	100,000	4,000	12	15
3-axle rigid HGV	25,000	2,050	16.5	15
4+axle Artic HGV	150,000	4,000	15	15

Source: The Consultant

The costs of fuel and lubricants were derived following research work to identify the economic costs of petrol and diesel in Moldova in 2008. This involved the exclusion of taxes and duties.

The resulting economic costs are presented in Table 16-20 below.

Table 16-20. Cost of Fuel and Lubricants

Item	Cost/Litre (€)
Petrol	0.57
Diesel	0.72
Oil (car)	2.15
Oil (other)	2.86

Source: The Consultant

In addition to the main vehicle classes three other classes of road user have been identified through the study's traffic surveys, motorcyclists, bicyclists and users of animal carts. The principal operating costs associated with these road users and input to HDM-4 are summarised in Table 16-21 below. Where information relating to these road users was not collected during the course of the traffic and economic surveys HDM-4 default values were used.

Table 16-21. Principal Operating Costs for Other Road Users (€)

Vehicle Class	New Vehicle Cost	Cost of New Tyre	Cost per hour of Repair/ Maintenance	Passenger in work time delay cost per hour	Passenger in non-work time delay cost per hour	Annual Interest (%)
Motorcycle	3,000	140	1.43	2.95	0.97	15
Bicycle	80	-	-	0.97		15
Animal Cart	120	-	-	0.97		0

Source: HDM-4/The Consultant

16.4.3. Value of Time

In line with the World Bank's recommendations work and business time has been valued at the full economic travel time rate and non-work travel time has been valued at a default value of 33% of the full rate. Travel to and from work (commuting) has been classified as non-work time. Work/business trips are valued on the assumption that an employee's value is equal to the wage rate plus any additional costs of employment. The latter have been taken to be approximately 33% of the wage rate.

Moldovan national statistics have been used to derive the economic value of travel time in 2008. The official national wage, quoted by www.infotech, is equivalent to € 1.10 per hour. The inclusion of 33% non-wage costs raises this to U€ 1.46 per hour (with non-work at €0.48/hour).

The expected rapid increase in real wages over the forecasting period has lead to the calculation of an average value of time over the appraisal period. It has been assumed that real wages grow in line with real per capita GDP to give an average economic value of working travel time over the whole 2008-2030 appraisal period of € 2.95 per hour, including the 33% non-wage cost uplift. The equivalent non-working travel time will be 33% of this or € 0.97 per hour.

These values of time are summarised in Table 16-22 below.

Table 16-22. Value of Time in Moldova (€/hr)

Base	Work	Non-work
2008	1.46	0.48
2008-2030 average	2.95	0.97

Source: The Consultant/www.infotech

The observed work/non-work journey split and the average vehicle occupancies from the study traffic surveys have been used to produce weighted average economic travel time per vehicle hour, shown in Table 16-23.

Table 16-23. Weighted Average Travel Time per Vehicle Hour

Vehicle Class	Persons	Value of Time/ Vehicle hour (€)
Passenger cars	2.5	2.46
Minibuses	6.4	11.30
Pickups/Light Goods Vehicles	2.0	3.61
Buses	18.8	36.90
Medium Goods Vehicles	1.4	2.75
Heavy Goods Vehicles	1.4	2.75

Source: The Consultant

HDM-4 Speed Validation

A comparison has been made between observed travel speeds and HDM-4 modelled vehicle speeds as part of the validation of the economic evaluation. This is of particular importance to the modelling of bypasses where relative speeds are significant to scheme benefits. The comparison shows a satisfactory degree of correlation with modelled travel speeds within 10% of observed travel speeds for each of the main bypassed sections.

16.5. Road Works Costs and Alternative Future Strategies

16.5.1. Alternative Future Strategies

HDM-4 compares a “without project” situation with one or more “with project” situations. This enables the net economic impact of the proposed scheme(s) to be enumerated. The without project situation should represent a realistic treatment of the road in the absence of project approval.

For the M3 Chisinau – Giurgiulesti corridor study a number of separate road improvement and rehabilitation projects are proposed. These projects include online and offline options. The latter, range from major realignments of the corridor to village bypasses and minor realignments. These offline schemes are listed in Table 16-24 below.

Table 16-24. Proposed Bypasses and Realignments: M3 Chisinau – Giurgiulesti

No.	Bypass/Extension	Length in km
1	M3 extension	19.0
2	Cimislia Bypass	14.3
2	Ciucur-Minjir Realignment	2.1
3	M3 extension II & Comrat Bypass	17.9
4	Chirsova Bypass	6.7
5	Congaz Bypass	6.4
6	Svetliî Bypass	3.6
7	New alignment & bypass, Ciumai – Burlaceni	15.0
8	Vulcăneşti Bypass	8.4
9	New alignment & bypasses of Slobozia Mare, Câşlița-Prut, Giurgiuleşti	20.7
	Total	114.1

Source: The Consultant

These offline proposals do not cover the entire length of the corridor, such that certain sections or parts of sections do not have an offline alternative.

The economic evaluation has concentrated on the modelling of the more significant realignment proposals to establish which have realistic economic potential while also examining an online alternative in which the proposed treatment reflects the specific characteristics and requirements of the particular road section. The selected offline proposals for detailed evaluation are:

- M3 extension/Cimislia bypass
- M3 extension II/Comrat bypass
- Ciumai/Burlaceni realignment/bypass
- Vulcanesti bypass
- Slobozia Mare/Giurgiulesti bypasses/southern corridor realignment

The other realignments consist of short sections which have only limited potential for traffic and economic benefits given the relatively satisfactory highway and travelling conditions on the existing alignment. Any advancement of these projects would be driven, to a significant degree, by other factors.

The economic modelling consequently consists of three scenarios:

- Do Minimum
- Do Something 1: Online
- Do Something 2: Offline (implementation of major offline projects + online elsewhere)

16.5.2. Do Minimum

A realistic do minimum situation has been assumed for the study corridor in the case of the proposed projects failing to proceed. The do minimum reflects the current maintenance standards and practices in Moldova. This represents keeping the road at current levels of serviceability. The do minimum can be summarised as follows:

- Routine maintenance/patching
- Resurfacing after 10-12 years where necessary (as indicated by HDM-4)

Chisinau – Porumbrei consists of a concrete pavement which requires a combination of the following routine maintenance activities:

- Joint sealing
- Slab replacement

16.5.3. Do Something 1: Online Road Rehabilitation/Reconstruction Strategy

The proposed road rehabilitation strategy has been drawn up in detail and costed for each of the study road sections. For all sections except Chisinau – Porumbrei and Cimislia - Comrat this will consist of the following:

- Reconstruction of existing road with 40mm asphalt concrete surface and a bituminous binder course of 70mm
- Pavement Option 1 has a bituminous base of between 100mm and 180mm and a cold recycled sub-base of between 180mm and 200mm (total pavement depth: 390mm – 490mm)
- Pavement Option 2 has a cold recycled base of between 180mm and 200mm and a cement-stabilised sub-base of between 180mm and 200mm plus a capping of the existing sub-base (total pavement depth: 470mm – 700mm)
- Road cross-section of 2 x 3.75m lanes + 2 x 3.75m paved shoulders (Cat-II)

In each case, the existing asphalt pavement will be removed or milled and processed for reuse/recycling. The cement-stabilised base will incorporate recycled asphalt from the existing pavement.

The reconstructed road sections have been designed with a CBR of between 5% and 8% at a relative compaction of 95% and a surface roughness on opening of 2.0 IRI.

