World Bank

Inventory of Local Roads in Kosovo

Final Report

April 2010

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1 Introduction

On May 14, 2009 COWI signed a contract with the World Bank for the execution of an inventory of local roads in Kosovo. The study was to:

- undertake an initial drive-through survey of up to 4.500 km of local roads
- identify the roads which will form the "core lifeline local roads" (approx. 1,500 km)
- undertake a visual inspection for these "core lifeline roads"
- to propose a list of highest priority sections of the local road network for rehabilitation/reconstruction.

During the inception phase of the study the project was mobilised and the initial review was carried out and concluded in early June 2009. This is reported in the Inception Report, dated June 2009 and revised July 2009.

In July 2009 the selection of roads for visual inspection was completed and reported in the Interim Report. The selection was then discussed with each of the 32 municipalities in Kosovo and subsequently adjusted, before it was finally approved by the MOT.

The visual inspections covered a total of 1,555 km of roads, and recordings were made per every 200 m. This major task was undertaken from mid October to early December 2009, after which data were entered into a database and submitted to the MOT together with an associated GIS map.

Based on this comprehensive database an HDM model for local roads in Kosovo was established, by which a number of improvement options for the various types of roads - asphalt, gravel and earth respectively - were analysed and an investment programme for the local roads was prepared.

This report summarises the approach and methodologies applied, and presents the main results and findings of the study.

2 Current Situation

During the Inception phase an initial review of data and information was undertaken. The following studies were reviewed in particular:

- Feasibility Study and Environmental Assessment for two main arterial roads. MTC, December 2006.
- Improving the Management of Secondary and Feeder Roads in Western Balkan Countries, Kosovo. World Bank, July 2007.
- Implementation of the Multi-Modal Transport Planning Strategy, European Agency for Reconstruction, May 2009 (the MMTS study).
- Draft Kosovo Spatial Plan, currently under preparation/updating.
- Data from the Statistical Bureau on population and households.

Our team has been involved in the preparation of all these studies.

2.1 Road categorisation

The road network in Kosovo is classified into the following three categories:

- Main (Magistral) roads.
- Regional roads.
- Local roads.

Whereas the main and regional roads are under the administration of the Ministry of Transport and Communications, the local roads are under the administration of the 32 municipalities. All roads within urban areas are administered by the urban municipalities.

The main and regional roads make up almost 2,000 km, of which the great majority is paved roads.

Table 2.1 Classification of national road network in Kosovo as per the MMTS Study.[1]

	Length (km)	% paved
Main roads	632	99%
Regional roads	1,319	81%
Total	1,951	87%

Source: the MMTS study

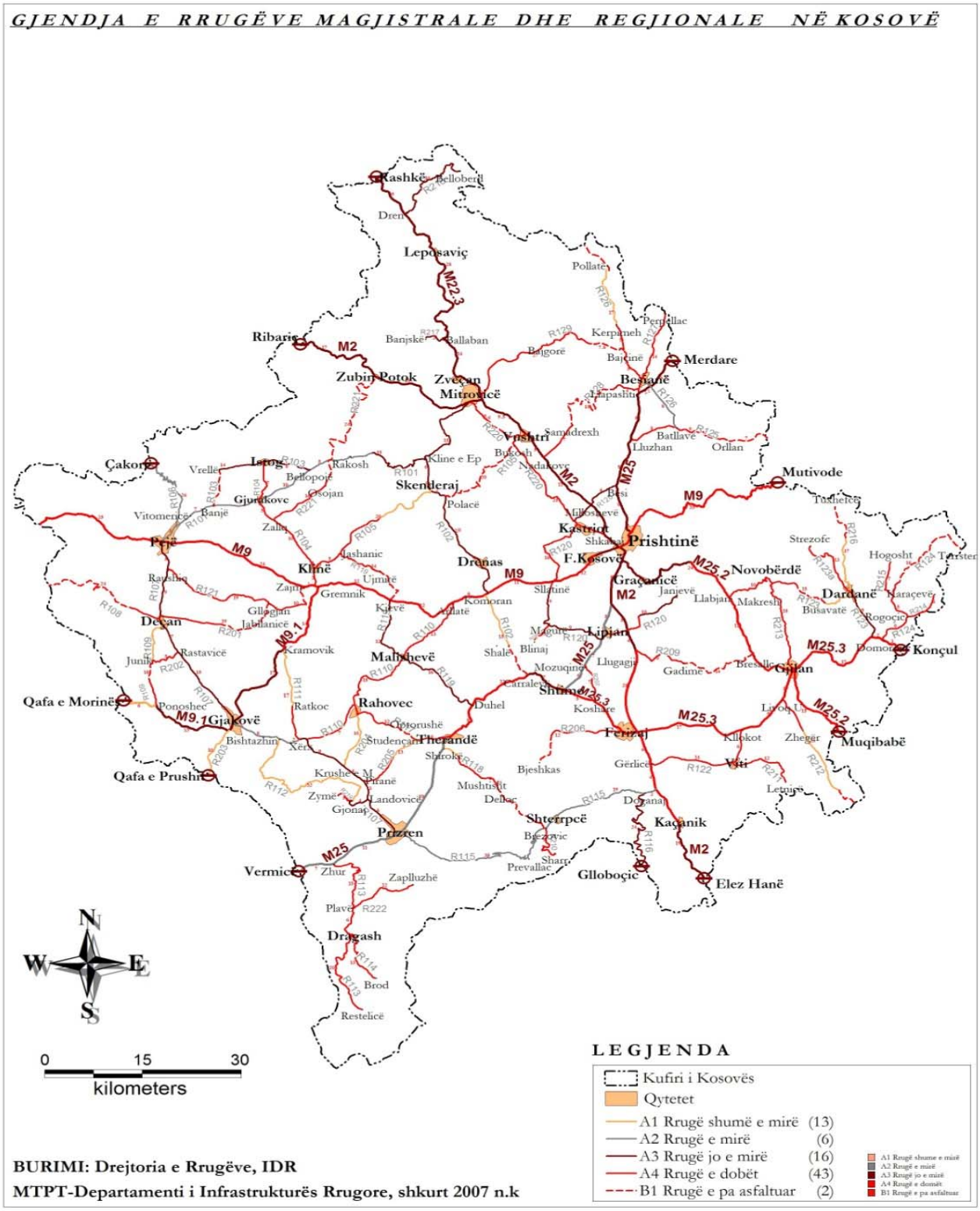
Figure 2.1 shows the main and regional road network as presented in the MMTS study.

There is no complete record of the local roads in Kosovo, but the total length has been estimated by the MTC at some 6,000 km[2]. The majority of this network is, however, in a poor state - much of it not even passable by car. Our initial site visits showed, that many remote settlements have very poor access to the national road network and to the local centres, particularly during winter time, and that this must inevitably be a constraint to economic development in some rural areas.

[1] Some minor adjustments have been made subsequent to the MMTS study, but the data are the latest available to the study team.

[2] Improving the Management of Secondary and Feeder Roads in Western Balkan Countries, Kosovo. World Bank, July 2007

Figure 2.1 National road network of Kosovo[3]



[3] Data are from 2007, which was the latest which was available to the Consultant

According to the Law on Roads and Regulation no. 2004/24, the municipalities have the full responsibility for management of local roads within their territories.

However, generally municipalities do not have sufficient capacity and financial means for this task, and moreover they have no complete records or maps of the local roads within their territories.

The maintenance and construction of local roads is financed via appropriations from the Kosovo Consolidated Budget, based on budget plans submitted by the municipalities. In recent years the MTC has been undertaking a major programme of rehabilitation of local roads - in co-operation with the municipalities - and under this programme several local roads have been rehabilitated or paved. This programme is planned to continue in the coming years.

2.2 Pavement condition survey practice

There are no systematic records of the condition of local roads, neither at central nor at municipal level.

Although not entirely satisfactorily, pavement conditions are monitored on the main and regional road network. The Road Directorate has acquired a bump integrator to measure roughness of the roads, but equipment for the measurements of deflections is not available in Kosovo and thus must be rented from outside when required. Visual inspections on the main and regional roads are undertaken regularly, but according to the MMTS study the quality of these inspections is insufficient for the purpose of planning and programming.

2.3 Traffic data collection procedure

Historic traffic data for Kosovo are scarce, since traffic counts were not systematically carried during and after the war. Only limited counts were undertaken as part of specific projects. However, from the beginning of 2007 new traffic counters were installed on the main and regional road network, with the assistance of the World Bank, and traffic data have been collected since early 2008. A total of 18 count stations were established, providing information not only on the level of traffic, but also on traffic variation over the day, the week and the year.

Traffic surveys have also been carried out as part of specific studies, notably the MMTS study, which undertook manual traffic counts over 24 hours at six locations in October 2007 and which also analysed the vehicle type distribution at 20 count stations on the main and regional road network. This information provides a good basis for the conversion of recorded hourly traffic levels into AADT, divided by vehicle type.

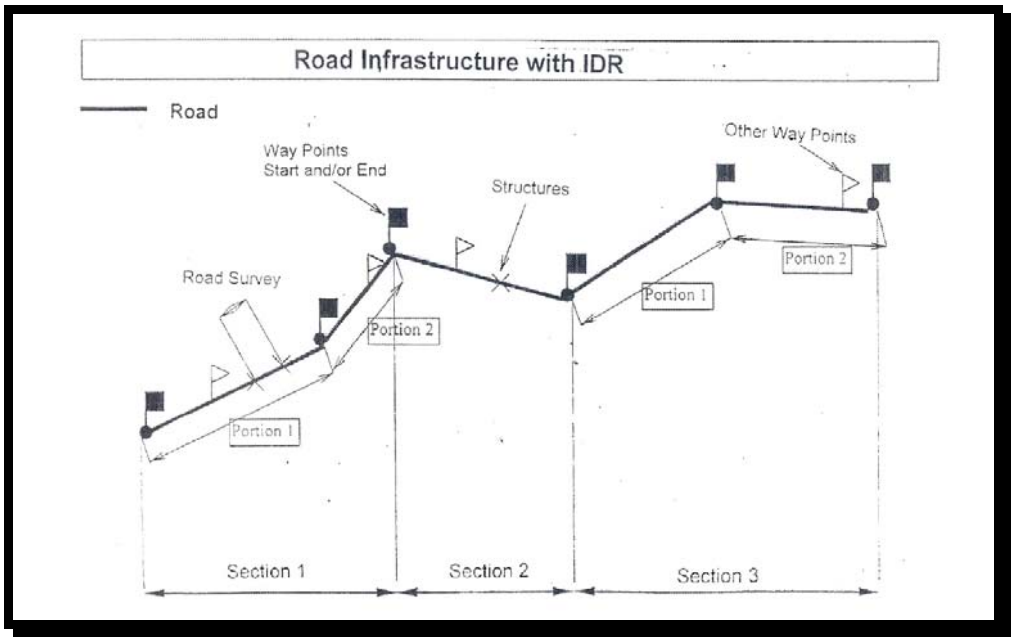
Data on axle loads on the main and regional roads are also available from an axle load survey carried out on 19 July 2007 as part of a road maintenance study.

2.4 Road information database

2.4.1 Structure of the road information database

Information on the Road Information Database has been presented by Ministry of Transport and Communication (MTC) and written information in the form of a user manual ("Road Information System IDR") has later been forwarded to COWI. Road Information System IDR or just IDR is used below as short name for the road information database. No details on the author and date of issue of the manual are available.

The data structure of IDR is shown on the figure below.



Roads are identified by road classification and road number. A start way point is part of the road definition. Start way point is automatically identified with chainage 0 km + 0 meter and cannot be changed.

Way points play an important role in identification of road sections and road portions. Way points include chainage xxx km + xxx meter and alphanumeric description. Way points include a field to enter a geographical position. Way points should not be changed or removed.

IDR includes only data about state roads (main and regional roads) maintained and operated by the Road Directorate at present. The upper level in the database including general road data allows classification of roads into 4 classes:

- NR= National Road or Magistrale Road
- RR= Regional Road
- LR= Local Road
- NCR= Non-classified road

Road characteristics are gathered in a number of tables including:

- Administrative characteristics
- Embankment
- Curves
- Parallel drainage Ditches
- Cross roads and Junctions
- Road width
- Road Alignment in Terrain
- Structures
- Longitudinal Crossfall
- Road Structure
- Road Damage
- Road Marking
- Road Signs
- Settlement Traverse
- Traffic Volume

Along the road characteristic records are identify by start chainage xxx km + xxx meter and end chainage xxx km + xxx meter, and point characteristics are recorded by chainage xxx km + xxx.

Information on road pavements is gathered in the Road Structure table including fields like:

- Material and thickness of wearing course
- Material and thickness of first base course
- Material and thickness of second base course
- Material and thickness of surface layer/frost protection layer

Information on road conditions is gathered in the Road Damage table including fields like:

- Type of damage
- Unit or Quantity of Damage
- Amount of Damage

IDR does not include geographical positions except for way points.

IDR Road Information Database includes only few coordinates, which limits the possibilities to map the information in a proper way. Plans how to integrate IDR with a Geographical Information System (GIS) have been considered, but not been implemented yet. A Geographical Road Database has been established in MapInfo software in parallel to and including the upper level data fields from IDR as part of the recent Multi Modal Transport Strategy project, but there is no dynamic link between the two databases.

2.4.2 Road Information Database Software

The core database format is Microsoft ACCESS, but the Road Information Database is accessed via a customized front end user interface. The user manual does not describe the software platform and how to bypass the user interface to enter bulk data from other sources.

2.5 The road construction market

The construction market in Kosovo is well developed, with well qualified road experts in the design offices and with contractors. In recent years the turnover in the sector has been substantial, which has helped maintain and develop the capacities and capabilities. The market seems well suited to undertake a continuing major investment in local roads.

On the other hand, according to the MMTS study there is an absence of strict contract management, and an insufficient site control and quality control. In order to ensure that investments are sustainable, it is recommended that future investments in the local roads be subject to improved supervision and quality control.

3 Drive-through Survey and Road Selection

3.1 Drive-through survey

The initial drive-through survey was undertaken for local roads in the whole of Kosovo. This was a major exercise which covered a total of 4,500 km of local roads.

The basis for the survey was the GIS-map of national and local roads developed during the MMTS study - with the assistance of MTC. This was considered the best available basis. It turned out, however, that the map was quite incomplete as far as the local roads were concerned: several important local roads were not included in the MMTS map, and on the other hand, some of the roads on the map did no longer exist or were barely passable by car.

Identification of the roads for survey was therefore also based on:

- Available topographical maps and other maps of Kosovo
- Available orthophotos
- Observations in the field
- Discussions with local inhabitants

The survey was undertaken by a number of teams, driving a 4-wheel drive car and equipped with GPS equipment. For safety reasons, each team consisted of a driver and a surveyor. Each survey team was able to cover 30 - 80 km per day, depending e.g. on the location and condition of the road, and on the accuracy of the MMTS map,

Before starting the field surveys of a particular day, a plan for the day was prepared in the home office: Enlarged prints of the roads to be surveyed were made, co-ordinates of important junctions and other points along the road segments were noted, and available topographical maps and orthophotos were printed out and compared to the MMTS map.

The drive through was recorded by GPS, using UTM_34 (UTM zone 34 (WGS84) northern hemisphere) and logging the position per 30 meters.

Simultaneously, the surveyor recorded the type of road surface (asphalt, gravel or earth) and an overall assessment of its conditions (good, fair or bad). The assessment of condition was made solely for the purposes of the subsequent

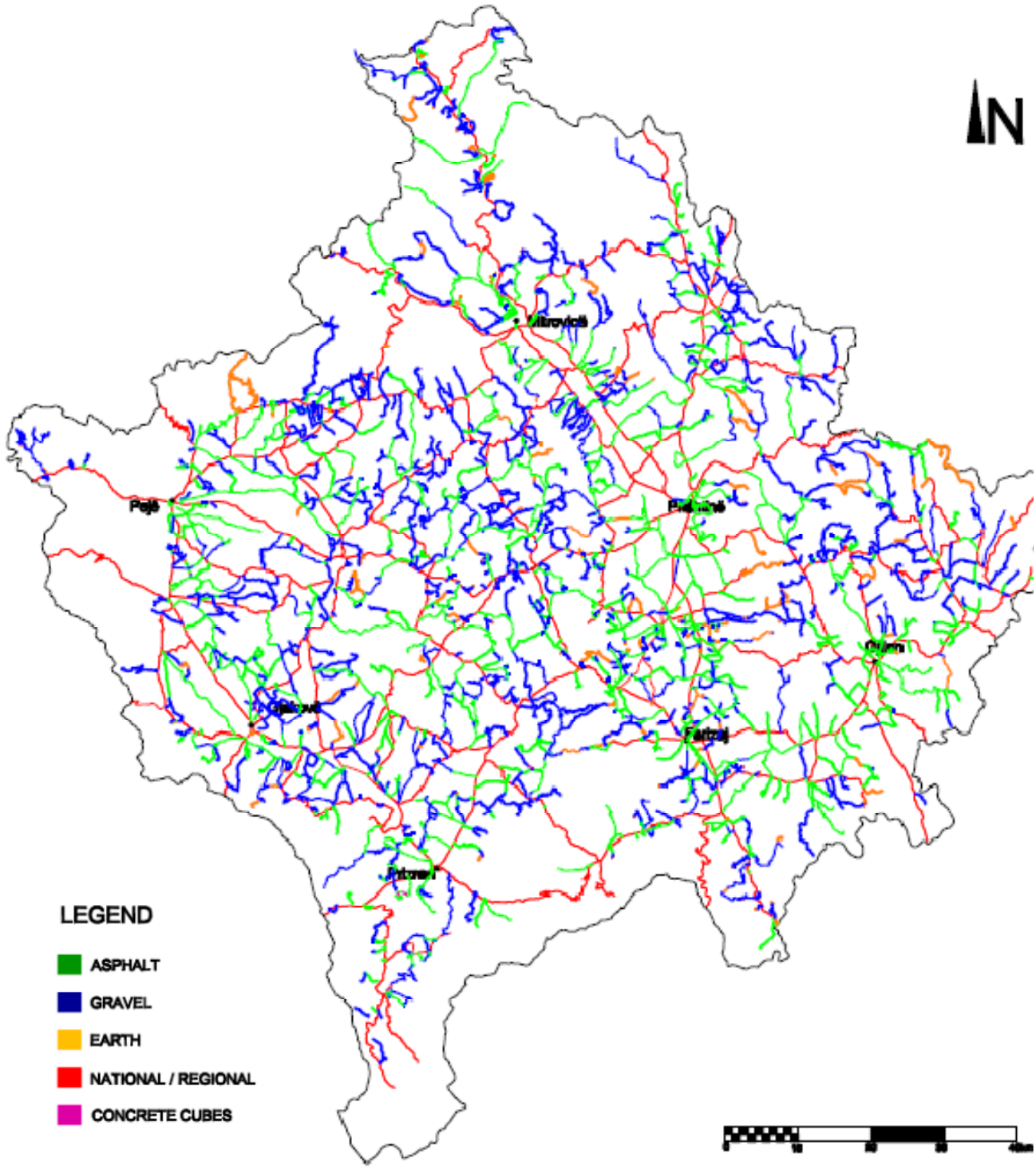
classification of roads. It mainly reflected the passability and comfort of the road, and it is not to be confused with the subsequent and more detailed visual inspections of the road surface.

In order to identify local roads not on the MTTS map and to investigate which roads are actually being used, local inhabitants were often consulted, and in a few cases also the local municipality staff.

After returning to the office, the GPS data - together with the manual recordings of road surfaces and conditions - were processed in CAD software, using separate layers per type and condition of road surface. Road alignments were also checked against other available maps when possible.

Figure 3.1 below presents the network which was covered by the drive-through survey.

Figure 3.1 Local road network covered by the drive-through survey



After completion of this survey, total mileage covered turned out as follows:

Table 3.1 Total network covered by survey (km and percentage)

	Km of road	Percentage
Asphalt	1,935	43%
Concrete blocks	3	0%
Gravel	2,271	50%
Earth	294	7%
Total	4,503	100%

There is no complete record or mapping of local roads in Kosovo, but it has been estimated by the MTC that there are some 6,000 km of local roads. After having driven through 4,500 km of these it is clear that the remaining local roads network - which may make up approximately 1,500 km - is in very poor state, and some parts of it hardly exists any more.

3.2 Selection of roads for visual inspections

After completion of the first drive-through survey and processing of data, the next step was to select some 1,500 km for visual inspections. The selected roads form the core local road network, which connects important villages and settlements to higher level road categories - the regional and national roads - and ensures their access to the primary centres.

The selection of roads for visual inspection was based on the following:

- map of national and regional roads in Kosovo;
- detailed map of villages, settlements and centres prepared by the Statistical Office for the purpose of the present study;
- observations made and information received during the drive-through survey;
- Consultations with 32 municipalities in Kosovo.

The selection of roads was made in a systematic way, using the same criteria throughout the network. The selection included the following:

- Local roads identified as roads of significant importance from the Kosovo Spatial Plan;
- Local roads connecting important villages and settlements to the national and regional network;

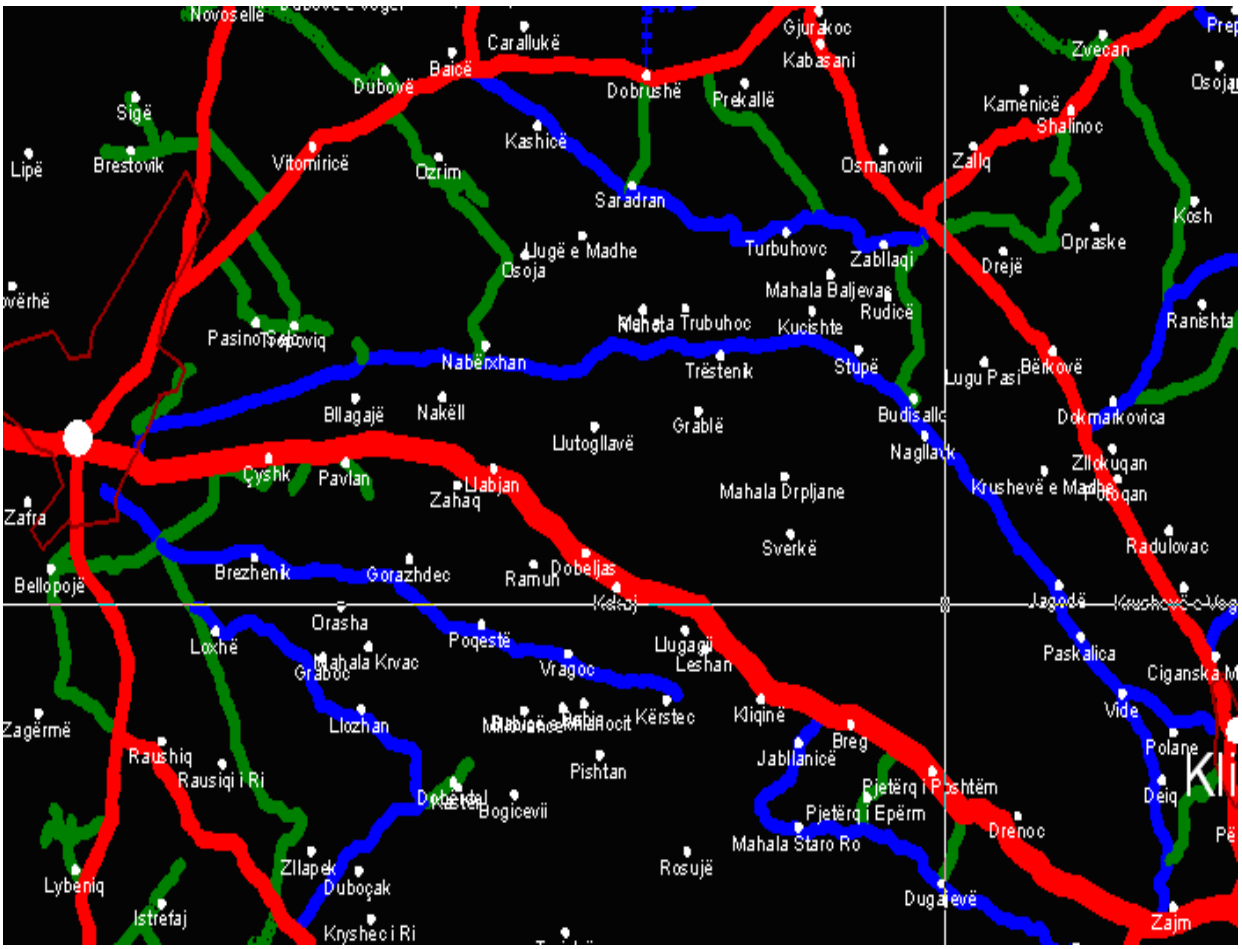
- Local roads connecting important villages and settlements to the nearest centres.

Priority was given to roads which form a network and roads which serve several villages and settlements, rather than short connecting roads from the national and regional network to nearby villages and settlements.

The selection includes all the roads listed in Annex 1 of the Terms of Reference.

Figure 3.2 below show an example of the selection of roads for visual inspections.

Figure 3.2 Example of the selection of roads for visual inspections



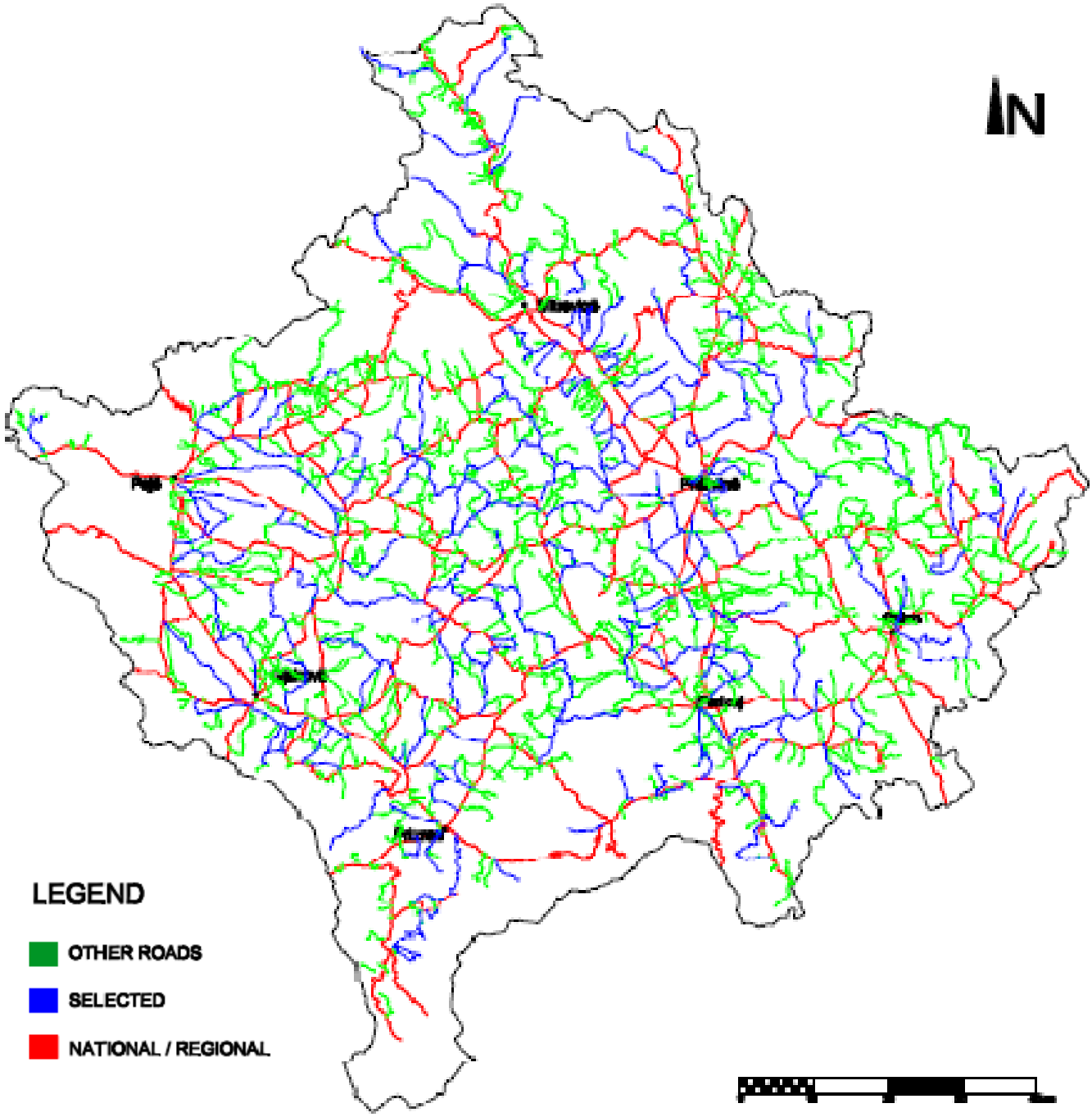
After completing the initial selection visits were paid to the 32 municipalities in Kosovo, and the selection was reviewed together with municipal staff. This led to a few adjustments, based on the detailed local knowledge of the municipalities. Finally, the selection was approved by the MTC.

Figure 3.3 below presents the selected local roads. The selected roads cover the entire Kosovo, and all municipalities are included. The length of roads included amount to the following:

Table 3.2 Length of roads (km) included in detailed survey.

	Km of road	Percentage
Asphalt	1,020	64%
Concrete blocks	0	0%
Gravel	536	34%
Earth	32	2%
Total	1,588	100%

Figure 3.3 Selected Local Roads in Kosovo for visual inspections



4 Inventory

4.1 GIS data and database preparation

Task 3 (named "inventory" in terms of reference) was a desk study, undertaken after approval of the selection of core roads for condition survey.

The collected GPS data for the core roads was rearranged in the GIS environment. Alignments as measured in the field are generally long graphical elements including several roads and passing through several junctions. The core roads in the inventory should, however, be split in all major junctions to establish graphical element corresponding to road sections in the alphanumeric database.

Subsequently the structure of the alphanumeric database was expanded to include additional fields to identify the sections, to store data collected in the visual conditions survey and to store results of the economic analyses.

The identification of roads include an alphanumeric reference (field name: ProjectRoadID as shown below in Section 6), allowing the uploading of the detailed database to the Road Database in Directory of Roads if relevant, and supporting the use of data if not accessed via a GIS interface. The alphanumeric reference has been established combining road names as defined below and unformatted location names as available from local maps.

Database tables to store data collected as part of the visual inspection is established to reflect the survey sheets as defined in section 5 below. These database tables have formed basis for the visual inspections, and subsequently for the establishment of the detailed database for the local roads including road conditions as recorded during the visual inspection.

Specific details of the database structure including examples of data are described in Section 6.

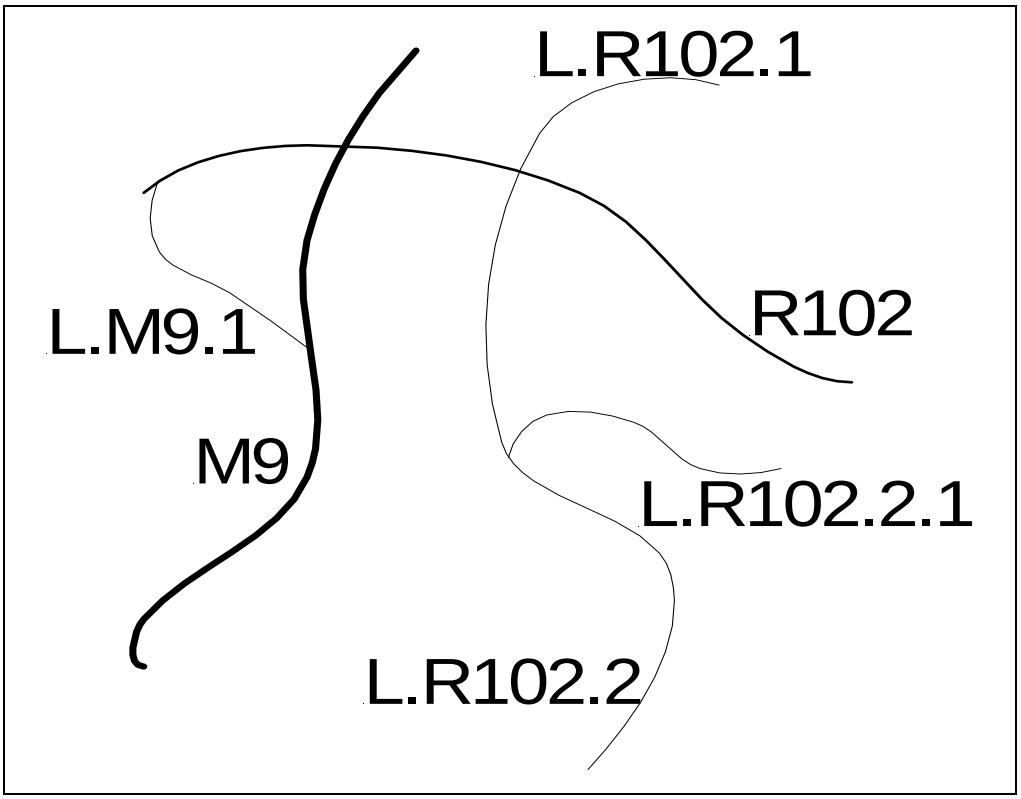
4.1.1 Name and chainage of local roads

For easy reference, project-specific names and chainages were applied to the local roads to be surveyed.

The Road Directorate in Kosovo uses the letter 'M' for Magistral roads and 'R' for Regional roads. In line with this, we used the letter 'L' for Local roads. All roads branch off from other roads, and thus local roads were named after the road from which it branches off.

In order to distinguish between local roads branching off from the same road a consecutive number was assigned to the end of the local road name. This principle for naming local roads in the present project is illustrated in *Figure 4.1* below.

Figure 4.1 Principle for naming local roads in the present project



Thus both local roads 'L.R102.1' and 'L.R102.2' branch off from regional road 'R102' whereas local road 'L.R102.2.1' branches off from local road 'L.R102.2'.

These project specific names of the local roads are also called project IDs, and they were primarily used for the purpose of the present study. In addition to this numbering of the local roads, we also attached place names to each of the roads - typically identifying the two end points. This is in line with the approach used in the present database of the MTC. Where necessary, also a "via" name was used. Since the database developed and used internally by our teams during the present study was basically a GIS tool, which is accessed through the GIS map on the screen, the final unique reference to be used in the Road Database was not needed in the field during this phase. The final completion of references as needed in the Road Database was completed only after the specific information of fields was available.

Regarding the chainage of the local roads, the point where they branch off from the road, being part of its name, was defined as Km 0+000. Thus both local roads 'L.R102.1' and 'L.R102.2' have Km 0+000 where they branch off from regional road 'R102' and both chainages are increasing when moving away from 'R102'.

5 Condition Survey

The next step was to undertake a visual inspection of the selected road network. Visual inspections were carried out per every 200 m of road. Before inspections started in the field, much time and care was devoted to the development, planning and testing of a survey methodology appropriate for the present project. The survey methodology was discussed with the World Bank and the GRD, who also took part in one of the inspection trips.

5.1.1 Parameters to be surveyed

Most of the parameters surveyed were to be used as input in a HDM-4 analysis and were therefore determined by the requirements of the HDM analyses. The data inputs for the HDM analysis can be grouped in the following three main areas:

- Construction parameters of the road
- Current condition of the road
- Traffic level on the road

During the drive-through survey roads were classified into the following three types:

- Asphalt roads
- Gravel roads
- Earth roads

For each of these types of roads different parameters are relevant to survey. The table below show the parameters which were recorded for each of the road types. The developed survey forms are shown in the Appendices.

Table 5.1. Parameters to be recorded for each type of road (underlined parameters are inputs in HDM-4).

