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CONSULTANT: Ecoplan d.o.o. Mostar

APPLICATION FOR ISSUANCE (EXTENSION) OF THE ENVIRONMENTAL PERMIT FOR THE PROJECT "MOTORWAY ON CORRIDOR VC, LOT 2 SECTION DOBOJ SOUTH (KARUŠE) - SARAJEVO SOUTH (TARČIN) with a total length of 145 km"

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Date September 2019

PROJECT DATA

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PROJECT:	APPLICATION FOR ISSUANCE (EXTENSION) OF THE ENVIRONMENTAL PERMIT FOR THE PROJECT "MOTORWAY ON CORRIDOR VC, LOT 2 SECTION DOBOJ SOUTH (KARUŠE) - SARAJEVO SOUTH (TARČIN) with a total length of 145 km"
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TABLE OF CONTENTS

1 . INTRODUCTION 8
1.1. NAME AND ADDRESS OF OPERATOR 10
1.2. EXCERPT FROM THE PLANNING ACT 11
2 . DESCRIPTION OF THE PROJECT 14
2.1. DESCRIPTION OF THE WIDER LOCATION 14
2.2. DESCRIPTION OF THE NARROWER LOCATION 15
2.3. TECHNICAL DESCRIPTION OF THE PROJECT 18
2.3.1. LOAD-BEARING SYSTEMS AND TUNNELLING 48
2.3.2. MATERIALS USED 50
2.3.3. LAND USE CONDITIONS DURING CONSTRUCTION AND OPERATION OF THE MOTORWAY .. 51
3 . DESCRIPTION OF THE ENVIRONMENT THAT COULD BE AFFECTED BY THE PROJECT 53
3.1. DEMOGRAPHIC AND ECONOMIC CHARACTERISTICS 53
3.1.1. POPULATION 53
3.1.2. SETTLEMENT STRUCTURE 54
3.2. CLIMATIC AND METEOROLOGICAL CHARACTERISTICS 56
3.2.1. AIR TEMPERATURES 57
3.2.2. TEMPERATURE CHARACTERISTICS OF SOIL 62
3.2.3. PRECIPITATION 65
3.2.4. ICING AND DEPOSITING OF SNOW 71
3.2.5. AIR HUMIDITY 71
3.2.6. FOG AND VISIBILITY 72
3.2.7. WIND 75
3.3. GEOMORPHOLOGICAL CHARACTERISTICS 78
3.4. GEOLOGICAL, ENGINEERING-GEOLOGICAL AND GEOTECHNICAL CHARACTERISTICS 79
3.4.1. ENGINEERING GEOLOGICAL AND HYDROGEOLOGICAL FEATURES OF ROCK MASSES 85
3.4.2. SEISMOTECTONIC CHARACTERISTICS 87
3.5. HYDROGEOLOGICAL CHARACTERISTICS 89
3.6. HYDROGRAPHIC CHARACTERISTICS 90
3.7. SOIL AND AGRICULTURAL LAND 93
3.8. FLORA AND FAUNA 97
3.8.1. FLORA 97
3.8.2. FAUNA 106
3.9. LANDSCAPE 109
3.10. PROTECTED PARTS OF NATURE 111
3.11. CULTURAL AND HISTORICAL HERITAGE 112
3.12. HUNTING 112
3.13. INFRASTRUCTURE 113
3.13.1. WATER MANAGEMENT INFRASTRUCTURE 113
3.13.2. ELECTRIC POWER SUPPLY 114
3.13.3. GAS TRANSPORT 114
3.13.4. TELECOMMUNICATIONS 114
3.14. IMPACT BY ROADSIDE SERVICE FACILITIES 114