Chisinau – Porumbrei consists of a dual two lane concrete pavement constructed in 1987 which has significant remaining design life in relation to study traffic forecasts. Repair work only is required for this section over the evaluation period. These activities will include:

- edge repair
- crack repair
- surface repair
- joint cleaning/sealing
- slab replacement
- drainage work

Cimislia – Comrat has been rehabilitated as of 2008 with funding from the Government of Moldova. As surveyed during the course of the study it has an excellent surface condition and does not appear to be in need of further rehabilitation work for the foreseeable future. Online work will consist of routine maintenance and patching only.

16.5.4. Do Something 2: Offline Road Improvements

These comprise the five major realignments and bypasses listed above. Preliminary designs for each of these projects have been drawn up to SNIP Cat-II standard (2x 3.75m lanes + 2 x 3.75m shoulders) and project-specific costs developed. Traffic forecasts for each of these schemes have been covered in section 15.2 above.

Pavement design follows that for the online reconstruction scenario with two options to allow different type and depth of courses below the wearing course:

- 40mm asphalt concrete surface;
- Pavement Option 1 has a bituminous binder course of 70mm, a bituminous base of between 150mm and 180mm and a cement-stabilised sub-base of 200mm to 220mm (total pavement depth: 460mm – 510mm);
- Pavement Option 2 has bituminous binder of between 120mm and 140mm, a cement-stabilised base of 200mm and a limestone capping of between 200mm and 240mm (total pavement depth: 570mm – 620mm).

Bypassed road sections would be subject to routine maintenance and patching only.

16.5.4. Unit Costs of Road Maintenance and Improvement

Table 16-25 gives details of the latest unit costs of road maintenance operations in Moldova as relevant to the current project. These have been based upon the Consultants' considerable experience of road maintenance projects in Moldova cross-referenced with the work of previous studies. Unit cost rates have been obtained for those operations anticipated for the study road.

Table 16-25. Maintenance Operation Unit Costs for National Roads in Moldova

Operation	Unit Cost €	
	Economic	Financial
Routine maintenance (Cat-I Concrete)	1.85/m^2	2.13/m^2
Routine maintenance + minor rehabilitation (Cat-I Concrete)	4.36/m^2	5.01/m^2
Routine maintenance (Cat-II & Cat-III)	0.43/m^2	0.50/m^2
Routine maintenance (Cat-III)	0.35/m^2	0.40/m^2
Resealing	1.77/m^2	2.04/m^2
Edge Break	13.98/m^2	16.07/m^2
Patching	25.91/m^2	29.78/m^2
Overlay (60mm)	13.83/m^2	15.06/m^2

Source: The Consultant/World Bank

Unit cost rates for the do something works, online and offline, have been costed on a section-specific basis, the recommended treatment for each section depending upon the existing pavement depth and quality and the appropriate traffic forecasts.

Table 16-26 below details the total, and per kilometre, capital costs of the proposed strategy for each section of the corridor for the online rehabilitation strategy. Table 16-27 provides the same for the principal offline M3 projects. These are preliminary costs and are subject to further checking and revision.

Table 16-26. Capital Costs of M3 Corridor Online Rehabilitation/Reconstruction Strategy

Section No.	Length (km)	Total Cost per section	Cost per kilometre
		€m	€m
1a*	32.00	2.672	0.084
1b*	2.34	0.098	0.042
2	14.46	14.531	1.005
3	8.50	8.956	1.054
4	5.10	4.984	0.977
5*	24.11	5.083	0.211
6	10.25	7.687	0.750
7	39.04	33.975	0.870
8	15.55	13.532	0.870
9	21.41	18.632	0.870
10	5.34	4.408	0.825
11	23.90	20.799	0.870
12	13.16	11.453	0.870
Total	215.16	159.202	0.740

Source: The Consultant
Notes: Economic costs
* Costs for sections 1&5 are for maintenance not reconstruction

Table 16-27. Capital Costs of M3 Corridor Major Offline Projects

Bypass/Extension		Length in km	Total Cost per section (€m)	Cost per kilometre (€m)
A	M3 extension/Cimislia Bypass	33.3	45.732	1.373
A-B1	Porumbrei-Cimislia from km 34 M3 to to the intersection with R3 road, km 66+800 to North of Cimislia	19.1	23.81	1.25
A-B2	Northwest bypass variant of Cimislia town, from the intersection with R3 road km 66+800 to North of Cimislia to km 65 M3 to South of Cimislia	7.15	13.75	1.92
B	M3 extension II/Comrat Bypass	17.9	16.564	0.925
C	New alignment/bypass, Ciumai – Burlaceni	15.0	10.691	0.711
D	Vulcăneşti Bypass	8.4	11.026	1.306
E	New alignment/bypasses of Slobozia Mare, Câşliţa-Prut, Giurgiuleşti	20.7	25.645	1.236
	Total	95.3	109.658	1.152

Source: The Consultant
Note: Economic costs

16.5.5. Residual value

For the offline road projects the residual value at the end of the evaluation period has been calculated through an assessment of the breakdown of the construction costs. Table 16-28 below shows the assumptions regarding operational life of the main components of road construction. These values have been taken from recent work carried out on behalf of the EU in Slovakia. Residual values, as a percentage of capital costs, will be confirmed for each offline scheme following finalisation of capital cost calculations.

Table 16-28. Asset Life of Road Construction

Asset	Asset Life (Years)
Highways	20
Bridges	60
Tunnels	100
Others	50

Source: The Consultant/EU

The online reconstruction schemes are assumed to have zero residual value at the end of the evaluation period.

Timing of Works
Completion of all works, online and offline is anticipated by 2011. In the cases of the Cimislia, Comrat and Slobozia Mare/Giurgiulesti/southern corridor bypasses the works will last up to two years. The other projects by section, online and offline, will each take approximately one year.

16.6. Project Economic Evaluation Parameters

Discount Rate
A discount rate of 12% has been adopted for this project in line with the Terms of Reference for the study. The discount base year has been taken to be 2008.

Evaluation Period
The evaluation period commences with project opening year in each case expected to be 2011. Final evaluation year is 20 years later, 2031.

Accident Costs
Accident costs and benefits have not been included within the economic evaluation because of difficulties obtaining reliable accident rates for the existing M3 corridor. Although accident clusters have been identified at certain locations it is evident that the accident dataset as provided by the traffic police is incomplete, presumably with regard to slight injury accidents.

In addition, the net effect on road safety, accident rates and costs of the proposed projects may be ambiguous without being supported by a major programme of road safety education and enforcement.

No other potential benefits, such as those from regional development, have been included in the economic evaluation to date because of the problems associated with monetisation of benefits as required for input to the HDM-4 methodology.

16.7. Results of Economic Analysis

Summary of Results

A summary of the results of the economic analysis using HDM-4 is provided in Tables 16-29 for online projects and 16-30 for offline projects. The target EIRR for the projects is 12%.