	Asphalt road	**Gravel road**	**Earth road**
Construction	• Road category[1)] • Speed limit • Number of lanes • Width of carriageway • Width of shoulder	• Road category[1)] • Number of lanes • Width of carriageway	• Road category[1)] • Number of lanes •
Condition	• Comfortable driving speed[2)] • All structural cracks • Wide structural cracks • Potholes • Patches • Depressions • Edge break area • Drainage	• Comfortable driving speed[2)] • Drainage	• Drainage
Traffic	• Total traffic during survey • Inhabitants	• Total traffic during survey • Inhabitants	• Total traffic during survey • Inhabitants

1) The road categories were numbered from 1 to 3 with '1' representing a road in good condition for its type (asphalt, gravel or earth) with possibly isolated defects and '3' representing a road in poor condition with widespread defects.

2) Comfortable driving speed will be used to assess the roughness of the road, see below.

The underlined parameters in the table above are direct input to HDM-4, whereas the other parameters may be used to guide the engineer/economist to suggest suitable types of intervention to be analysed.

One parameter in HDM-4 is the roughness of the road expressed according to the International Roughness Index (IRI). This parameter was not directly measured, but based on an assessment of the comfortable driving speed combined

with the extent of defects observed on the road. For this purpose the Overseas Road Note 5 was used.[4]

The 'Comfortable driving speed' is a subjective parameter. Different persons may assess the comfortable driving speed differently for any given road section. Countermeasures to avoid this difference are described in Section 5.1.2 below.

Rutting was not measured in the present condition survey. Rutting is generally associated with traffic safety and quantities of asphalt to rectify this defect. However, the extent of rutting is minimal on the local roads in Kosovo and as the driving speed is low rutting does not constitute any safety risks. The survey teams were instructed to take note (in the comments columns) of any rutting problems which whey might notice.

5.1.2 Survey method

The survey covered a relatively large road network (approx. 1,600 km) and was undertaken at a relatively high level of detail (survey per 200 meter subsections). Within the limited time and budgetary framework available for the survey, a windscreen survey was the only feasible method. Only the road width was measured, whereas other parameters were based on visual inspections. All parameters were surveyed in the same drive-through. The survey method has been carefully planned and tested in the field during several days, and survey engineers were carefully trained.

The survey was undertaken by teams of two engineers, with the following distribution of work:

- Engineer 1:
  - Drive car at speed not exceeding 20 km/h
  - Count traffic in both directions
  - Assess comfortable driving speed
  - Stop at every 200 meter

- Engineer 2 :
  - Assess construction and condition of roads as per survey forms
  - Fill out survey forms for every 200 meter

In order to secure accuracy in the recordings, great effort was made to "calibrating" the eyesight of each engineer/surveyor. The "calibration" was done by having the team of engineers drive over any given test section while performing their assigned tasks. Afterwards the various parameters were measured; the assessed comfortable driving speed was verified and the defects were measured with a folding rule.

[4] Overseas Road Note 5 - A guide to road project appraisal; Overseas Unit, Transport and Road Research Laboratory (TRRL); United Kingdom, 1998

By repeating this process several times for the different types of parameters and defects, both before and during the actual survey, the engineers were trained and tested for their tasks.

As more than one team was involved, the team members were "calibrated" against each other in order to limit the discrepancy.

Based on the comparison of the two independent survey results carried out on a 12 km asphalt road within one month there was only insignificant discrepancies in results, indicating that the survey methods were identical and could be approved by the GRD-staff while observing the second survey of the road section.

Due to the large number of parameters that the engineer in the passenger side had to survey, it was important that the driving speed did not exceed approx. 20 km/h. Keeping a constant speed also made the level of accuracy in the survey more uniform with regards to surveying defects on the road.

5.1.3 Traffic counts

Traffic counts were carried out along with the condition survey utilizing the Moving Observer Method. The information listed below was recorded by the survey team while surveying the road condition. Traffic counts were carried out both when driving and when stopping to enter road characteristics and road condition.

- t1: time entering the section
- x: vehicles travelling in the opposite direction and vehicles overtaking the observer or passing when stopped
- z: vehicles overtaken by the observer (often = 0)
- t2: time leaving the section

The hourly flow was estimated as follows, assuming t1 and t2 are measured in hours:

- hourly flow = (x - z)/(t2 - t1)

Subsequently hourly traffic volumes were converted into AADT, as described in Section 0.

5.1.4 Location of schools, hospitals and health centres

The location of schools, hospitals and health centres along the roads was recorded, together with the X-Y coordinate of the access roads leading to them. The information was entered in the comments column and transferred to the data base

5.1.5 Population and households

Information on population and households along each of the roads in the database was also entered.

The Statistical Office was able to provide the number of households 2008 for all settlements in Kosovo. The number of households is a good relative indication of the importance of a road.

Unfortunately no recent and reliable information on the population in Kosovo exists. However, based on the number of households in Kosovo 1991 and the total population in Kosovo 1991, an average number of inhabitants per household were calculated at 6.44. Using this average number of people per household on the 2008 households, a proxy of the present population of settlements was arrived.

The total population and number of households along each of the roads - including minor branched off from the roads - were entered into the database.

5.1.6 Evaluation of condition survey

The construction parameters as well as the current condition of the roads varied from local road to local road and could also vary along the same road. Based on the recorded condition each 200 meter segment was rated according to the table below:

Table 5.2. Classification of road types.

Road Class	Current condition
Good asphalt	• All structural cracks max. 2% • Wide structural cracks max. 2% • Potholes max. 5%
Medium good asphalt	• All structural cracks max. 10% • Wide structural cracks max.< 10% • Potholes max. 20%
Medium poor asphalt	• All structural cracks max. 40% • Wide structural cracks max. 40% • Potholes max. 50%
Poor asphalt	• All structural cracks max. 100% • Wide structural cracks max. 100% • Potholes max. 100%
Fair gravel	• Comfortable driving speed min. 40 km/h
Fair gravel	• Comfortable driving speed max. 40 km/h
Earth	• Earth road

Depending on the Road Class different interventions could be proposed in the following HDM modelling.

However, it would be unrealistic to mobilise a Contractor for any given intervention on only a 200 meter segment of road and thus all roads were divided into homogeneous sub-sections.

Thus if an asphalt road has e.g. one 200 meter segment being gravel the entire road is still considered to be asphalt. If on the other hand a larger portion of e.g. an asphalt road is either earth or gravel the road is subdivided into two or more homogeneous sub-sections. Likewise if the condition of an asphalt road changes Road Class the entire sub-section is classified according to the "dominant" Road Class.

However, no homogeneous sub-section was generally less than 600 meters, which can be considered as the minimum length to justify mobilisation of a Contractor.

This resulted in the following lengths of Road Classes:

Table 5.3. Classification of road types.

Road Class	Length [Km]	Road type		
		Asphalt	Gravel	Earth
Good asphalt	679.4	99.9%	0.1%	0.0%
Medium good asphalt	92.8	99.4%	0.6%	0.0%
Medium poor asphalt	105.8	100.0%	0.0%	0.0%
Poor asphalt	135.4	99.7%	0.3%	0.0%
Fair gravel	115.8	0.3%	99.7%	0.0%
Poor gravel	423.4	0.1%	99.8%	0.1%
Earth	31.2	0.0%	1.9%	98.1%

This sub-division of all the roads based on Road Classes as well as homogeneous sub-sections provide average input data for the HDM modelling, see Table 8.8 later in the present report.

6 Database for Local Roads

6.1 Establishment of database

Location of roads has in this study been collected automatically with GPS equipment in the drive-through survey and stored in Geographical Information Software. Further additions of road characteristics including surface type, road width and road conditions of selected core local roads were added in the conditions survey utilising software tailored to the condition survey sheets as defined above in section 5. Geographical Information including detailed road alignment and alphanumeric data including road characteristics and road condition was combined in the Geographical Information Software for internal use to facilitate the analyses of the project.

The database as submitted to the Ministry of Transport and Communication (MTC) has finally been established in the latest Microsoft ACCESS version (ACCESS 2000 file format, Office 2007 user interface). The database is organized in a hierarchy corresponding to IDR including a road table, a road section table and a table including detailed road characteristics and road condition.

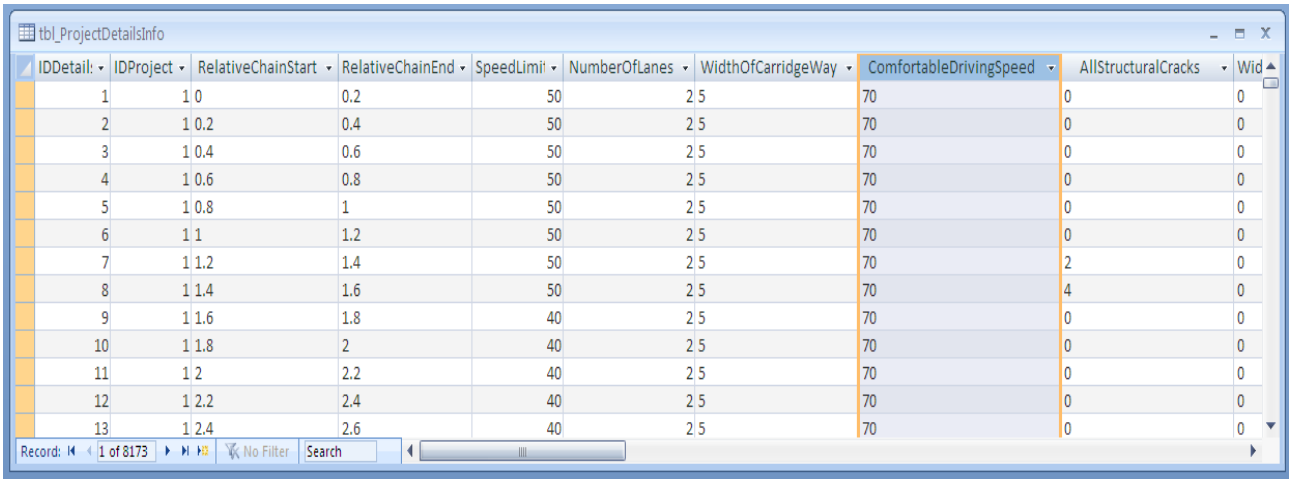
The figure below corresponds to the road section table in IDR.

tbl_ProjectMainInfo

IDProject	ProjectRoadID	ID_Road	DateOfSurve	KMStart	KMEnd	GPSCoordinateStart	GPSCoordinateEnd	RoadSection
1	L3001-R110-Tërpezë-Novosellë-Divjakë-Kleçkë-Gaden-	33	10/26/2009	0+000	21+400	0483936/4708169	0493599/4698512	1
2	L3001-R110-Tërpezë-Novosellë-Divjakë-Kleçkë-Gaden-	33	10/26/2009	0+000	21+400	0483936/4708169	0493599/4698512	2
3	L3002-R11-Lagja(Kajajve-Belajve-e Madhe)-Ladroc-Ra	34	10/27/2009	0+000	8+600	0481638/4706231	0485891/4703174	1
4	L3003-R119-Bellanicë-Ngucat-Temeginë-R119	35	10/26/2009	0+000	10+100	0484369/4700514	0485995/4698370	1
5	L3003-R119-Bellanicë-Ngucat-Temeginë-R119	35	10/26/2009	0+000	10+100	0484369/4700514	0485995/4698370	2
6	L3004-R119-Lagja e Pintolleve-Nishor-L3005	36	10/28/2009	0+000	4+200	0484940/4699422	0483853/4696472	1
7	L3004-R119-Lagja e Pintolleve-Nishor-L3005	36	10/28/2009	0+000	4+200	0484940/4699422	0483853/4696472	2
8	L3005-R119-Lagja e Hazrollve-Lagja e Kodralive-Nez	37	10/28/2009	0+000	16+400	0481813/4701334	0482670/4689740	
9	L3005-R119-Lagja e Hazrollve-Lagja e Kodralive-Nez	37	10/28/2009	0+000	16+400	0481813/4701334	0482670/4689740	2
10	L3005-R119-Lagja e Hazrollve-Lagja e Kodralive-Nez	37	10/28/2009	0+000	16+400	0481813/4701334	0482670/4689740	3
11	L3006-R110-Dragobill-Marali-Pagarushë-Lagja e Rexh	38	10/27/2009	0+000	13+600	0477414/4701082	0478663/4691076	1
12	L3006-R110-Dragobill-Marali-Pagarushë-Lagja e Rexh	38	10/27/2009	0+000	13+600	0477414/4701082	0478663/4691076	2
13	L3006-R110-Dragobill-Marali-Pagarushë-Lagja e Rexh	38	10/27/2009	0+000	13+600	0477414/4701082	0478663/4691076	3
14	L3006-R110-Dragobill-Marali-Pagarushë-Lagja e Rexh	38	10/27/2009	0+000	13+600	0477414/4701082	0478663/4691076	4
15	L3007-Lubizhë-Turjakë-Garaçevë-Panorc-Rudne-Llapçe	39	10/31/2009	0+000	15+400	0475506/4705862	0463741/4707363	1

Record: 6 of 382 No Filter Search

The figure below shows parts of the detailed road characteristic and road condition table.

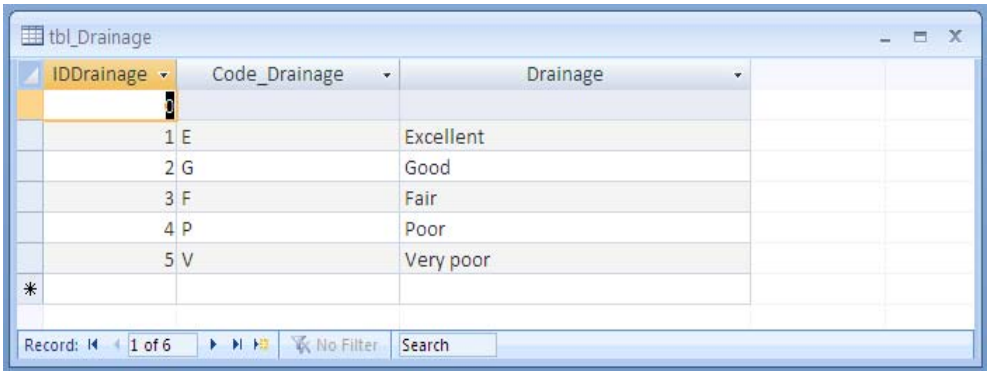


tbl_ProjectDetailsInfo

IDDetail	IDProject	RelativeChainStart	RelativeChainEnd	SpeedLimit	NumberOfLanes	WidthOfCarridgeWay	ComfortableDrivingSpeed	AllStructuralCracks	Wid
1	1	0	0.2	50	2	5	70	0	0
2	1	0.2	0.4	50	2	5	70	0	0
3	1	0.4	0.6	50	2	5	70	0	0
4	1	0.6	0.8	50	2	5	70	0	0
5	1	0.8	1	50	2	5	70	0	0
6	1	1	1.2	50	2	5	70	0	0
7	1	1.2	1.4	50	2	5	70	2	0
8	1	1.4	1.6	50	2	5	70	4	0
9	1	1.6	1.8	40	2	5	70	0	0
10	1	1.8	2	40	2	5	70	0	0
11	1	2	2.2	40	2	5	70	0	0
12	1	2.2	2.4	40	2	5	70	0	0
13	1	2.4	2.6	40	2	5	70	0	0

Record: 1 of 8173 No Filter Search

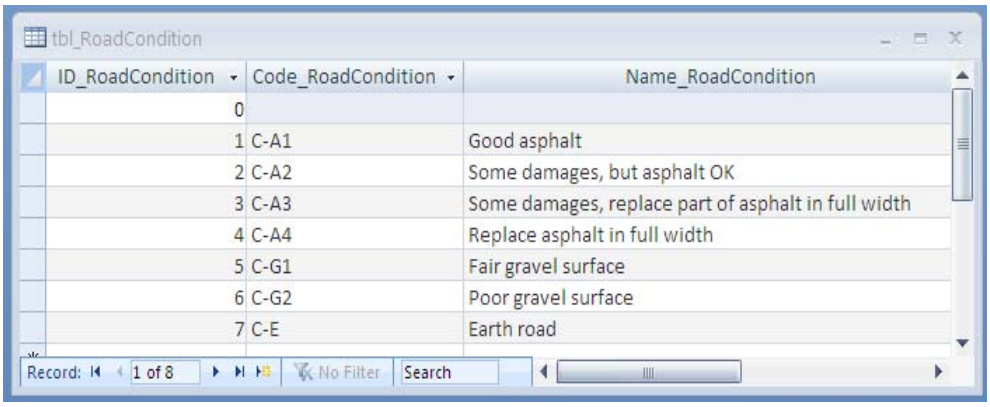
The ACCESS database structure includes a number of small tables with codes as defined in the drive-through and condition survey ensuring a stringent validation of data entered into the database. Two such examples are shown below.



tbl_Drainage

IDDrainage	Code_Drainage	Drainage
1	E	Excellent
2	G	Good
3	F	Fair
4	P	Poor
5	V	Very poor

Record: 1 of 6 No Filter Search

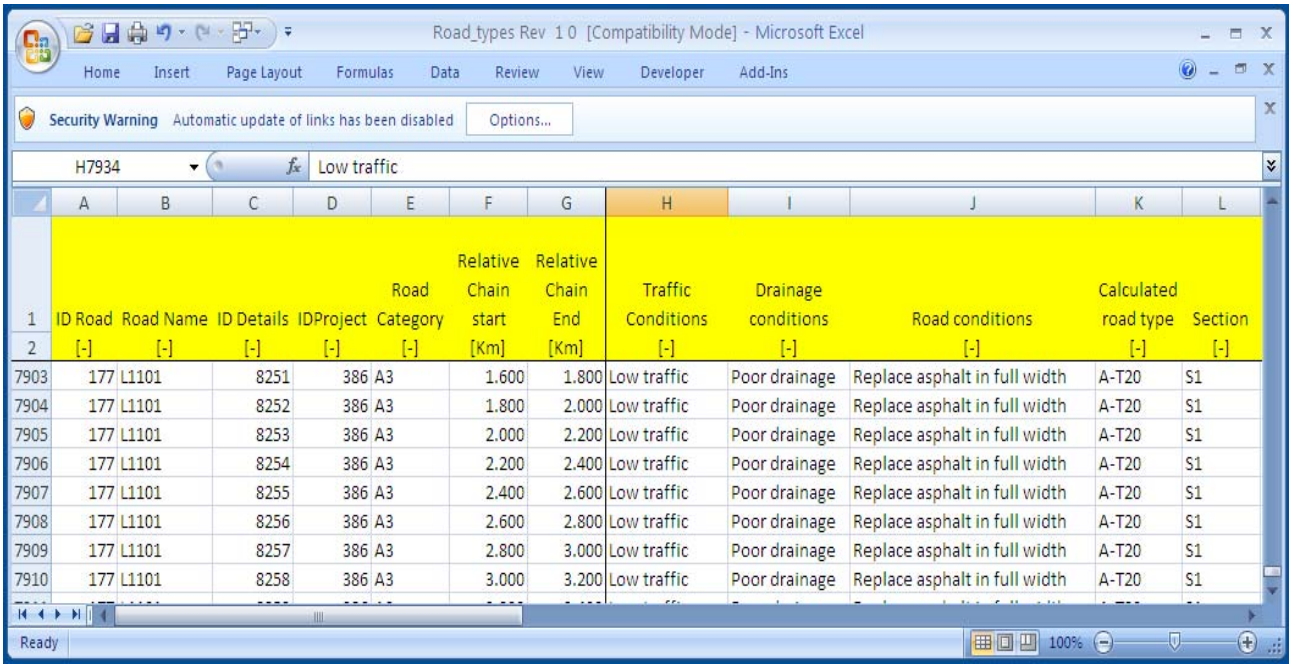


tbl_RoadCondition

ID_RoadCondition	Code_RoadCondition	Name_RoadCondition
0		
1	C-A1	Good asphalt
2	C-A2	Some damages, but asphalt OK
3	C-A3	Some damages, replace part of asphalt in full width
4	C-A4	Replace asphalt in full width
5	C-G1	Fair gravel surface
6	C-G2	Poor gravel surface
7	C-E	Earth road

Record: 1 of 8 No Filter Search

ACCESS databases are well known to the DGR and the MTC, who also has the required software licences. The data has also been prepared in a flat EXCEL file to ensure a minimum of requirements. A part of the EXCEL file is shown in the figure below including surveyed road data and condition and including analyses of considered interventions to improve the roads.



Road_types Rev 1 0 [Compatibility Mode] - Microsoft Excel

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H7934 Low traffic

	A	B	C	D	E	F	G	H	I	J	K	L
1	ID Road	Road Name	ID Details	IDProject	Road Category	Relative Chain start	Relative Chain End	Traffic Conditions	Drainage conditions	Road conditions	Calculated road type	Section
2	[-]	[-]	[-]	[-]	[-]	[Km]	[Km]	[-]	[-]	[-]	[-]	[-]
7903	177	L1101	8251	386	A3	1.600	1.800	Low traffic	Poor drainage	Replace asphalt in full width	A-T20	S1
7904	177	L1101	8252	386	A3	1.800	2.000	Low traffic	Poor drainage	Replace asphalt in full width	A-T20	S1
7905	177	L1101	8253	386	A3	2.000	2.200	Low traffic	Poor drainage	Replace asphalt in full width	A-T20	S1
7906	177	L1101	8254	386	A3	2.200	2.400	Low traffic	Poor drainage	Replace asphalt in full width	A-T20	S1
7907	177	L1101	8255	386	A3	2.400	2.600	Low traffic	Poor drainage	Replace asphalt in full width	A-T20	S1
7908	177	L1101	8256	386	A3	2.600	2.800	Low traffic	Poor drainage	Replace asphalt in full width	A-T20	S1
7909	177	L1101	8257	386	A3	2.800	3.000	Low traffic	Poor drainage	Replace asphalt in full width	A-T20	S1
7910	177	L1101	8258	386	A3	3.000	3.200	Low traffic	Poor drainage	Replace asphalt in full width	A-T20	S1

Ready 100%

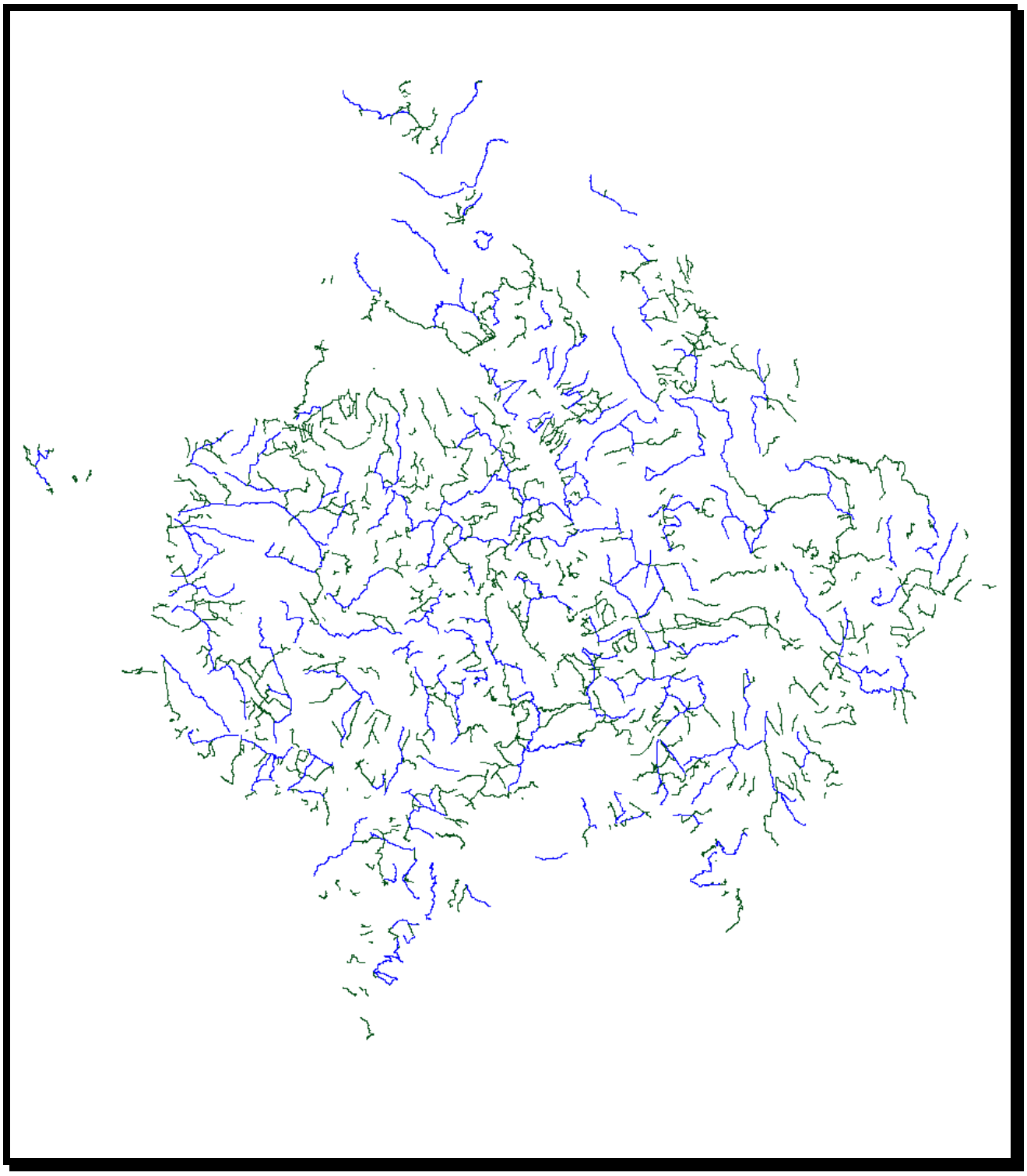
Two Geographical Information System databases have been submitted:

- A GIS database including all road alignments as automatically recorded by GPS equipment in the drive-through survey without any alphanumeric information

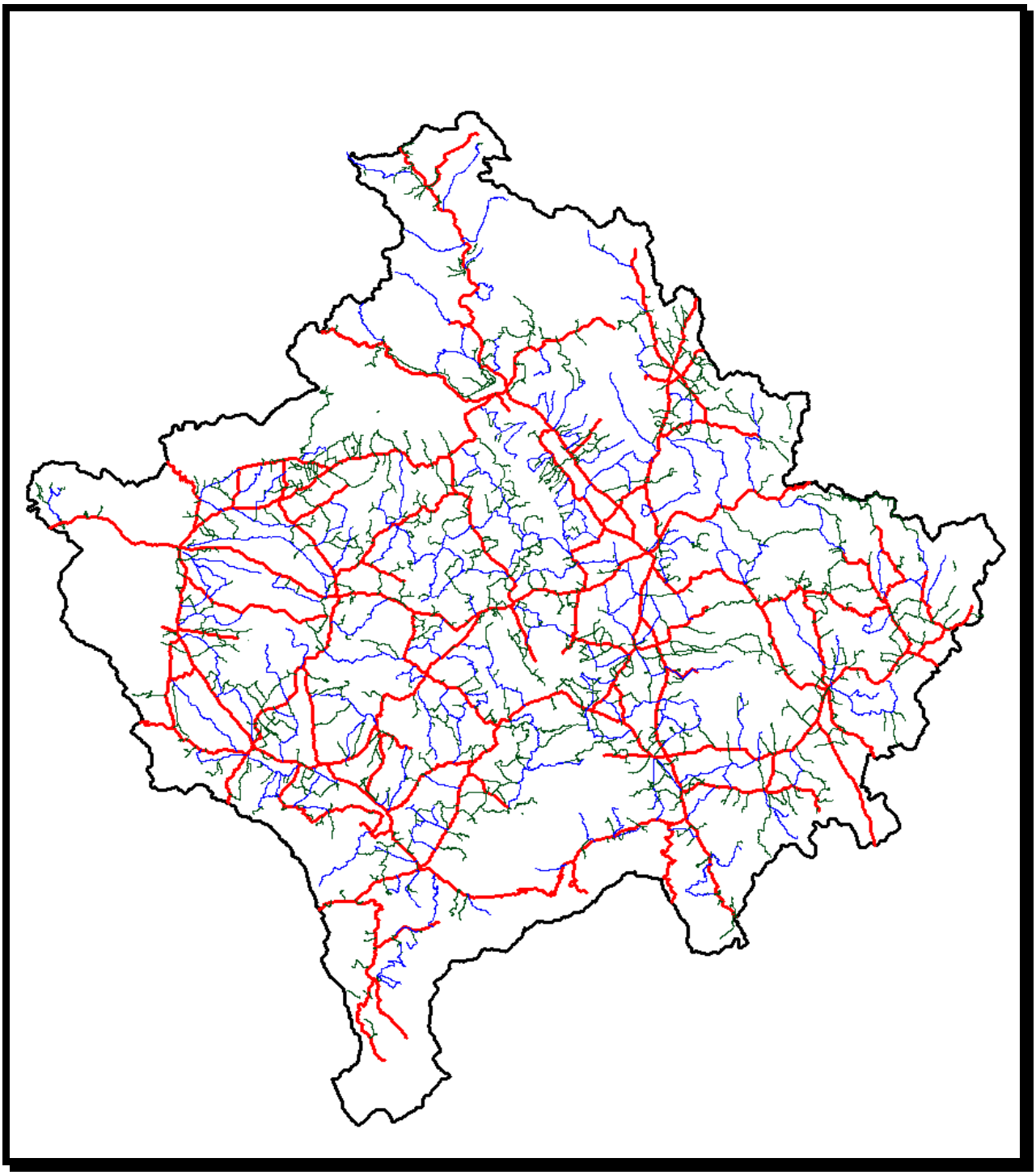
- A GIS database including the selected core roads combined with alphanumeric road characteristic and road condition as collected during the condition survey allowing thematic maps to be generated.

The latter has - upon mutual agreement with the MTC - been submitted as a GIS database, using MapInfo in conjunction with an Access database. This allows the user to draw all the relevant tables and information from the database, while at the same time presenting the results in GIS format.

The figure below shows alignments of all the local roads as measured when driving through. The basis is the original GPS data measured automatically when driving. All detailed coordinates from the drive- trough survey are stored in the GIS file.



The figure below shows alignments of the local roads in combination with state roads (main roads and regional roads) shown in red and the Kosovo border shown in black. State roads and borders were received from MTC in MapInfo format. The combined figure is established in MapInfo after conversion of the local roads into MapInfo format.



It has been agreed with MTC that they prefer database deliverables as described above including GIS databases rather than an alphanumeric database in IDR format. The reason is lack of integration between geographical information and alphanumeric information in IDR. The structure of the IDR database and the user interface is not suited to handle in an effective way the detailed data per 200 meter as collected in this study.

6.2 Operation and updating of the database

The road inspections have provided our team with in-dept knowledge of the state of local roads in Kosovo, and the database developed under the study has been a valuable tool for the preparation of the investment plan. Furthermore, the database has been developed in a highly user friendly form and in a software with which the GRD is fully familiar. Thus, the GRD has all the required skills and capabilities to operate the database. Also, since the database is prepared in the widely used standard softwares Access and MapInfo, it can easily be used by other professionals - e.g. in connection with further studies and analyses.

The local roads are administered by the 32 Municipalities, and ideally the database should therefore be submitted to the Municipalities for the use in their planning and maintenance of the roads. In principle, the Municipalities could greatly benefit from having access to this data. However, the Municipalities would generally not have the required skills and capabilities to operate and maintain the database, and it would therefore be of little value to most of them.

Therefore, we recommend that the database be operated and maintained by the GRD - on behalf of the Municipalities. Although the GRD has the professional capabilities to do so, their in-house resources may be insufficient for this work, and the GRD may need to acquire additional capacity - or to outsource the operation of the data base to external parties.

The main challenge, however, will be the updating of the database. If not currently and regularly updated, the database will soon become of little value:

- Roads will continue to deteriorate as a consequence of wear and tear, and condition data may therefore soon be outdated
- Municipalities continue to undertake repair and maintenance works on their roads, thereby changing the road characteristics
- Municipalities occasionally also undertake construction or rehabilitation works which make data in the current database totally invalid
- The Ministry of Transport is implementing a major investment programme in local roads which involves a major improvement of the conditions of the local roads.

In order to keep the database updated there is therefore a need for the Municipalities and the MOT to report on major repair, rehabilitation and construction works undertaken on the local roads. In addition, there is the need for a regular visual inspection of the local roads, following the procedures and methodologies developed under the present study.

On this basis we recommend the following:

- The GRD takes on the task of operating the database on behalf of the relevant stakeholders (in particular the Municipalities and the MOT). The GRD has the competences to do so, but we estimate that a total of 2 Man Month per year will be required for this task.

- Municipalities are requested to report on important repair and construction/rehabilitation works which they undertake. The data will be entered in the database by the GRD.

- The MOT will report to the GRD on the construction/rehabilitation works, which the ministry finances on the local roads.

- Every 3 years a complete inspection of the local roads - following the methodologies and procedures of the present study - is undertaken. This exercise may be allocated to local consultants

7 Traffic Demand

No traffic counts are currently available for the local road network. Traffic estimation will therefore be based on the moving vehicle traffic counts described above.

The observed traffic data will be transformed first into hourly traffic as described above and then into AADT. For the conversion into AADT, the general traffic variation over the day, observed on main and regional road network, will be applied. Detailed manual traffic counts over 24 hours on weekdays were carried out at 6 locations in October 2007 on main and regional roads as part of the MMTS study. On this basis the average daily distribution may be calculated, as presented in below table.

Table 7.1 Hourly traffic variation - weekdays (Source: MMTS counts October 2007).

Time of day	Vehicles	Distribution
7:00-8:00	3,225	7.9%
8:00-9:00	3,067	7.6%
9:00-10:00	2,440	6.0%
10:00-11:00	2,534	6.2%
11:00-12:00	2,450	6.0%
12:00-13:00	2,294	5.7%
13:00-14:00	2,464	6.1%
14:00-15:00	2,812	6.9%
15:00-16:00	2,814	6.9%
16:00-17:00	2,716	6.7%
17:00-18:00	2,827	7.0%
18:00-19:00	2,948	7.3%
19:00-7:00	7,992	19.7%
Total 0:00-24:00	40,583	100%

An estimate of the distribution of traffic by vehicle type - i.e. the percentage of heavy vehicles - will also be required. The percentage of heavy vehicles on rural local roads is often relatively high compared to roads next to urban areas and often relatively low compared to main roads in rural areas. Distribution be-

tween vehicle types on local roads is therefore assumed to be at the same level as on main and regional roads, and the results of the MMTS study will thus be applicable.

The MMTS study analysed the vehicle type distribution at 20 count stations on the main and regional road network. The results are presented in below table.

Table 7.2 Vehicle type distribution (Source: MMTS study January 2008).

Name	Road	Car	Minibus	Pick Up	Bus	2-Ax Truck	3-Ax Truck	>3-Ax Truck	Total
Doganaj	M2	7,389	176	423	72	160	20	412	8,652
Vataj	R116	1,000	16	41	7	38	5	13	1,119
Sojeve	M25.3	5,921	241	580	59	240	30	65	7,135
Pasijan	M25.2	1,618	53	129	11	85	11	16	1,922
Raniluk	M25.3	6,295	117	282	77	113	14	58	6,958
Konjuh	M25	8,202	198	477	117	199	25	138	9,357
Caraljevo	M25.3	4,734	165	408	92	313	39	179	5,929
Babush	M2	11,246	278	675	110	370	46	368	13,093
Slatina	M9	17,274	419	1,012	285	461	58	240	19,748
Slivovo	M25.2	4,144	69	166	65	80	10	26	4,559
Grastica	M9	1,422	20	49	1	46	6	3	1,547
Vranidol	M25	10,911	256	616	197	246	31	128	12,384
Milosheve	M2	14,202	448	1,073	200	358	45	247	16,572
Brobanic	R101	3,222	97	233	28	98	12	80	3,771
Kushtove	M2	2,295	86	206	9	83	10	54	2,744
Simonida	M22.3	1,899	62	152	29	80	10	81	2,315
Zahaq	M9	6,232	193	469	103	240	30	106	7,373
Dranoc	R107	6,746	181	439	140	205	26	55	7,793
Pirana	R107	7,334	221	534	128	249	31	87	8,584
Vlasnje	M25	4,295	131	315	60	116	14	33	4,964
Total		126,382	3,426	8,278	1,791	3,778	472	2,391	146,520
Distribution		86.3%	2.3%	5.7%	1.2%	2.6%	0.3%	1.6%	100.0%

The development in traffic demand will be estimated assuming a simple annual growth over the time horizon of the economic analyses. The assumed annual growth will be based on key figures of the MMTS study" (see National Transport Model Report, MMTS study).