4 . DESCRIPTION OF THE NATURE AND QUANTITIES OF EXPECTED EMISSIONS FROM PLANTS AND FACILITIES INTO THE ENVIRONMENT (AIR, WATER, SOIL) AND IDENTIFICATION OF SIGNIFICANT ENVIRONMENTAL IMPACTS 116
4.1. EMISSIONS RESULTING FROM PROJECT IMPLEMENTATION....................116
4.1.1. ESTIMATION OF EMISSIONS DURING ROAD CONSTRUCTION....................116
4.1.2. ESTIMATION OF EMISSIONS DURING ROAD OPERATION....................117
4.2. IDENTIFICATION OF ENVIRONMENTAL IMPACTS OF THE PROJECT 117
4.2.1. SOCIAL IMPACTS 119
4.2.2. IMPACT ON MICROCLIMATE....................121
4.2.3. IMPACT ON WATERS....................121
4.2.4. IMPACT ON AIR 123
4.2.5. IMPACT ON SOIL AND AGRICULTURAL LAND 126
4.2.6. IMPACT ON FLORA 133
4.2.7. IMPACT ON FAUNA 135
4.2.8. IMPACT ON LANDSCAPE 136
4.2.9. IMPACT ON PROTECTED PARTS OF NATURE 136
4.2.10. IMPACT ON CULTURAL AND HISTORICAL HERITAGE....................137
4.2.11. IMPACT ON HUNTING....................137
4.2.12. IMPACT OF NOISE AND VIBRATIONS 138
4.2.13. IMPACT ON INFRASTRUCTURE 139
5 . DESCRIPTION OF MEASURES TO MITIGATE ADVERSE ENVIRONMENTAL IMPACTS....................141
5.1. GENERAL MEASURES TO MITIGATE ADVERSE ENVIRONMENTAL IMPACTS 141
5.2. SPECIAL MEASURES TO MITIGATE ADVERSE ENVIRONMENTAL IMPACTS 143
5.2.1. POPULATION 143
5.2.2. MICROCLIMATE....................143
5.2.3. WATERS....................144
5.2.4. AIR 147
5.2.5. SOIL 147
5.2.1. FLORA 149
5.2.1. FAUNA 152
5.2.2. LANDSCAPE 154
5.2.3. PROTECTED PARTS OF NATURE 154
5.2.4. CULTURAL AND HISTORICAL HERITAGE....................155
5.2.5. NOISE AND VIBRATIONS....................155
5.2.6. INFRASTRUCTURE 156
5.3. TECHNICAL MEASURES TO MITIGATE ADVERSE ENVIRONMENTAL IMPACTS 157
6 . DESCRIPTION OF MEASURES FOR MONITORING EMISSIONS 159
6.1. MEASURES FOR ENVIRONMENTAL IMPLEMENTATION 159
6.2. PHYSICAL AND BIOLOGICAL ENVIRONMENT MONITORING PLAN 160
6.3. THE POSSIBILITY OF LARGE-SCALE ACCIDENTS....................162
7 . CONSIDERED ALTERNATIVES AND ENVIRONMENTAL REASONS FOR SELECTING THE GIVEN SOLUTION 164
8 . A COPY OF THE APPLICATION FOR OTHER PERMITS THAT WILL BE OBTAINED TOGETHER WITH THE ENVIRONMENTAL PERMIT 166
9 . NON-TECHNICAL SUMMARY....................167
9.1. PURPOSE AND OBJECTIVE OF THE PROJECT....................168

9.2. SOCIOECONOMIC SIGNIFICANCE OF THE PROJECT 168
9.3. DESCRIPTION OF THE ENVIRONMENT THAT COULD BE VULNERABLE TO PROJECT IMPACTS 169
9.4. THE MAIN POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES 171
9.5. MONITORING SYSTEM 187
9.6. CONCLUSION 187
10. LIST OF LAWS 188
11. APPENDICES 191

Appendix 1.	Wider layout plan of Lot 2 (sheet 1-2)	M 1:25 000
Appendix 2.	Layout plan (sheet 1-14)	M 1:10 000
Appendix 3.	Geological map 1: 25000 (sheet 1-2)	M 1:25 000
Appendix 4.	Hydrogeological map 1:25000 (sheet 1-2)	M 1:25 000
Appendix 5.	Engineering geological map 1:25000 (sheet 1-4)	M 1:10 000
Appendix 6.	Overview of environmental project impacts (sheet 1-10)	M 1:10 000
Appendix 7.	Map of proposed mitigation measures (sheet 1-10)	M 1:10 000
Appendix 8.	Table of potential impacts and mitigation measures	
Appendix 9.	Answer to the inquiry regarding the application for issuance of the environmental permit	
Appendix 10.	A copy of the application for other permits that will be obtained together with the environmental permit	
Appendix 11.	Waste management plans	