Table 16-29. Summary of Economic Analysis for M3 Corridor Online Rehabilitation

Section		Net Present Value (NPV, €m)	NPV/Cost Ratio	Economic Internal Rate of Return (%)
1	Chisinau - Porumbrei	Concrete: minor renewals only		
2	Porumbrei – R3 junction	4.13	0.356	14.9
3	R3 junction - Cimislia	11.02	1.541	23.2
4	Cimislia urban area	7.61	1.912	24.9
5	Cimislia - Comrat	No major online works		
6	Comrat urban area	20.07	1.967	26.0
7	Comrat – R38 junction	31.23	1.152	21.0
8	R38 junction – Ciumai	0.08	0.007	12.1
9	Ciumai – Vulcanesti	0.97	0.065	12.7
10	Vulcanesti urban area	1.15	0.328	15.4
11	Vulcanesti – Slobozia Mare	-1.86	-0.112	10.8
12	Slobozia Mare – Giurgiulesti	6.91	0.756	18.3
Total	M3 Corridor: Chisinau – Giurgiulesti*	73.31	0.661	17.6

*** excludes sections 1&5 (not reconstructed)**
Source: The Consultant

Table 16-30. Summary of Economic Analysis for M3 Major Offline Projects

Bypass/Extension		Net Present Value (NPV, €m)	NPV/Cost Ratio	Economic Internal Rate of Return (%)
A	M3 extension/Cimislia Bypass	-55.06	-1.300	-
A-B1	Porumbrei-Cimislia from km 34 M3 to to the intersection with R3 road, km 66+800 to North of Cimislia	6.45	0.292	15.0
A-B2	Northwest bypass variant of Cimislia town, from the intersection with R3 road km 66+800 to North of Cimislia to km 65 M3 to South of Cimislia	-17.02	-1.339	-
B	M3 extension II/Comrat Bypass	0.25	0.016	12.2
C	New alignment/bypass, Ciumai – Burlaceni	1.16	0.123	13.2
D	Vulcăneşti Bypass	-21.88	-2.253	-
E	New alignment/bypasses of Slobozia Mare, Câşliţa-Prut, Giurgiuleşti	-5.31	-0.224	9.2

Source: The Consultant

16.8. Sensitivity Analysis

A sensitivity analysis has been conducted on the results of the economic modelling. The following scenarios have been modelled within the sensitivity analysis:

+20% scheme capital costs

-20% scheme capital costs

-20% base year traffic

+20% base year traffic

-20% traffic growth (low or pessimistic)

+20% traffic growth (high or optimistic)

Each of these sensitivity tests were applied to both the low and high traffic growth scenarios for the whole project scheme. The results of the sensitivity analysis are summarised in Table 16-31 below.

Table 16-31. Sensitivity Analysis for Online Reconstruction (% Economic IRR)

	Scheme Capital Cost		Base Year Traffic		Traffic Growth	
	+20%	-20%	-20%	+20%	Low	High
2. Porumbrei – R3 junction	13.1	17.1	13.9	17.6	11.9	17.4
3. R3 junction – Cimislia	20.7	26.4	19.6	26.5	19.9	26.5
4. Cimislia urban area	22.4	28.3	20.6	29.0	21.1	28.0
6. Comrat urban area	23.2	29.7	21.9	29.8	22.4	29.0
7. Comrat – R38 junction	18.6	24.0	17.5	24.2	17.1	24.2
8. R38 junction – Ciumai	10.2	14.6	9.6	14.3	8.8	14.9
9. Ciumai – Vulcanesti	10.8	15.1	10.2	14.9	9.9	15.2
10. Vulcanesti urban area	13.2	18.3	12.5	18.0	12.1	18.1
11. Vulcanesti – Slobozia Mare	9.1	13.1	8.9	12.9	7.2	13.9
12. Slobozia Mare – Giurgiulesti	16.2	21.1	15.5	20.8	13.8	22.2
M3 Corridor: Chisinau – Giurgiulesti*	15.5	20.4	14.8	20.5	14.1	20.6

Note: *sections 1 & 5 not subject to reconstruction and not included
Source: The Consultant

Table 16-32. Sensitivity Analysis for Major Offline Projects (% Economic IRR)

Bypass/Extension		Scheme Capital Cost		Base Year Traffic		Traffic Growth	
		+20%	-20%	-20%	+20%	Low	High
A	M3 extension/Cimislia Bypass	-	-	-	-	-	-
A-B1	Porumbrei-Cimislia from km 34 M3 to to the intersection with R3 road, km 66+800 to North of Cimislia	12.9		7.0		11.8	
A-B2	Northwest bypass variant of Cimislia town, from the intersection with R3 road km 66+800 to North of Cimislia to km 65 M3 to South of Cimislia	-	-	-	-	-	-
B	M3 extension II/Comrat Bypass	10.4	14.5	3.5	17.6	6.0	17.0
C	New alignment/bypass, Ciumai – Burlaceni	11.4	15.8	10.7	15.6	9.1	16.9
D	Vulcăneşti Bypass	-	-	-	-	-	-
E	New alignment/bypasses of Slobozia Mare, Câşliţa-Prut, Giurgiuleşti	7.4	11.7	4.5	13.2	1.8	15.0

Source: The Consultant

16.9. Conclusions and Recommendations

The following detailed conclusions can be drawn from the economic assessment using HDM-4 with a discount rate of 12%.

16.9.1. Offline Schemes

Cimislia Bypass/M3 Extension

- This project is not economically viable as planned, producing a NPV of €-55.1m;
- A combination of a significantly higher end to end length (4.4 km) than the existing route and relatively low traffic diversion (these two factors are inter-related) results in a very poor economic performance. Time savings are minimal and voc benefits are negative as a result of the additional journey length;
- To achieve viability opening year traffic would have to increase to almost three times the forecast level or capital costs would have to reduce by a factor of more than five;
- With forecast traffic growth opening year would have to be delayed by approximately 15 years before the scheme could achieve economic viability;
- The project does not approach viability in any of the sensitivity tests carried out;
- Online reconstruction looks a much better economic prospect for the M3 corridor between Porumbrei and Cimislia.

Comrat Bypass

- This project is just economically viable as planned, producing an EIRR of 12.2% and a NPV of €0.25m;
- A combination of a significant reduction in length (2.5 km) compared to the existing route and relatively high traffic diversion deliver a competitive economic performance. Voc savings comprise over 60% of road user benefits, time savings the remainder;
- However, as currently modelled the project is highly marginal and would be vulnerable to negative changes in any of the major inputs. In this regard it should be noted that scheme capital costs have yet to be finalised;
- The project does not achieve viability in any of the pessimistic sensitivity tests carried out although it is more vulnerable to changes in base year traffic and traffic growth than capital costs;
- Online reconstruction performs strongly in economic terms.

Ciumai – Burlaceni Realignment

- This project is economically viable as planned, producing an EIRR of 13.2% and a NPV of €1.16m;
- A combination of a reduction in journey length (1.1 km) on the proposed realignment and the relatively poor condition and alignment of the existing road produce a viable economic scheme. User benefits are in the ratio 2:1 Voc to time savings;
- However, as currently modelled the project is marginal and would be vulnerable to negative changes in any of the major inputs. In this regard it should be noted that scheme capital costs have yet to be finalised;
- The project does not achieve viability in any of the pessimistic sensitivity tests carried out although it is more vulnerable to changes in base year traffic and traffic growth than capital costs;
- Online reconstruction produces a slightly inferior economic return to the realignment.

Vulcanesti Bypass

- This project is not economically viable as planned, producing a NPV of
- €-21.9m;
- A combination of a significantly higher end to end length (3.1 km) than the existing route and low traffic (less than 1,100 per day in opening year) plus high construction costs results in a very poor economic performance. Time savings are negligible and voc benefits are negative as a result of the additional journey length;
- The project does not approach viability in any of the sensitivity tests carried out;

- Online reconstruction looks a much better economic prospect.

Slobozia Mare & Giurgiulesti Bypasses & Southern Corridor Realignment

- This project is not quite economically viable as modelled, producing an EIRR of 9.2% and a NPV of €-5.31m;
- The project produces a significant reduction in length (6.7 km) compared to the existing route but this is outweighed by low traffic volumes and relatively high capital costs. Voc savings comprise over 80% of road user benefits;
- However, as currently modelled the project is marginal and would be susceptible to changes in any of the major inputs, although it is noted that it would require a greater than 20% reduction in capital costs to achieve viability;
- The project achieves viability in the optimistic traffic-based sensitivity tests;
- Online reconstruction performs better economically.

16.9.2. Online Schemes

Online Reconstruction

In general the online reconstruction schemes perform well economically. Reconstruction of all the corridor sections requiring attention produces an overall EIRR of 17.6%. Two sections should be noted for bucking this positive trend:

- Cuimai – Vulcanesti produces a slightly inferior, 12.7% compared to 13.2%, return to its offline counterpart; and
- Vulcanesti – Slobozia Mare, with an EIRR of 10.8%, fails to achieve the required rate of return.