Traffic demand estimation has been important input to the HDM-4 model calculations, since traffic is crucial to estimation of the benefits (operation cost savings) as well as cost (need for maintenance, rehabilitation and road improvements).

8 HDM modelling and Economic Analysis

8.1 Introduction

This section describes the approach and methodology for the economic analysis and includes:

- Study approach and methodology covering details about data collection and input for the HDM model.
- Traffic projections applied for the road categories of the survey.
- Results of the economic analysis that will be used for the proposed Investment Plan - see Section 9 below.

8.2 Study approach and methodology

8.2.1 Data collection

The data used for the economic analysis are mentioned below and include the technical roads inputs as well as data collection from various sources in Kosovo which include the Ministry of Transport and Telecommunication, the Road Directorate of Kosovo, Household surveys, Action Plan and Investment Plan for the Roads Sector from May 2009 and updated price information on vehicle categories used for the analysis. The below mentioned model parameters are included in the economic analysis of the selected roads:

- Technical specification of investment and maintenance alternatives;
- Cost estimates for investment alternatives;
- Cost estimates for maintenance strategies;
- Vehicle operating costs;
- Vehicle characteristic;
- GDP and traffic growth forecasts;
- Time values.

8.2.2 Methodology

The economic analysis has been performed by using the HDM-4 model - version 2.04. The model analyses the total transport costs of the road improvement

and maintenance options that have been identified by the project. The identified options are compared with a "Without Project" or reference base case where a minimum of road maintenance and possibly deferred rehabilitation required to keep the road in existence.

The costs and benefits taken into consideration by the model are for vehicle traffic only, and non-vehicular traffic is not considered significant for the analysis at this stage:

- Costs of road improvement/rehabilitation (incl. cost of design, supervision, land acquisition where and if required and environmental mitigation measures);
- Residual value of the road at the end of the analysis period;
- Maintenance costs;
- Vehicle operating costs (VOC) and savings; and
- Travel time costs/savings to passengers and freight.

Other exogenous costs and benefits, which are normally less quantifiable, are not analysed at this stage as part of the economic analysis, but could possibly include:

Induced economic development in the project areas and region, such as industrial, agricultural or tourist activities that were previously constraints;

- Direct employment effect from road upgrading and associated services during construction; and
- Social benefits arising from the increased mobility of the population surrounding the project area, including improved accessibility to health, education and other services.

For the purpose of the economic analysis, all costs and benefits are expressed in real resource values to the economy. Taxes, duties and most other transfer payments are deducted the market prices.

The main future economic benefits expected from the improvement of existing roads are savings in economic vehicle operating and passenger time costs for the road traffic.

The results of the economic evaluation are expressed in terms of Economic Internal Rate of Return (EIRR), Net Present Value (NPV) discounted at 7%, and Net Present Value over Investment Cost Ratio (NPV/C).

8.2.3 HDM-model Input

Data collection and review

Input for the HDM model consists of a number of data ranging from technical road specification to economic cost prices of the identified work measures and maintenance, vehicle operating costs, time costs etc.

In addition cost on maintenance labour, crew wages and passenger time value are representing estimates from cities in the project area. Costs are expressed in economic terms based on financial prices expressed as market prices. The financial costs are converted to economic costs by subtracting taxes, levies and duties.

The following two sub-sections present the vehicle fleet characteristics and the road user costs as summarised in Table 8.1 and Table 8.2 respectively. The data is obtained from various institutional sources in Kosovo and has been updated to reflect the recent development in economic prices of the relevant parameters such as time value and fuel/diesel prices. This is done to quantify the project costs and benefits accordingly. One main and recently updated source of information has been the *Action Plan and Investment Plan for the Roads Sector, May 2009 from the Ministry of Transport and Communications as part of the Multi-Modal Transport Strategy and Action Plan for the Kosovo road sector.*

Vehicle fleet characteristics

The vehicle fleet characteristics are based on experience from previous studies on site visual verification of the vehicle fleet on the "project" road combined with the Consultant's judgement. The vehicle fleet characteristics are used as technical input to the HDM-4 modelling.

Table 8.1 Vehicle Fleet Characteristics.

	Cars	Vans & Pickups	Small Buses	Large Buses	Small Trucks	Medium Trucks	Heavy Trucks
Passenger Car Space Equiv.	1.0	1.2	1.2	1.6	1.4	1.6	1.8
Operating Weight (ton)	1.2	2.9	2.4	14.0	9.3	18.4	30.5
No. of wheels	4	4	4	6	6	10	18
No. of axles	2	2	2	2	2	3	3
Tyre type	Radial	Bias ply	Radial	Bias ply	Bias ply	Bias ply	Bias ply
Base no. of recaps	1	1	1	1	1	1	1
Retread costs (%)	50%	50%	50%	50%	50%	50%	50%
Annual KM	12,000	30,000	30,000	70,000	40,000	55,000	80,000
Working hours	400	1,300	850	2,000	1,200	1,600	2,000
Average life (years)	14	8	8	12	14	14	12
Private use (%)	100%	0	0	0	0	0	0
Passengers (no.)	2.15	2.30	4.30	28.00	0.00	0.00	0.00
Work related passenger trips	38	68	68	68	0	0	0
ESALF	0.001	0.004	0.001	1.690	0.470	2.670	3.320

Source: Action Plan and Investment Plan for the Roads Sector, May 2009 from the Ministry of Transport and Communications as part of the Multi-Modal Transport Strategy and Action Plan for the Kosovo road sector.

Road user costs

Road user costs are presented below in Table 8.2 which shows a division between vehicle categories. The economic unit cost data has been updated to current price levels measured in EUR.

Table 8.2 VOC data - (Economic unit prices in EUR).

	Cars	Vans & Pickups	Small Buses	Large Buses	Small Trucks	Medium Trucks	Heavy Trucks
New Vehicle Price	11,000	11,000	30,000	80,000	29,500	101,500	125,000
Replacement tire	30	60	67	210	90	200	240
Fuel (per litre)	0.36	0.36	0.36	0.36	0.36	0.36	0.36
Lubricant oil (per litre)	4.65	4.65	4.65	4.65	4.65	4.65	4.65
Maintenance labour costs (per hour)	2.03	2.03	2.03	2.21	2.21	2.21	2.21
Crew wages (per hour)	0.00	1.49	1.17	1.51	1.71	1.63	1.77
Annual Overheads	450	1,070	580	2,840	520	1,720	2,720
Annual interest (%)	10%	10%	10%	10%	10%	10%	10%
Passenger working time (per hour)	4.80	1.66	1.66	1.66	0.00	0.00	0.00
Passenger Non-work time (per hour)	1.44	0.83	0.83	0.83	0.00	0.00	0.00
Cargo costs (per hour)	0.00	0.03	0.00	0.00	0.07	0.67	1.02

Source: Action Plan and Investment Plan for the Roads Sector, May 2009 from the Ministry of Transport and Communications as part of the Multi-Modal Transport Strategy and Action Plan for the Kosovo road sector.

All costs used in the analysis need to be expressed in economic terms, excluding taxes, in order to exclude transfer payments within the economy and correct for distortions between international and domestic prices caused by applications of duties and taxes on traded items.

Vehicle and tyre prices

Prices on new vehicles have been presented for the nine vehicle categories and are based on information from dealers and importers and have further been verified from recent road studies.

Maintenance labour and crew costs

The Consultant has collected information on the current level of salaries for maintenance and crew in Kosovo in order to assess the likely unit costs for those categories.

Value of time for passengers and freight

The value of time of passengers and freight used for this study is reflecting the average income levels of the owners of the vehicles which are substantially higher than the average. The time values being considered are reflecting also the salary levels in the project region of typical vehicle owners e.g. 4WD and cars, whereas the value of time for bus passengers is regarded considerably lower to reflect the average income level of the local population.

The value of time for freight is reflecting the value of goods in transit.

8.2.4 Present traffic

During the condition survey of the selected asphalt, gravel and earth roads, the traffic was measured on each of the selected roads types and the average traffic levels for the different road types has subsequently been estimated. The present traffic estimates generally differs between the three road surface types in favour of the asphalt paved roads since their location generally is closer to towns and where the population generally are recorded higher than for areas with gravel and earth roads. The amount of traffic is then followed by the gravel and earth roads. There is, however, for certain cases some sections of gravel and earth roads where the traffic level is relatively high compared to the traffic on asphalt road. This is typically the case where asphalt roads are interrupted by short sections of either gravel or earth sections.

Table 8.3 to Table 8.5 below show the estimated level of traffic for asphalt, gravel and earth road types, also indicating the low, medium and high traffic levels.

Table 8.3 Traffic level (AADT) for Low, Medium and High traffic level for Asphalt roads.

	Car	Minibus	Pick Up	Bus	2-Axle Truck	3-Axle Truck	>3-Axle Truck	Total
High traffic level	863	57	23	12	26	3	16	1,000
Medium Traffic level	345	23	9	5	10	1	7	400
Low traffic level	155	10	4	2	5	1	3	180
Traffic distribution	86.3%	2.3%	5.7%	1.2%	2.6%	0.3%	1.6%	100%

Source: Visual inspections by Consultant - Nov/Dec 2009

Table 8.4 Traffic level (AADT) for Low, Medium and High traffic level for Gravel roads.

	Car	Minibus	Pick Up	Bus	2-Axle Truck	3-Axle Truck	>3-Axle Truck	Total
High traffic level	604	40	16	9	18	2	11	700
Medium Traffic level	259	17	7	4	8	1	5	300
Low traffic level	104	7	3	1	3	1	2	120
Traffic distribution	86.3%	2.3%	5.7%	1.2%	2.6%	0.3%	1.6%	100%

Source: Visual inspections by Consultant - Nov/Dec 2009

Table 8.5 Traffic level (AADT) for Low, Medium and High traffic level for Earth roads.

	Car	Minibus	Pick Up	Bus	2-Axle Truck	3-Axle Truck	>3-Axle Truck	Total
High traffic level	604	40	16	9	18	2	11	700
Medium Traffic level	259	17	7	4	8	1	5	300
Low traffic level	85	6	2	1	3	1	2	99
Traffic distribution	86.3%	2.3%	5.7%	1.2%	2.6%	0.3%	1.6%	100%

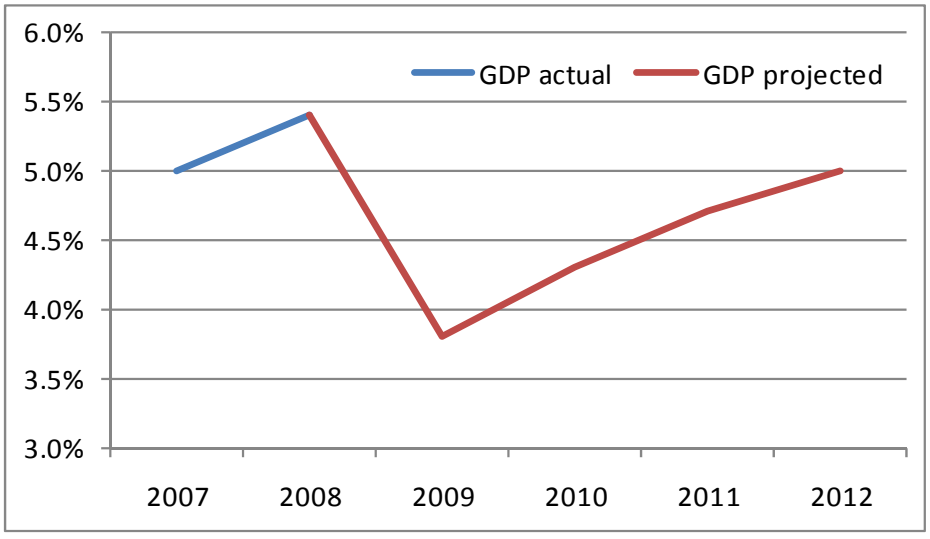
Source: Visual inspections by Consultant - Nov/Dec 2009

8.2.5 Macroeconomic profile

Economic growth has continued at a strong pace at an estimated 5.4% p.a., supported in part by foreign assistance and on-going workers' remittances (estimated at around 12% of GDP). Private consumption and public investment accounted for a large part of this growth. The recession in Europe has so far had little impact on the real growth of the Kosovo economy given that the economy export base (about 6% of GDP) and Foreign Direct Investment are small and public expenditures are rising rapidly.

The visual impression in Pristine is one of booming economic activity, including in the construction and services sectors. According to an IMF staffs' mission in June 2009 the real GDP growth was projected to 3.5% in 2009 and about 4% in 2010 with further expected growth in the years ahead aiming at 5% annual growth in year 2012. Figure 8.1 below shows the actual and projected real GDP development for Kosovo.

Figure 8.1 Actual and projected real GDP development for Kosovo.



Source: IMF staffs mission in June 2009.

Domestic price inflation has mirrored movements in global food and fuel price inflation, picking up in 2008, before falling back to low levels at end year. The

December-on- December inflation rate in 2008 was 0.5%. Latest statistical data show annual deflation in January - May 2009 (-0.5%, -1.2%, -2.0% -3.5% and -4.4% respectively). IMF has forecasted an average annual deflation of -2.1% in 2009.

The current account deficit is estimated to have reached 30.5% of GDP in 2008, up from 25% in 2007. In 2008 exports grew by 20.2% compared to 2007. But contracting global trade has also started affecting Kosovo: recent data show an average decline of 40% in exports from November 2008 to May 2009 as compared to the same period one year earlier. The decline is recorded in almost every type of export goods and not only in base metals, which constitute the main category of Kosovo exports. However, due to the improvement of metal prices in commodity markets exports are improving as well. At the same time, imports did not decline but increased in 2008 and are flat in 2009.

8.2.6 Traffic projections

Transport demand elasticities

Statistical experience indicates that demand for transport tends to increase at a faster rate than economic growth, measured by national or regional GDP development. This relationship is generally referred to as the income elasticity of demand for transport over time measured by the change in transport demand as a result of changes in income. Generally, when testing the relationship between transport demand and income, the elasticity tends to range between 1 and 2. In Kosovo there is limited established evidence on the transport demand elasticities, but based on this relationship from other countries in the region the below Table 8.6 provides transport demand elasticities which are applied for the present project.

Table 8.6 Estimated Transport Demand Elasticities.

Vehicle Categories		2010-2020	2021 forward
Passenger Transport	Cars	1.15	1.05
	Pickup / St. Wagon	1.15	1.05
	Small Bus	1.15	1.05
	Large Bus	1.15	1.05
Freight Transport	Small Truck	1.1	1
	Medium Truck	1.1	1
	Heavy Truck	1.1	1

Source: Official Statistics, COWI Surveys and Consultants estimates.

Traffic growth projections

The location of the roads included in the survey is spread over the country and regional and local economic growth may differ depending on which part of the country the roads are located. The national GDP growth is, however, applied

for all types and location of roads. Therefore based on the traffic demand elasticities and an average real GDP growth of 4.9% between year 2010 and 2020 and an annual estimated real GDP growth of 4.5 % from year 2021 and forward, Table 8.7 below provides the annual traffic growth rates used for the traffic projection for the economic analysis of the survey roads.

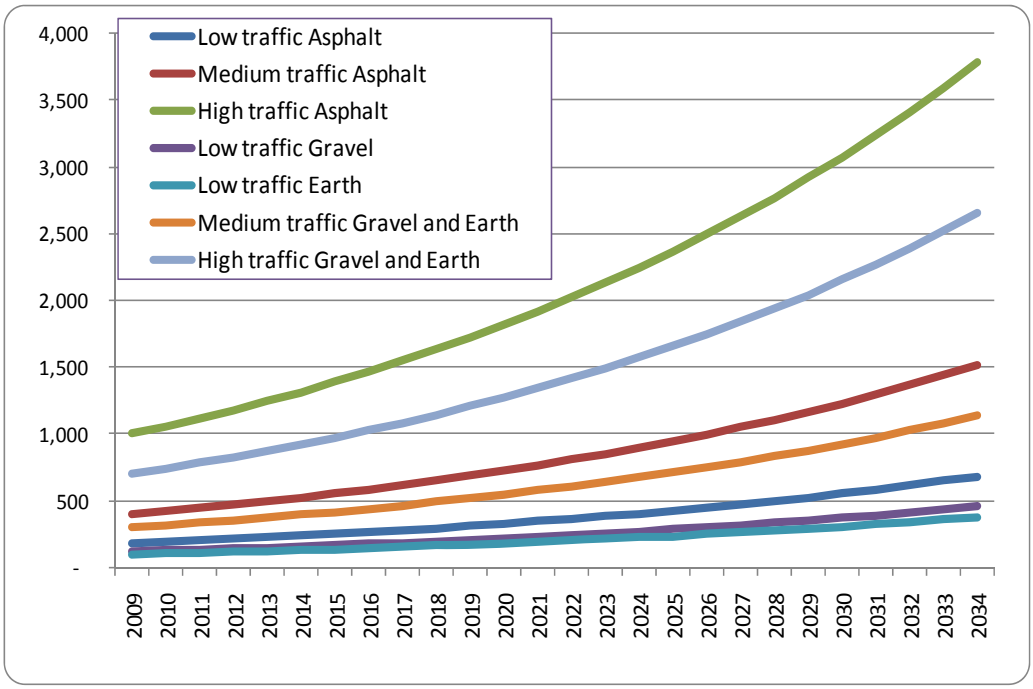
Table 8.7 Annual traffic growth rates.

Vehicle Categories	2010 - 2020	2021 - forward
Passenger Transport	5.6%	4.7%
Freight Transport	5.4%	4.5%

Source: Official Statistics and Consultants estimates.

Figure 8.2 provides the traffic development for asphalt, gravel and earth road types for the three traffic levels based on the referred present traffic shown in Section 8.2.4 and above traffic growth. Tables with detailed traffic data for the different road categories are presented in **Appendix 8-1**.

Figure 8.2 Projected traffic for Low, Medium and High traffic levels for Asphalt Gravel and Earth roads.



8.2.7 Selected road types

The road condition survey was carried out in November and December 2009 on the selected 1,555 kilometre of roads for this project. The survey covered asphalt, gravel and earth roads of which asphalt roads accounted for 66 % and

gravel roads 32%, whereas earth roads represent only 2% of the selected road survey network.

Table 8.8 below shows the condition of the selected roads indicated by various parameters to determine the physical condition of the roads covering road width and shoulders, drainage, AADT, speed limit, structural number, surface thickness, roughness, cracking, potholes and edge break.

Each road type represent three traffic levels - low, medium and high therefore increase the number of road types from 14 to 42[5]. Earth roads E1 and E2 distinguish between good and poor drainage but in reality they are the same as they both have poor drainage condition.

[5] Only 39 road types were included in the economic analysis as 3 road types are practically identical.

Table 8.8 Results of Condition survey of Road Types, November/December 2009.

Road Type		Condition of Road Type (2009)											
		Width	Shoulder width	Drainage	AADT 2009	Current driving speed limit	Structural number	Surface thickness	Roughness (IRI)	All structural cracking	Wide structural cracking	Potholes	Edge break
		meter	meter	Good or poor	vehicles per day	km/ hour		mm	m/km	%	%	no/km	m2/km
A1	Good Asphalt & Good Drainage	5.40	1.0	Good	400	42	4.53	100+40	2.5	0.6	0.1	1.0	17.0
A2	Good Asphalt & Poor Drainage	5.40	1.0	Poor	400	42	4.53	100+40	2.5	0.6	0.1	1.0	17.0
A3	Medium Good Asphalt & Good Drainage	5.10	1.5	Good	400	40	4.09	100+40	2.5	5.5	0.6	6.0	160.0
A4	Medium Good Asphalt & Poor Drainage	5.10	1.5	Poor	400	40	4.09	100+40	2.5	5.5	0.6	6.0	160.0
A5	Medium Poor Asphalt & Good Drainage	4.75	1.5	Good	400	40	3.70	100+40	3.5	17.0	2.5	9.0	290.0
A6	Medium Poor Asphalt & Poor Drainage	4.75	1.5	Poor	400	40	3.70	100+40	3.5	17.0	2.5	9.0	290.0
A7	Poor Asphalt & Good Drainage	4.60	1.2	Good	400	37	3.32	100+40	9.0	56.0	13.0	19.5	380.0
A8	Poor Asphalt & Poor Drainage	4.60	1.2	Poor	400	37	3.32	100+40	9.0	56.0	13.0	19.5	380.0
G1	Fair Gravel & Good Drainage	5.20	0	Good	300	35	n/a	200	12.0				
G2	Fair Gravel & Poor Drainage	5.20	0	Poor	300	35	n/a	200	12.0				
G3	Poor Gravel & Good Drainage	4.40	0	Good	300	35	n/a	100	21.0				
G4	Poor Gravel & Poor Drainage	4.40	0	Poor	300	35	n/a	100	21.0				
E1	Earth & Good Drainage	4.00	0	Poor	300	35	n/a	5	20.0				
E2	Earth & Poor Drainage	4.00	0	Poor	300	35	n/a	5	20.0				

Source: COWI road network condition survey of 1,555 km of asphalt, gravel and earth roads, November/December 2009.

8.3 Upgrading/rehabilitation & maintenance strategies

8.3.1 Upgrading/rehabilitation alternatives

The relevant upgrading and rehabilitation options for the selected road network in Kosovo used for the economic analysis are presented in the following.

The economic upgrading and rehabilitation costs estimates are summarised in Table 8.9 below for the selected asphalt, gravel and earth sections and the selected alternative work measures for upgrading and rehabilitating the roads. The economic costs of the projects are considered to be the total expenditures incurred to realise the project less the taxes and duties of approx. 20%. The cost includes 10% for contingencies and includes cost of supervision of 1.5%.

As can be seen from below Table 8.9 and Table 8.10 each road type has been allocated alternative work measures for the selected upgrading/rehabilitation. The respective economic costs of the alternative work measures differs depending on both the road type and the category of work, of which Reconstruction of all Layers on an asphalt road is far the most expensive but also the most long lasting solution with the slowest deterioration.

See Section 9 for more details about the selected road types and solutions for alternative work measures.

The deterioration of the different road types for the various alternative work measures are illustrated in Figure 8.3 to Figure 8.5 as well as in **Appendix 8.2**.

- For asphalt roads four alternatives (ALT 1 - 4) have been selected (Asphalt Overlay, Reconstruction Asphalt only, Reconstruction all Layers and Surface Dressing)

- For Gravel roads five alternatives (ALT 5 -9) have been selected (Fill Potholes, Gravel and Reshape, Gravel and Reclaim, Surface Dressing and Asphalt). Alternative 5 - Fill potholes is regarded as almost identical to the base case alternative and therefore not considered for the analysis.

- For Earth roads three alternatives (ALT 10 - 12) have been selected (upgrade to Gravel, Surface Dressing and Asphalt)

8.3.2 Implementation period

Implementation of the alternative upgrading/rehabilitation work measures has for comparison purposes been set to one year and the same for all the alternative work measures, despite the duration, may differ in reality. The duration does not include time for preparatory activities such as design, preparation of tender materials, and tendering and selection process for supervision and construction. The economic period for analysis is 25 years starting from year 2010.

Table 8.9: Characteristics of Upgrading and Rehabilitation Options for Asphalt, Gravel and Earth Road Types.

Road Types		ALT 1 - Overlay Asphalt				ALT 2 - Reconstruction Asphalt				ALT 3 - Reconstruction all Layers				ALT 4 - Surface Dressing			
		Structural number	Surface thickness	Speed	Roughness (IRI)	Structural number	Surface thickness	Speed	Roughness (IRI)	Structural number	Surface thickness	Speed	Roughness (IRI)	Structural number	Surface thickness	Speed	Roughness (IRI)
			mm	km/ hour	m/km		mm	km/ hour	m/km		mm	km/ hour	m/km		mm	km/ hour	m/km
A1	Good Asphalt & Good Drainage	5.32	50	60	2.0	6.02	70	60	2.0	4.84	120	60	2.0	n/a	n/a	n/a	n/a
A2	Good Asphalt & Poor Drainage	5.32	50	60	2.0	6.02	70	60	2.0	4.84	120	60	2.0	n/a	n/a	n/a	n/a
A3	Medium Good Asphalt & Good Drainage	4.88	50	60	2.0	5.58	70	60	2.0	4.84	120	60	2.0	4.09	15	60	2.5
A4	Medium Good Asphalt & Poor Drainage	4.88	50	60	2.0	5.58	70	60	2.0	4.84	120	60	2.0	4.09	15	60	2.5
A5	Medium Poor Asphalt & Good Drainage	4.49	50	60	2.0	5.19	70	60	2.0	4.84	120	60	2.0	3.70	15	60	3.5
A6	Medium Poor Asphalt & Poor Drainage	4.49	50	60	2.0	5.19	70	60	2.0	4.84	120	60	2.0	3.70	15	60	3.5
A7	Poor Asphalt & Good Drainage	4.11	50	60	2.0	4.81	70	60	2.0	4.84	120	60	2.0	3.32	15	50	7.25
A8	Poor Asphalt & Poor Drainage	4.11	50	60	2.0	4.81	70	60	2.0	4.84	120	60	2.0	3.32	15	50	7.25
Road Types		ALT 6 & 10 - Gravel and Reshape				ALT 7 - Gravel and Reclaim				ALT 8 & 11 - Surface Dressing				ALT 9 & 12 - Asphalt			
		Structural number	Surface thickness	Speed	Roughness (IRI)	Structural number	Surface thickness	Speed	Roughness (IRI)	Structural number	Surface thickness	Speed	Roughness (IRI)	Structural number	Surface thickness	Speed	Roughness (IRI)
			mm	km/ hour	m/km		mm	km/ hour	m/km		mm	km/ hour	m/km		mm	km/ hour	m/km
G1	Fair Gravel & Good Drainage	n/a	200	45	5.0	n/a	200	45	4.0	2.60	15	50	4.5	4.89	120	60	2
G2	Fair Gravel & Poor Drainage	n/a	200	45	5.0	n/a	200	45	4.0	2.60	15	50	4.5	4.89	120	60	2
G3	Poor Gravel & Good Drainage	n/a	200	45	5.0	n/a	200	45	4.0	2.16	15	50	4.5	4.45	120	60	2
G4	Poor Gravel & Poor Drainage	n/a	200	45	5.0	n/a	200	45	4.0	2.16	15	50	4.5	4.45	120	60	2
E1	Earth & Good Drainage	n/a	200	45	5.0	n/a	n/a	n/a	n/a	3	15	50	4.5	6.00	120	60	2
E2	Earth & Poor Drainage	n/a	200	45	5.0	n/a	n/a	n/a	n/a	3	15	50	4.5	6.00	120	60	2

Table 8.10: Costs of Upgrading and Rehabilitation Options for Asphalt, Gravel and Earth Road Types (Euro/km).

Asphalt Road Types		Good Asphalt	Good Asphalt	Medium Good Asphalt	Medium Good Asphalt	Medium Poor Asphalt	Medium Poor Asphalt	Poor Asphalt	Poor Asphalt
		Good Drainage	Poor Drainage	Good Drainage	Poor Drainage	Good Drainage	Poor Drainage	Good Drainage	Poor Drainage
Alt 1	Asphalt cost/km (Asphalt overlay)	136,080	160,080	128,520	152,520	120,960	144,960	115,920	139,920
Alt 2	Asphalt cost/km (Reconstruction Asphalt only)	185,328	209,328	175,032	199,032	164,736	188,736	157,872	181,872
Alt 3	Asphalt cost/km (Reconstruction all layers)	389,448	413,448	367,812	391,812	346,176	370,176	331,752	355,752
Alt 4	Asphalt cost/km (Surface dressing)	N/A	N/A	30,600	54,600	28,800	52,800	27,600	51,600
Gravel Road Types		**Fair Gravel**	**Fair Gravel**	**Poor Gravel**	**Poor Gravel**				
		Good Drainage	**Poor Drainage**	**Good Drainage**	**Poor Drainage**				
Alt 5	Gravel cost/km (Fill potholes)	N/A	N/A	N/A	N/A				
Alt 6	Gravel cost/km (Gravel and reshape)	56,784	80,784	48,048	72,048				
Alt 7	Gravel cost/km (Gravel and reclaim)	71,136	95,136	60,192	84,192				
Alt 8	Gravel cost/km (Surface dressing)	102,336	126,336	86,592	110,592				
Alt 9	Gravel cost/km (Asphalt)	366,288	390,288	309,936	333,936				
Asphalt Road Types		**Earth**	**Earth**						
		Good Drainage	**Poor Drainage**						
Alt 10	Earth cost/km (Earth to Gravel)	N/A	231,840						
Alt 11	Earth cost/km (Earth to Surface Dressing)	N/A	255,840						
Alt 12	Earth cost/km (Earth to Asphalt)	N/A	462,240						

Source: Consultant's estimates of economic prises for alternative work measures including cost of contingencies and supervision.

Note: Alternative 5 (fill potholes) has not been included as it is basically identical to the base case alternative. Results for earth road with good drainage are not included as being similar to earth road with poor drainage.

8.3.3 Deterioration of road types

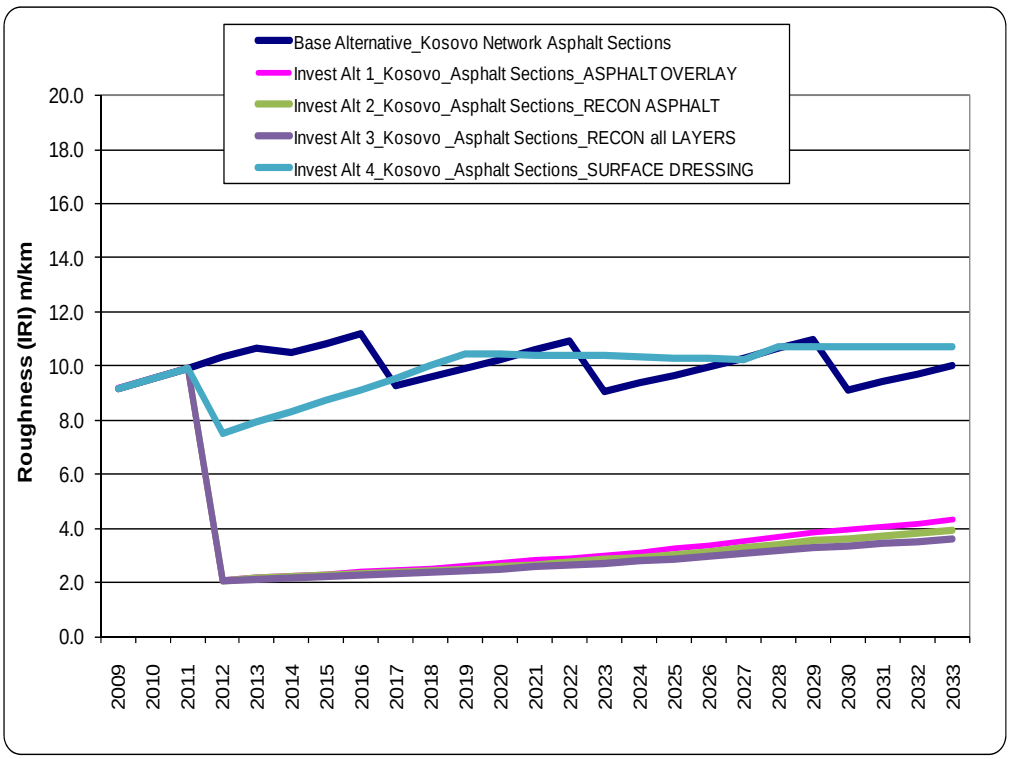
Deterioration of the different road types selected for the present survey is measured by roughness in meters per km and illustrated in graphs below for a few samples as well as in **Appendix 8.2** for all road types. The technical condition and the different road types vary considerably and therefore also the initial roughness measured during the road network survey carried out in November/December 2009. The initial roughnesses on different road types were for:

- Base case alternative for asphalt, gravel and earth road types.
- Asphalt roads range between 2.5 m/km and 9 m/km.
- Gravel roads range between 12 m/km to 21 m/km, and
- Earth roads 20 m/km.

After upgrading/rehabilitation of the road types by applying the selected alternatives for work measures, the roughness will immediately be reduced to new lower levels in the majority of cases (except for surface dressing on asphalt). The deterioration of the road types is shown over a 25 year analysis period.

The illustrated deterioration of the different road type have been modelled in HDM in such a way that the selected alternative work measures for upgrading/ rehabilitation allow for a technically justified deterioration profile for the different road types, depending on their initial physical condition.

*Figure 8.3 Roughness development based on Alternative work measures for upgrading/rehabilitation for **Poor Asphalt Road with Poor Drainage.***



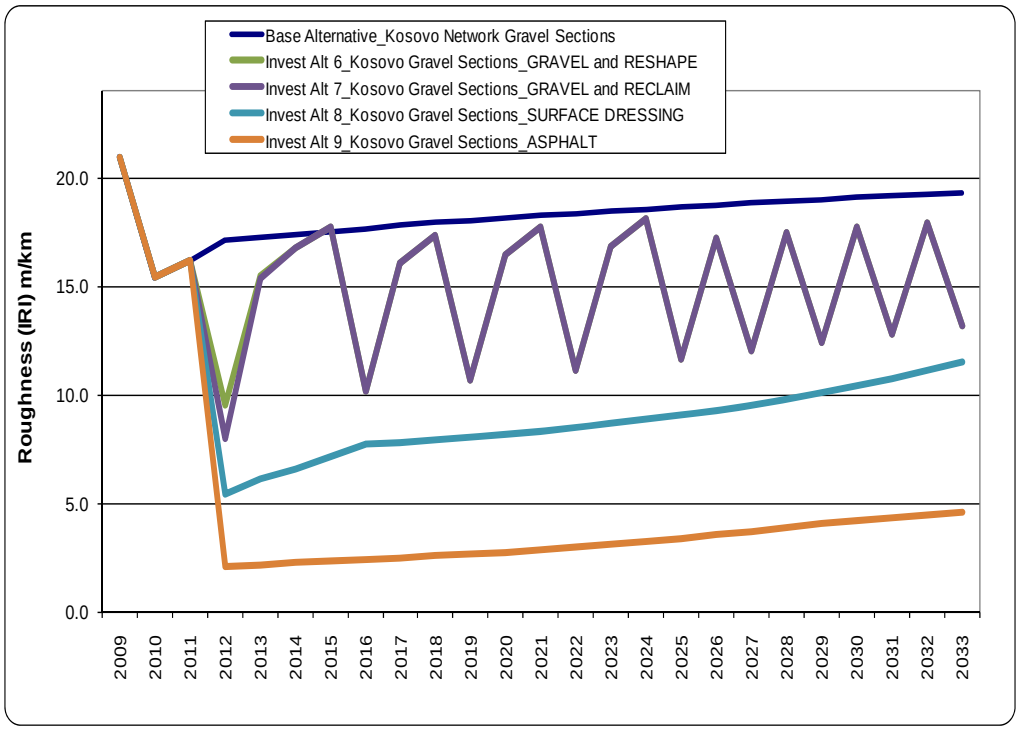
Source HDM computations

Required strategies for maintenance have further been developed to ensure that the different road types perform technically well over the period of analysis. E.g. the intervention Surface Dressing is not as durable as Asphalt Overlay and Reconstruction, consequently this intervention requires more frequent maintenance.