LIST OF FIGURES

Figure 1: Excerpt from the Spatial plan of the area of special features of significance for FBiH "Motorway on the Corridor Vc" - view of the Crni Vrh tunnel area on section Medakovo - Ozimica *12*
Figure 2: Excerpt from the Spatial plan of the area of special features of significance for FBiH "Motorway on the Corridor Vc" - view of the sections that are the subject of the Application *13*
Figure 3: Corridor Vc through Bosnia and Herzegovina *15*
Figure 4: View of sections and subsections on a topographic map *17*
Figure 5: Start of the section *19*
Figure 6: Tunnel Crni Vrh *19*
Figure 7: Longitudinal section of the main route *20*
Figure 8: Interchange Medakovo *21*
Figure 9: Interchange Ozimica *21*
Figure 10: Route on the topographic map *25*
Figure 11: View of the route on orthophoto base - part I *26*
Figure 12: View of the route on orthophoto base - part II *26*
Figure 13: Changes in section 3 in relation to the 2007 Study *28*
Figure 14: Changes in section 3 in relation to the 2007 Study *28*
Figure 15: Start of the motorway section Poprikuše – Nemila and Poprikuše interchange *30*
Figure 16: End of the motorway section Poprikuše - Nemila (Kovanići settlement) *30*
Figure 17: View of subsection Nemila – Vranduk on orthophoto base *32*
Figure 18: View of the change of the Nemila - Vranduk subsection route in relation to the 2007 Study ... *33*
Figure 19: Subsection Vranduk - Ponirak *34*
Figure 20: Subsection Ponirak - Southern exit from the Zenica tunnel *37*
Figure 21: Subsection Southern exit from the Zenica tunnel - Zenica North *40*
Figure 22: View of the subsection V route and view of the Donja Gračanica interchange *42*
Figure 23: View of the longitudinal section of the main route right axis *42*
Figure 24: View of the longitudinal section of the main route left axis *42*
Figure 25: Layout plan of the route of subsection I Donja Gračanica - Klopče on orthophoto, comparison with the route from the 2007 Study *45*
Figure 26: Layout plan of the route of subsection II Klopče – Drivuša on orthophoto, comparison with the route from the 2007 Study *47*
Figure 27: Mean monthly air temperatures (℃) 1961-1990 ..... *57*
Figure 28: MS Zenica, mean monthly air temperatures (℃) 1998-2018 ..... *58*
Figure 29: Map of temperature distribution shown by isotherms (1931-1990). *59*
Figure 30: Mean January temperatures (°C)1961-1990 ..... *60*
Figure 31: MS Zenica, mean January temperatures (°C)1998-2018 ..... *60*
Figure 32: Mean July temperatures (°C)1961-1990 ..... *60*
Figure 33: MS Zenica, mean July temperatures (°C)1998-2018 ..... *60*
Figure 34: Minimum January temperatures (°C 1961-1990) *61*
Figure 35: Maximum July temperatures (°C) 1961-1990 ..... *61*
Figure 36: Maximum annual amplitudes (°C) 1961-1990 ..... *61*
Figure 37: Zero isotherm penetration depth (cm) 1961-1990 ..... *63*
Figure 38: Mean soil temperatures (°C) 1961-1990 ..... *63*
Figure 39: MS Zenica, mean monthly soil temperatures (°C) for the period 2001-2018 ..... *64*
Figure 40: Maximum and minimum soil temperatures (°C) 1961-1990 ..... *65*
Figure 41: MS Zenica, mean min. and max. soil temperatures for the period 2001-2018 (°C), January and July *65*