In the cases of Cimislia, Comrat and Vulcanesti online reconstruction clearly outperforms the bypasses in economic terms. In the case of the Slobozia Mare/Giurgiulesti bypasses/realignment, reconstruction is not convincingly superior because of the poor performance of reconstruction of the Vulcanesti – Slobozia Mare section.

A majority of the reconstructed sections achieve economic viability in all of the sensitivity tests carried out. It is reasonable to assume that most of these schemes are sufficiently robust to withstand upward revisions to costs.

Understandably, the northern corridor sections with higher traffic flows generally perform better than the southern sections even with generally higher per kilometre capital cost rates. In addition to Vulcanesti – Slobozia Mare the most unconvincing sections for reconstruction are the two between the R38 junction and Vulcanesti, both of which fail to reach the 12% target return in each of the pessimistic scenarios. Interestingly, the Vulcanesti urban section is robust in terms of online reconstruction.

Online Maintenance

Two sections do not require reconstruction in the immediate future. Chisinau to Porumbrei consists of a concrete carriageway that will require maintenance and minor renewal work but is expected to perform satisfactorily over the evaluation period under the forecast traffic loadings.

Cimislia to Comrat consists of an asphalt concrete pavement that has been rehabilitated as of 2008. It currently has an excellent surface as indicated by the roughness measurements for the study. HDM-4 indicates that a reconstruction may be required and economically attractive by 2022, eleven years after anticipated project opening year.

Table 16-33 below provides a recommended strategy for M3 corridor rehabilitation and extension on the basis of the economic evaluation work carried out. Factors and issues outside the economic evaluation have not been taken into account.

Table 16-33. M3 Corridor: Recommended Strategy following Economic Evaluation

M3 Corridor		Economic Recommendation	Comments/ Explanation
from	**to**		
Chisinau	Porumbrei	Maintenance only	Concrete pavement. Maintenance and minor renewals sufficient over evaluation period.
Porumbrei	Cimislia	Online reconstruction	Offline scheme not viable as currently proposed.
Cimislia		Online reconstruction	Bypass not viable as currently proposed. A rethink of the Cimislia bypass scheme is required.
Cimislia	Comrat	Maintenance only	Rehabilitated in 2008. Further major work not needed until approximately 2022.
Comrat		Online reconstruction or Bypass	Reconstruction performs better but bypass is viable and may be preferable for non-economic reasons.
Comrat	R38 junction	Online reconstruction	Clearly viable. Construction of village bypasses (Chirsova, Congaz and Svetlii) would almost certainly be incrementally negative, given high per kilometre costs, but one or more could be incorporated within the wider reconstruction scheme for non-economic reasons without impairing the overall scheme's viability.
R38 junction	Ciumai	Online reconstruction	Viable but vulnerable to changes in key input variables (traffic, costs).
Ciumai	Vulcanesti	Realignment option	Both alternatives viable, realignment marginally preferable economically.
Vulcanesti		Online reconstruction	Bypass not viable as currently proposed. Reconstruction viable.
Vulcanesti	Slobozia Mare	Further assessment advisable	Neither alternative performs well economically and further work, particularly relating to costs, may be required before a final decision can be made. A delay to implementation may be advisable.
Slobozia Mare	Giurgiulesti	Online reconstruction (but reference required to Vulcanesti – Slobozia Mare)	Linked to the above section in terms of the offline scheme. Online reconstruction is viable.

Source: The Consultant

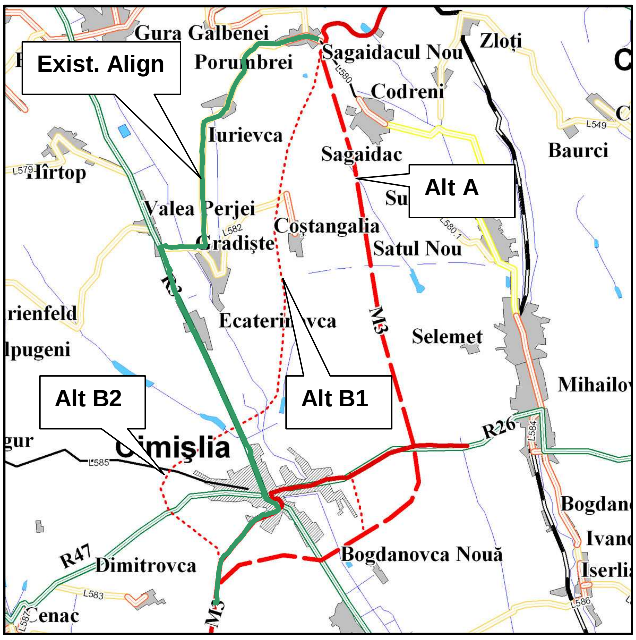
17. ALTERNATIVE B : M3 EXTENSION PORUMBREI TO CIMISLIA

This section of the M3 feasibility study describes and discusses a comparison of the possible connections between Porumbrei and Cimislia. The initial Porumbrei – Cimislia alternative (ALT A) has been analysed within the framework of the M3 feasibility study and was found to be not a viable candidate because of it's length, relatively high cost and low economic rate of return, and environmental impact. In addition, its alignment is not conducive for the continuous and shortest connection of the existing M3. The initial alternative was planned and financed in the Former Soviet Union and was intended to connect Chisinau with Basarabeasca serving strategic and military purposes., which led to the additional length.

17.1 Alternative B Description

The beneficiary of the study: The Ministry of Construction and Territorial Development subsequently submitted a request to the study team to develop an alternate alignment that would connect the terminus of the existing 4 lane category I M3 at Porumbrei to the existing M3 corridor south of Cimislia. The particular importance of this connection for the Ministry is based on:

- The Corridor Chisinau – Giurgiulesti is European Road E597 connecting the Trans European Network (TEN) corridors VII Danube with TEN corridor IX;
- M3 Draft Feasibility study found sections between Comrat and Giurgiulesti feasible and for the section Comrat – Ciumai design is currently being carried out.
- The section Cimislia – Comrat will be rehabilitated this year.
- Efforts of the City of Cimislia are underway to identify and plan an urban road system for the municipality.
- Porumbrei to Cimislia is a possible candidate for financing by other organizations.
- The project will aid in developing one continuous corridor connecting Chisinau with the South of Moldova.



In order to respond to the comment/request of the beneficiary the study team concluded to developed and test an additional Alternative B.

Out of the above-mentioned reasons Alternative B was identified that is comprised of B1 -Porumbrei to Cimislia North, and B2 -Cimislia bypass. See Figure 17-2 for detail. The following options are compared:

1. Existing alignment
2. Alternative A (originally planned alignment)
3. Alternative B (newly developed alternative)
   a. B1 Porumbrei to Cimislia North
   b. B2 Cimislia bypass

In order to receive comments from the local authorities a stakeholder meeting took place on May 21, 2009 in Cimislia where the study team presented the Alternative B1.

17.2 Alternative B Comparison

During the course of this evaluation a preliminary design, consistent of plan and profile was developed for Alternative B: In addition, several field views were undertaken to inspect the potential route and assess social as well as environmental impacts. Several meetings took place with the local representatives, and the Ministry of Construction and Territorial Development. Figure 17-1 presents a selection of photographs depicting the new alignment B1.