The modelling of HDM with regard to e.g. the performance of surface dressing intervention showed surprisingly no potholes development at all by HDM over the years as part of the deterioration of, in particular, the original gravel and earth road types. Consequently, the consultant found it necessary to alternatively model more frequent surface dressings and edge repair interventions as a maintenance strategy for this intervention to ensure a more realistic speed of surface deterioration. The surface deterioration of which as a minimum stayed within the roughness limits of the base investment alternative. Therefore the amount of annual maintenance costs associated to the surface dressing intervention carried out on original gravel and earth road types will be higher compared to other types of interventions such as an asphalt solution.

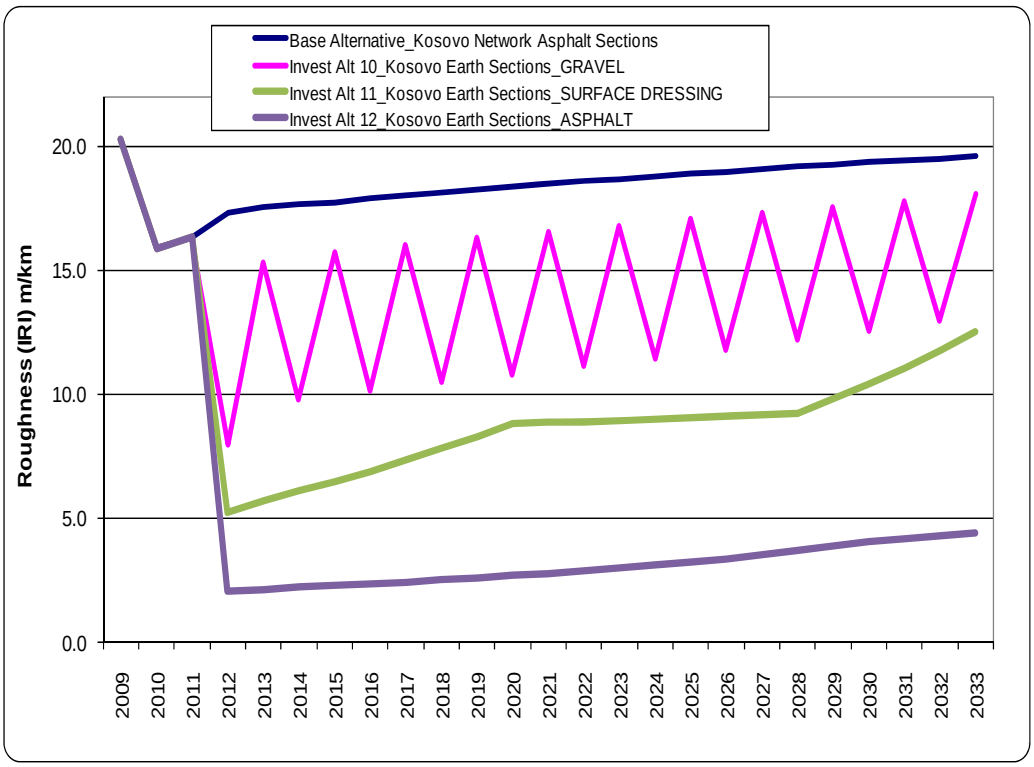
The maintenance strategies applied along with the defined interventions are presented in Section 8.3.4 below.

*Figure 8.4 Roughness development based on Alternative work measures for upgrading/rehabilitation for **Poor Gravel Road with Poor drainage.***



Source HDM computations

*Figure 8.5 Roughness development based on Alternative work measures for upgrading/rehabilitation for **Earth Roads with Poor Drainage.***



Source HDM computations

8.3.4 Maintenance strategies

The Transport Sector Investment Programme generally prioritizes maintenance above improvements and capital works and regular maintenance, including routine maintenance above periodic maintenance.

The HDM model is supplied with estimated maintenance requirements and costs for the existing and the upgrade option of projects. The maintenance strategies are based on the deterioration of the road types over time as is estimated by the HDM-4 model and as a result of the impacts by traffic. The corresponding annual costs are estimated by HDM-4 which is based on updated information on unit costs estimates.

The maintenance works strategies include pothole patching and overlay and are in the HDM model set to be responsive maintenance work initiated according to Table 8.11. The maintenance strategies on the road segments are found adequate according to the HDM-4 generated roughness development on the segments. Roughness development of the road sections before and after upgrading and rehabilitation options is shown in **Appendix 8.2.**

Table 8.11 Maintenance Strategies used for Base Case and Investment Alternatives for road types for asphalt, gravel and earth respectively.

Maintenance Strategy	Description	Costs, EUR	Base Case Alternative	Investment Alternative
Bituminous Surfaces				
Routine maintenance	Routine maintenance every year	1,000 per km	Scheduled every year	Scheduled every year
Pothole Patching	100% repair of potholes, 4 month time lapse to patching	31 per m^2	Responsive when pothole > 1 no. per km	Responsive when pothole > 1 no. per km
Edge repair	Edges > 50 per m^2 / km, 100% repair	20 per m^2	Responsive derived	Responsive derived
Crack sealing	All structural or wide structural cracking > 5 %	1.5 per m^2	Responsive derived - 100% repair	Responsive derived - 100% repair
Surface dressing	15 mm (strength coefficient 0.2) single bituminous surface dressing including necessary patching, edge repair and crack sealing	5 per m^2	Responsive after year 2016 when IRI > 10	Responsive derived when total damaged area > 50 % and IRI < 10
Thin overlay *	25 mm overlay (strength coefficient 0.4) single bituminous surface dressing including necessary patching, edge repair and crack sealing	13 per m^2	Responsive when IRI > 11 derived effect	Responsive when IRI > 11 derived effect
Gravel/Earth Surfaces				
Spot re-gravelling	100% annual material loss replaced	26 per m3	Every year	Every year

Source: Consultant's maintenance strategies
Note: Thin overlay is not used as maintenance works when investment alternative is surface dressing.

8.4 Results of the economic analysis

8.4.1 Approach

The economic analysis is carried out based on output from the HDM-4 model (version 2.04), which is transferred to an Excel model that compares costs and benefits of the proposed road investments over a period of time.

This is done by comparing the "investment options" with the "base case", which basically only includes maintenance that will be sufficient to keep the condition of the existing road at the present standard.

Discount factor and currency
A discount rate of 7% is applied for the calculation of the Net Present Value (NPV) which is based on the rate applied by the "*Action Plan and Investment Plan for the Roads Sector, May 2009 from the Ministry of Transport and Communications as part of the Multi-Modal Transport Strategy and Action Plan for the Kosovo road sector".* All costs are measured in economic prices and expressed in EUR.

8.4.2 Results of economic analysis

Indicators to illustrate the economic results of the road network analyses are presented in the following Table 8.12 to Table 8.17, including the Economic Internal Rate of Return (EIRR), the Net Present Value (NPV/km in *1,000 Euro*), and the NPV/Cost of work measures respectively. Furthermore, the NPV of the maintenance costs associated with the alternative work measures for upgrading/rehabilitating the different road types is presented. The results of the economic analysis have in below Section 9 been used in preparation of the proposed prioritisation of work measures for the various road types that has been identified for the surveyed road network. Subsequently, an Investment Plan is proposed and presented for every road type ranked for every of the ten most viable investment.

The economic analysis will be able to identify the most economically viable road types. This can be done through generation of net-benefits; such as reduced vehicle operating costs, net-benefits from saved time and net-benefits from reduced maintenance costs. For some road types, even with high economic return, the annual maintenance followed by an upgrading to e.g. Surface Dressing may be of such magnitude that it becomes a disbenefit to the specific road type. The road type may have a high economic return, but the annual maintenance expenses shall be regarded as a financial resource that will be necessary to spend to ensure that the road type maintains its strength and surface condition over the analysis period.

Therefore in support of the economic analysis of the identified road types and subsequent alternative work measures for upgrading, the public maintenance budget should be taken seriously into consideration when selecting the optimum alternative investment alternative.

Along with the results of the economic analysis Table 8.18 and Table 8.19 provide information on the present value of the annual maintenance costs for each road type and selected alternative work measures.

Economic Internal Rate of Return (EIRR)
Table 8.12 and Table 8.13 below provide EIRR for each road type and alternative road measure. Economically viable alternatives should be equal or higher than 7% which is used as the discount factor for the economic analysis.

Table 8.12 Economic Internal Rate of Return (EIRR) for Asphalt road types based on alternative work measures.

Road Type		Surface	ASPHALT			
		Alternative	ALT 1	ALT 2	ALT 3	ALT 4
		Alternative Work Measures	OVERLAY	RECONSTRUCTION ASPHALT	RECONSTRUCTION all LAYERS	SURFACE DRESSING
		Traffic				
A1-L	Good Asphalt & Good Drainage	Low	**-6.1%**	-6.8%	n/a	n/a
A1-M		Medium	**-4.4%**	-5.3%	-7.2%	n/a
A1-H		High	**-2.2%**	-3.4%	-5.8%	n/a
A2-L	Good Asphalt & Poor Drainage	Low	**-6.4%**	-7.2%	n/a	n/a
A2-M		Medium	**-5.1%**	-5.9%	-7.5%	n/a
A2-H		High	**-3.3%**	-4.0%	-6.1%	n/a
A3-L	Medium Good Asphalt & Good Drainage	Low	-3.9%	-5.2%	-7.4%	**7.0%**
A3-M		Medium	-0.3%	-2.0%	-5.3%	**11.3%**
A3-H		High	5.0%	2.6%	-1.8%	**19.9%**
A4-L	Medium Good Asphalt & Poor Drainage	Low	-4.6%	-5.7%	-7.5%	**0.3%**
A4-M		Medium	-1.3%	-2.7%	-5.5%	**4.4%**
A4-H		High	3.6%	1.7%	-2.1%	**10.7%**
A5-L	Medium Poor Asphalt & Good Drainage	Low	0.1%	-1.7%	-5.2%	**14.7%**
A5-M		Medium	3.9%	1.6%	-2.7%	**19.8%**
A5-H		High	10.7%	7.4%	1.6%	**31.2%**
A6-L	Medium Poor Asphalt & Poor Drainage	Low	-1.1%	-2.5%	-5.4%	**4.4%**
A6-M		Medium	2.5%	0.7%	-3.0%	**8.1%**
A6-H		High	8.7%	6.2%	1.2%	**15.4%**
A7-L	Poor Asphalt & Good Drainage	Low	**13.9%**	9.3%	1.4%	11.9%
A7-M		Medium	**20.7%**	14.9%	5.3%	10.9%
A7-H		High	**37.2%**	27.4%	12.8%	10.3%
A8-L	Poor Asphalt & Poor Drainage	Low	**10.9%**	7.5%	0.8%	n/a
A8-M		Medium	**17.1%**	12.7%	4.6%	n/a
A8-H		High	**31.1%**	23.9%	11.8%	19.9%

Note: Alternative 4 (surface dressing) has not been applied for good condition asphalt road types as it is not regarded technically viable.

As seen from Table 8.12, the economic viability indicated by EIRR show for the 24 asphalt road types (8 times 3 traffic levels) that those asphalt roads in the present best condition (A1 to A2 all traffic levels) are regarded as being in such a good condition that it is not economically viable to propose any alternative work measures besides the necessary periodic maintenance. Road type A3 and A4 which is medium good asphalt will likewise not be economically viable for work alternative ALT 1 to ALT 3 whereas ALT 4 (surface dressing) is indicating viable returns for the road types with medium and high traffic levels. The four road types A1 to A4 have all presently low roughness levels of 2.5 m/km and the proposed work measures will therefore only provide minimal benefits to those roads.

Road type A5 and A6 generally show economic viability for high traffic when Overlay and Surface Dressing are proposed as work measure. Road type A7 and A8 which are poor asphalt are viable for Overlay, Reconstruction of Asphalt and Surface Dressing, especially for medium and high road types. Generally A5 to A8 have higher initial roughness of 3.5 to 9 m/km and are thereby providing considerable benefits, mainly from reduced vehicle operating costs.

As seen from Table 8.13 below all road types with gravel indicate economic viability for all four alternatives ALT 6 to ALT 9 when traffic is medium or high.

Table 8.13 Economic Internal Rate of Return (EIRR) for Gravel and Earth road types based on different work measures.

Road Type		Surface	GRAVEL				EARTH		
		Alternative	ALT 6	ALT 7	ALT 8	ALT 9	ALT 10	ALT 11	ALT 12
		Alternative Work Measures	GRAVEL and RESHAPE	GRAVEL and RECLAIM	SURFACE DRESSING	ASPHALT	GRAVEL	SURFACE DRESSING	ASPHALT
		Traffic							
G1-L	Fair Gravel & Good Drainage	Low	-6.0%	-6.6%	n/a	**1.3%**			
G1-M		Medium	15.8%	12.7%	**21.6%**	10.8%			
G1-H		High	51.0%	38.8%	**71.0%**	25.8%			
G2-L	Fair Gravel & Poor Drainage	Low	-7.0%	-2.7%	n/a	**0.9%**			
G2-M		Medium	11.1%	11.8%	**16.6%**	10.1%			
G2-H		High	33.5%	32.5%	**56.8%**	24.4%			
G3-L	Poor Gravel & Good Drainage	Low	-2.6%	0.2%	n/a	**2.3%**			
G3-M		Medium	19.3%	18.3%	**24.6%**	12.6%			
G3-H		High	60.8%	52.8%	**80.9%**	29.4%			
G4-L	Poor Gravel & Poor Drainage	Low	-4.4%	-2.0%	n/a	**1.8%**			
G4-M		Medium	13.1%	13.2%	**18.6%**	11.6%			
G4-H		High	37.5%	36.1%	**62.2%**	27.5%			
E1-L	Earth & Good Drainage	Low					n/a	n/a	n/a
E1-M		Medium					n/a	n/a	n/a
E1-H		High					n/a	n/a	n/a
E2-L	Earth & Poor Drainage	Low					-3.5%	-2.9%	**-1.6%**
E2-M		Medium					5.5%	**11.7%**	8.1%
E2-H		High					16.6%	**31.6%**	20.7%

Note: Alternative 5 (fill potholes) has not been included as it is basically identical to the base case alternative. Results for earth road with good drainage are not included as being similar to earth road with poor drainage.

ALT 8 - Surface Dressing - is the most viable alternative followed by Gravel and Reshape which can be explained by the considerable improvement of the roughness on the roads for both upgraded gravel and upgrading to asphalt solutions.

Earth road E2 indicates sufficient economic viability for high traffic for all three alternatives ALT 10 - 12 and also for Surface Dressing when there is medium traffic.

Net Present Value (NPV)

Table 8.14 and Table 8.15 below provide the Net Present Value in 1,000 Euro for the different investment alternatives based on a discount factor of 7%. Positive NPVs indicate economically viable alternatives. See section 9 below for details about the selected alternatives and comparison of economic indicators.

Table 8.14 NPV/km (1,000 Euro) for Asphalt road types based on different work measures.

Road Type		Surface	ASPHALT			
		Alternative	ALT 1	ALT 2	ALT 3	ALT 4
		Alternative Work Measures	OVERLAY	RECONSTRUCTION ASPHALT	RECONSTRUCTION all LAYERS	SURFACE DRESSING
		Traffic				
A1-L	Good Asphalt & Good Drainage	Low	-97.6	-139.1	-313.4	n/a
A1-M		Medium	-93.9	-135.1	-309.3	n/a
A1-H		High	-85.4	-126.8	-300.3	n/a
A2-L	Good Asphalt & Poor Drainage	Low	-118.5	-159.6	-334.2	n/a
A2-M		Medium	-114.5	-155.4	-329.6	n/a
A2-H		High	-106.0	-147.6	-320.6	n/a
A3-L	Medium Good Asphalt & Good Drainage	Low	-80.5	-119.7	-284.0	0.1
A3-M		Medium	-64.4	-103.5	-267.5	10.4
A3-H		High	-22.0	-61.6	-225.1	37.2
A4-L	Medium Good Asphalt & Poor Drainage	Low	-101.3	-140.1	-304.9	-20.4
A4-M		Medium	-85.1	-123.8	-288.1	-10.0
A4-H		High	-42.2	-81.8	-245.3	16.8
A5-L	Medium Poor Asphalt & Good Drainage	Low	-55.7	-92.5	-246.9	12.5
A5-M		Medium	-29.0	-65.8	-219.7	24.4
A5-H		High	44.2	5.7	-147.4	55.7
A6-L	Medium Poor Asphalt & Poor Drainage	Low	-76.1	-113.0	-267.6	-7.9
A6-M		Medium	-49.5	-86.2	-240.3	4.0
A6-H		High	24.2	-14.3	-167.1	35.6
A7-L	Poor Asphalt & Good Drainage	Low	61.4	26.8	-121.3	-18.0
A7-M		Medium	140.9	106.1	-41.4	-16.9
A7-H		High	353.0	315.8	169.4	-22.7
A8-L	Poor Asphalt & Poor Drainage	Low	41.0	6.1	-142.0	-38.7
A8-M		Medium	121.2	85.9	-61.7	-37.2
A8-H		High	333.6	296.6	150.3	-43.0

Note: Alternative 4 (surface dressing) has not been applied for good condition asphalt road types as it is not regarded technically viable.

Table 8.15 NPV/km (1,000 Euro) for Gravel and Earth road types based on different work measures.

Road Type		Surface	GRAVEL				EARTH		
		Alternative	ALT 6	ALT 7	ALT 8	ALT 9	ALT 10	ALT 11	ALT 12
		Alternative Work Measures	GRAVEL and RESHAPE	GRAVEL and RECLAIM	SURFACE DRESSING	ASPHALT	GRAVEL	SURFACE DRESSING	ASPHALT
		Traffic							
G1-L	Fair Gravel & Good Drainage	Low	-39.7	-52.0	-112.9	-154.3			
G1-M		Medium	54.5	42.3	113.8	136.5			
G1-H		High	243.1	230.8	648.2	824.0			
G2-L	Fair Gravel & Poor Drainage	Low	-60.2	-56.0	-133.4	-174.8			
G2-M		Medium	34.1	45.8	93.3	116.0			
G2-H		High	222.6	249.5	627.7	803.5			
G3-L	Poor Gravel & Good Drainage	Low	-28.9	-26.4	-83.0	-111.3			
G3-M		Medium	66.6	74.8	132.3	174.6			
G3-H		High	257.0	280.1	660.4	858.8			
G4-L	Poor Gravel & Poor Drainage	Low	-49.4	-46.9	-103.5	-131.8			
G4-M		Medium	46.1	54.3	111.8	154.1			
G4-H		High	236.6	259.6	639.9	838.4			
E1-L	Earth & Good Drainage	Low					n/a	n/a	n/a
E1-M		Medium					n/a	n/a	n/a
E1-H		High					n/a	n/a	n/a
E2-L	Earth & Poor Drainage	Low					-155.3	-161.9	-269.1
E2-M		Medium					-28.8	109.1	46.3
E2-H		High					241.4	699.2	730.3

Note: Alternative 5 (fill potholes) has not been included as it is basically identical to the base case alternative. Results for earth road with good drainage are not included as being similar to earth road with poor drainage.

NPV/Investment Cost Ratio

Table 8.16 and Table 8.17 below provide the NPV/Investment cost ratio for the selected investment alternatives. The ratio shall be assessed along with the EIRR and NPV, but the highest ratio will normally indicate the most viable alternative among the different road types. See section 9 below for details about the selected alternatives and comparison of economic indicators.

Table 8.16 NPV/Investment Cost Ratio for Asphalt road types based on different work measures.

Road Type		Surface	ASPHALT			
		Alternative	ALT 1	ALT 2	ALT 3	ALT 4
		Alternative Work Measures	OVERLAY	RECONSTRUCTION ASPHALT	RECONSTRUCTION all LAYERS	SURFACE DRESSING
		Traffic				
A1-L	Good Asphalt & Good Drainage	Low	-0.72	-0.75	-0.80	n/a
A1-M		Medium	-0.59	-0.65	-0.75	n/a
A1-H		High	-0.63	-0.68	-0.77	n/a
A2-L	Good Asphalt & Poor Drainage	Low	-0.74	-0.76	-0.81	n/a
A2-M		Medium	-0.84	-0.84	-0.85	n/a
A2-H		High	-0.66	-0.70	-0.78	n/a
A3-L	Medium Good Asphalt & Good Drainage	Low	-0.63	-0.68	-0.77	0.00
A3-M		Medium	-0.42	-0.52	-0.68	0.19
A3-H		High	-0.17	-0.35	-0.61	1.22
A4-L	Medium Good Asphalt & Poor Drainage	Low	-0.66	-0.70	-0.78	-0.37
A4-M		Medium	-0.66	-0.71	-0.78	-0.33
A4-H		High	-0.28	-0.41	-0.63	0.31
A5-L	Medium Poor Asphalt & Good Drainage	Low	-0.46	-0.56	-0.71	0.43
A5-M		Medium	-0.20	-0.35	-0.59	0.46
A5-H		High	0.37	0.03	-0.43	1.93
A6-L	Medium Poor Asphalt & Poor Drainage	Low	-0.53	-0.60	-0.72	-0.15
A6-M		Medium	-0.41	-0.52	-0.69	0.14
A6-H		High	0.17	-0.08	-0.45	0.67
A7-L	Poor Asphalt & Good Drainage	Low	0.53	0.17	-0.37	-0.65
A7-M		Medium	1.01	0.58	-0.12	-0.33
A7-H		High	3.05	2.00	0.51	-0.82
A8-L	Poor Asphalt & Poor Drainage	Low	0.29	0.03	-0.40	-0.75
A8-M		Medium	1.05	0.54	-0.19	-1.35
A8-H		High	2.38	1.63	0.42	-0.83

Note: Alternative 4 (surface dressing) has not been applied for good condition asphalt road types as it is not regarded technically viable.

Table 8.17 NPV/Investment Cost Ratio for Gravel and Earth road types based on different work measures.

Road Type		Surface	GRAVEL				EARTH		
		Alternative	ALT 6	ALT 7	ALT 8	ALT 9	ALT 10	ALT 11	ALT 12
		Alternative Work Measures	GRAVEL and RESHAPE	GRAVEL and RECLAIM	SURFACE DRESSING	ASPHALT	GRAVEL	SURFACE DRESSING	ASPHALT
		Traffic							
G1-L	Fair Gravel & Good Drainage	Low	-0.70	-0.73	-1.10	-0.42			
G1-M		Medium	0.68	0.44	0.90	0.35			
G1-H		High	4.28	3.24	6.33	2.25			
G2-L	Fair Gravel & Poor Drainage	Low	-0.75	-0.59	-1.06	-0.45			
G2-M		Medium	0.60	0.64	0.91	0.32			
G2-H		High	2.76	2.62	4.97	2.06			
G3-L	Poor Gravel & Good Drainage	Low	-0.60	-0.44	-0.96	-0.36			
G3-M		Medium	0.92	0.89	1.20	0.52			
G3-H		High	5.35	4.65	7.63	2.77			
G4-L	Poor Gravel & Poor Drainage	Low	-0.69	-0.56	-0.94	-0.39			
G4-M		Medium	0.96	0.90	1.29	0.50			
G4-H		High	3.28	3.08	5.79	2.51			
E1-L	Earth & Good Drainage	Low					n/a	n/a	n/a
E1-M		Medium					n/a	n/a	n/a
E1-H		High					n/a	n/a	n/a
E2-L	Earth & Poor Drainage	Low					-0.67	-0.63	-0.58
E2-M		Medium					-0.12	0.43	0.10
E2-H		High					1.04	2.73	1.58

Note: Alternative 5 (fill potholes) has not been included as it is basically identical to the base case alternative. Results for earth road with good drainage are not included as being similar to earth road with poor drainage.

NPV/km of Maintenance Cost

Table 8.18 and Table 8.19 below provide the NPV/km of the annual maintenance cost which is necessary to ensure that the particular upgraded road type maintain its physical condition over the period of the analysis. These costs are financial resources that will have to be allocated for the annual road maintenance budget and will therefore influence the decision on how much investments to propose for the investment plan. See section 9 below for details about the selected alternatives and comparison of economic indicators.

Table 8.18 NPV/km of future annual maintenance costs for Asphalt road types from alternative work measures (Euro 2010).

Road Type		Surface	ASPHALT			
		Alternative	ALT 1	ALT 2	ALT 3	ALT 4
		Alternative Work Measures	OVERLAY	RECONSTRUCTION ASPHALT	RECONSTRUCTION all LAYERS	SURFACE DRESSING
		Traffic				
A1-L	Good Asphalt & Good Drainage	Low	20,251	20,188	20,449	36,093
A1-M		Medium	20,784	21,115	21,699	36,950
A1-H		High	26,823	28,769	29,482	46,136
A2-L	Good Asphalt & Poor Drainage	Low	20,647	20,188	20,841	36,093
A2-M		Medium	21,142	21,115	21,699	37,236
A2-H		High	26,823	29,232	29,482	46,534
A3-L	Medium Good Asphalt & Good Drainage	Low	24,456	24,415	24,542	23,622
A3-M		Medium	25,163	25,658	25,784	25,237
A3-H		High	33,070	35,923	36,482	35,527
A4-L	Medium Good Asphalt & Poor Drainage	Low	24,829	24,415	24,910	23,623
A4-M		Medium	25,495	25,658	26,073	25,237
A4-H		High	33,070	35,923	36,482	35,527
A5-L	Medium Poor Asphalt & Good Drainage	Low	27,094	27,082	26,860	26,012
A5-M		Medium	28,252	28,926	28,698	28,196
A5-H		High	37,620	42,013	42,122	41,275
A6-L	Medium Poor Asphalt & Poor Drainage	Low	27,094	27,082	27,200	26,013
A6-M		Medium	28,567	28,926	29,043	28,196
A6-H		High	37,620	42,013	42,122	41,275
A7-L	Poor Asphalt & Good Drainage	Low	30,329	29,760	29,760	122,334
A7-M		Medium	31,549	32,013	32,013	125,461
A7-H		High	41,652	46,471	46,471	147,075
A8-L	Poor Asphalt & Poor Drainage	Low	30,329	30,088	30,088	122,879
A8-M		Medium	31,229	32,013	32,013	125,936
A8-H		High	41,662	46,471	46,471	147,079

Note: Alternative 4 (surface dressing) has not been applied for good condition asphalt road types as it is not regarded technically viable.

Table 8.19 NPV/km of future annual maintenance costs for Gravel and Earth road types for alternative work measures.

Road Type		Surface	GRAVEL				EARTH		
		Alternative	ALT 6	ALT 7	ALT 8	ALT 9	ALT 10	ALT 11	ALT 12
		Alternative Work Measures	GRAVEL and RESHAPE	GRAVEL and RECLAIM	SURFACE DRESSING	ASPHALT	GRAVEL	SURFACE DRESSING	ASPHALT
		Traffic							
G1-L	Fair Gravel & Good Drainage	Low	56,855	56,855	165,795	21,756			
G1-M		Medium	91,640	91,640	169,635	24,976			
G1-H		High	135,580	135,580	180,226	34,972			
G2-L	Fair Gravel & Poor Drainage	Low	56,855	41,210	165,795	21,756			
G2-M		Medium	91,640	70,028	169,635	24,976			
G2-H		High	135,580	100,541	180,226	34,972			
G3-L	Poor Gravel & Good Drainage	Low	46,720	34,870	140,770	20,141			
G3-M		Medium	75,179	58,469	158,509	23,386			
G3-H		High	114,722	85,068	171,712	33,812			
G4-L	Poor Gravel & Poor Drainage	Low	46,720	34,870	140,770	20,141			
G4-M		Medium	75,179	58,469	158,509	23,386			
G4-H		High	114,722	85,068	171,712	33,812			
E1-L	Earth & Good Drainage	Low					n/a	n/a	n/a
E1-M		Medium					n/a	n/a	n/a
E1-H		High					n/a	n/a	n/a
E2-L	Earth & Poor Drainage	Low					30,341	66,608	18,090
E2-M		Medium					52,458	69,673	21,033
E2-H		High					62,944	79,436	30,896

Note: Alternative 5 (fill potholes) has not been included as it is basically identical to the base case alternative. Results for earth road with good drainage are not included as being similar to earth road with poor drainage.

Breakdown of economic benefits

The breakdown of the economic benefits and costs besides investment costs differs considerable depending on the different road types, their present physical condition, traffic level and the alternative selected work measures.

The breakdown indicates that the majority of the benefits come from savings in vehicle operating costs, o.a.:

- as a result of better roads,
- as a result of lower roughness in particular on the roads in poor condition after improvement and savings in travel time,
- as a result of better surface condition and increased driving speed.

The speed limits on the majority of the surveyed roads are approx. 50 km/hour. Although the technical condition of the roads after improvement allow for a higher comfortable driving speed, the benefits from time saving are comparable

lower, due to the regulatory speed limitation. Gravel and earth roads will gain relatively more time saving benefits than asphalt roads as the present speed on gravel and earth is between 30 and 35 km/hour and 40-45 km /hour for asphalt roads.

Maintenance costs differ considerably between the alternative work measures and the corresponding analysed road types. In those cases where the selected interventions e.g. surface dressing on gravel roads where traffic is high, the maintenance costs will be higher than in the base case alternative and therefore be a disbenefit.This road type will require more frequent surface dressing maintenance in order for the roads to maintain a comfortable physical condition over the period of analysis. The same is the case for gravel roads which are gravelled and reclaimed and gravelled and reshaped.

Asphalt solution such as reconstruction of asphalt, earth or gravel roads which are upgraded to asphalt will generally require limited annual maintenance over the period of analysis as the deterioration of such road types is slower.

9 Investment Plan

9.1 Introduction

This chapter proposes a prioritised investment plan for local roads in Kosovo, based on the economic analyses in Section 8.4.

The economic analyses are performed by using the HDM-4 model which is considered to be the most appropriate tool for this type of analysis. Also, the HDM model has already been used in previous studies in Kosovo, and some experience already exists with this model. Although details of the analyses in the present study could be more comprehensive, the HDM-4 model still provide a full analysis of the selected network using information regarding the road conditions and traffic levels. The model has captured the key parameters of the roads as recorded from the field survey, as well as unit costs for the various improvement options and for the subsequent maintenance strategies, and on this basis it possible to compare the economic effects of various investment options.

9.1.1 Selected road network

The selected local road network as seen from Table 9.1 below consist of local roads of 1,555 km of which asphalt roads amount to 66%, gravel roads to 32% and earth roads 2%. The table show further that 46% of the asphalt roads have high traffic with 1,000 vehicles/day, 34% medium traffic with 400 vehicles/day and 20% low traffic with 180 vehicles/day. Gravel roads have 8.5% with high traffic (700 vehicles/day), 53.5% with medium traffic (300 vehicles/day) and 38% with low traffic (120 vehicles/day).

For earth roads the low traffic account for 18% (100 vehicles/day), 27% for medium (300 vehicles/day) and almost 55% of high traffic (700 vehicles/day). For all roads despite surface, the low traffic account for 27%, medium traffic 40% and high traffic 33%.

Table 9.1 Length and shares of road types of selected road network.

Road Type	Traffic	Length (km)1)	Length in pct. of road type	Length in pct. of survey network	Length of road type in pct. of survey network
Asphalt	Low	209	20.4%	13.4%	66.0%
	Medium	348	33.9%	22.4%	
	High	469	45.7%	30.2%	
Gravel	Low	189	38.0%	12.1%	31.9%
	Medium	265	53.5%	17.1%	
	High	42	8.5%	2.7%	
Earth	Low	18	54.7%	1.1%	2.1%
	Medium	9	27.3%	0.6%	
	High	6	18.0%	0.4%	
Total		1,555		100%	100%

Source: COWI road network survey November/December 2009

Note 1) The selected length of roads are 1,588 and the difference of 33 km covers those sections with insufficient road data for the economic analysis.

9.2 Ranking of road Interventions

Ranking of the road types based on the optimal interventions is determined by the results of the economic analysis as presented in Section 0, indicated by EIRR, NPV and NPV/Cost. Furthermore it is relevant to take into consideration the annual maintenance costs associated to each intervention.

Two alternative rankings of interventions are presented at this stage as the annual maintenance of roads has some financial implications on the budget concerning the annual road maintenance. This therefore requires further consideration as it influences the future financial budget allocation.

1 **Alternative 1**: Ranking of road types based on economic viability.

2 **Alternative 2:** Ranking of road types based on a combination of economic viability and the present value of future road maintenance expenses associated to the different interventions.

The main differences between the two alternatives are:

- Alternative 1 has lower total cost of intervention than Alternative 2,
- Alternative 2 generally offers better interventions (more durable asphalt solutions) than Alternative 1,

- Alternative 1 requires higher annual maintenance expenses to ensure the durability of the roads (asphalt solutions) than Alternative 2,

The results of the two alternatives are presented in the following.

9.2.1 Result tables for Alternative 1 and 2

Table 9.2 and Table 9.5 below present each of the road types with their optimal interventions, for each of the alternatives respectively. The tables show the road types for asphalt, gravel and earth, including the condition of drainage. Furthermore it shows the length of each road type, its share of the whole survey network and the share of its road type category (asphalt, gravel or earth). Information is also provided on the average number of inhabitants for each road type as well as the average number of vehicles.

The selected intervention for each road type is listed to illustrate which work measures are found most appropriate from an economic return view based on a sufficient technical performance of the road types over the duration of the analysis. In this regard roughness development for each road type based on different types of interventions has been analysed and is presented in **Appendix 8.2**.

The road types are listed and ranked based on their economic viability indicated by EIRR as shown in Table 9.3 and Table 9.6 below. The tables provide information on each road type; the selected intervention (work measure), economic internal rate of return (EIRR), Cost/km of intervention, net present value (NPV) of investment, NPV/Cost ratio and the NPV of the maintenance costs associated to each of the road type and their selected intervention.

Table 9.4 and Table 9.7 illustrate the total costs of interventions of the ranked road types based on the selected work measures. Groups of the ranked road types (3 groups of 10 and 1 group of 9) have been organised to indicate average values of the number of inhabitants and vehicles of each group as well as the average cost/km of the different selected interventions. Sums are shown for the length of the grouped road types, the total NPV of the maintenance costs and the total costs of road interventions. The total NPV costs of maintenance and total costs of interventions are further shown separately for each road type.

Appendix 9.1 provides a summary of all results of Alternative 1 and 2.

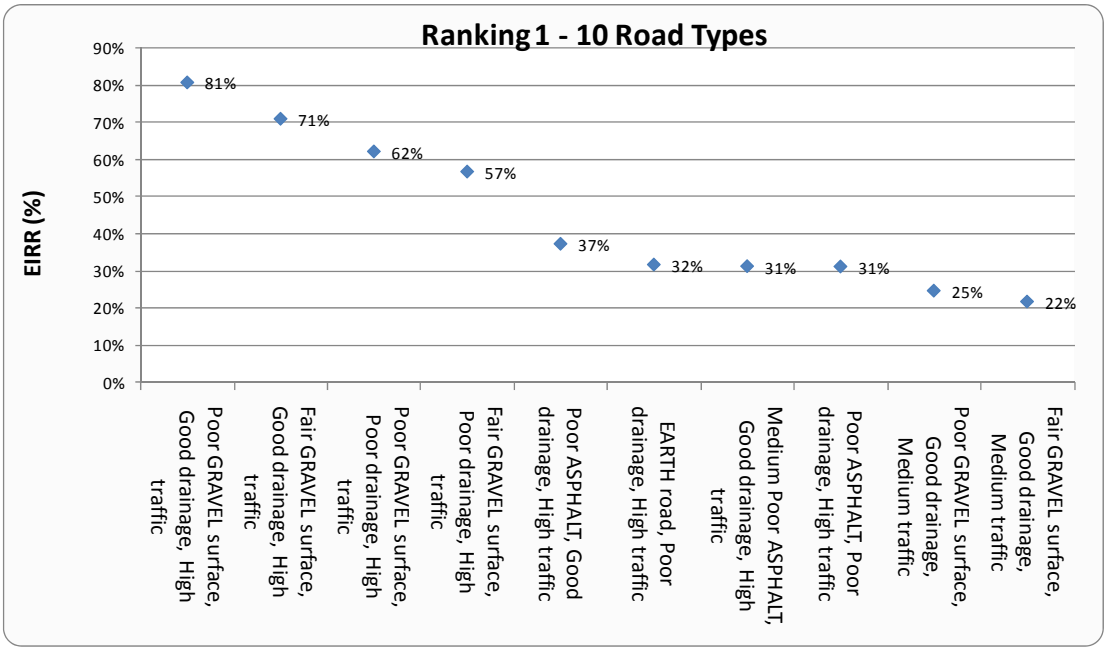
Appendix 9.2 provides maps with the location of the ranked road types highlighted by colours.