Figure 42: Mean monthly precipitation 1961-1990 .... ***66***
Figure 43: MS Zenica, mean annual precipitation 1999-2018 .... ***66***
Figure 44: MS Zenica, mean monthly precipitation 1999-2018 .... ***67***
Figure 45: MS Zenica, comparative diagrams of mean annual precipitation and mean annual air temperatures (1999-2018) ***67***
Figure 46: Change of annual precipitation along the route (l/m^2) 1961-1990 .... ***67***
Figure 47: Main annual precipitation map ***68***
Figure 48: Mean number of days with snow cover ≥ 10 cm 1961-1990 .... ***69***
Figure 49: Map f Mean number of days with snow cover higher than 1 cm ***69***
Figure 50: Map of mean number of days with snow cover higher than 10 cm ***70***
Figure 51: Mean number of days with snow cover ≥ 30 cm, 1961-1990 .... ***70***
Figure 52: Mean number of days with snow cover ≥ 50 cm, 1961-1990 .... ***71***
Figure 53: Mean annual values of relative air humidity (%), 1961-1990 .... ***71***
Figure 54: MS Zenica, mean annual values of relative air humidity (%) 1989-2018 .... ***72***
Figure 55: MS Zenica, mean monthly values of relative air humidity (%)(1989-2018) ***72***
Figure 56: MS Zenica, mean annual number of days with fog 1988-2018 .... ***73***
Figure 57: MS Zenica, mean monthly and mean monthly maximum number of days with fog 1988-2018 ***73***
Figure 58: Mean number of days with fog 1961-1990 .... ***74***
Figure 59: Variation in annual number of days with fog along the route 1961-1990 .... ***74***
Figure 60: MS Butmir-Airport, annual distribution of maximum wind speeds 1961-1990 .... ***75***
Figure 61: MS Butmir-Airport, average number of days with gale-force wind by months 1961-1990 .... ***76***
Figure 62: MS Zenica, annual distribution of maximum wind speeds 1961-1990 .... ***76***
Figure 63: MS Doboj, annual distribution of maximum wind speeds 1961-1990 .... ***77***
Figure 64: MS Zenica, wind direction frequencies (%) 1998-2018 .... ***77***
Figure 65: MS Zenica, mean wind speeds (m/s) 1998-2018 .... ***77***
Figure 66: Seismological map of Bosnia and Herzegovina for the return period of 100 years ***89***
Figure 67: Part of the route of LOT 2 with a complex of agricultural land in the river valley (Source: Google Earth) ***96***
Figure 68: View of route positions of 7 optimization study solution variants for section 4 and section 5 . ***166***

LIST OF TABLES

Table 1: List of sections with available project documentation ***9***
Table 2: Structures in sections 1 and 2 .... ***23***
Table 3: Structures on the route ***31***
Table 4: Overview of rock mass categories (forecast) (left tunnel tube) ***49***
Table 5: Overview of rock mass categories (forecast) (left tunnel tube) ***49***
Table 6: Population projection in the planning period by municipalities ***53***
Table 7: Projection of population in the narrower influence area according to the Spatial plan of the area of special features on Corridor Vc ***53***
Table 8: Coordinates of meteorological stations processed for the period 1961-1990 .... ***57***
Table 9: The first and the last day with frost on average for the measurement period 1961-1990 .... ***62***
Table 10: Bridges over watercourses on this section are the following ***91***
Table 11: Overview of parts of individual soil types on the entire LOT 2 corridor Vc route ***96***
Table 12: Overview of the most dominant part of fauna on the considered sections ***108***
Table 13: Overview of potential quantities of motor fuel and lubricants by sections ***123***
Table 14: Quantities of pollutants during operation of machinery ***123***
Table 15: Limit air quality values in FBiH - for the purpose of protecting human health ***126***

Table 16: Types of soil present in the area of the observed sections **131**
Table 17: Land capability classes for the 500 m strip, indirect impact zone **132**
Table 18: Presence of agricultural land capability classes in the 50 m wide route corridor (direct impact zone) **132**
Table 19: Land use categories **132**
Table 20: Agricultural land uses **133**
Table 21: Distribution of agro-zones **133**
Table 22: Overview of losses of flora elements by individual sections **134**