Tables 17-1 through 17-4 provide a qualitative assessment of the alternatives in regard to

- Efficiency of Travel, Safety, and Accessibility
- Environmental Comparison - M3 Extensions
- Design Criteria / Constructability
- Socio-economic and Cost

Figure 17-1. Alternative B1 Photos

	Begin M3 Extension km 34 Porumbrei
	Land slide area km 35

	Previous works to stabilize slope km 35
	Earth work and bridge for M3 extension approx. km 36
	Begin Alt B – alignment on existing farm roads through primarily agricultural areas km 5
	Continuation of Alt B through agricultural areas km 7

		Continuation of Alt B through agricultural areas
		Stream and wet meadows at in vicinity of Km 10 - to be avoided
		Stream and wet meadows at about Km 10 - to be avoided
		At potential crossing of river at km 18

Figure 17-2. M3 extension and Cimislia Bypass Alternatives

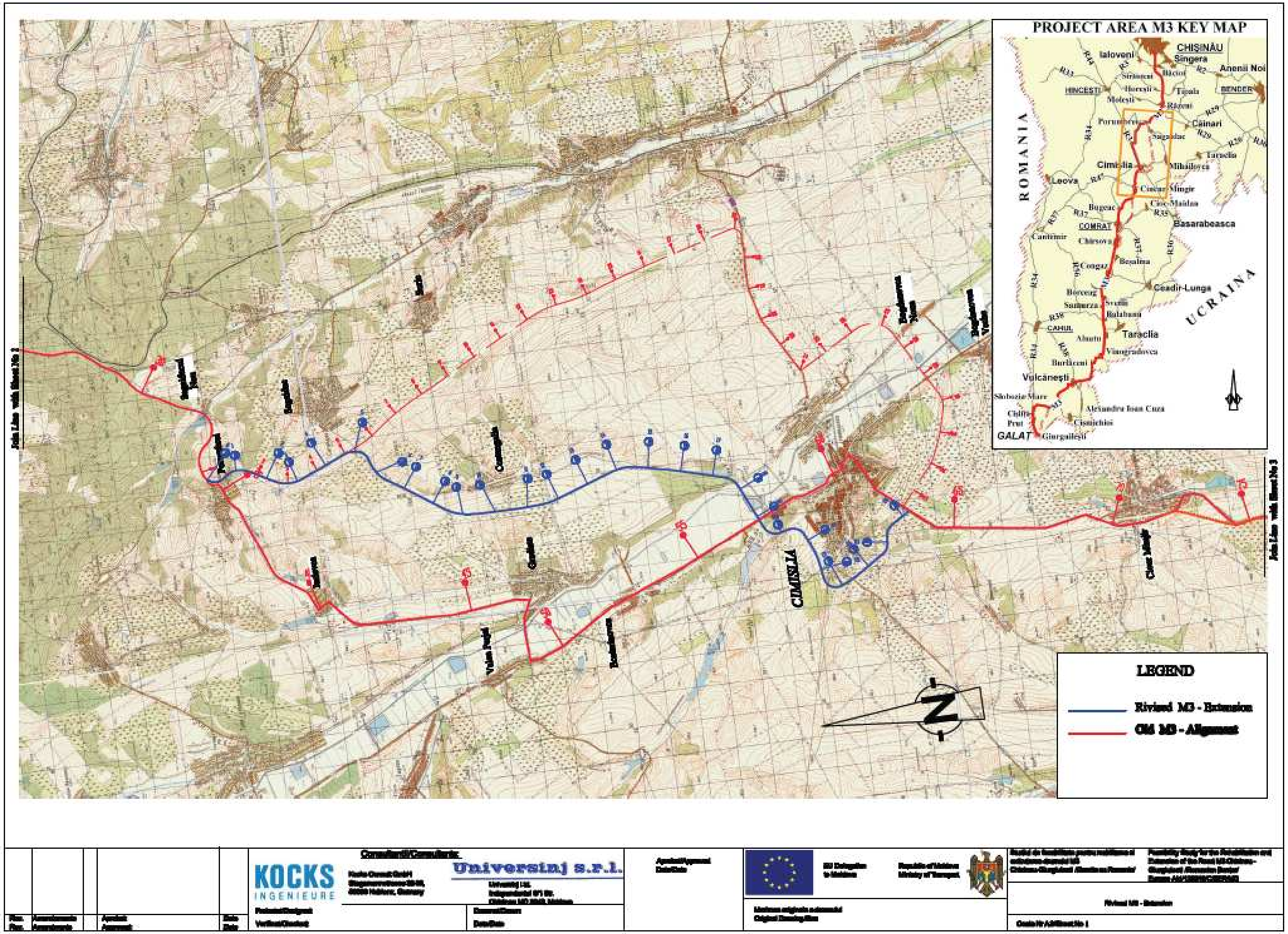


Table 17-1. Efficiency of Travel, Safety, and Accessibility - M3 extensions

Evaluation Criteria	Existing Alignment: Porumbrei to Cimislia South	Alternative A M3 Extension to Cimislia south	Porumbrei to Cimislia North B1	Alternative B1 Cimislia Bypass B2
Length of existing road	28.9 km	8.0 km		
Length of new road	Potentially new bypasses of villages*	25.5 km	19.1 km	7.15 km
Combined length	28.9	33.5	26.25	26.25
Estimated travel speed	50 km/h	80 km/h	80 km/h	80 km/h
Travel time in minutes	35 min	25 min	20 min	20 min
Traffic in 2011 in (000) average	3,700	1,600	3,600	3,400
Maintaining or Improving Access	Will Maintain existing access to Villages	Will not provide additional direct access; Access could be provided to the village of Sagaidac,	Access could be provided to the village of Sagaidac,Costangalia and Gradiste	Access can be provided through interchanges to Cimislia
Improved regional circulation	Will not improve interregional circulation;	Will contribute to a continuous M3 Corridor Chisinau – Giurgiulesti	Will contribute to a continuous M3 Corridor Chisinau – Giurgiulesti	Will contribute to a continuous M3 Corridor Chisinau – Giurgiulesti
Improved local circulation	Current load restriction on truck traffic;	Inter-regional traffic diverted from local road network;	Inter-regional traffic diverted from local road network;	Inter-regional traffic diverted from local road network;
Congestion	Congestion might become an issue within 20 year time horizon	2 lane construction on 4 Lane Right-of Way	2 lane construction on 4 Lane Right-of Way	2 lane construction on 4 Lane Right-of Way
Traffic efficiency during Construction	Temporary detours needed during construction	Traffic on existing alignment	Traffic on existing alignment	Traffic on existing alignment
Impact	**Least effective option**	**Medium effective option**	**Highly effective option**	**Highly effective option**

Source Consultant

Table 17-2. Design Criteria / Constructability - M3 Extensions

Evaluation Criteria	Existing Alignment: Porumbrei to Cimislia South	Alternative A M3 Extension to Cimislia south	Porumbrei to Cimislia North B1	Alternative B1 Cimislia Bypass B2
Topography	Rolling to hilly terrain	Rolling sections and 19 km long valley - flat	Rolling Terrain	Rolling Terrain
Type of Improvement	Reconstruction	Partially new alignment	New alignment	New alignment
Land ownership	On existing Right-of-Way	Previously in Government ownership; land title might have been expired since then; multiple land owners; very high soil quality – increased cost	Land will need to be acquired; difficulties in land acquisition anticipated	Land will need to be acquired; difficulties in land acquisition anticipated
Needed land area	Potential land acquisition needed to improve alignment and bypass villages	82.05 ha	64.87 ha	
Grade separated and other structures	Several bridge replacement needed for upgrade	Stabilization of slope north of Porumbrei; several bridges needed; extensive drainage channels along main valley, crossing of Cogilnic river and valley	Stabilization of slope north of Porumbrei; several bridges needed; less drainage structures crossing of Cogilnic river and valley	Steep grades, hilly terrain
Achievement of Desirable horizontal and vertical parameter	Bypasses for the local jurisdictions need to be considered because of sub-standard design i.e. grades > 8 percent?	Issues with usage of R47 as part of the alignment; large radii turns needed for high speed alignment southern bypass section through hilly terrain over relatively long distance	General achievability – alignment needs further refinement	Sections with relatively steep slopes
Impact	**Medium: Difficult reconstruction through hilly terrain and settled areas**	**Medium: existing earth works, drainage issues**	**Medium: new alignment and design**	**Medium: new alignment and design**