Results of Alternative 1

Figure 9.3 below illustrates the 10 highest ranked road types with interventions of Alternative 1. Figure 9.2 below illustrates the location of the 10 highest ranked road types of Alternative 1 based on selected interventions.

The specific type of intervention associated to Figure 9.1 below can be observed from Table 9.3 below along with economic results of the interventions.

Figure 9.1 The 10 highest ranked road types of Alternative 1 based on selected interventions.



The results of Alternative 1 - see Table 9.3 and Table 9.4 - show that:

- The roads types are listed based on their economic viability and those road types with high and medium traffic are generally those with highest economic return.
- Generally, the economic return of the selected interventions suggests upgrading from both gravel and earth to an asphalt solution.
- The majority of the most economic viable interventions are gravel roads that are upgraded to a Surface Dressing asphalt solution.
- Surface Dressing is generally not as durable as other asphalt interventions and therefore requires more maintenance works to ensure a sufficient technical performance over a longer period of time. The cost of this intervention, however, is much lower than other asphalt interventions.
- The asphalt road types that are in present poor condition with high initial roughness gives relatively high economic return when intervened with Overlay or Surface Dressing solution which are less expensive than Reconstruction of Asphalt.
- The 10 best ranked road types with interventions represent 197 km of road corresponding to 13% of the surveyed network. The average traffic is 806 vehicles per day and the average cost of interventions is EUR/km 115,526. Total costs of interventions are almost EUR 20 million and total present value of future maintenance expenses are EUR 21.5 million.

- The 11 to 20 ranked road types with interventions represent 349 km or 22% of network and the average cost of interventions is EUR/km 100,553. Total costs of interventions are EUR 35.7 million and total present value of future maintenance expenses are EUR 38 million.

- The 21 to 30 ranked road types with interventions represent 284 km or 18% of network and the average cost of interventions is EUR/km 142,608. Total costs of interventions are almost EUR 65 million and total present value of future maintenance expenses are only EUR 6.5 million as a result of more durable interventions.

- The 31 to 39 ranked road types with interventions represent the remaining 725 km or 47% of the network and the average cost of interventions is EUR/km 199,512. Total costs of interventions are almost EUR 111 million and total present value of future maintenance expenses are only EUR 17 million as a result of more durable interventions.

- The total cost of the 39 road type's amount to almost EUR 232 million and the total present value of future maintenance expenses amount to EUR 83 million.

Figure 9.2 **Alternative 1:** *Maps with location of 10 highest ranked road types with interventions.*

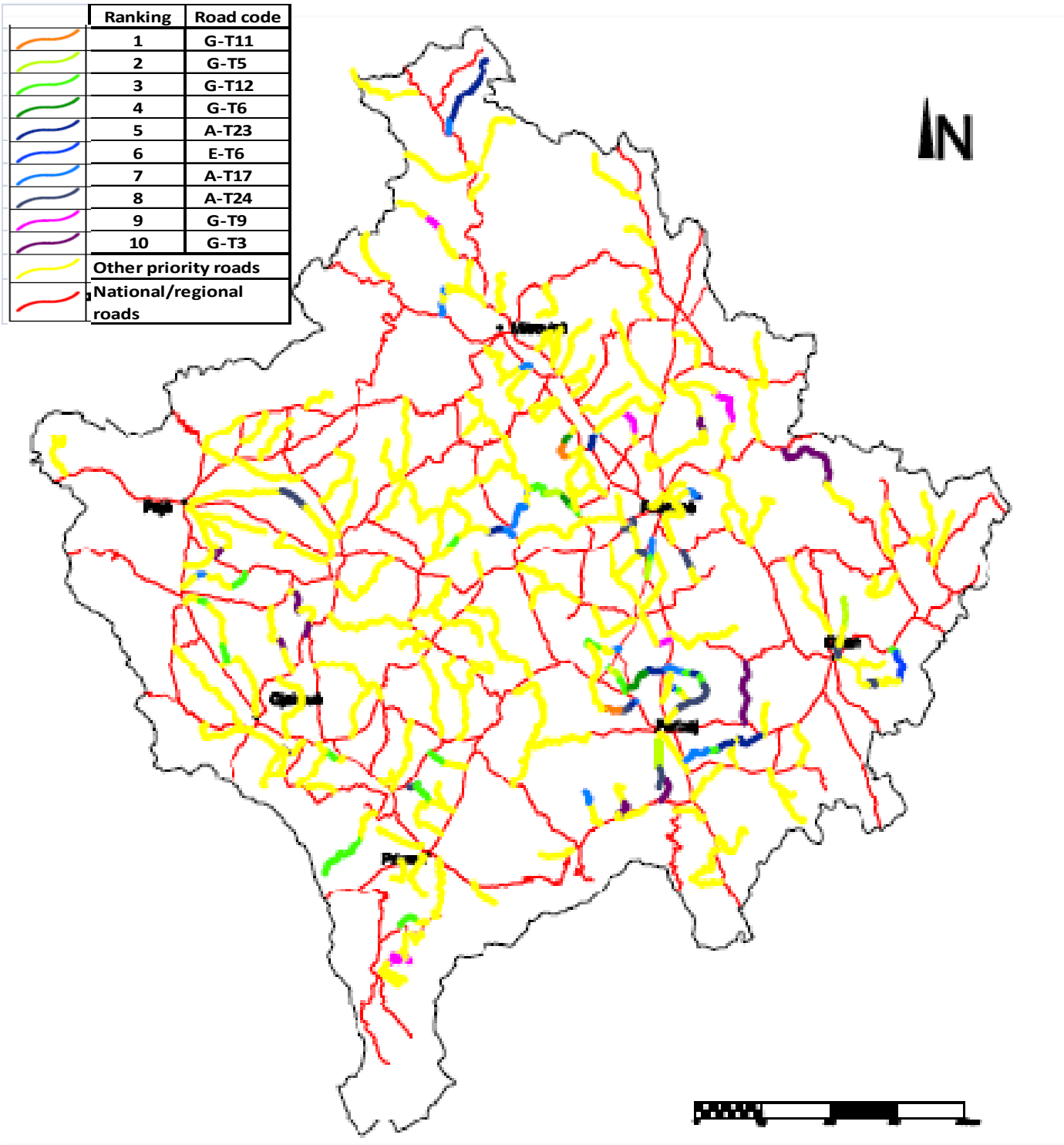


Table 9.2 ***Alternative 1:*** *List of ranked road types with information on road condition, proposed intervention, length of road types, average number of inhabitants and average number of vehicles.*

Ranking	Condition of Roads			Alternative (work measures)		Length of selected survey network			Inhabi-tants (ave.)	Vehic-les (ave.)
	Road Type Code	Road name	Road Type	Work Measure	Alter-native	Length (km)	Length (%) of total network	Length (%) of road type	Inhabi-tants (ave.)	Vehic-les (ave.)
1	G-T11	Poor GRAVEL surface, Good drainage, High traffic	Gravel	SURFACE DRESSING	ALT 8	6.4	0%	1%	1,669	929
2	G-T5	Fair GRAVEL surface, Good drainage, High traffic	Gravel	SURFACE DRESSING	ALT 8	14.6	1%	3%	4,699	880
3	G-T12	Poor GRAVEL surface, Poor drainage, High traffic	Gravel	SURFACE DRESSING	ALT 8	13.8	1%	3%	1,749	111
4	G-T6	Fair GRAVEL surface, Poor drainage, High traffic	Gravel	SURFACE DRESSING	ALT 8	7.6	0%	2%	1,974	1,342
5	A-T23	Poor ASPHALT, Good drainage, High traffic	Asphalt	OVERLAY	ALT 1	31.2	2%	3%	3,840	1,100
6	E-T6	EARTH road, Poor drainage, High traffic	Earth	SURFACE DRESSING	ALT 11	5.8	0%	18%	2,224	693
7	A-T17	Medium Poor ASPHALT, Good drainage, High traffic	Asphalt	SURFACE DRESSING	ALT 4	34	2%	3%	3,395	984
8	A-T24	Poor ASPHALT, Poor drainage, High traffic	Asphalt	OVERLAY	ALT 1	25.2	2%	2%	3,484	1,414
9	G-T9	Poor GRAVEL surface, Good drainage, Medium traffic	Gravel	SURFACE DRESSING	ALT 8	16.2	1%	3%	3,037	284
10	G-T3	Fair GRAVEL surface, Good drainage, Medium traffic	Gravel	SURFACE DRESSING	ALT 8	42.6	3%	9%	1,627	327
11	A-T21	Poor ASPHALT, Good drainage, Medium traffic	Asphalt	OVERLAY	ALT 1	15	1%	1%	1,814	290
12	A-T11	Medium Good ASPHALT, Good drainage, High traffic	Asphalt	SURFACE DRESSING	ALT 4	22.8	1%	2%	2,958	1,166
13	A-T15	Medium Poor ASPHALT, Good drainage, Medium traffic	Asphalt	SURFACE DRESSING	ALT 4	21.4	1%	2%	3,019	328
14	G-T10	Poor GRAVEL surface, Poor drainage, Medium traffic	Gravel	SURFACE DRESSING	ALT 8	180.2	12%	36%	2,828	302
15	A-T22	Poor ASPHALT, Poor drainage, Medium traffic	Asphalt	OVERLAY	ALT 1	28.8	2%	3%	2,286	337
16	G-T4	Fair GRAVEL surface, Poor drainage, Medium traffic	Gravel	SURFACE DRESSING	ALT 8	26.4	2%	5%	2,151	331
17	A-T18	Medium Poor ASPHALT, Poor drainage, High traffic	Asphalt	SURFACE DRESSING	ALT 4	31.4	2%	3%	3,273	804
18	A-T13	Medium Poor ASPHALT, Good drainage, Low traffic	Asphalt	SURFACE DRESSING	ALT 4	1.8	0%	0%	764	134
19	A-T19	Poor ASPHALT, Good drainage, Low traffic	Asphalt	OVERLAY	ALT 1	12.2	1%	1%	2,726	155
20	E-T4	EARTH road, Poor drainage, Medium traffic	Earth	SURFACE DRESSING	ALT 11	8.8	1%	27%	3,665	348
21	A-T9	Medium Good ASPHALT, Good drainage, Medium traffic	Asphalt	SURFACE DRESSING	ALT 4	22.4	1%	2%	2,280	328
22	A-T20	Poor ASPHALT, Poor drainage, Low traffic	Asphalt	OVERLAY	ALT 1	23	1%	2%	1,474	151
23	A-T12	Medium Good ASPHALT, Poor drainage, High traffic	Asphalt	SURFACE DRESSING	ALT 4	15.6	1%	2%	7,330	920
24	A-T16	Medium Poor ASPHALT, Poor drainage, Medium traffic	Asphalt	SURFACE DRESSING	ALT 4	8	1%	1%	2,798	371
25	A-T7	Medium Good ASPHALT, Good drainage, Low traffic	Asphalt	SURFACE DRESSING	ALT 4	15.8	1%	2%	1,681	145
26	A-T14	Medium Poor ASPHALT, Poor drainage, Low traffic	Asphalt	SURFACE DRESSING	ALT 4	9.4	1%	1%	1,440	145
27	A-T10	Medium Good ASPHALT, Poor drainage, Medium traffic	Asphalt	SURFACE DRESSING	ALT 4	15	1%	1%	1,981	327
28	G-T7	Poor GRAVEL surface, Good drainage, Low traffic	Gravel	ASPHALT	ALT 9	23.2	1%	5%	1,536	109
29	G-T8	Poor GRAVEL surface, Poor drainage, Low traffic	Gravel	ASPHALT	ALT 9	140.8	9%	28%	1,698	98
30	G-T1	Fair GRAVEL surface, Good drainage, Low traffic	Gravel	ASPHALT	ALT 9	10.8	1%	2%	2,220	95
31	G-T2	Fair GRAVEL surface, Poor drainage, Low traffic	Gravel	ASPHALT	ALT 9	13.8	1%	3%	1,749	111
32	A-T8	Medium Good ASPHALT, Poor drainage, Low traffic	Asphalt	SURFACE DRESSING	ALT 4	11.2	1%	1%	2,101	155
33	E-T2	EARTH road, Poor drainage, Low traffic	Earth	ASPHALT	ALT 12	17.6	1%	55%	2,146	88
34	A-T5	Good ASPHALT, Good drainage, High traffic	Asphalt	OVERLAY	ALT 1	228.4	15%	22%	3,578	1,105
35	A-T6	Good ASPHALT, Poor drainage, High traffic	Asphalt	OVERLAY	ALT 1	80.8	5%	8%	4,890	826
36	A-T3	Good ASPHALT, Good drainage, Medium traffic	Asphalt	OVERLAY	ALT 1	171.6	11%	17%	2,453	342
37	A-T4	Good ASPHALT, Poor drainage, Medium traffic	Asphalt	OVERLAY	ALT 1	66.2	4%	6%	3,113	367
38	A-T1	Good ASPHALT, Good drainage, Low traffic	Asphalt	OVERLAY	ALT 1	108.8	7%	11%	1,762	128
39	A-T2	Good ASPHALT, Poor drainage, Low traffic	Asphalt	OVERLAY	ALT 1	26.8	2%	3%	1,931	133

Table 9.3 ***Alternative 1:*** *List of ranked road types with information on economic indicators for the identified intervention.*

Ranking	Condition of Roads		Economic Indicators					Alternative (work measures)	
	Road Type Code	Road name	EIRR (%)	Cost/km (EURO)	NPV/km 2010 (1,000 Euro)	NPV/ Cost Ratio	Mainte-nance Costs/km (NPV Euro)	Work Measure	Alter-native
1	G-T11	Poor GRAVEL surface, Good drainage, High traffic	80.9%	86,592	660.4	7.63	171,712	SURFACE DRESSING	ALT 8
2	G-T5	Fair GRAVEL surface, Good drainage, High traffic	71.0%	102,336	648.2	6.33	180,226	SURFACE DRESSING	ALT 8
3	G-T12	Poor GRAVEL surface, Poor drainage, High traffic	62.2%	110,592	639.9	5.79	171,712	SURFACE DRESSING	ALT 8
4	G-T6	Fair GRAVEL surface, Poor drainage, High traffic	56.8%	126,336	627.7	4.97	180,226	SURFACE DRESSING	ALT 8
5	A-T23	Poor ASPHALT, Good drainage, High traffic	37.2%	115,920	353.0	3.05	41,652	OVERLAY	ALT 1
6	E-T6	EARTH road, Poor drainage, High traffic	31.6%	255,840	699.2	2.73	79,436	SURFACE DRESSING	ALT 11
7	A-T17	Medium Poor ASPHALT, Good drainage, High traffic	31.2%	28,800	55.7	1.93	41,275	SURFACE DRESSING	ALT 4
8	A-T24	Poor ASPHALT, Poor drainage, High traffic	31.1%	139,920	333.6	2.38	41,662	OVERLAY	ALT 1
9	G-T9	Poor GRAVEL surface, Good drainage, Medium traffic	24.6%	86,592	132.3	1.20	158,509	SURFACE DRESSING	ALT 8
10	G-T3	Fair GRAVEL surface, Good drainage, Medium traffic	21.6%	102,336	113.8	0.90	169,635	SURFACE DRESSING	ALT 8
11	A-T21	Poor ASPHALT, Good drainage, Medium traffic	20.7%	115,920	140.9	1.01	31,549	OVERLAY	ALT 1
12	A-T11	Medium Good ASPHALT, Good drainage, High traffic	19.9%	30,600	37.2	1.22	35,527	SURFACE DRESSING	ALT 4
13	A-T15	Medium Poor ASPHALT, Good drainage, Medium traffic	19.8%	28,800	24.4	0.46	28,196	SURFACE DRESSING	ALT 4
14	G-T10	Poor GRAVEL surface, Poor drainage, Medium traffic	18.6%	110,592	111.8	1.29	158,509	SURFACE DRESSING	ALT 8
15	A-T22	Poor ASPHALT, Poor drainage, Medium traffic	17.1%	139,920	121.2	1.05	31,229	OVERLAY	ALT 1
16	G-T4	Fair GRAVEL surface, Poor drainage, Medium traffic	16.6%	126,336	93.3	0.91	169,635	SURFACE DRESSING	ALT 8
17	A-T18	Medium Poor ASPHALT, Poor drainage, High traffic	15.4%	52,800	35.6	0.67	41,275	SURFACE DRESSING	ALT 4
18	A-T13	Medium Poor ASPHALT, Good drainage, Low traffic	14.7%	28,800	12.5	0.43	26,012	SURFACE DRESSING	ALT 4
19	A-T19	Poor ASPHALT, Good drainage, Low traffic	13.9%	115,920	61.4	0.53	30,329	OVERLAY	ALT 1
20	E-T4	EARTH road, Poor drainage, Medium traffic	11.7%	255,840	109.1	0.43	69,673	SURFACE DRESSING	ALT 11
21	A-T9	Medium Good ASPHALT, Good drainage, Medium traffic	11.3%	30,600	10.4	0.19	25,237	SURFACE DRESSING	ALT 4
22	A-T20	Poor ASPHALT, Poor drainage, Low traffic	10.9%	139,920	41.0	0.29	30,329	OVERLAY	ALT 1
23	A-T12	Medium Good ASPHALT, Poor drainage, High traffic	10.7%	54,600	16.8	0.31	35,527	SURFACE DRESSING	ALT 4
24	A-T16	Medium Poor ASPHALT, Poor drainage, Medium traffic	8.1%	52,800	4.0	0.14	28,196	SURFACE DRESSING	ALT 4
25	A-T7	Medium Good ASPHALT, Good drainage, Low traffic	7.0%	30,600	0.1	0.00	23,622	SURFACE DRESSING	ALT 4
26	A-T14	Medium Poor ASPHALT, Poor drainage, Low traffic	4.4%	52,800	-7.9	-0.15	26,013	SURFACE DRESSING	ALT 4
27	A-T10	Medium Good ASPHALT, Poor drainage, Medium traffic	4.4%	54,600	-10.0	-0.33	25,237	SURFACE DRESSING	ALT 4
28	G-T7	Poor GRAVEL surface, Good drainage, Low traffic	2.3%	309,936	-111.3	-0.36	20,141	ASPHALT	ALT 9
29	G-T8	Poor GRAVEL surface, Poor drainage, Low traffic	1.8%	333,936	-131.8	-0.39	20,141	ASPHALT	ALT 9
30	G-T1	Fair GRAVEL surface, Good drainage, Low traffic	1.3%	366,288	-154.3	-0.42	21,756	ASPHALT	ALT 9
31	G-T2	Fair GRAVEL surface, Poor drainage, Low traffic	0.9%	390,288	-174.8	-0.45	21,756	ASPHALT	ALT 9
32	A-T8	Medium Good ASPHALT, Poor drainage, Low traffic	0.3%	54,600	-20.4	-0.37	23,623	SURFACE DRESSING	ALT 4
33	E-T2	EARTH road, Poor drainage, Low traffic	-1.6%	462,240	-269.1	-0.58	18,090	ASPHALT	ALT 12
34	A-T5	Good ASPHALT, Good drainage, High traffic	-2.2%	136,080	-85.4	-0.63	26,823	OVERLAY	ALT 1
35	A-T6	Good ASPHALT, Poor drainage, High traffic	-3.3%	160,080	-106.0	-0.66	26,823	OVERLAY	ALT 1
36	A-T3	Good ASPHALT, Good drainage, Medium traffic	-4.4%	136,080	-93.9	-0.59	20,784	OVERLAY	ALT 1
37	A-T4	Good ASPHALT, Poor drainage, Medium traffic	-5.1%	160,080	-114.5	-0.84	21,142	OVERLAY	ALT 1
38	A-T1	Good ASPHALT, Good drainage, Low traffic	-6.1%	136,080	-97.6	-0.72	20,251	OVERLAY	ALT 1
39	A-T2	Good ASPHALT, Poor drainage, Low traffic	-6.4%	160,080	-118.5	-0.74	20,647	OVERLAY	ALT 1

Table 9.4 ***Alternative 1:*** *List of ranked road types with information on economic indicators, selected intervention, summary data for groups of ranked road type, total maintenance costs and total intervention costs.*

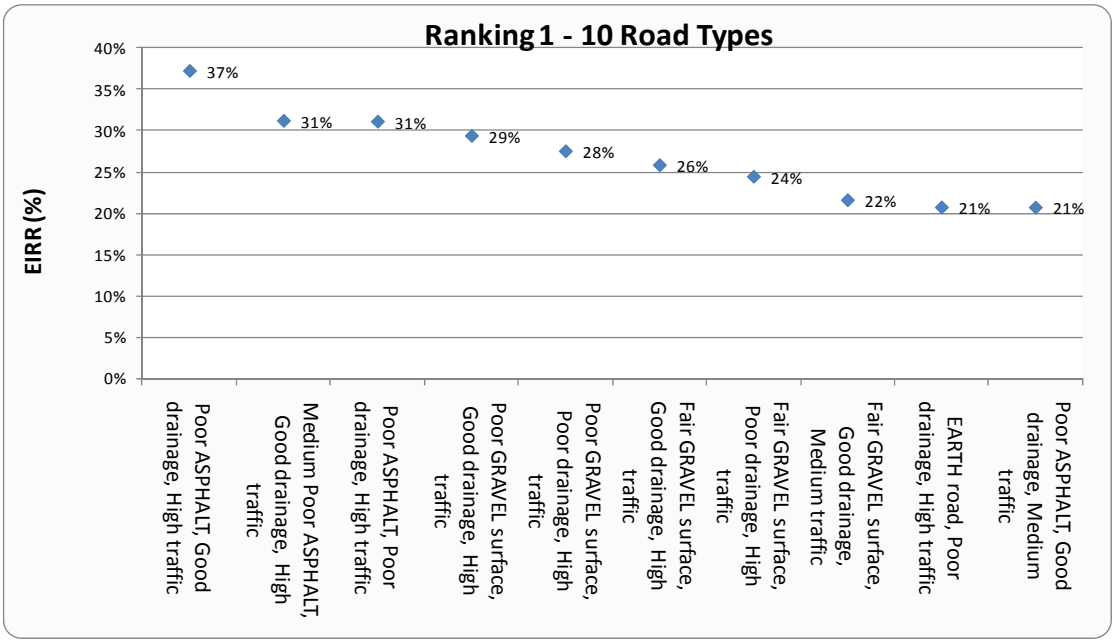
Ranking	Condition of Roads		Alternative (work measures)	Per every group of Ranked Road Type							Total Costs (EURO)	
	Road Type Code	Road Type	Work Measure	Vehic-les (ave.)	Inhabi-tants (average 2,866)	Length (km)	Length (%) of network	Average Cost/km (Euro) of Group of Ranked Road Type	Total Mainte-nance Cost (NPV Euro) per Group of Ranked Road Type	Total Cost (Euro) per Group of Ranked Road Type	Total Mainte-nance Cost (Euro) per Road Type	Total Cost (Euro) per Road Type
1	G-T11	Gravel	SURFACE DRESSING								1,098,958	554,189
2	G-T5	Gravel	SURFACE DRESSING								2,631,294	1,494,106
3	G-T12	Gravel	SURFACE DRESSING								2,369,627	1,526,170
4	G-T6	Gravel	SURFACE DRESSING								1,369,715	960,154
5	A-T23	Asphalt	OVERLAY					**Average/Sum of 10 ranked road types**			1,299,545	3,616,704
6	E-T6	Earth	SURFACE DRESSING								460,730	1,483,872
7	A-T17	Asphalt	SURFACE DRESSING								1,403,345	979,200
8	A-T24	Asphalt	OVERLAY								1,049,872	3,525,984
9	G-T9	Gravel	SURFACE DRESSING								2,567,853	1,402,790
10	G-T3	Gravel	SURFACE DRESSING	806	2,770	197	13%	115,526	21,477,393	19,902,682	7,226,454	4,359,514
11	A-T21	Asphalt	OVERLAY								473,232	1,738,800
12	A-T11	Asphalt	SURFACE DRESSING								810,014	697,680
13	A-T15	Asphalt	SURFACE DRESSING								603,392	616,320
14	G-T10	Gravel	SURFACE DRESSING								28,563,398	19,928,678
15	A-T22	Asphalt	OVERLAY					**Average/Sum of 10 ranked road types**			899,385	4,029,696
16	G-T4	Gravel	SURFACE DRESSING								4,478,366	3,335,270
17	A-T18	Asphalt	SURFACE DRESSING								1,296,051	1,657,920
18	A-T13	Asphalt	SURFACE DRESSING								46,821	51,840
19	A-T19	Asphalt	OVERLAY								370,008	1,414,224
20	E-T4	Earth	SURFACE DRESSING	419	2,548	349	22%	100,553	38,153,785	35,721,821	613,119	2,251,392
21	A-T9	Asphalt	SURFACE DRESSING								565,303	685,440
22	A-T20	Asphalt	OVERLAY								697,557	3,218,160
23	A-T12	Asphalt	SURFACE DRESSING								554,222	851,760
24	A-T16	Asphalt	SURFACE DRESSING								225,568	422,400
25	A-T7	Asphalt	SURFACE DRESSING					**Average/Sum of 10 ranked road types**			373,227	483,480
26	A-T14	Asphalt	SURFACE DRESSING								244,524	496,320
27	A-T10	Asphalt	SURFACE DRESSING								378,551	819,000
28	G-T7	Gravel	ASPHALT								467,264	7,190,515
29	G-T8	Gravel	ASPHALT								2,835,810	47,018,189
30	G-T1	Gravel	ASPHALT	269	2,444	284	18%	142,608	6,576,985	65,141,174	234,960	3,955,910
31	G-T2	Gravel	ASPHALT								300,226	5,385,974
32	A-T8	Asphalt	SURFACE DRESSING								264,581	611,520
33	E-T2	Earth	ASPHALT								318,392	8,135,424
34	A-T5	Asphalt	OVERLAY					**Average/Sum of 9 ranked road types**			6,126,431	31,080,672
35	A-T6	Asphalt	OVERLAY								2,167,320	12,934,464
36	A-T3	Asphalt	OVERLAY								3,566,451	23,351,328
37	A-T4	Asphalt	OVERLAY								1,399,596	10,597,296
38	A-T1	Asphalt	OVERLAY								2,203,336	14,805,504
39	A-T2	Asphalt	OVERLAY	362	2,636	725	47%	199,512	16,899,672	111,192,326	553,338	4,290,144
						1,555	**100%**		**83,107,834**	**231,958,003**	**83,107,834**	**231,958,003**

Results of Alternative 2

The general conclusions for Alternative 1 and 2 are very similar, however, for Alternative 2 a change has been made in ten of the high ranked road types with respect to the proposed type of road interventions[6]. Despite lower economic return the alternatively proposed Asphalt solution still provides economically viable solutions. The Asphalt interventions are replaced for those gravel and road types where Surface Dressing initially was suggested as well as their corresponding annual cost of maintenance. Figure 9.3 below illustrates the 10th highest ranked road types with interventions of Alternative 2. Figure 9.4 below illustrates the location of the 10 highest ranked road types of Alternative 2 based on selected interventions.

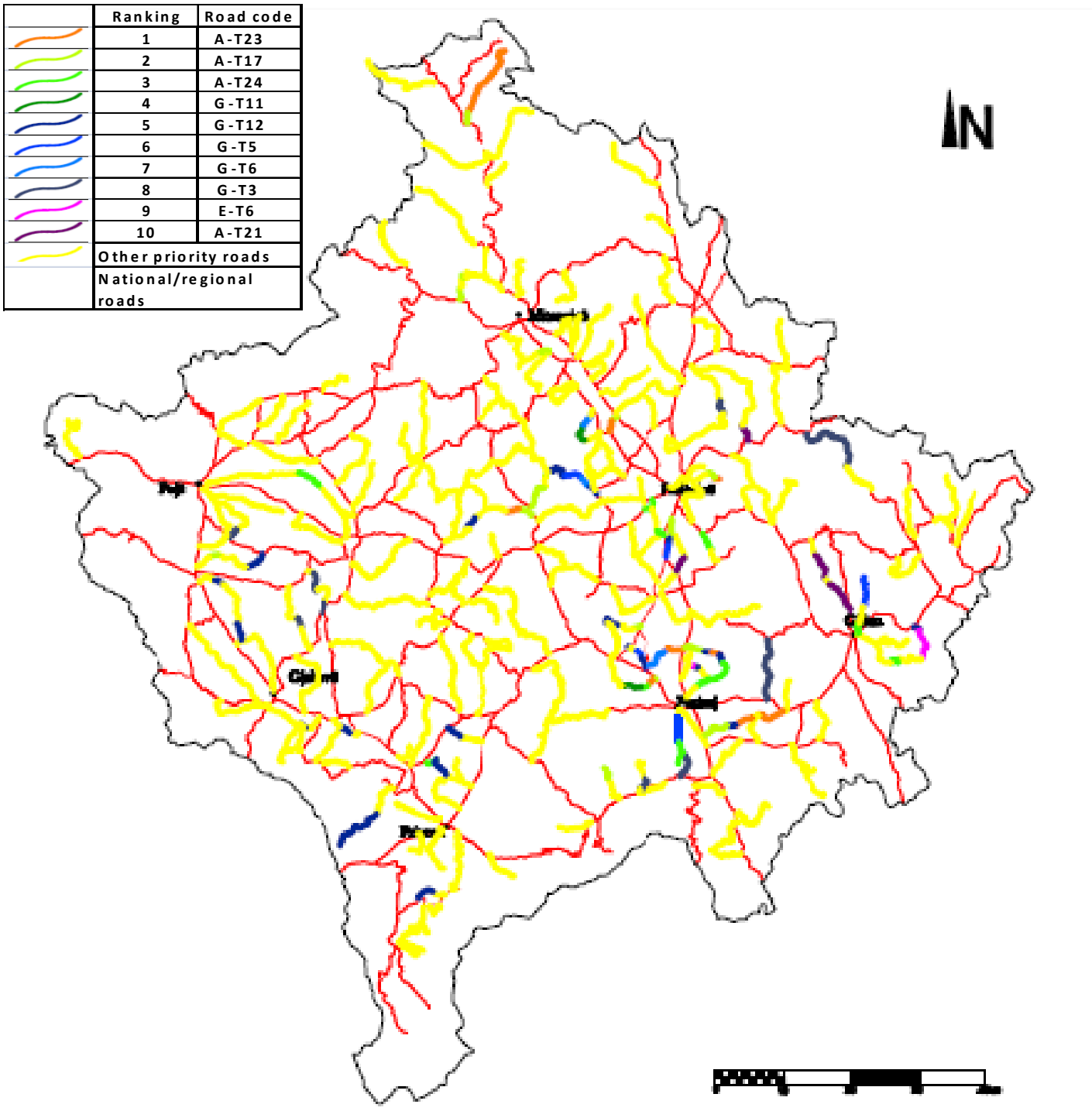
The specific type of intervention associated with the figure below can be observed from Table 9.6 below along with economic results of the interventions.

Figure 9.3 The 10 highest ranked road types of Alternative 2 based on selected interventions.



[6] Road Type Code where changes have been made: G-T11, G-T5, G-T12, G-T6, E-T6, G-T9, G-T3, G-T10, G-T4 and E-T4

Figure 9.4 **Alternative 2:** *Maps with location of 10 highest ranked road types with interventions.*



The results of Alternative 2 - see Table 9.6 and Table 9.7 - show that:

- Road types are listed based on their economic viability and those road types with high and medium traffic are generally those with the highest economic returns.

- Generally the economic return of the selected interventions suggests up-grading from both gravel and earth to asphalt solutions.

- The majority of the most economically viable roads types are gravel roads that are upgraded to asphalt solution.

- The durability of Asphalt is better compared to e.g. Surface Dressing and therefore requires less maintenance works to ensure a sufficient technical performance over a longer period of time. The cost of this intervention is, however, more expensive compared to e.g. Surface Dressing.

- The asphalt road types that presently are in poor condition with high initial roughness gives relatively high economic return when intervened with Overlay or Surface Dressing solution which are relatively less expensive than Reconstruction of Asphalt.

- The ten best ranked road types with interventions represent 196 km of road corresponding to 13% of the surveyed network. The average traffic is 807 vehicles/day and the average cost of interventions is EUR/km 236,558. Total costs of interventions are almost EUR 32 million and the total present value of future maintenance expenses are EUR 13 million.

- The 11 to 20 ranked road types with interventions represent 360 km or 23% of the network and average cost of interventions is EUR/km 121,123. Total costs of interventions are EUR 77.5 million and the total present value of future maintenance expenses are EUR 9.9 million.

- The 21 to 30 ranked road types with interventions represent 274 km or 18% of network and the average cost of interventions is EUR/km 210,809. Total costs of interventions are almost EUR 75.6 million and the total present value of future maintenance expenses are only EUR 6.1 million as a result of more durable interventions.

- The 31 to 39 ranked road types with interventions represent the remaining 725 km or 47% of the network and the average cost of interventions is EUR/km 199,512. Total costs of interventions are almost EUR 111 million and total present value of future maintenance expenses are only EUR 17 million as a result of more durable interventions.

- The total cost of the 39 road types amount to almost EUR 296 million and the total present value of future maintenance expenses amount to EUR 46 million.

Table 9.5 ***Alternative 2:*** *List of ranked road types with information on road condition, proposed intervention, length of road types, average number of inhabitants and average number of vehicles.*

Ranking	Condition of Roads			Alternative (work measures)		Length of selected survey network			Inhabi-tants (ave.)	Vehic-les (ave.)
	Road Type Code	Road name	Road Type	Work Measure	Alter-native	Length (km)	Length (%) of total network	Length (%) of road type	Inhabi-tants (ave.)	Vehic-les (ave.)
1	A-T23	Poor ASPHALT, Good drainage, High traffic	Asphalt	OVERLAY	ALT 1	31.2	2%	3%	3,840	1,100
2	A-T17	Medium Poor ASPHALT, Good drainage, High traffic	Asphalt	SURFACE DRESSING	ALT 4	34	2%	3%	3,395	984
3	A-T24	Poor ASPHALT, Poor drainage, High traffic	Asphalt	OVERLAY	ALT 1	25.2	2%	2%	3,484	1,414
4	G-T11	Poor GRAVEL surface, Good drainage, High traffic	Gravel	ASPHALT	ALT 9	6.4	0%	1%	1,669	929
5	G-T12	Poor GRAVEL surface, Poor drainage, High traffic	Gravel	ASPHALT	ALT 9	13.8	1%	3%	1,749	111
6	G-T5	Fair GRAVEL surface, Good drainage, High traffic	Gravel	ASPHALT	ALT 9	14.6	1%	3%	4,699	880
7	G-T6	Fair GRAVEL surface, Poor drainage, High traffic	Gravel	ASPHALT	ALT 9	7.6	0%	2%	1,974	1,342
8	G-T3	Fair GRAVEL surface, Good drainage, Medium traffic	Gravel	SURFACE DRESSING	ALT 8	42.6	3%	9%	1,627	327
9	E-T6	EARTH road, Poor drainage, High traffic	Earth	ASPHALT	ALT 12	5.8	0%	18%	2,224	693
10	A-T21	Poor ASPHALT, Good drainage, Medium traffic	Asphalt	OVERLAY	ALT 1	15	1%	1%	1,814	290
11	A-T11	Medium Good ASPHALT, Good drainage, High traffic	Asphalt	SURFACE DRESSING	ALT 4	22.8	1%	2%	2,958	1,166
12	A-T15	Medium Poor ASPHALT, Good drainage, Medium traffic	Asphalt	SURFACE DRESSING	ALT 4	21.4	1%	2%	3,019	328
13	A-T22	Poor ASPHALT, Poor drainage, Medium traffic	Asphalt	OVERLAY	ALT 1	28.8	2%	3%	2,286	337
14	A-T18	Medium Poor ASPHALT, Poor drainage, High traffic	Asphalt	SURFACE DRESSING	ALT 4	31.4	2%	3%	3,273	804
15	A-T13	Medium Poor ASPHALT, Good drainage, Low traffic	Asphalt	SURFACE DRESSING	ALT 4	1.8	0%	0%	764	134
16	A-T19	Poor ASPHALT, Good drainage, Low traffic	Asphalt	OVERLAY	ALT 1	12.2	1%	1%	2,726	155
17	G-T9	Poor GRAVEL surface, Good drainage, Medium traffic	Gravel	ASPHALT	ALT 9	16.2	1%	3%	3,037	284
18	G-T10	Poor GRAVEL surface, Poor drainage, Medium traffic	Gravel	ASPHALT	ALT 9	180.2	12%	36%	2,828	302
19	A-T9	Medium Good ASPHALT, Good drainage, Medium traffic	Asphalt	SURFACE DRESSING	ALT 4	22.4	1%	2%	2,280	328
20	A-T20	Poor ASPHALT, Poor drainage, Low traffic	Asphalt	OVERLAY	ALT 1	23	1%	2%	1,474	151
21	A-T12	Medium Good ASPHALT, Poor drainage, High traffic	Asphalt	SURFACE DRESSING	ALT 4	15.6	1%	2%	7,330	920
22	G-T4	Fair GRAVEL surface, Poor drainage, Medium traffic	Gravel	ASPHALT	ALT 9	26.4	2%	5%	2,151	331
23	A-T16	Medium Poor ASPHALT, Poor drainage, Medium traffic	Asphalt	SURFACE DRESSING	ALT 4	8	1%	1%	2,798	371
24	E-T4	EARTH road, Poor drainage, Medium traffic	Earth	ASPHALT	ALT 12	8.8	1%	27%	3,665	348
25	A-T7	Medium Good ASPHALT, Good drainage, Low traffic	Asphalt	SURFACE DRESSING	ALT 4	15.8	1%	2%	1,681	145
26	A-T14	Medium Poor ASPHALT, Poor drainage, Low traffic	Asphalt	SURFACE DRESSING	ALT 4	9.4	1%	1%	1,440	145
27	A-T10	Medium Good ASPHALT, Poor drainage, Medium traffic	Asphalt	SURFACE DRESSING	ALT 4	15	1%	1%	1,981	327
28	G-T7	Poor GRAVEL surface, Good drainage, Low traffic	Gravel	ASPHALT	ALT 9	23.2	1%	5%	1,536	109
29	G-T8	Poor GRAVEL surface, Poor drainage, Low traffic	Gravel	ASPHALT	ALT 9	140.8	9%	28%	1,698	98
30	G-T1	Fair GRAVEL surface, Good drainage, Low traffic	Gravel	ASPHALT	ALT 9	10.8	1%	2%	2,220	95
31	G-T2	Fair GRAVEL surface, Poor drainage, Low traffic	Gravel	ASPHALT	ALT 9	13.8	1%	3%	1,749	111
32	A-T8	Medium Good ASPHALT, Poor drainage, Low traffic	Asphalt	SURFACE DRESSING	ALT 4	11.2	1%	1%	2,101	155
33	E-T2	EARTH road, Poor drainage, Low traffic	Earth	ASPHALT	ALT 12	17.6	1%	55%	2,146	88
34	A-T5	Good ASPHALT, Good drainage, High traffic	Asphalt	OVERLAY	ALT 1	228.4	15%	22%	3,578	1,105
35	A-T6	Good ASPHALT, Poor drainage, High traffic	Asphalt	OVERLAY	ALT 1	80.8	5%	8%	4,890	826
36	A-T3	Good ASPHALT, Good drainage, Medium traffic	Asphalt	OVERLAY	ALT 1	171.6	11%	17%	2,453	342
37	A-T4	Good ASPHALT, Poor drainage, Medium traffic	Asphalt	OVERLAY	ALT 1	66.2	4%	6%	3,113	367
38	A-T1	Good ASPHALT, Good drainage, Low traffic	Asphalt	OVERLAY	ALT 1	108.8	7%	11%	1,762	128
39	A-T2	Good ASPHALT, Poor drainage, Low traffic	Asphalt	OVERLAY	ALT 1	26.8	2%	3%	1,931	133

Table 9.6 Alternative 2: List of ranked road types with information on economic indicators for the identified intervention.

Ranking	Condition of Roads			Economic Indicators					Alternative (work measures)	
	Road Type Code	Road name	Road Type	EIRR (%)	Cost/km (EURO)	NPV/km 2010 (1,000 Euro)	NPV/ Cost Ratio	Mainte-nance Costs/km (NPV Euro)	Work Measure	Alter-native
1	A-T23	Poor ASPHALT, Good drainage, High traffic	Asphalt	37.2%	115,920	353.0	3.05	41,652	OVERLAY	ALT 1
2	A-T17	Medium Poor ASPHALT, Good drainage, High traffic	Asphalt	31.2%	28,800	55.7	1.93	41,275	SURFACE DRESSING	ALT 4
3	A-T24	Poor ASPHALT, Poor drainage, High traffic	Asphalt	31.1%	139,920	333.6	2.38	41,662	OVERLAY	ALT 1
4	G-T11	Poor GRAVEL surface, Good drainage, High traffic	Gravel	29.4%	309,936	858.8	2.77	33,812	ASPHALT	ALT 9
5	G-T12	Poor GRAVEL surface, Poor drainage, High traffic	Gravel	27.5%	333,936	838.4	2.51	33,812	ASPHALT	ALT 9
6	G-T5	Fair GRAVEL surface, Good drainage, High traffic	Gravel	25.8%	366,288	824.0	2.25	34,972	ASPHALT	ALT 9
7	G-T6	Fair GRAVEL surface, Poor drainage, High traffic	Gravel	24.4%	390,288	803.5	2.06	34,972	ASPHALT	ALT 9
8	G-T3	Fair GRAVEL surface, Good drainage, Medium traffic	Gravel	21.6%	102,336	113.8	0.90	169,635	SURFACE DRESSING	ALT 8
9	E-T6	EARTH road, Poor drainage, High traffic	Earth	20.7%	462,240	730.3	1.58	30,896	ASPHALT	ALT 12
10	A-T21	Poor ASPHALT, Good drainage, Medium traffic	Asphalt	20.7%	115,920	140.9	1.01	31,549	OVERLAY	ALT 1
11	A-T11	Medium Good ASPHALT, Good drainage, High traffic	Asphalt	19.9%	30,600	37.2	1.22	35,527	SURFACE DRESSING	ALT 4
12	A-T15	Medium Poor ASPHALT, Good drainage, Medium traffic	Asphalt	19.8%	28,800	24.4	0.46	28,196	SURFACE DRESSING	ALT 4
13	A-T22	Poor ASPHALT, Poor drainage, Medium traffic	Asphalt	17.1%	139,920	121.2	1.05	31,229	OVERLAY	ALT 1
14	A-T18	Medium Poor ASPHALT, Poor drainage, High traffic	Asphalt	15.4%	52,800	35.6	0.67	41,275	SURFACE DRESSING	ALT 4
15	A-T13	Medium Poor ASPHALT, Good drainage, Low traffic	Asphalt	14.7%	28,800	12.5	0.43	26,012	SURFACE DRESSING	ALT 4
16	A-T19	Poor ASPHALT, Good drainage, Low traffic	Asphalt	13.9%	115,920	61.4	0.53	30,329	OVERLAY	ALT 1
17	G-T9	Poor GRAVEL surface, Good drainage, Medium traffic	Gravel	12.6%	309,936	174.6	0.52	23,386	ASPHALT	ALT 9
18	G-T10	Poor GRAVEL surface, Poor drainage, Medium traffic	Gravel	11.6%	333,936	154.1	0.50	23,386	ASPHALT	ALT 9
19	A-T9	Medium Good ASPHALT, Good drainage, Medium traffic	Asphalt	11.3%	30,600	10.4	0.19	25,237	SURFACE DRESSING	ALT 4
20	A-T20	Poor ASPHALT, Poor drainage, Low traffic	Asphalt	10.9%	139,920	41.0	0.29	30,329	OVERLAY	ALT 1
21	A-T12	Medium Good ASPHALT, Poor drainage, High traffic	Asphalt	10.7%	54,600	16.8	0.31	35,527	SURFACE DRESSING	ALT 4
22	G-T4	Fair GRAVEL surface, Poor drainage, Medium traffic	Gravel	10.1%	390,288	116.0	0.32	24,976	ASPHALT	ALT 9
23	A-T16	Medium Poor ASPHALT, Poor drainage, Medium traffic	Asphalt	8.1%	52,800	4.0	0.14	28,196	SURFACE DRESSING	ALT 4
24	E-T4	EARTH road, Poor drainage, Medium traffic	Earth	8.1%	462,240	46.3	0.10	21,033	ASPHALT	ALT 12
25	A-T7	Medium Good ASPHALT, Good drainage, Low traffic	Asphalt	7.0%	30,600	0.1	0.00	23,622	SURFACE DRESSING	ALT 4
26	A-T14	Medium Poor ASPHALT, Poor drainage, Low traffic	Asphalt	4.4%	52,800	-7.9	-0.15	26,013	SURFACE DRESSING	ALT 4
27	A-T10	Medium Good ASPHALT, Poor drainage, Medium traffic	Asphalt	4.4%	54,600	-10.0	-0.33	25,237	SURFACE DRESSING	ALT 4
28	G-T7	Poor GRAVEL surface, Good drainage, Low traffic	Gravel	2.3%	309,936	-111.3	-0.36	20,141	ASPHALT	ALT 9
29	G-T8	Poor GRAVEL surface, Poor drainage, Low traffic	Gravel	1.8%	333,936	-131.8	-0.39	20,141	ASPHALT	ALT 9
30	G-T1	Fair GRAVEL surface, Good drainage, Low traffic	Gravel	1.3%	366,288	-154.3	-0.42	21,756	ASPHALT	ALT 9
31	G-T2	Fair GRAVEL surface, Poor drainage, Low traffic	Gravel	0.9%	390,288	-174.8	-0.45	21,756	ASPHALT	ALT 9
32	A-T8	Medium Good ASPHALT, Poor drainage, Low traffic	Asphalt	0.3%	54,600	-20.4	-0.37	23,623	SURFACE DRESSING	ALT 4
33	E-T2	EARTH road, Poor drainage, Low traffic	Earth	-1.6%	462,240	-269.1	-0.58	18,090	ASPHALT	ALT 12
34	A-T5	Good ASPHALT, Good drainage, High traffic	Asphalt	-2.2%	136,080	-85.4	-0.63	26,823	OVERLAY	ALT 1
35	A-T6	Good ASPHALT, Poor drainage, High traffic	Asphalt	-3.3%	160,080	-106.0	-0.66	26,823	OVERLAY	ALT 1
36	A-T3	Good ASPHALT, Good drainage, Medium traffic	Asphalt	-4.4%	136,080	-93.9	-0.59	20,784	OVERLAY	ALT 1
37	A-T4	Good ASPHALT, Poor drainage, Medium traffic	Asphalt	-5.1%	160,080	-114.5	-0.84	21,142	OVERLAY	ALT 1
38	A-T1	Good ASPHALT, Good drainage, Low traffic	Asphalt	-6.1%	136,080	-97.6	-0.72	20,251	OVERLAY	ALT 1
39	A-T2	Good ASPHALT, Poor drainage, Low traffic	Asphalt	-6.4%	160,080	-118.5	-0.74	20,647	OVERLAY	ALT 1

Table 9.7 Alternative 2: List of ranked road types with information on economic indicators, selected intervention, summary data for groups of ranked road type, total maintenance costs and total intervention costs.

Ranking	Condition of Roads		Alternative (work measures)		Per every group of Ranked Road Type							Total Costs (EURO)	
	Road Type Code	Road Type	Work Measure	Alter-native	Vehic-les (ave.)	Inhabi-tants (average 2,866)	Length (km)	Length (%) of network	Average Cost/km (Euro) of Group of Ranked Road Type	Total Mainte-nance Cost (NPV Euro) per Group of Ranked Road Type	Total Cost (Euro) per Group of Ranked Road Type	Total Mainte-nance Cost (Euro) per Road Type	Total Cost (Euro) per Road Type
1	A-T23	Asphalt	OVERLAY	ALT 1								1,299,545	3,616,704
2	A-T17	Asphalt	SURFACE DRESSING	ALT 4								1,403,345	979,200
3	A-T24	Asphalt	OVERLAY	ALT 1								1,049,872	3,525,984
4	G-T11	Gravel	ASPHALT	ALT 9								216,400	1,983,590
5	G-T12	Gravel	ASPHALT	ALT 9					**Average/Sum of 10 ranked road types**			466,612	4,608,317
6	G-T5	Gravel	ASPHALT	ALT 9								510,589	5,347,805
7	G-T6	Gravel	ASPHALT	ALT 9								265,786	2,966,189
8	G-T3	Gravel	SURFACE DRESSING	ALT 8								7,226,454	4,359,514
9	E-T6	Earth	ASPHALT	ALT 12								179,197	2,680,992
10	A-T21	Asphalt	OVERLAY	ALT 1	807	2,648	196	13%	236,558	13,091,033	31,807,094	473,232	1,738,800
11	A-T11	Asphalt	SURFACE DRESSING	ALT 4								810,014	697,680
12	A-T15	Asphalt	SURFACE DRESSING	ALT 4								603,392	616,320
13	A-T22	Asphalt	OVERLAY	ALT 1								899,385	4,029,696
14	A-T18	Asphalt	SURFACE DRESSING	ALT 4								1,296,051	1,657,920
15	A-T13	Asphalt	SURFACE DRESSING	ALT 4					**Average/Sum of 10 ranked road types**			46,821	51,840
16	A-T19	Asphalt	OVERLAY	ALT 1								370,008	1,414,224
17	G-T9	Gravel	ASPHALT	ALT 9								378,851	5,020,963
18	G-T10	Gravel	ASPHALT	ALT 9								4,214,128	60,175,267
19	A-T9	Asphalt	SURFACE DRESSING	ALT 4								565,303	685,440
20	A-T20	Asphalt	OVERLAY	ALT 1	399	2,464	360	23%	121,123	9,881,508	77,567,510	697,557	3,218,160
21	A-T12	Asphalt	SURFACE DRESSING	ALT 4								554,222	851,760
22	G-T4	Gravel	ASPHALT	ALT 9								659,374	10,303,603
23	A-T16	Asphalt	SURFACE DRESSING	ALT 4								225,568	422,400
24	E-T4	Earth	ASPHALT	ALT 12								185,094	4,067,712
25	A-T7	Asphalt	SURFACE DRESSING	ALT 4					**Average/Sum of 10 ranked road types**			373,227	483,480
26	A-T14	Asphalt	SURFACE DRESSING	ALT 4								244,524	496,320
27	A-T10	Asphalt	SURFACE DRESSING	ALT 4								378,551	819,000
28	G-T7	Gravel	ASPHALT	ALT 9								467,264	7,190,515
29	G-T8	Gravel	ASPHALT	ALT 9								2,835,810	47,018,189
30	G-T1	Gravel	ASPHALT	ALT 9	289	2,650	274	18%	210,809	6,158,594	75,608,890	234,960	3,955,910
31	G-T2	Gravel	ASPHALT	ALT 9								300,226	5,385,974
32	A-T8	Asphalt	SURFACE DRESSING	ALT 4								264,581	611,520
33	E-T2	Earth	ASPHALT	ALT 12								318,392	8,135,424
34	A-T5	Asphalt	OVERLAY	ALT 1					**Average/Sum of 9 ranked road types**			6,126,431	31,080,672
35	A-T6	Asphalt	OVERLAY	ALT 1								2,167,320	12,934,464
36	A-T3	Asphalt	OVERLAY	ALT 1								3,566,451	23,351,328
37	A-T4	Asphalt	OVERLAY	ALT 1								1,399,596	10,597,296
38	A-T1	Asphalt	OVERLAY	ALT 1								2,203,336	14,805,504
39	A-T2	Asphalt	OVERLAY	ALT 1	362	2,636	725	47%	199,512	16,899,672	111,192,326	553,338	4,290,144
							1,555	**100%**		**46,030,807**	**296,175,821**	**46,030,807**	**296,175,821**

10 Conclusions and Recommendations

Based on the analyses of the two alternatives in Section 9.2, **Alternative 1** provides from an economic point of view the most viable interventions, however, **Alternative 2** should be considered when future road maintenance expenses are included in the overall evaluation of best alternatives.

The main differences between the two alternatives are summarised below:

- Alternative 1 has lower total costs of road interventions for all road types than Alternative 2, but at the same time higher annual expenses for road maintenance.

- Total cost of road interventions are EUR 232 million for Alternative 1 compared to EUR 296 million for Alternative 2. A difference of EUR 64 million in favour of Alternative 1.

- Present value of future maintenance expenses are EUR 83 million for Alternative 1 compared to EUR 46 million for Alternative 2. A difference of EUR 37 million in favour of Alternative 2.

- The selected asphalt solutions selected for several of the road types of Alternative 2 are more durable than the Surface Dressing interventions selected from Alternative 1.

The municipalities have the full responsibility for the management of the local roads within their territories. The municipalities do, however, generally not have the sufficient capacity and financial means for this task.

Therefore, although Alternative 1 is economically the most viable alternative also covering lower initial costs of interventions, it implies higher annual maintenance expenses. Consequently the municipalities will face difficulties in the future for ensuring the required maintenance of the local roads not only due to limited financial resources but also insufficient technical capabilities.

Appendix 8-1 Traffic data

Asphalt Road Types

Low traffic	Car	Pick Up	Minibus	Bus	2-Ax Truck	3-Ax Truck	>3-Ax Truck	Total
2010 - 2020	5.65%	5.65%	5.65%	5.65%	4.73%	4.73%	4.73%	
2021 forward	5.40%	5.40%	5.40%	5.40%	4.50%	4.50%	4.50%	
2009	155	10	4	2	5	1	3	180
2010	164	11	4	2	5	1	3	190
2011	173	11	5	2	5	1	3	201
2012	183	12	5	3	5	1	3	212
2013	193	13	5	3	6	1	4	224
2014	204	13	6	3	6	1	4	236
2015	216	14	6	3	6	1	4	250
2016	228	15	6	3	6	1	4	264
2017	241	16	7	3	7	1	4	279
2018	255	17	7	4	7	1	4	294
2019	269	18	7	4	7	1	5	311
2020	284	19	8	4	8	1	5	328
2021	299	20	8	4	8	1	5	346
2022	316	21	9	4	8	1	5	364
2023	333	22	9	5	9	1	6	384
2024	351	23	10	5	9	1	6	404
2025	370	24	10	5	10	1	6	426
2026	389	26	11	6	10	1	6	449
2027	410	27	11	6	11	1	7	473
2028	433	28	12	6	11	1	7	498
2029	456	30	12	6	11	2	7	525
2030	481	31	13	7	12	2	8	553
2031	507	33	14	7	13	2	8	583
2032	534	35	14	8	13	2	8	614
2033	563	37	15	8	14	2	9	647
2034	593	39	16	8	14	2	9	682

Medium Traffic	Car	Pick Up	Minibus	Bus	2-Ax Truck	3-Ax Truck	>3-Ax Truck	Total
2010 - 2020	5.65%	5.65%	5.65%	5.65%	4.73%	4.73%	4.73%	
2021 forward	5.40%	5.40%	5.40%	5.40%	4.50%	4.50%	4.50%	
2009	345	23	9	5	10	1	7	400
2010	365	24	10	5	11	1	7	422
2011	385	25	10	5	11	1	7	446
2012	407	27	11	6	12	1	7	471
2013	430	28	12	6	12	2	8	497
2014	454	30	12	6	13	2	8	525
2015	480	31	13	7	14	2	9	555
2016	507	33	14	7	14	2	9	586
2017	535	35	15	8	15	2	9	619
2018	566	37	15	8	16	2	10	653
2019	598	39	16	8	16	2	10	690
2020	631	41	17	9	17	2	11	729
2021	665	44	18	9	18	2	11	768
2022	701	46	19	10	19	2	12	809
2023	739	48	20	10	20	2	12	852
2024	779	51	21	11	20	3	13	898
2025	821	54	22	12	21	3	14	946
2026	865	57	23	12	22	3	14	997
2027	912	60	25	13	23	3	15	1,051
2028	961	63	26	14	24	3	15	1,107
2029	1,013	66	27	14	25	3	16	1,166
2030	1,068	70	29	15	27	3	17	1,229
2031	1,126	74	31	16	28	3	18	1,295
2032	1,187	78	32	17	29	4	18	1,364
2033	1,251	82	34	18	30	4	19	1,438
2034	1,318	86	36	19	32	4	20	1,515

High traffic	Car	Pick Up	Minibus	Bus	2-Ax Truck	3-Ax Truck	>3-Ax Truck	Total
2010 - 2020	5.65%	5.65%	5.65%	5.65%	4.73%	4.73%	4.73%	
2021 forward	5.40%	5.40%	5.40%	5.40%	4.50%	4.50%	4.50%	
2009	863	57	23	12	26	3	16	1,000
2010	911	60	25	13	27	3	17	1,056
2011	963	63	26	14	28	4	18	1,115
2012	1,017	67	28	14	30	4	19	1,178
2013	1,074	70	29	15	31	4	20	1,244
2014	1,135	74	31	16	32	4	21	1,313
2015	1,199	79	33	17	34	4	22	1,387
2016	1,267	83	34	18	36	4	23	1,465
2017	1,338	88	36	19	37	5	24	1,547
2018	1,414	93	38	20	39	5	25	1,634
2019	1,494	98	41	21	41	5	26	1,725
2020	1,578	103	43	22	43	5	27	1,822
2021	1,663	109	45	24	45	6	28	1,920
2022	1,753	115	48	25	47	6	30	2,023
2023	1,848	121	50	26	49	6	31	2,131
2024	1,948	128	53	28	51	6	32	2,245
2025	2,053	134	56	29	53	7	34	2,366
2026	2,164	142	59	31	56	7	35	2,493
2027	2,281	149	62	32	58	7	37	2,627
2028	2,404	157	65	34	61	8	39	2,767
2029	2,533	166	69	36	64	8	40	2,916
2030	2,670	175	72	38	67	8	42	3,072
2031	2,814	184	76	40	70	9	44	3,237
2032	2,966	194	80	42	73	9	46	3,411
2033	3,127	205	85	44	76	10	48	3,594
2034	3,295	216	89	47	79	10	50	3,787

Gravel Road Types

Low traffic	Car	Pick Up	Minibus	Bus	2-Ax Truck	3-Ax Truck	>3-Ax Truck	Total
2010 - 2020	5.65%	5.65%	5.65%	5.65%	4.73%	4.73%	4.73%	0
2021 forward	5.40%	5.40%	5.40%	5.40%	4.50%	4.50%	4.50%	0
2009	104	7	3	1	3	1	2	120
2010	109	7	3	2	3	1	2	127
2011	116	8	3	2	3	1	2	134
2012	122	8	3	2	4	1	2	142
2013	129	8	3	2	4	1	2	149
2014	136	9	4	2	4	1	2	158
2015	144	9	4	2	4	1	3	167
2016	152	10	4	2	4	1	3	176
2017	161	11	4	2	4	1	3	186
2018	170	11	5	2	5	1	3	196
2019	179	12	5	3	5	1	3	207
2020	189	12	5	3	5	1	3	219
2021	200	13	5	3	5	1	3	231
2022	210	14	6	3	6	1	4	243
2023	222	15	6	3	6	1	4	256
2024	234	15	6	3	6	1	4	270
2025	246	16	7	3	6	1	4	284
2026	260	17	7	4	7	1	4	300
2027	274	18	7	4	7	1	4	316
2028	288	19	8	4	7	1	5	333
2029	304	20	8	4	8	1	5	350
2030	320	21	9	5	8	2	5	369
2031	338	22	9	5	8	2	5	389
2032	356	23	10	5	9	2	6	410
2033	375	25	10	5	9	2	6	432
2034	395	26	11	6	10	2	6	455

Medium Traffic	Car	Pick Up	Minibus	Bus	2-Ax Truck	3-Ax Truck	>3-Ax Truck	Total
2010 - 2020	5.65%	5.65%	5.65%	5.65%	4.73%	4.73%	4.73%	0
2021 forward	5.40%	5.40%	5.40%	5.40%	4.50%	4.50%	4.50%	0
2009	259	17	7	4	8	1	5	300
2010	273	18	7	4	8	1	5	317
2011	289	19	8	4	8	1	5	335
2012	305	20	8	4	9	1	6	353
2013	322	21	9	5	9	1	6	373
2014	341	22	9	5	10	1	6	394
2015	360	24	10	5	10	1	6	416
2016	380	25	10	5	11	1	7	439
2017	402	26	11	6	11	1	7	464
2018	424	28	12	6	12	1	7	490
2019	448	29	12	6	12	2	8	518
2020	473	31	13	7	13	2	8	547
2021	499	33	14	7	13	2	8	576
2022	526	34	14	7	14	2	9	607
2023	554	36	15	8	15	2	9	639
2024	584	38	16	8	15	2	10	674
2025	616	40	17	9	16	2	10	710
2026	649	43	18	9	17	2	11	748
2027	684	45	19	10	18	2	11	788
2028	721	47	20	10	18	2	12	830
2029	760	50	21	11	19	2	12	875
2030	801	52	22	11	20	2	13	922
2031	844	55	23	12	21	3	13	971
2032	890	58	24	13	22	3	14	1,023
2033	938	61	25	13	23	3	14	1,078
2034	989	65	27	14	24	3	15	1,136

High traffic	Car	Pick Up	Minibus	Bus	2-Ax Truck	3-Ax Truck	>3-Ax Truck	Total
2010 - 2020	5.65%	5.65%	5.65%	5.65%	4.73%	4.73%	4.73%	0
2021 forward	5.40%	5.40%	5.40%	5.40%	4.50%	4.50%	4.50%	0
2009	604	40	16	9	18	2	11	700
2010	638	42	17	9	19	2	12	739
2011	674	44	18	10	20	2	13	781
2012	712	47	19	10	21	3	13	825
2013	752	49	20	11	22	3	14	871
2014	795	52	22	11	23	3	14	920
2015	840	55	23	12	24	3	15	971
2016	887	58	24	13	25	3	16	1,026
2017	937	61	25	13	26	3	17	1,083
2018	990	65	27	14	27	3	17	1,144
2019	1,046	69	28	15	29	4	18	1,208
2020	1,105	72	30	16	30	4	19	1,276
2021	1,165	76	32	16	31	4	20	1,344
2022	1,228	80	33	17	33	4	21	1,416
2023	1,294	85	35	18	34	4	22	1,492
2024	1,364	89	37	19	36	4	23	1,572
2025	1,437	94	39	20	37	5	24	1,657
2026	1,515	99	41	21	39	5	25	1,745
2027	1,597	105	43	23	41	5	26	1,839
2028	1,683	110	46	24	43	5	27	1,938
2029	1,774	116	48	25	45	6	28	2,042
2030	1,870	122	51	26	47	6	29	2,151
2031	1,971	129	53	28	49	6	31	2,267
2032	2,077	136	56	29	51	6	32	2,388
2033	2,189	143	59	31	53	7	34	2,517
2034	2,307	151	63	33	56	7	35	2,652

Earth Road Types

Low traffic	Car	Pick Up	Minibus	Bus	2-Ax Truck	3-Ax Truck	>3-Ax Truck	Total
2010 - 2020	5.65%	5.65%	5.65%	5.65%	4.73%	4.73%	4.73%	0
2021 forward	5.40%	5.40%	5.40%	5.40%	4.50%	4.50%	4.50%	0
2009	85	6	2	1	3	1	2	99
2010	90	6	2	1	3	1	2	105
2011	95	6	3	1	3	1	2	111
2012	101	7	3	1	3	1	2	117
2013	106	7	3	2	3	1	2	123
2014	112	7	3	2	3	1	2	130
2015	119	8	3	2	3	1	2	138
2016	125	8	3	2	4	1	2	145
2017	133	9	4	2	4	1	2	153
2018	140	9	4	2	4	1	2	162
2019	148	10	4	2	4	1	3	171
2020	156	10	4	2	4	1	3	181
2021	165	11	4	2	4	1	3	190
2022	174	11	5	2	5	1	3	201
2023	183	12	5	3	5	1	3	211
2024	193	13	5	3	5	1	3	223
2025	203	13	6	3	5	1	3	235
2026	214	14	6	3	6	1	3	247
2027	226	15	6	3	6	1	4	260
2028	238	16	6	3	6	1	4	274
2029	251	16	7	4	6	1	4	289
2030	264	17	7	4	7	1	4	305
2031	279	18	8	4	7	1	4	321
2032	294	19	8	4	7	1	5	338
2033	310	20	8	4	8	2	5	356
2034	326	21	9	5	8	2	5	376

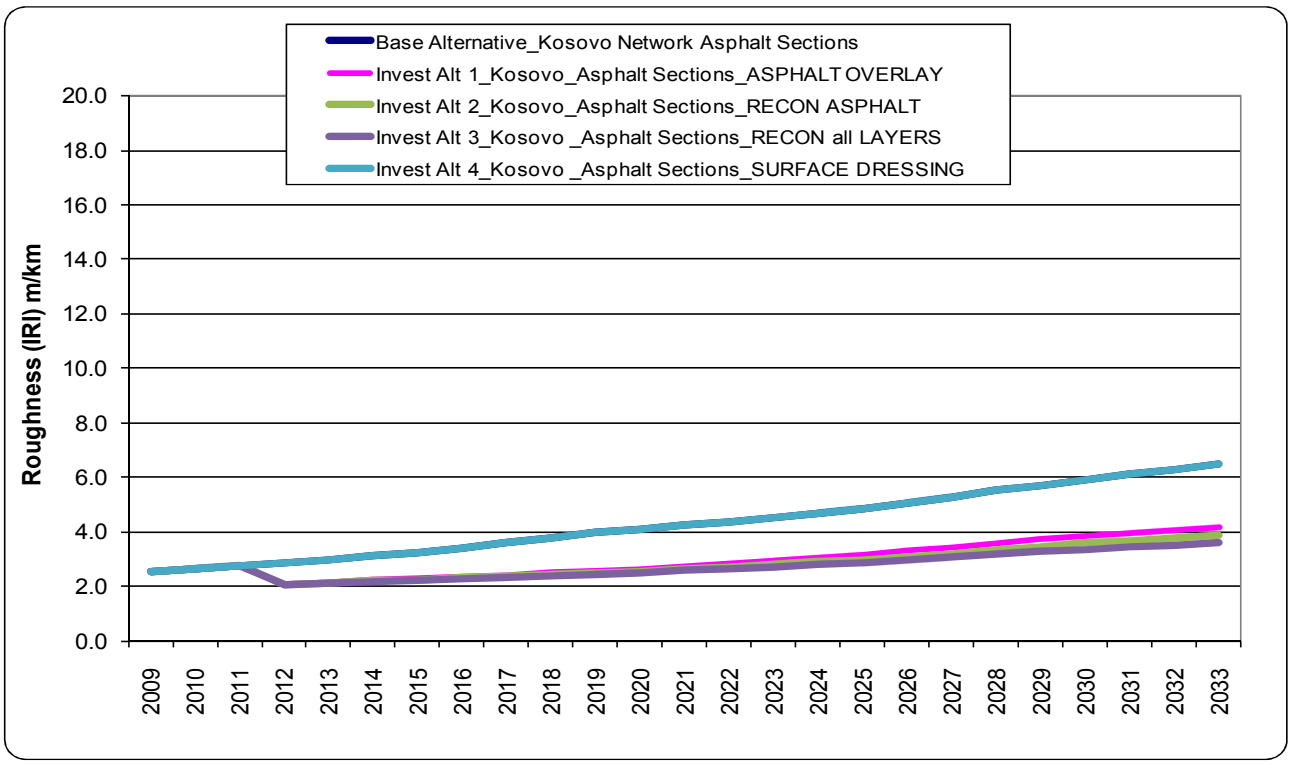
Medium Traffic	Car	Pick Up	Minibus	Bus	2-Ax Truck	3-Ax Truck	>3-Ax Truck	Total
2010 - 2020	5.65%	5.65%	5.65%	5.65%	4.73%	4.73%	4.73%	0
2021 forward	5.40%	5.40%	5.40%	5.40%	4.50%	4.50%	4.50%	0
2009	259	17	7	4	8	1	5	300
2010	273	18	7	4	8	1	5	317
2011	289	19	8	4	8	1	5	335
2012	305	20	8	4	9	1	6	353
2013	322	21	9	5	9	1	6	373
2014	341	22	9	5	10	1	6	394
2015	360	24	10	5	10	1	6	416
2016	380	25	10	5	11	1	7	439
2017	402	26	11	6	11	1	7	464
2018	424	28	12	6	12	1	7	490
2019	448	29	12	6	12	2	8	518
2020	473	31	13	7	13	2	8	547
2021	499	33	14	7	13	2	8	576
2022	526	34	14	7	14	2	9	607
2023	554	36	15	8	15	2	9	639
2024	584	38	16	8	15	2	10	674
2025	616	40	17	9	16	2	10	710
2026	649	43	18	9	17	2	11	748
2027	684	45	19	10	18	2	11	788
2028	721	47	20	10	18	2	12	830
2029	760	50	21	11	19	2	12	875
2030	801	52	22	11	20	2	13	922
2031	844	55	23	12	21	3	13	971
2032	890	58	24	13	22	3	14	1,023
2033	938	61	25	13	23	3	14	1,078
2034	989	65	27	14	24	3	15	1,136

High traffic	Car	Pick Up	Minibus	Bus	2-Ax Truck	3-Ax Truck	>3-Ax Truck	Total
2010 - 2020	5.65%	5.65%	5.65%	5.65%	4.73%	4.73%	4.73%	0
2021 forward	5.40%	5.40%	5.40%	5.40%	4.50%	4.50%	4.50%	0
2009	604	40	16	9	18	2	11	700
2010	638	42	17	9	19	2	12	739
2011	674	44	18	10	20	2	13	781
2012	712	47	19	10	21	3	13	825
2013	752	49	20	11	22	3	14	871
2014	795	52	22	11	23	3	14	920
2015	840	55	23	12	24	3	15	971
2016	887	58	24	13	25	3	16	1,026
2017	937	61	25	13	26	3	17	1,083
2018	990	65	27	14	27	3	17	1,144
2019	1,046	69	28	15	29	4	18	1,208
2020	1,105	72	30	16	30	4	19	1,276
2021	1,165	76	32	16	31	4	20	1,344
2022	1,228	80	33	17	33	4	21	1,416
2023	1,294	85	35	18	34	4	22	1,492
2024	1,364	89	37	19	36	4	23	1,572
2025	1,437	94	39	20	37	5	24	1,657
2026	1,515	99	41	21	39	5	25	1,745
2027	1,597	105	43	23	41	5	26	1,839
2028	1,683	110	46	24	43	5	27	1,938
2029	1,774	116	48	25	45	6	28	2,042
2030	1,870	122	51	26	47	6	29	2,151
2031	1,971	129	53	28	49	6	31	2,267
2032	2,077	136	56	29	51	6	32	2,388
2033	2,189	143	59	31	53	7	34	2,517
2034	2,307	151	63	33	56	7	35	2,652