Source Consultant

Table 17-3. Environmental Comparison - M3 Extensions

Evaluation Criteria	Existing Alignment: Porumbrei to Cimislia South	Alternative A M3 Extension to Cimislia south	Porumbrei to Cimislia North B1	Alternative B1 Cimislia Bypass B2
Air Quality	Based on expected traffic volumes it is not to be expected that existing legal standards for relevant air pollutants (e.g. CO, Nox, SO2, PB) are exceeded. However the most sensitive environmental receptor with regard to air emissions is human health. Because the existing alignment runs through the villages of Porumbrei, Iurievca, Gradiste, Valea Perjei and Ecaterinovca potential impact on air quality is considered as **high** for this variant.	Based on expected traffic volumes it is not to be expected that existing legal standards for relevant air pollutants (e.g. CO, Nox, SO2, PB) are exceeded. The variant doesn't traverse any villages or settlements which are the most sensitive receptors with regard to air emissions. However it traverses agricultural land. Therefore the potential environmental impact on air quality is considered **medium**.	Based on expected traffic volumes it is not to be expected that existing legal standards for relevant air pollutants (e.g. CO, Nox, SO2, PB) are exceeded. The variant doesn't traverse any villages or settlements which are the most sensitive receptors with regard to air emissions. However it traverses agricultural land. Therefore the potential environmental impact on air quality is considered **medium**.	**Like variant B1.**
Noise	With regard to noise emissions sensitive receptors are the residential areas within villages and towns. Highly sensitive receptors are special buildings like schools and hospitals. Because the existing alignment runs through the villages of Porumbrei, Iurievca, Gradiste, Valea Perjei and Ecaterinovca potential impact on air quality is considered as **high** for this variant.	Sensitive receptors are the residential areas within villages and towns. Because the variant avoids traversing any settlement area impact of this variant is considered as **low**.	Sensitive receptors are the residential areas within villages and towns. Because the variant avoids traversing any settlement area impact of this variant is considered as **low.**	**Like variant B1.**
Impact on archaeological sites / cultural heritage	The existing alignment crosses Trajan Wall at bout km 50 in between the villages of Valea Perjei and Ecaterinovca. Reconstruction of existing alignment will only add to this previous impact and is therefore considered as **low.**	Trajan Wall is crossed at a section where its characteristic peculiarity is already reduced due to previous impacts. Partly it has been converted to a farm track. Therefore impact is considered **low.**	Trajan Wall is crossed at a section where its characteristic peculiarity is already reduced due to previous impacts. Partly it has been converted to a farm track. Therefore impact is considered **low.**	**No impacts on archaeological sites identified.**

Source Consultant

Table 17-3. Environmental Comparison - M3 Extensions (Continued)

Evaluation Criteria	Existing Alignment: Porumbrei to Cimislia South	Alternative A M3 Extension to Cimislia south	Porumbrei to Cimislia North B1	Alternative B1 Cimislia Bypass B2
Impact on Fauna	There is already a disruption of animal habitats due to the existing alignment. Therefore the additional impact due to reconstruction of the existing alignment will be only minor and mostly confined to the construction phase. Impact on Fauna is therefore considered as **low.**	Land use alongside the alignment is mainly agricultural with a variety of landscape structures like vineyards (partly abandoned), orchards, tree rows and grows. They offer habitat functions for a variety of animal species (birds, reptiles, mammals, various insects). Previous impacts are agricultural use and already conducted earthworks on the first half of the section. The variant would cause partly loss and disruption of animal habitats. Impact is considered as **medium.**	The different habitat types within the proposed alignment section (abandoned vineyards, orchards, tree rows and groves, meadows) offer living space for a variety of animal species. During field surveys on 26th of May golden orioles and storks could be observed. Impact on fauna is considered **high.**	Habitat types not as ecologically valuable as in section B1 due to lower diversity of agricultural use. Also previous impact of illegal landfill in first half of B2 lowers habitat value for different animal species. Impact is considered as **low.**
Impact on Flora and Vegetation	Reconstruction of existing alignment will only have very limited impact on roadside vegetation. Impact is considered **low.**	In first half of alignment section previous impact due to already conducted site clearing and earthworks. Loss of mainly agricultural fields in second half of alignment which are of minor ecological value. Impact is considered **medium.**	Alignment will cause loss of different valuable vegetation structures like vineyards (partly abandoned), orchards, tree rows, grows and meadows. Therefore impact is considered **high.**	Within the first km of the bypass section loss of tree plantations, especially within the cut section at km 19+600. Over most of the bypass loss of agricultural fields. Also previous impact of landfill in first half of B2. Impact is considered as **medium.**

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Table 17-3. Environmental Comparison - M3 Extensions (Continued)

Evaluation Criteria	Existing Alignment: Porumbrei to Cimislia South	Alternative A M3 Extension to Cimislia south	Porumbrei to Cimislia North B1	Alternative B1 Cimislia Bypass B2
Impact on soils	Reconstruction of existing alignment will only have very limited impact beyond the already existing previous one and is therefore considered as **low.**	In first half of alignment section previous impact due to already conducted site clearing and earthworks. Loss of very valuable Chernosern soils in second half of alignment. According to information received in discussion in meeting on 21st of May bonity of topsoil 80% and higher. Impact is considered **high.**	Loss of valuable agriculturally used topsoil. Impact is considered **high.**	Loss of valuable agriculturally used topsoil. Previous impact of landfill in first half of B2. Impact is considered as **high.**
Impact on ground and surface water	Reconstruction of existing alignment will only have very limited impact beyond the already existing previous one and is therefore considered as **low.**	Surface sealing will lead to increased surface water runoff and reduced infiltration rates. There are no water protection areas within the vicinity of the new road. Impact is considered **medium.**	Surface sealing will lead to increased surface water runoff and reduced infiltration rates. There are no water protection areas within the vicinity of the new road. Crossing of river Cogalnic at km 18+500. Impact is considered **medium.**	**Like variant B1.**
Geomorphology, landslides	No landslide prone section identified. Impact **low.**	Landslide prone area at km 35 close to beginning of the alignment section. Geological/Geotechnical assessment required. Impact considered **high.**	Landslide prone area at km 35 close to beginning of the alignment section. Geological/Geotechnical assessment required. Impact considered **high.**	No landslide prone section identified. Impact **low.**

Source Consultant

Table 17-4. Socio-economic and Cost - M3 Extensions

Evaluation Criteria	Existing Alignment: Porumbrei to Cimislia South	Alternative A M3 Extension to Cimislia south	Porumbrei to Cimislia North B1	Alternative B1 Cimislia Bypass B2
Use of existing road infrastructure	Will make use of existing road and right-of way	New alignment and road, partially earth works completed	New alignment and road, partially earth works completed	Complete New alignment
Resettlement considerations	Little resettlement issues	Major resettlement issues, numerous land owners, difficult legal situation in Moldova	Major resettlement issues, numerous land owners, difficult legal situation in Moldova	Major resettlement issues, numerous land owners, difficult legal situation in Moldova
Cost in € Million	28.06	45.7	23.81	13.75
EIRR	21.6*	negative	15.0	negative
Impact	**Positive: Least cost**	**Negative: Cost**	**Medium positive: Sufficient EIRR**	**Medium negative: Low EIRR**

*average all sections
Source Consultant

17.3 Alternative B Evaluation

Cost/Benefit Analysis Summary from HDM-4

The Alternative B was tested regarding its economic viability using HDM-4, using the same parameters than the economic analysis for Alternative A as well as the rest of the corridor. Table 17-5presents the network configuration for the analysis.