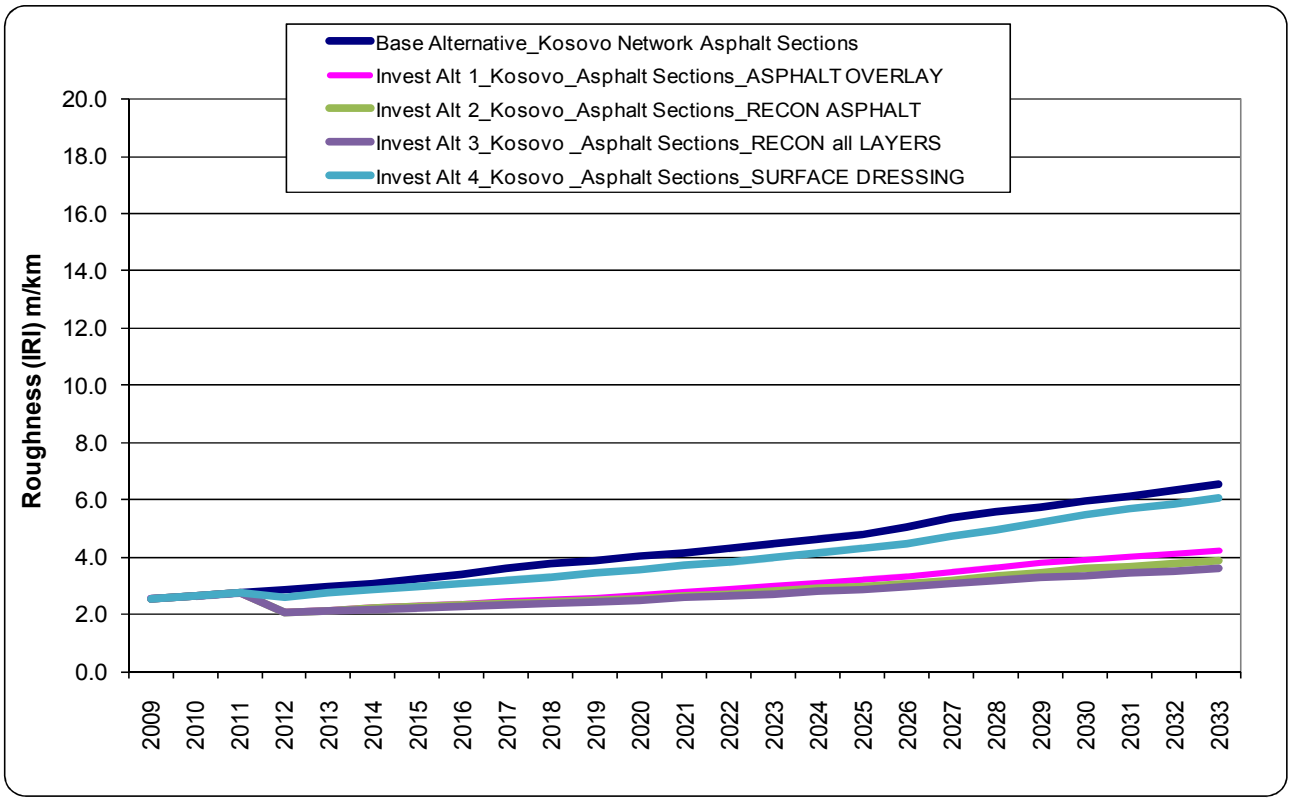
Appendix 8-2 Roughness development

Appendix 8-2

A1 and A2_Good Asphalt

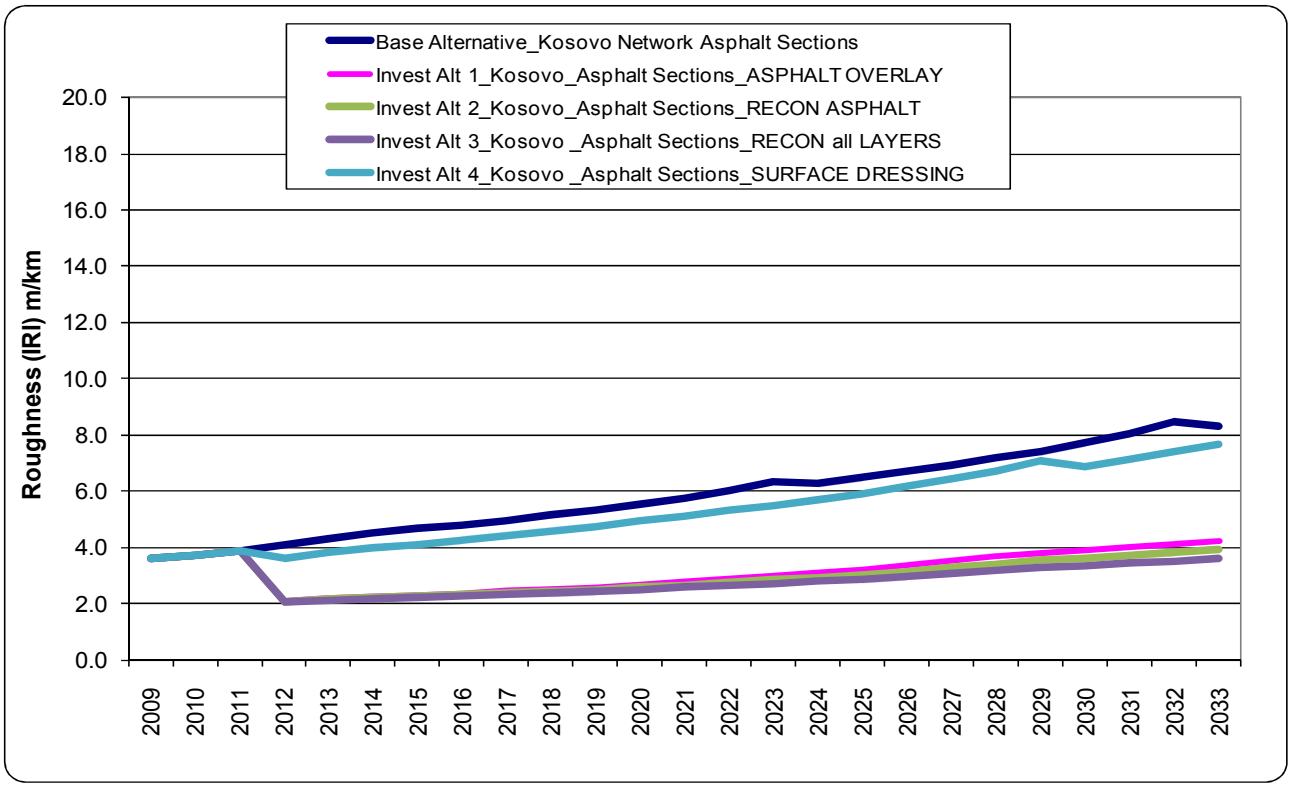


A3 and A4_Medium Good Asphalt

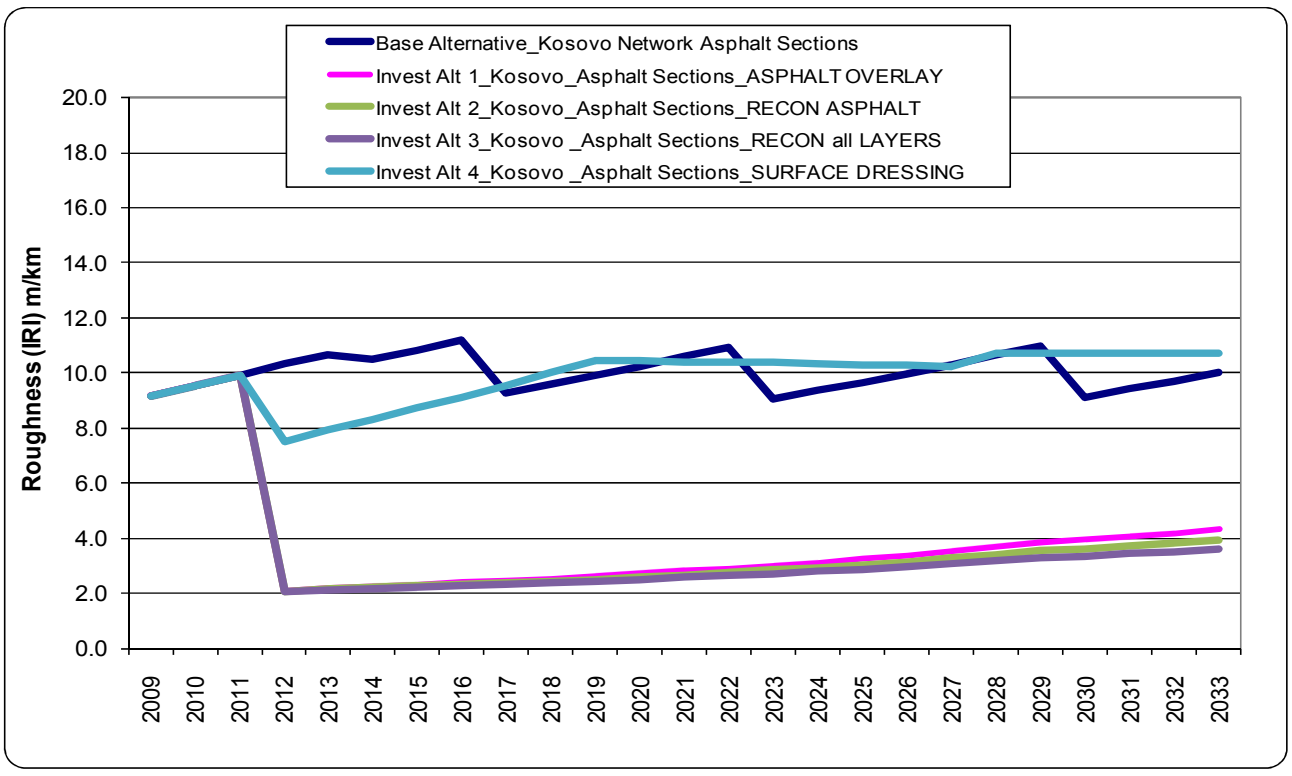


Appendix 8-2

A5 and A6_Medium Poor Asphalt

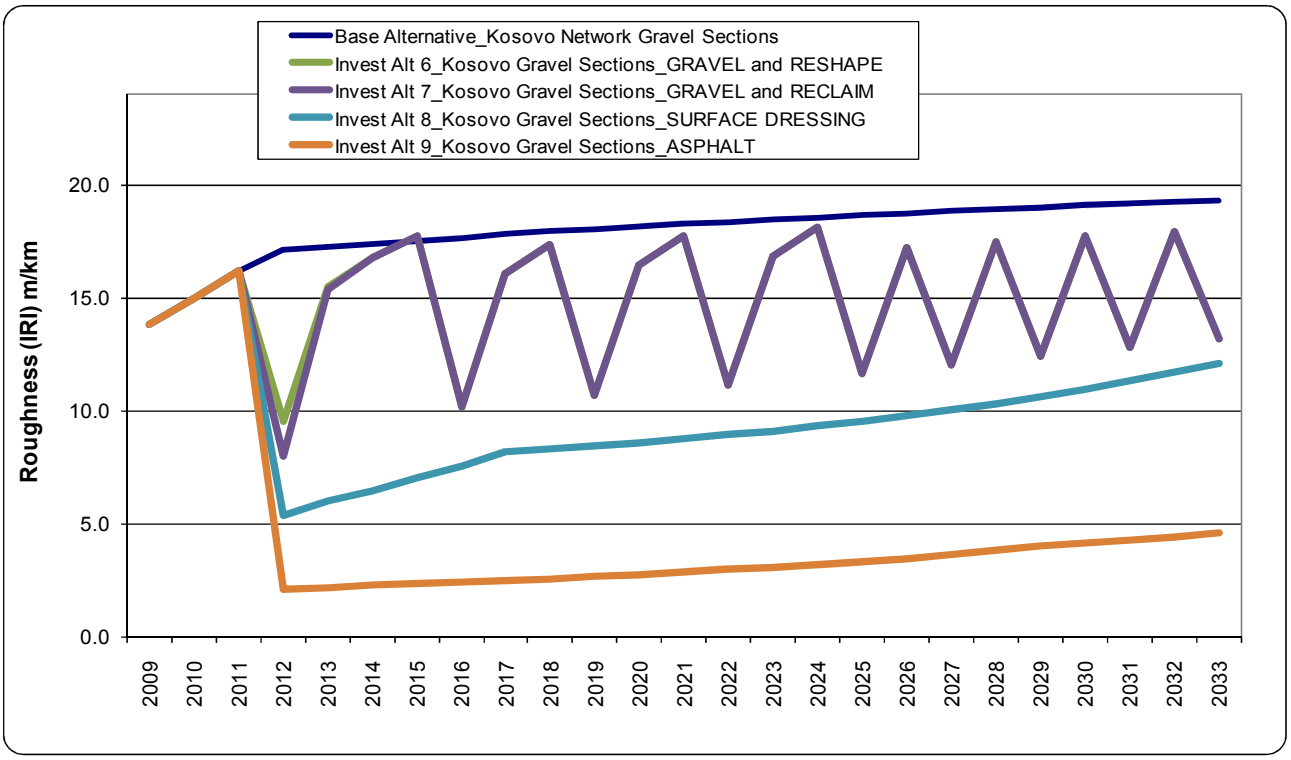


A7 and A8_Poor Asphalt

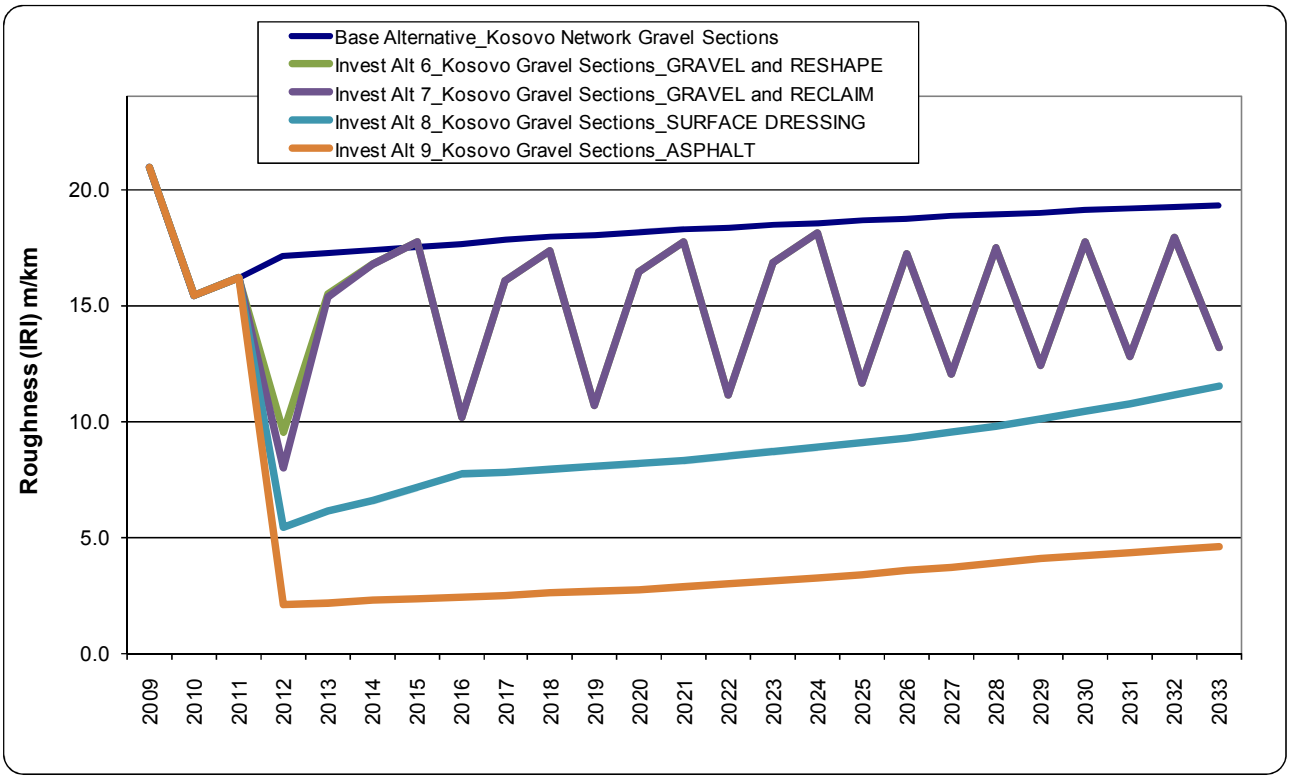


Appendix 8-2

G1 and G2_Fair Gravel

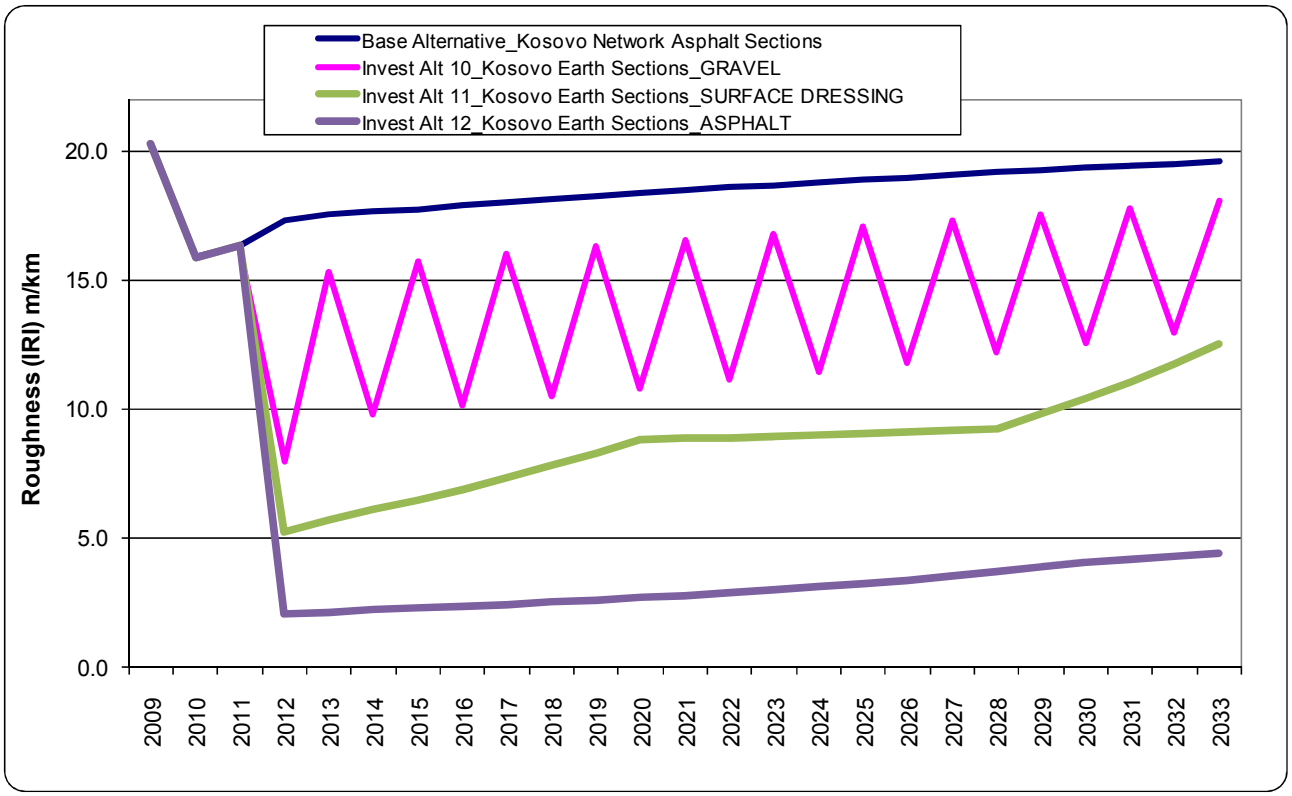


G3 and G4_Poor Gravel



Appendix 8-2

E1 and E2_Earth



Appendix 9-1 Ranking of road types - Alternative 1 and 2

Alternative 1

Ranking	Condition of Roads						Economic Indicators					Alternative (work measures)		Length of selected survey network			Inhabi-tants (ave.)	Vehic- les (ave.)	Per every group of Ranked Road Type							Total Costs (EURO)	
	Road Type Code	Road name	Road Type	Surface Condition	Drai-nage	Traffic level	EIRR (%)	Cost/ km (EURO)	NPV/km 2010 (1,000 Euro)	NPV/ Cost Ratio	Mainte-nance Costs/km (NPV Euro)	Work Measure	Alter-native	Length (km)	Length (%) of total net-work	Length (%) of road type	Inhabi-tants (ave.)	Vehic- les (ave.)	Vehic-les (ave.)	Inhabi-tants (ave 2,866)	Length (km)	Length (%) of net-work	Ave. Cost/ km (Euro) of Group of Ranked Road Type	Total Mainte-nance Cost (NPV Euro) per Group of Ranked Road Type	Total Cost (Euro) per Group of Ranked Road Type	Total Mainte-nance Cost (Euro) per Road Type	Total Cost (Euro) per Road Type
1	G-T11	Poor GRAVEL surface, Good drainage,	Gravel	Poor	Good	High	80.9%	86,592	660.4	7.63	171,712	SURFACE DRESSING	ALT 8	6.4	0%	1%	1,669	929								1,098,958	554,189
2	G-T5	Fair GRAVEL surface, Good drainage,	Gravel	Fair	Good	High	71.0%	102,336	648.2	6.33	180,226	SURFACE DRESSING	ALT 8	14.6	1%	3%	4,699	880								2,631,294	1,494,106
3	G-T12	Poor GRAVEL surface, Poor drainage,	Gravel	Poor	Poor	High	62.2%	110,592	639.9	5.79	171,712	SURFACE DRESSING	ALT 8	13.8	1%	3%	1,749	111								2,369,627	1,526,170
4	G-T6	Fair GRAVEL surface, Poor drainage,	Gravel	Fair	Poor	High	56.8%	126,336	627.7	4.97	180,226	SURFACE DRESSING	ALT 8	7.6	0%	2%	1,974	1,342								1,369,715	960,154
5	A-T23	Poor ASPHALT, Good drainage,	Asphalt	Full replace	Good	High	37.2%	115,920	353.0	3.05	41,652	OVERLAY	ALT 1	31.2	2%	3%	3,840	1,100	Average/Sum of 10 ranked road types							1,299,545	3,616,704
6	E-T6	EARTH road, Poor drainage,	Earth	Earth	Poor	High	31.6%	255,840	699.2	2.73	79,436	SURFACE DRESSING	ALT 11	5.8	0%	18%	2,224	693								460,730	1,483,872
7	A-T17	Medium Poor ASPHALT, Good drainage,	Asphalt	Part replace	Good	High	31.2%	28,800	55.7	1.93	41,275	SURFACE DRESSING	ALT 4	34	2%	3%	3,395	984								1,403,345	979,200
8	A-T24	Poor ASPHALT, Poor drainage,	Asphalt	Full replace	Poor	High	31.1%	139,920	333.6	2.38	41,662	OVERLAY	ALT 1	25.2	2%	2%	3,484	1,414								1,049,872	3,525,984
9	G-T9	Poor GRAVEL surface, Good drainage,	Gravel	Poor	Good	Medium	24.6%	86,592	132.3	1.20	158,509	SURFACE DRESSING	ALT 8	16.2	1%	3%	3,037	284								2,567,853	1,402,790
10	G-T3	Fair GRAVEL surface, Good drainage,	Gravel	Fair	Good	Medium	21.6%	102,336	113.8	0.90	169,635	SURFACE DRESSING	ALT 8	42.6	3%	9%	1,627	327	806	2,770	197	13%	115,526	21,477,393	19,902,682	7,226,454	4,359,514
11	A-T21	Poor ASPHALT, Good drainage,	Asphalt	Full replace	Good	Medium	20.7%	115,920	140.9	1.01	31,549	OVERLAY	ALT 1	15	1%	1%	1,814	290								473,232	1,738,800
12	A-T11	Medium Good ASPHALT, Good drainage,	Asphalt	Some damages	Good	High	19.9%	30,600	37.2	1.22	35,527	SURFACE DRESSING	ALT 4	22.8	1%	2%	2,958	1,166								810,014	697,680
13	A-T15	Medium Poor ASPHALT, Good drainage,	Asphalt	Some damages	Good	Medium	19.8%	28,800	24.4	0.46	28,196	SURFACE DRESSING	ALT 4	21.4	1%	2%	3,019	328								603,392	616,320
14	G-T10	Poor GRAVEL surface, Poor drainage,	Gravel	Poor	Poor	Medium	18.6%	110,592	111.8	1.29	158,509	SURFACE DRESSING	ALT 8	180.2	12%	36%	2,828	302								28,563,398	19,928,678
15	A-T22	Poor ASPHALT, Poor drainage,	Asphalt	Full replace	Poor	Medium	17.1%	139,920	121.2	1.05	31,229	OVERLAY	ALT 1	28.8	2%	3%	2,286	337	Average/Sum of 10 ranked road types							899,385	4,029,696
16	G-T4	Fair GRAVEL surface, Poor drainage,	Gravel	Fair	Poor	Medium	16.6%	126,336	93.3	0.91	169,635	SURFACE DRESSING	ALT 8	26.4	2%	5%	2,151	331								4,478,366	3,335,270
17	A-T18	Medium Poor ASPHALT, Poor drainage,	Asphalt	Part replace	Poor	High	15.4%	52,800	35.6	0.67	41,275	SURFACE DRESSING	ALT 4	31.4	2%	3%	3,273	804								1,296,051	1,657,920
18	A-T13	Medium Poor ASPHALT, Good drainage,	Asphalt	Some damages	Good	Low	14.7%	28,800	12.5	0.43	26,012	SURFACE DRESSING	ALT 4	1.8	0%	0%	764	134								46,821	51,840
19	A-T19	Poor ASPHALT, Good drainage,	Asphalt	Full replace	Good	Low	13.9%	115,920	61.4	0.53	30,329	OVERLAY	ALT 1	12.2	1%	1%	2,726	155								370,008	1,414,224
20	E-T4	EARTH road, Poor drainage,	Earth	Earth	Poor	Medium	11.7%	255,840	109.1	0.43	69,673	SURFACE DRESSING	ALT 11	8.8	1%	27%	3,665	348	419	2,548	349	22%	100,553	38,153,785	35,721,821	613,119	2,251,392
21	A-T9	Medium Good ASPHALT, Good drainage,	Asphalt	Some damages	Good	Medium	11.3%	30,600	10.4	0.19	25,237	SURFACE DRESSING	ALT 4	22.4	1%	2%	2,280	328								565,303	685,440
22	A-T20	Poor ASPHALT, Poor drainage,	Asphalt	Full replace	Poor	Low	10.9%	139,920	41.0	0.29	30,329	OVERLAY	ALT 1	23	1%	2%	1,474	151								697,557	3,218,160
23	A-T12	Medium Good ASPHALT, Poor drainage,	Asphalt	Some damages	Poor	High	10.7%	54,600	16.8	0.31	35,527	SURFACE DRESSING	ALT 4	15.6	1%	2%	7,330	920								554,222	851,760
24	A-T16	Medium Poor ASPHALT, Poor drainage,	Asphalt	Some damages	Poor	Medium	8.1%	52,800	4.0	0.14	28,196	SURFACE DRESSING	ALT 4	8	1%	1%	2,798	371								225,568	422,400
25	A-T7	Medium Good ASPHALT, Good drainage,	Asphalt	Some damages	Good	Low	7.0%	30,600	0.1	0.00	23,622	SURFACE DRESSING	ALT 4	15.8	1%	2%	1,681	145	Average/Sum of 10 ranked road types							373,227	483,480
26	A-T14	Medium Poor ASPHALT, Poor drainage,	Asphalt	Some damages	Poor	Low	4.4%	52,800	-7.9	-0.15	26,013	SURFACE DRESSING	ALT 4	9.4	1%	1%	1,440	145								244,524	496,320
27	A-T10	Medium Good ASPHALT, Poor drainage,	Asphalt	Some damages	Poor	Medium	4.4%	54,600	-10.0	-0.33	25,237	SURFACE DRESSING	ALT 4	15	1%	1%	1,981	327								378,551	819,000
28	G-T7	Poor GRAVEL surface, Good drainage,	Gravel	Poor	Good	Low	2.3%	309,936	-111.3	-0.36	20,141	ASPHALT	ALT 9	23.2	1%	5%	1,536	109								467,264	7,190,515
29	G-T8	Poor GRAVEL surface, Poor drainage,	Gravel	Poor	Poor	Low	1.8%	333,936	-131.8	-0.39	20,141	ASPHALT	ALT 9	140.8	9%	28%	1,698	98								2,835,810	47,018,189
30	G-T1	Fair GRAVEL surface, Good drainage,	Gravel	Fair	Good	Low	1.3%	366,288	-154.3	-0.42	21,756	ASPHALT	ALT 9	10.8	1%	2%	2,220	95	269	2,444	284	18%	142,608	6,576,985	65,141,174	234,960	3,955,910
31	G-T2	Fair GRAVEL surface, Poor drainage,	Gravel	Fair	Poor	Low	0.9%	390,288	-174.8	-0.45	21,756	ASPHALT	ALT 9	13.8	1%	3%	1,749	111								300,226	5,385,974
32	A-T8	Medium Good ASPHALT, Poor drainage,	Asphalt	Some damages	Poor	Low	0.3%	54,600	-20.4	-0.37	23,623	SURFACE DRESSING	ALT 4	11.2	1%	1%	2,101	155								264,581	611,520
33	E-T2	EARTH road, Poor drainage,	Earth	Earth	Poor	Low	-1.6%	462,240	-269.1	-0.58	18,090	ASPHALT	ALT 12	17.6	1%	55%	2,146	88								318,392	8,135,424
34	A-T5	Good ASPHALT, Good drainage,	Asphalt	Good	Good	High	-2.2%	136,080	-85.4	-0.63	26,823	OVERLAY	ALT 1	228.4	15%	22%	3,578	1,105	Average/Sum of 9 ranked road types							6,126,431	31,080,672
35	A-T6	Good ASPHALT, Poor drainage,	Asphalt	Good	Poor	High	-3.3%	160,080	-106.0	-0.66	26,823	OVERLAY	ALT 1	80.8	5%	8%	4,890	826								2,167,320	12,934,464
36	A-T3	Good ASPHALT, Good drainage,	Asphalt	Good	Good	Medium	-4.4%	136,080	-93.9	-0.59	20,784	OVERLAY	ALT 1	171.6	11%	17%	2,453	342								3,566,451	23,351,328
37	A-T4	Good ASPHALT, Poor drainage,	Asphalt	Good	Poor	Medium	-5.1%	160,080	-114.5	-0.84	21,142	OVERLAY	ALT 1	66.2	4%	6%	3,113	367								1,399,596	10,597,296
38	A-T1	Good ASPHALT, Good drainage,	Asphalt	Good	Good	Low	-6.1%	136,080	-97.6	-0.72	20,251	OVERLAY	ALT 1	108.8	7%	11%	1,762	128								2,203,336	14,805,504
39	A-T2	Good ASPHALT, Poor drainage,	Asphalt	Good	Poor	Low	-6.4%	160,080	-118.5	-0.74	20,647	OVERLAY	ALT 1	26.8	2%	3%	1,931	133	362	2,636	725	47%	199,512	16,899,672	111,192,326	553,338	4,290,144
														1,555	100%						**1,555**	**100%**		**83,107,834**	**231,958,003**	**83,107,834**	**231,958,003**

Alternative 2

Ranking	Condition of Roads						Economic Indicators					Alternative (work measures)		Length of selected survey network			Inhabi-tants (ave.)	Vehic- les (ave.)	Per every group of Ranked Road Type							Total Costs (EURO)	
	Road Type Code	Road name	Road Type	Surface Condition	Drai-nage	Traffic level	EIRR (%)	Cost/ km (EURO)	NPV/km 2010 (1,000 Euro)	NPV/ Cost Ratio	Mainte-nance Costs/km (NPV Euro)	Work Measure	Alter-native	Length (km)	Length (%) of total net-work	Length (%) of road type	Inhabi-tants (ave.)	Vehic- les (ave.)	Vehic-les (ave.)	Inhabi-tants (ave 2,866)	Length (km)	Length (%) of net-work	Ave. Cost/ km (Euro) of Group of Ranked Road Type	Total Mainte-nance Cost (NPV Euro) per Group of Ranked Road Type	Total Cost (Euro) per Group of Ranked Road Type	Total Mainte-nance Cost (Euro) per Road Type	Total Cost (Euro) per Road Type
1	A-T23	Poor ASPHALT, Good drainage,	Asphalt	Full replace	Good	High	37.2%	115,920	353.0	3.05	41,652	OVERLAY	ALT 1	31.2	2%	3%	3,840	1,100								1,299,545	3,616,704
2	A-T17	Poor ASPHALT, Good drainage,	Asphalt	Part replace	Good	High	31.2%	28,800	55.7	1.93	41,275	SURFACE DRESSING	ALT 4	34	2%	3%	3,395	984								1,403,345	979,200
3	A-T24	Poor ASPHALT, Poor drainage,	Asphalt	Full replace	Poor	High	31.1%	139,920	333.6	2.38	41,662	OVERLAY	ALT 1	25.2	2%	2%	3,484	1,414								1,049,872	3,525,984
4	G-T11	Poor GRAVEL surface, Good drainage,	Gravel	Poor	Good	High	29.4%	309,936	858.8	2.77	33,812	ASPHALT	ALT 9	6.4	0%	1%	1,669	929								216,400	1,983,590
5	G-T12	Poor GRAVEL surface, Poor drainage,	Gravel	Poor	Poor	High	27.5%	333,936	838.4	2.51	33,812	ASPHALT	ALT 9	13.8	1%	3%	1,749	111								466,612	4,608,317
6	G-T5	Fair GRAVEL surface, Good drainage,	Gravel	Fair	Good	High	25.8%	366,288	824.0	2.25	34,972	ASPHALT	ALT 9	14.6	1%	3%	4,699	880								510,589	5,347,805
7	G-T6	Fair GRAVEL surface, Poor drainage,	Gravel	Fair	Poor	High	24.4%	390,288	803.5	2.06	34,972	ASPHALT	ALT 9	7.6	0%	2%	1,974	1,342								265,786	2,966,189
8	G-T3	Fair GRAVEL surface, Good drainage,	Gravel	Fair	Good	Medium	21.6%	102,336	113.8	0.90	169,635	SURFACE DRESSING	ALT 8	42.6	3%	9%	1,627	327								7,226,454	4,359,514
9	E-T6	EARTH road, Poor drainage,	Earth	Earth	Poor	High	20.7%	462,240	730.3	1.58	30,896	ASPHALT	ALT 12	5.8	0%	18%	2,224	693								179,197	2,680,992
10	A-T21	Poor ASPHALT, Good drainage,	Asphalt	Full replace	Good	Medium	20.7%	115,920	140.9	1.01	31,549	OVERLAY	ALT 1	15	1%	1%	1,814	290	807	2,648	196	13%	236,558	13,091,033	31,807,094	473,232	1,738,800
11	A-T11	Good ASPHALT, Good drainage,	Asphalt	Some damages	Good	High	19.9%	30,600	37.2	1.22	35,527	SURFACE DRESSING	ALT 4	22.8	1%	2%	2,958	1,166								810,014	697,680
12	A-T15	Poor ASPHALT, Good drainage,	Asphalt	Some damages	Good	Medium	19.8%	28,800	24.4	0.46	28,196	SURFACE DRESSING	ALT 4	21.4	1%	2%	3,019	328								603,392	616,320
13	A-T22	Poor ASPHALT, Poor drainage,	Asphalt	Full replace	Poor	Medium	17.1%	139,920	121.2	1.05	31,229	OVERLAY	ALT 1	28.8	2%	3%	2,286	337								899,385	4,029,696
14	A-T18	Poor ASPHALT, Poor drainage,	Asphalt	Part replace	Poor	High	15.4%	52,800	35.6	0.67	41,275	SURFACE DRESSING	ALT 4	31.4	2%	3%	3,273	804								1,296,051	1,657,920
15	A-T13	Poor ASPHALT, Good drainage,	Asphalt	Some damages	Good	Low	14.7%	28,800	12.5	0.43	26,012	SURFACE DRESSING	ALT 4	1.8	0%	0%	764	134								46,821	51,840
16	A-T19	Poor ASPHALT, Good drainage,	Asphalt	Full replace	Good	Low	13.9%	115,920	61.4	0.53	30,329	OVERLAY	ALT 1	12.2	1%	1%	2,726	155								370,008	1,414,224
17	G-T9	Poor GRAVEL surface, Good drainage,	Gravel	Poor	Good	Medium	12.6%	309,936	174.6	0.52	23,386	ASPHALT	ALT 9	16.2	1%	3%	3,037	284								378,851	5,020,963
18	G-T10	Poor GRAVEL surface, Poor drainage,	Gravel	Poor	Poor	Medium	11.6%	333,936	154.1	0.50	23,386	ASPHALT	ALT 9	180.2	12%	36%	2,828	302								4,214,128	60,175,267
19	A-T9	Good ASPHALT, Good drainage,	Asphalt	Some damages	Good	Medium	11.3%	30,600	10.4	0.19	25,237	SURFACE DRESSING	ALT 4	22.4	1%	2%	2,280	328								565,303	685,440
20	A-T20	Poor ASPHALT, Poor drainage,	Asphalt	Full replace	Poor	Low	10.9%	139,920	41.0	0.29	30,329	OVERLAY	ALT 1	23	1%	2%	1,474	151	399	2,464	360	23%	121,123	9,881,508	77,567,510	697,557	3,218,160
21	A-T12	Good ASPHALT, Poor drainage,	Asphalt	Some damages	Poor	High	10.7%	54,600	16.8	0.31	35,527	SURFACE DRESSING	ALT 4	15.6	1%	2%	7,330	920								554,222	851,760
22	G-T4	Fair GRAVEL surface, Poor drainage,	Gravel	Fair	Poor	Medium	10.1%	390,288	116.0	0.32	24,976	ASPHALT	ALT 9	26.4	2%	5%	2,151	331								659,374	10,303,603
23	A-T16	Poor ASPHALT, Poor drainage,	Asphalt	Some damages	Poor	Medium	8.1%	52,800	4.0	0.14	28,196	SURFACE DRESSING	ALT 4	8	1%	1%	2,798	371								225,568	422,400
24	E-T4	EARTH road, Poor drainage,	Earth	Earth	Poor	Medium	8.1%	462,240	46.3	0.10	21,033	ASPHALT	ALT 12	8.8	1%	27%	3,665	348								185,094	4,067,712
25	A-T7	Good ASPHALT, Good drainage,	Asphalt	Some damages	Good	Low	7.0%	30,600	0.1	0.00	23,622	SURFACE DRESSING	ALT 4	15.8	1%	2%	1,681	145								373,227	483,480
26	A-T14	Poor ASPHALT, Poor drainage,	Asphalt	Some damages	Poor	Low	4.4%	52,800	-7.9	-0.15	26,013	SURFACE DRESSING	ALT 4	9.4	1%	1%	1,440	145								244,524	496,320
27	A-T10	Good ASPHALT, Poor drainage,	Asphalt	Some damages	Poor	Medium	4.4%	54,600	-10.0	-0.33	25,237	SURFACE DRESSING	ALT 4	15	1%	1%	1,981	327								378,551	819,000
28	G-T7	Poor GRAVEL surface, Good drainage,	Gravel	Poor	Good	Low	2.3%	309,936	-111.3	-0.36	20,141	ASPHALT	ALT 9	23.2	1%	5%	1,536	109								467,264	7,190,515
29	G-T8	Poor GRAVEL surface, Poor drainage,	Gravel	Poor	Poor	Low	1.8%	333,936	-131.8	-0.39	20,141	ASPHALT	ALT 9	140.8	9%	28%	1,698	98								2,835,810	47,018,189
30	G-T1	Fair GRAVEL surface, Good drainage,	Gravel	Fair	Good	Low	1.3%	366,288	-154.3	-0.42	21,756	ASPHALT	ALT 9	10.8	1%	2%	2,220	95	289	2,650	274	18%	210,809	6,158,594	75,608,890	234,960	3,955,910
31	G-T2	Fair GRAVEL surface, Poor drainage,	Gravel	Fair	Poor	Low	0.9%	390,288	-174.8	-0.45	21,756	ASPHALT	ALT 9	13.8	1%	3%	1,749	111								300,226	5,385,974
32	A-T8	Good ASPHALT, Poor drainage,	Asphalt	Some damages	Poor	Low	0.3%	54,600	-20.4	-0.37	23,623	SURFACE DRESSING	ALT 4	11.2	1%	1%	2,101	155								264,581	611,520
33	E-T2	EARTH road, Poor drainage,	Earth	Earth	Poor	Low	-1.6%	462,240	-269.1	-0.58	18,090	ASPHALT	ALT 12	17.6	1%	55%	2,146	88								318,392	8,135,424
34	A-T5	Good ASPHALT, Good drainage,	Asphalt	Good	Good	High	-2.2%	136,080	-85.4	-0.63	26,823	OVERLAY	ALT 1	228.4	15%	22%	3,578	1,105								6,126,431	31,080,672
35	A-T6	Good ASPHALT, Poor drainage,	Asphalt	Good	Poor	High	-3.3%	160,080	-106.0	-0.66	26,823	OVERLAY	ALT 1	80.8	5%	8%	4,890	826								2,167,320	12,934,464
36	A-T3	Good ASPHALT, Good drainage,	Asphalt	Good	Good	Medium	-4.4%	136,080	-93.9	-0.59	20,784	OVERLAY	ALT 1	171.6	11%	17%	2,453	342								3,566,451	23,351,328
37	A-T4	Good ASPHALT, Poor drainage,	Asphalt	Good	Poor	Medium	-5.1%	160,080	-114.5	-0.84	21,142	OVERLAY	ALT 1	66.2	4%	6%	3,113	367								1,399,596	10,597,296
38	A-T1	Good ASPHALT, Good drainage,	Asphalt	Good	Good	Low	-6.1%	136,080	-97.6	-0.72	20,251	OVERLAY	ALT 1	108.8	7%	11%	1,762	128								2,203,336	14,805,504
39	A-T2	Good ASPHALT, Poor drainage,	Asphalt	Good	Poor	Low	-6.4%	160,080	-118.5	-0.74	20,647	OVERLAY	ALT 1	26.8	2%	3%	1,931	133	362	2,636	725	47%	199,512	16,899,672	111,192,326	553,338	4,290,144
														1,555	100%						**1,555**	**100%**		**46,030,807**	**296,175,821**	**46,030,807**	**296,175,821**

Average/Sum of 10 ranked road types

Average/Sum of 10 ranked road types

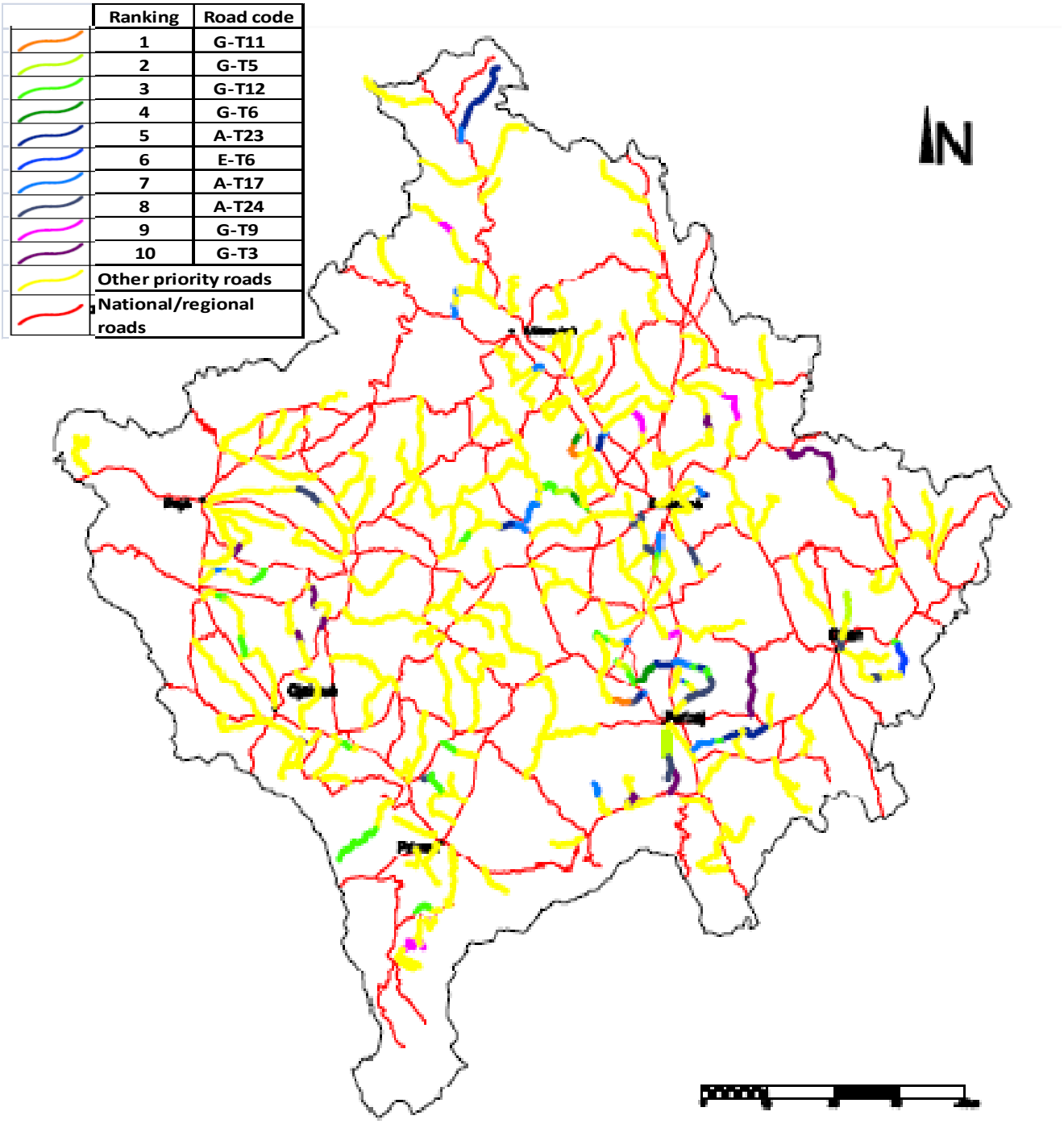
Average/Sum of 10 ranked road types

Average/Sum of 9 ranked road types

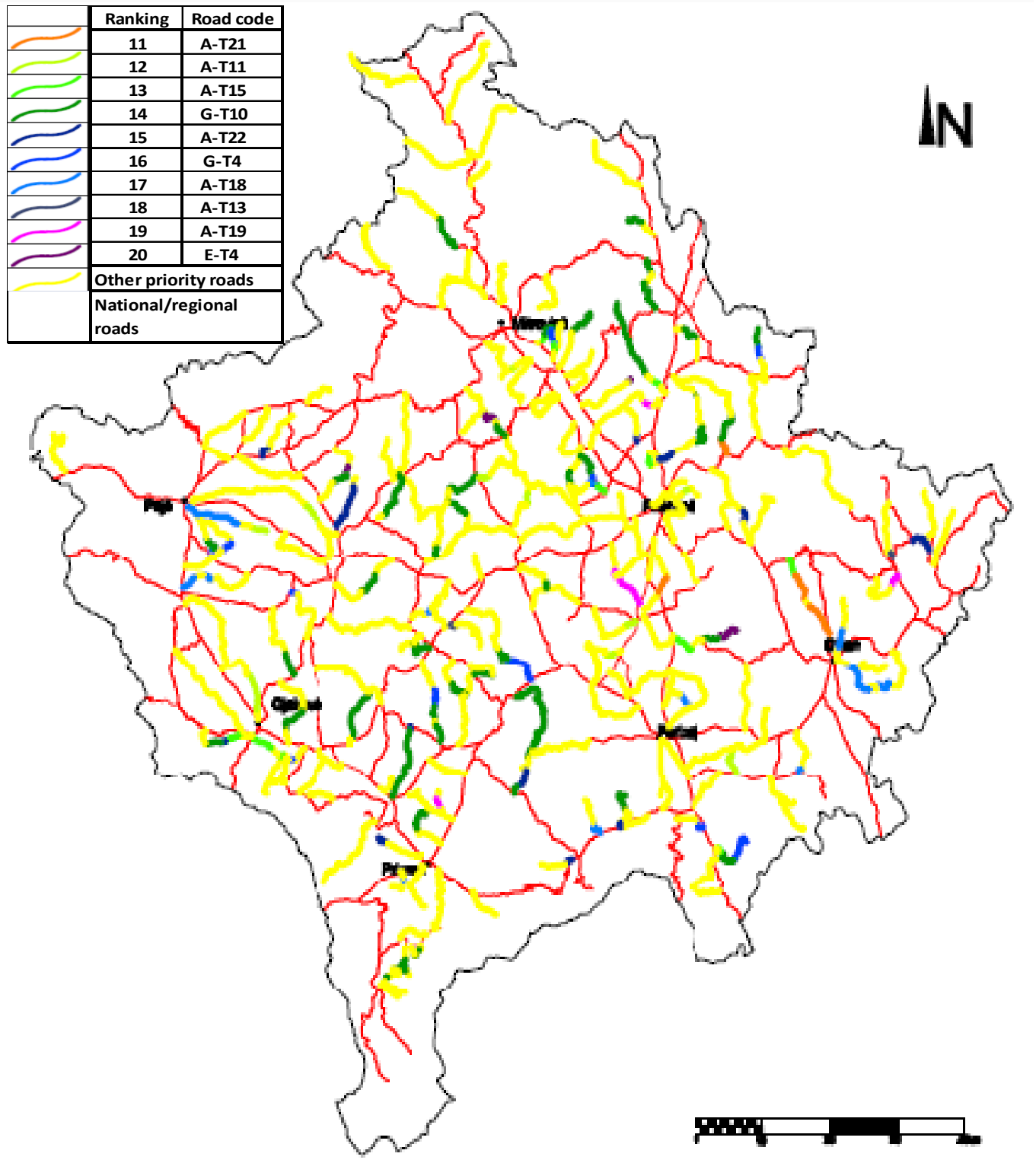
Appendix 9-2 Maps with location of road types

Alternative 1

Alternative 1: Maps with location of 10 highest ranked road types with interventions

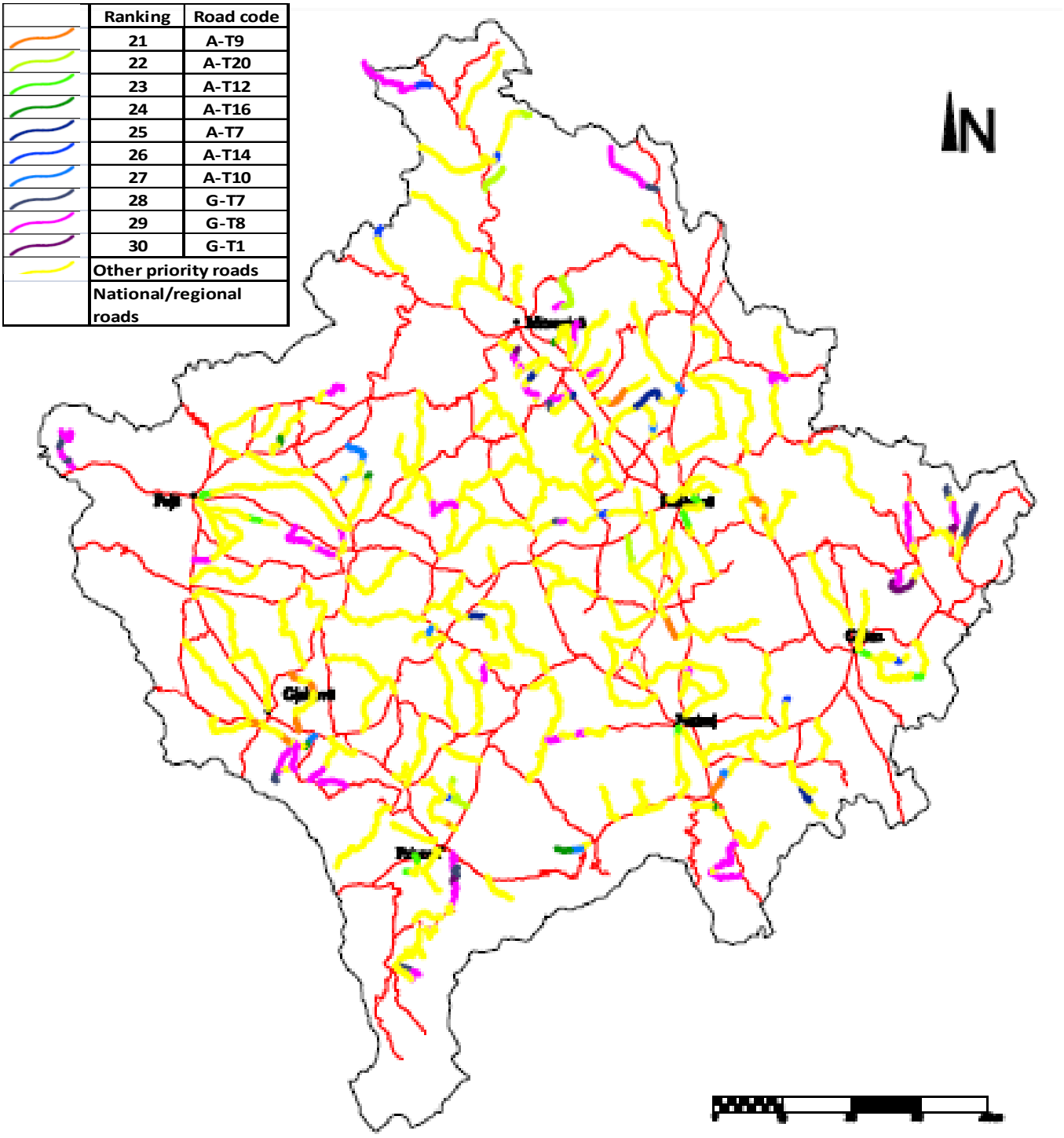


Alternative 1: Maps with location of 11-20 ranked road types with interventions



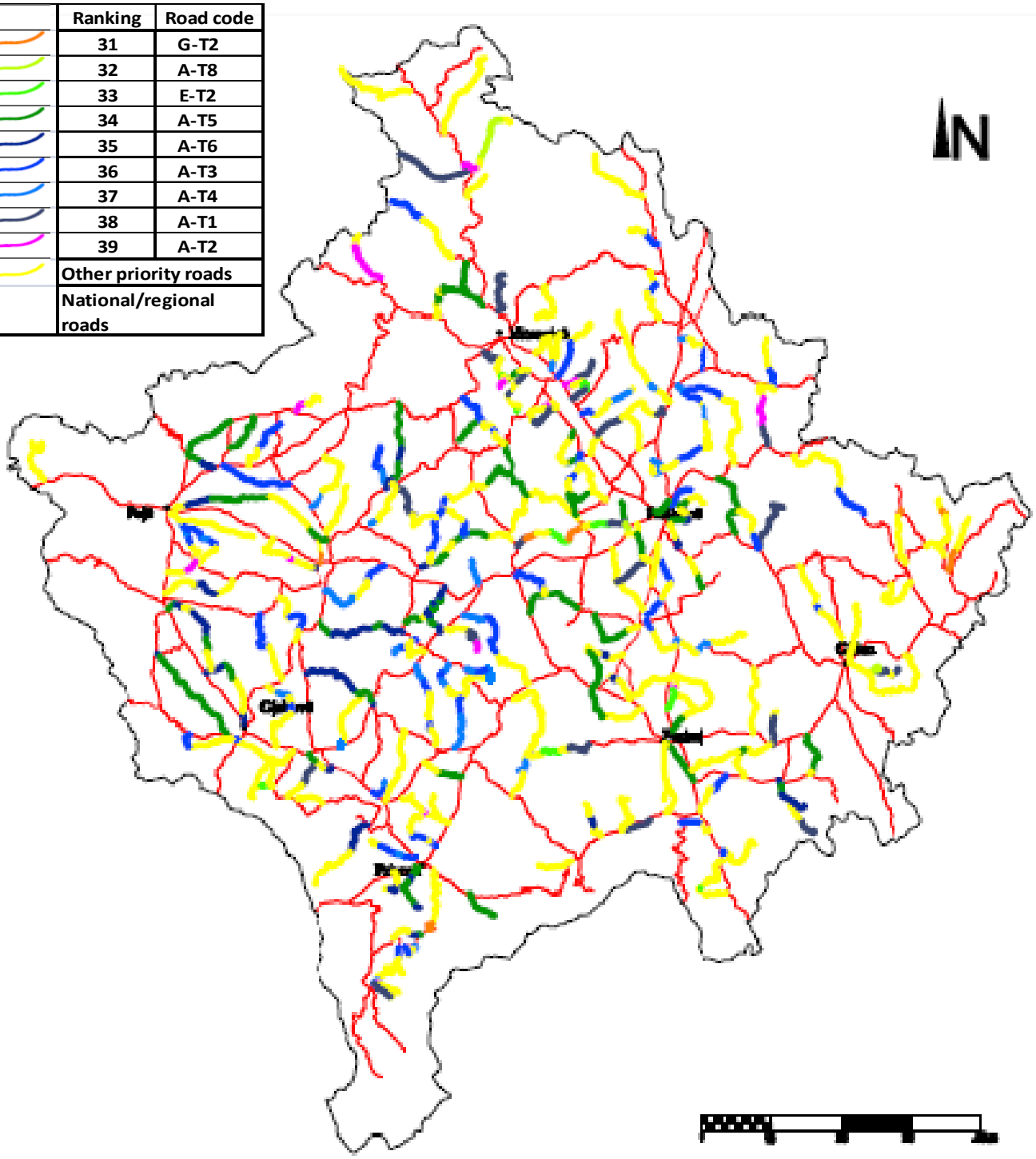
Alternative 1: Maps with location of 21-30 ranked road types with interventions

Ranking	Road code
21	A-T9
22	A-T20
23	A-T12
24	A-T16
25	A-T7
26	A-T14
27	A-T10
28	G-T7
29	G-T8
30	G-T1
Other priority roads	
National/regional roads	



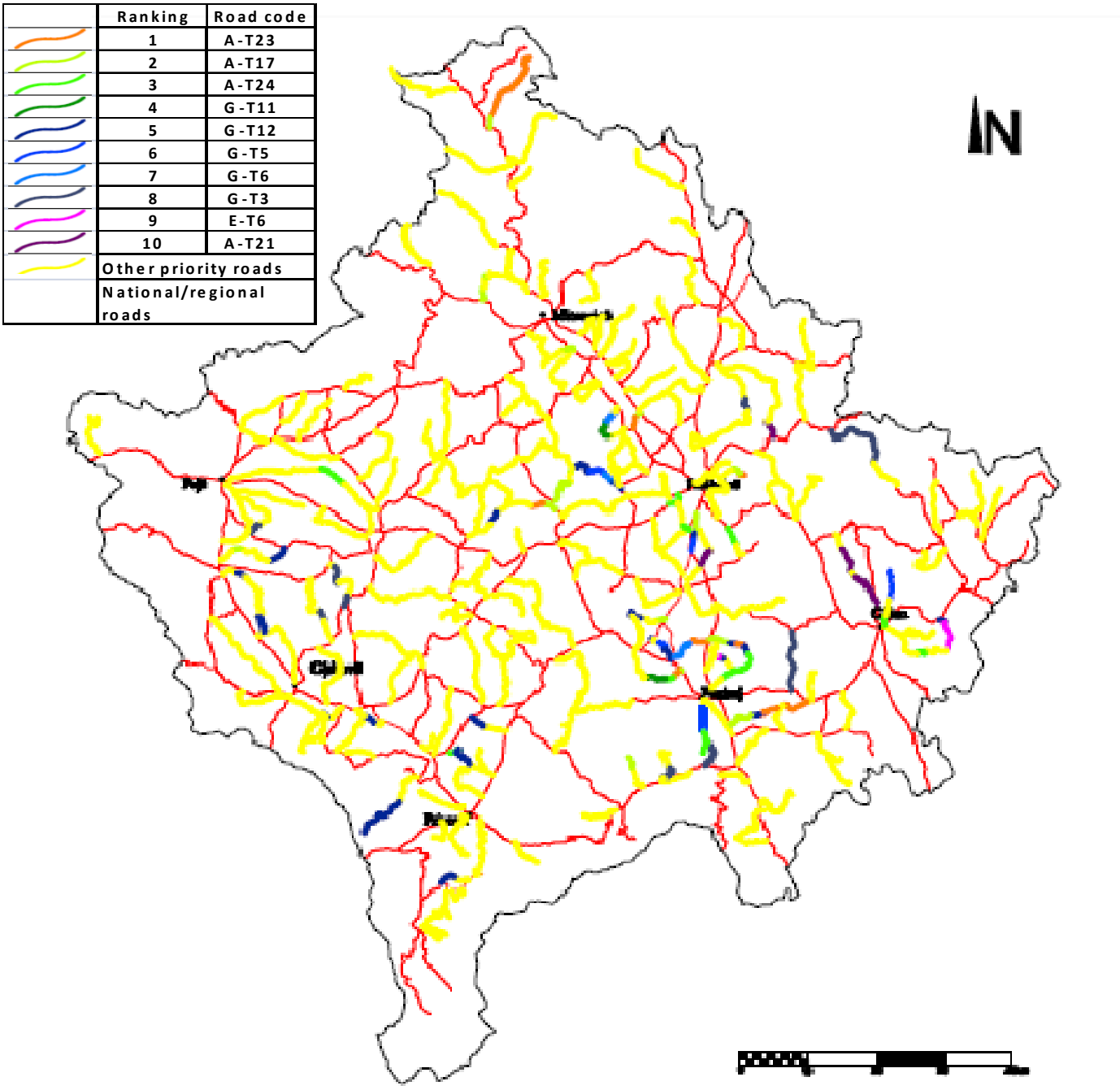
Alternative 1: Maps with location of 31-39 ranked road types with interventions

Ranking	Road code
31	G-T2
32	A-T8
33	E-T2
34	A-T5
35	A-T6
36	A-T3
37	A-T4
38	A-T1
39	A-T2
Other priority roads	
National/regional roads	



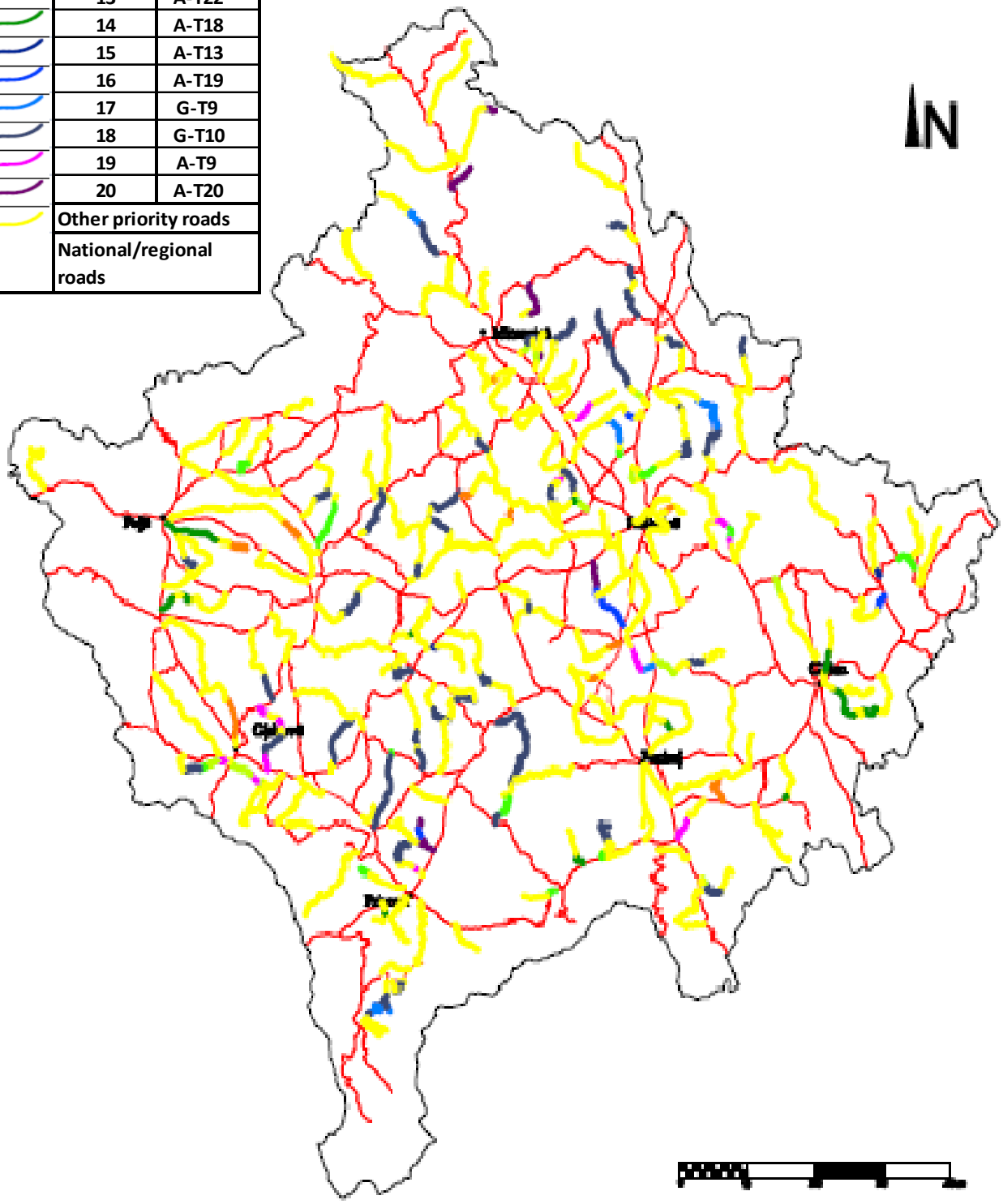
Alternative 2

Alternative 2: Maps with location of 10 highest ranked road types with interventions



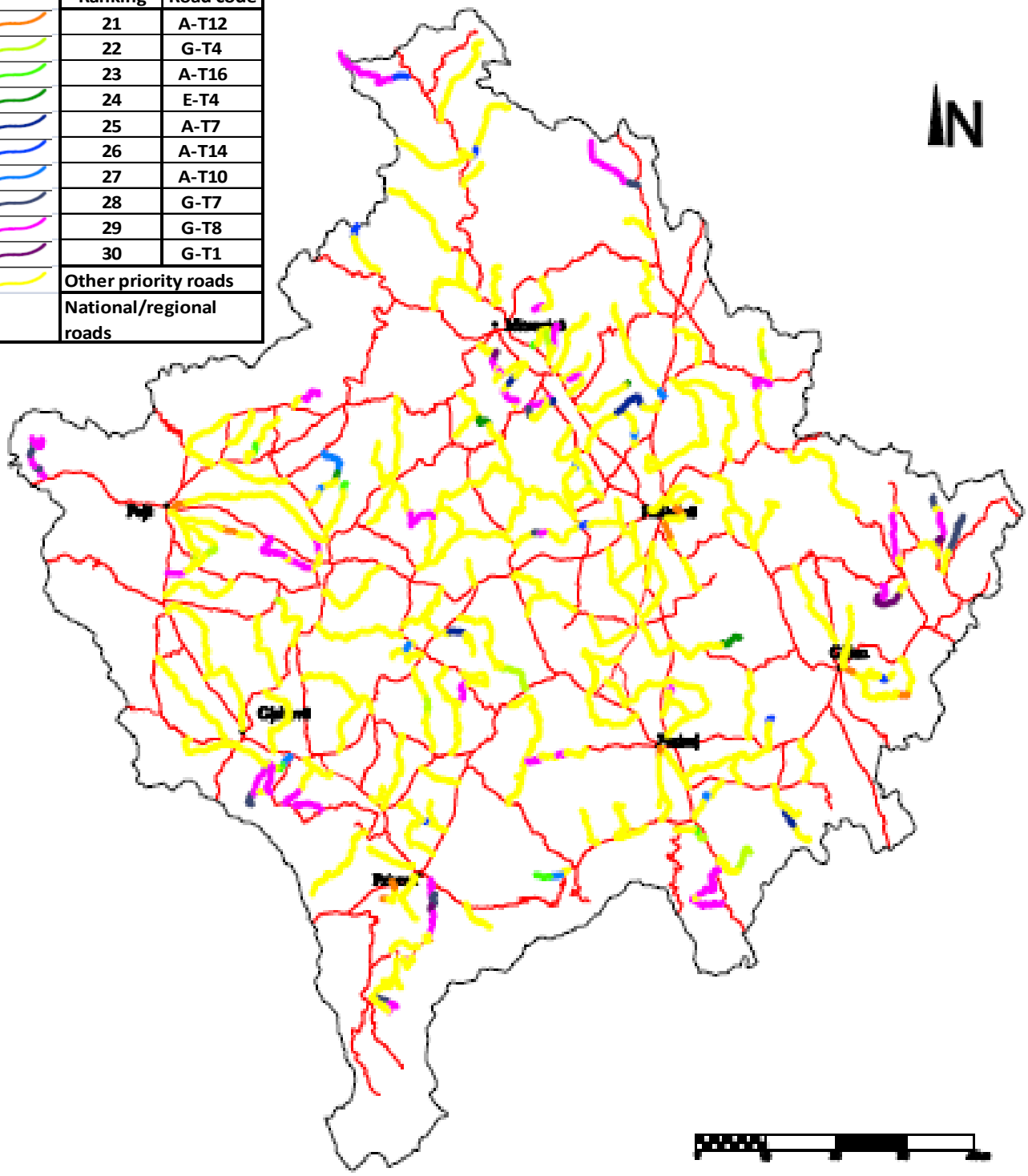
Alternative 2: Maps with location of 11-20 ranked road types with interventions

Ranking	Road code
11	A-T11
12	A-T15
13	A-T22
14	A-T18
15	A-T13
16	A-T19
17	G-T9
18	G-T10
19	A-T9
20	A-T20
Other priority roads	
National/regional roads	



Alternative 2: Maps with location of 21-30 ranked road types with interventions

Ranking	Road code
21	A-T12
22	G-T4
23	A-T16
24	E-T4
25	A-T7
26	A-T14
27	A-T10
28	G-T7
29	G-T8
30	G-T1
Other priority roads	
National/regional roads	



Alternative 2: Maps with location of 31-39 ranked road types with interventions

	Ranking	Road code
	31	G-T2
	32	A-T8
	33	E-T2
	34	A-T5
	35	A-T6
	36	A-T3
	37	A-T4
	38	A-T1
	39	A-T2
	Other priority roads	
	National/regional roads