Table 17-5. Road Network Porumbrei – Cimislia

Existing Network					
From	To	Route	km	km	Length (km)
Porumbrei	R3 jct		0.000	14.500	14.500
R3 jct	Cimislia north	R3	14.500	22.900	8.400
Cimislia north	Cimislia south	town	22.900	29.350	6.450
				Total	**29.350**
M3 Extension/Cimislia NW bp Scheme					
From	To	Route	km	km	Length (km)
Porumbrei	Cimislia north	B1	0.000	19.100	19.100
Cimislia north	Cimislia south	B2	19.100	26.250	7.150
				Total	**26.250**

Source Consultant

Alternative B has a total length of 26.25 km and is 3.1 km shorter then the distanced travelled on the existing alignment. The first of the two sections making up Alternative B from Porumbrei to Cimislia North is 3.8 km shorter than the current distance. Equating to an almost 20% reduction in length. The bypass section, however is longer by 700m or 11 percent.

Estimated construction cost for B1 are €23.81 Million (or €1.56 M per km) and €13.75 Million for the bypass section or 2.404 per km.

Traffic estimation is based on the originally developed traffic forecast with an additional traffic diversion effect caused by the proximity and higher speed of Alternative B. Traffic for the Alternative B evaluation is presented in Table 17-6. Around 3,000 vpd were attributed to the existing section between Porumbrei and Cimislia (based on a Ground Count at Razeni from September 2008), 3,680 vpd north of Cimislia, and around 4,000 vpd Cimislia Urban area. .

Table17-6. 2008 Traffic Without Scheme – M3 extensions

		2008 AADT								
Link No.		**Motor-cycle**	**Car**	**Mini-bus**	**Pickup**	**Bus**	**Light Truck**	**Med Truck**	**Heavy Truck**	**Artic truck**	**Total**
2	Porumbrei - R3 junction	12	2,017	233	296	39	157	105	25	115	2,999
3	R3 junction - Cimislia bp N	6	2,624	166	409	59	124	117	31	146	3,682
4	Cimislia urban area	15	2,822	151	392	71	168	125	35	207	3,986

Source Consultant

Table 17-7 presents the distribution of traffic with the Alternative B (B1+B2) alignment in place. Traffic along the Alternative B will potentially increase to over 3,600 vpd including generated traffic, diverted, and port generated traffic. (see chapter 3 for details)

Table 17-7. Traffic with Alternative B in Place 2011 – M3 extensions

2011 AADT											
Existing Corridor		**Motor-cycle**	**Car**	**Mini-bus**	**Pickup**	**Bus**	**Light Truck**	**Med. Truck**	**Heavy Truck**	**Artic truck**	**Total**
*2**	Porumbrei - R3 junction	3	592	68	85	13	45	37	8	38	889
*3**	R3 junction - Cimislia north	0	1,022	34	162	28	30	49	13	64	1,402
4	Cimislia urban area	13	2,432	130	328	60	139	113	30	177	3,422
With Alternative B											
23bp*	M3 extension	11	2,494	244	365	49	165	125	29	135	3,616
4bp	Cimislia NW Bypass	13	2,437	130	329	59	140	111	29	174	3,422

revised 23/5/09
Source Consultant

Using the parameters described above an additional HDM-4 run was facilitated. Identifying the B1 alternative as feasible while the Cimislia bypass at this point in time is not economically feasible. Table 17-8 presents the results of the economic modelling. It has to be noted that the B1 alternative is very sensitive to changes in the base variables: traffic, traffic growth and cost.

Table 17-8. Results of HDM-4 modelling

Scheme		€uro m	%
		npv	eirr
B1	M3 Extension	6.45	15.0
B2	Cimislia NW bp	-17.02	-
Sensitivity Tests			eirr
B1	base traffic -20%	-8.34	7.0
	low traffic growth	-0.46	11.8
	cap costs +20%	2.06	12.9

Source Consultant

Environmental Assessment:

According to the overall ranking the alternative B1 causes the highest environmental impact, ranking high in 4 out of 8 environmental evaluation criteria. Second rank is alternative A ranking high in 2 out of 8 environmental evaluation criteria and medium in 4 of them. The existing alignment has the third rank providing a high evaluation with regard to two of the criteria and low evaluation in 4 of them. The alternative with the lowest environmental impact is the alternative B1 (bypass Cimislia).

When looking separately on human (air quality, noise, cultural heritage), biological (fauna, flora) and physical (soils, ground and surface water, geomorphology/landslides) environment the results are the following. With regard to the human environment the alternative with the highest impacts is the existing alignment option. All other alternatives rank equal. For the biological environment most impacts are caused by alternative B1 followed by alternative A, B2 and the existing alignment option. For the physical environment most impacts are caused by alternatives A and B1, followed by B2 and the existing alignment.

By summarizing the results and attributing the same weight to each of the criteria the environmentally best alternative is the B2 (bypass himislia), followed by the existing alignment option. Next comes alternative A followed by alternative B1.

However, improvements to the existing alignment provide a higher economic rate of return and might be less environmentally intrusive than the complete new construction of ALT B1.

Recommendation

The newly developed Alternative B Porumbrei to Cimislia (B1) is a shorter and more used route between Porumbrei and Cimislia and is by far the more attractive route compared to Alt A. It attracts more traffic and provides shorter travel time. Alt B2, the Cimislia bypass is currently not economically feasible because of its additional length compared to the current alignment.

The study team recommends to include the B1 alignment in the government's effort to conduct the necessary land acquisition procedures to make it an eligible candidate project for engineering design and financing. The project is recommended in the short to mid term range, and further monitoring of traffic growth and cost are needed.

18 PROJECT IMPLEMENTATION PROPOSALS

18.1 Project Implementation Considerations

The overall conclusion of this feasibility study is that improvements to the M3 Corrdior as an overall scheme are warranted and that an improved high level roadway will be beneficial to the development of Moldova especially in interconnecting the central to southern parts of the country.

As in many other transition countries, low traffic volumes are still predominant along the study corridor, which together with relatively high construction costs determine the economic feasibility. However, as identified in the previous chapter several section of the corridor show sufficient economic rates of return. The following sections are feasible:

- The Porumbrei to Cimislia reconstruction on existing alignment
- The Porumbrei to Cimislia extension Alternative B1
- The Comrat urban section - online reconstruction as well as the Comrat bypass
- The sections Comrat to R38 and R38 to Ciumai (the southern portion more vulnerable to changes in cost)
- The Ciumai to Vulcanesti reconstruction or realignment option
- The new alignment and bypasses of Slobozia Mare – Giurgiulesti is currently marginable viable and depends much on the development of the Giurgiulesti Freeport.

While the economic analysis is one major decision criteria in the project selection process other aspects need to be considered in the development and staging of a continuous M3 corridor. These are:

- Making best economic use of existing investment (i.e. M3 km0 to km34)
- Development of a seamless, continuous corridor
- National network connectivity
- Overall economic development benefit of the corridor
- Negative and positive social as well as environmental effects of existing traffic conditions as much as potential future conditions.
- Land aquisition

Summarizing the above, a project assessment matrix is used to qualitatively assess the impacts of the above named factors together with the economic evaluation. Table 18-1 presents the sections from Chisinau to Comrat and the southern corridor portion from Comrat to Giurgiulesti.

18.2 Project Evaluation and Recommendation

Chisinau – Porumbrei
The maintenance and repair of the existing concrete section of M3 needs to be carried out as soon as possible to avoid further deterioration of the existing roadway. Particular emphasis should be given to measures for accident reduction including signage, speed reduction and separation of traffic modes on the high-speed section of M3.

Porumbrei – Valea Perjei, M3 extension and Cimislia bypass
The the M3 extension Alternative B1 as well as the reconstruction of the existing alignment are feasible. Economic return on the investment is higher for th ereconstruction option; However the Cimislia bypass Alternative B2 is currently not economically feasible, The immediate term recommendation is to use the current alignment from Porumbrei to Valea Perjei until land acquisition procedures are resolved and potential financing for the section is secured.

Table 18-1. Project Recommendation and Phasing

Section	Existing Road Category	Proposed Road Category	Type of Work	Cost per km	Economic Feasibility.	Economic development	Network connectivity	Social	Land Acquisition	Env. Category	Env. Impact	Rating	Time frame	Eng. design eligible
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Chisinau- Porumbrei	I	I	Maintenance and Repair	+	+	o	+	o	o	+	o	+++	s	**yes**
M3 extension Cimislia bypass B1	N/A	II	New build of 2 L on 4 L RoW	-	+	+	+	+	-	-	o	+	s	no
Cimislia Bypass B2	N/A	II	New build of 2 L bypass	-	-	o	+	+	-	-	o	--	m	**no**
Porumbrei- Valea Perjei, (R 3)	IV	III / II	Rehabilitation /Reconstruction	+	++	o	-	-	o	+	-	+	m	
Intersection R 3 – Cimislia	III	II[1]	Rehabilitated by 2009										l	
Cimişlia urban	III	II[1]	Currently rehabilitated										l	
Cimislia –Comrat	III	II[1]	Currently rehabilitated										l	
Comrat – Urban Area	III	II	Reconstruction	+	+	o	-	-	+	+	-	+	m	
Bypass Comrat	N/A		New 2 L bypass	o	+	+	+	o	-	-	+	++	s	no
Comrat –Balabanu(R38)	III	II	Reconstruction	+	+	o	o	o	+	+	-	+++	s	**yes**
Balabanu(R38) –Ciumai	III	II	Reconstruction	+	+	o	o	o	+	+	-	+++	s	**yes**
Bypasses of Ciucur-Minjir, Chirsova, Congaz, Svetlii	N/A	II	New bypass	-	-	o	o	+	-	-	+	--	l	
Ciumai – Vulcaneşti	IV	II	Reconstruction	+	+	o	+	+	-	-	+	+++	s	no
Vulcaneşti urban section	III	III	Reconstruction	+	+	o	o	-	+	+	-	++	s	**yes**
Bypass Vulcanesti	N/A	II	New 2 L bypass	-	-	+	-	+	-	-	+	--	l	
New alignment and bypass of Slobozia Mare - Giurgiulesti	IV / N/A	II	New 2 L bypass	o	o	+	+	+	-	-	+	++	s	no
Vulcanesti -Slobozia Mare- Giurgiulesti	IV	IV[2]	Rehabilitation	+	o	-	-	-	+	+	-	-	m	
Slobozia Mare- Giurgiulesti	IV	IV[2]	Rehabilitation	+	-	-	-	-	+	+	+	o	m	

[1] Because of current rehabilitation improvements to Cat II postponed	Colum 8: will connect or shorten corridor	Colum 12: + if addresses current neg. environmental impact on population
[2] If Giurgiulesti – Vulcanesti new alignment, no change	Colum 9: + if addresses current neg. social impact on population	Colum 13: Sum of + & -, o = neutral
Colum 5 & 6: Results of Economic Feasibility Analysis	Colum 10: Land Acquisition Needed	Colum 14: Timeframe s= short; m= medium= long
Colum 7: Contributes to regional economic development	Colum 11: if Env. Category A then – / if Env. B Category then +	Colum 15: can design work carried out immediately?

Intersection R3 to Cimislia, Cimislia urban section, Cimislia – Comrat
The section of M3 from the intersection with R3 to Cimislia, as well as the section from Cimislia to Comrat have recently been rehabilitated or are scheduled to be rehabilitated. Because of the ongoing rehabilitation measure, no short-term improvements are proposed. In the medium to long term, traffic needs to be monitored and potential improvements reassessed, particularly in conjunction with the potential M3 extension and Cimislia bypass.

Comrat Bypass
The Comrat bypass alignment is shorter then the current existing and will allow long-distance trips to bypass the urban section of Comrat. The residents of Comrat would be relieved of the through traffic. Since the bypass alignment is partially build and social and environmental negative effects of the new construction be limited.

Comrat –Ciumai
The rehabilitation of the existing Comrat to Ciumai section will allow establishing a continuous corridor also in light with the currently ongoing rehabilitation measures between Comrat and Cimislia.

Ciumai – Vulcaneşti
The Ciumai-Vulcanesti realignment – reconstruction would have an immediate benefit in creating a continuous improved corridor, by providing a higher lever and a more direct route addressing the so-called “Bolgrad bypass” issue:

The currently 15 km connection is result of the break up of the Soviet Union. The original M3 road passed through Bolgrad – now part of the independent Ukraine – so an alternative route entirely within Moldova was created at low cost and over a limited time period. The carriageway is extremely narrow with sharp (90°) curves and is highly unsuitable for heavy truck traffic.

Vulcanesti urban section
Vulcanesti urban section reconstruction should be considered in the medium term since bypass of Vulcanesti is not viable as currently proposed.

Vulcanesti -Slobozia Mare-Giurgiulesti
Improvements to the Vulcanesti -Slobozia Mare-Giurgiulesti section of M3 will be necessary eventually with or without the bypasses of Slobozia Mare – Giurgiulesti in place. However, because of the reasons stated above preference should be given to the bypass option. With bypass option in place improvements to Slobozia Mare-Giurgiulesti can be postponed.

New alignment and bypasses of Slobozia Mare – Giurgiulesti
The alternative does not perform well economically, however with an EIRR of 9.2%, is close to be economically viable. Because of low traffic volumes between Giurgiulesti and Vulcanesti, the reconstruction of the existing alignment does not score significantly higher than the new alignment option.

However, due to the expected traffic from Giurgiulesti Port and particularly the type of heavy truck traffic and dangerous goods traffic it is not advisable to route existing and future traffic through the village of Giurgiulesti, Cislita-Prut and Slobozia Mare.

The project should be included in the short term project category with additional emphasis on possible cost savings in the new construction.

Other Bypasses
The bypasses of Vulcanesti, Ciucur-Minjir, Chirsova, Congaz, and Svetlii are currently not viable mainly because of low traffic volumes together with additional length of travel on the bypass options. Traffic volumes along the M3 corridor need to be monitored and if warranted the feasibility of the bypass options reassessed.

The short term projects listed above will contribute considerably to the development of a continuous M3 corridor. The improvements between Giurgiulesti and Comrat will also contribute to the fulfilment of the host investment agreement between the Investor of Giurgiulesti port and the Government of Moldova, in addition to providing adequate access to and from the Giurgiulesti Freeport.

18.3 Recommendation for Engineering Design

The ToR specifies to identify 1 to 2 roadway sections for engineering design and preparation of detailed drawings and Tender Documents for the priority sections. One major obstacle in implementing the candidate projects is the unresolved question of land acquisition. As identified in Chapter 14 the bypass sections are predominatly in private ownership and land acquisition process will be lengthy. In addition, to facilitate engineering design level of detail governmental approval for the land aquisition process is needed.

In a meeting between the Consultant, the Ministry of Construction and Territorial Development, State Road Administration, as well as The Millenium Challenge Coorporation, as potential funding agency, it was determined that a two-staged approach should be persued.

Within the time frame and scope of this budget the two sections:

1. Comrat to Balabanu (R38) and
2. Balabanu (R38) to Ciumai

are proposed for the engineering design and preparation of tender documents.

At the same time the Ministry of Construction and Territorial Development will initiate the land acquisition process for the priority sections. Once completed design and potential funding for these section could be incorporated in the MCC efforts.