LIST OF ABBREVIATIONS

EIS	Environmental Impact Study
BiH	Bosnia and Herzegovina
FBiH	Federation of Bosnia and Herzegovina
CSOP	Construction Site Organization Plan
HPP	Hydropower Plant
LC	Local Community
TMCC	Traffic Maintenance and Control Centre
RSF	Roadside Service Facility
WMP	Waste Management Plan
TG	Toll Gate
EP BiH	Public Enterprise Electric Utility of Bosnia and Herzegovina
TS	Transformer Substation
TK	Telecommunications
PCMW	Public Company Motorways of the Federation of Bosnia and Herzegovina

1. INTRODUCTION

PC Motorways of the Federation of Bosnia and Herzegovina (FBiH) is responsible for construction, management and maintenance of motorways in FBiH. One of the key projects is the development and construction of a motorway that is part of the trans-European network of Corridor Vc, which connects Budapest (Hungary) and the Ploče port (Croatia). The total length of Corridor Vc is 321 km, of which 285 km passes through FBiH. About 100 km of the motorway has already been constructed and is in operation

For construction of the subject sections on the Corridor Vc, PC Motorways of the Federation of Bosnia and Herzegovina (PCMW) have developed the Environmental Impact Study for LOT 2 - Section DOBOJ SOUTH (KARUŠE) - SARAJEVO SOUTH (TARČIN) in 2007

Pursuant to Articles 68 and 71 of the Law on Environmental Protection (Official Gazette of FBiH, no. 33/03), Article 18 of the Law Amending the Law on Environmental Protection (Official Gazette of FBiH, no. 38/09), and Article 200 of the Law on Administrative Procedure (Official Gazette of FBiH, No. 2/98), the Federal Ministry of Environment and Tourism issued the Decision on Environmental Permit UP-I/05/2-23-11-4/14 SS of 18 February 2014.

The Decision was issued for the entire LOT 2 in a total length of 145 km, which consisted of four sectors:

- Karuše - Donja Gračanica
- Donja Gračanica - Kakanj
- Kakanj - Vlakovo
- Vlakovo - Tarčin

The sectors are divided into a total of eight sections:

- Section 1 Karuše - Medakovo
- Section 2 Medakovo - Ozimica
- Section 3 Ozimica - Poprikuše
- Section 4 Poprikuše - Nemila
- Section 5 Nemila - Donja Gračanica
- Section 6 Donja Gračanica - Drivuša
- Section 7 Drivuša - Kakanj
- Section 8 Kakanj - Tarčin

In the previous period since the above-mentioned integral Environmental Permit was obtained until today, individual sections were constructed and completed in stages and Operating Permit was obtained for them.

Essentially, this Application for Extension of the Environmental Permit for Lot 2 applies to the unconstructed sections and sections in the construction stage (Section 1 Karuše-Medakovo, Section 2 Medakovo-Ozimica, Section 3 Ozimica-Poprikuše, Section 4 Poprikuše -Nemila, Section 5 Nemila-Donja Gračanica and Section 6 Donja Gračanica-Drivuša) in a total length of approximately 70 km.

Lot 2 sections (Section 7 Drivuša-Kakanj and Section 8 Kakanj-Tarčin) in a total length of approximately 75 km, which have already been constructed and with obtained Operating Permits, are not subject of this application.

Activities on preparation of the Spatial plan of the area of special features of significance for the Federation of Bosnia and Herzegovina "Motorway on the Corridor Vc" for a period of 20 years are initiated by adopting the Decision of establishing the area "Motorway on the Corridor Vc" as an area of special features of significance for the Federation of BiH (Official Gazette of FBiH no. 56/08) and by the Decision to start developing the Spatial plan of the area of special features of significance for the Federation of BiH "Motorway on the Corridor Vc" for the period from 2008 to 2028 (Official Gazette of FBiH, no. 48/08), and the Plan was adopted on 9 February 2017.

This Application for Extension of the Environmental Permit for Lot 2 has been updated in relation to the Environmental Impact Study for LOT 2: SECTION DOBOJ SOUTH (KARUŠE) - SARAJEVO SOUTH (TARČIN) only in the part concerning: change of legislature and obligations of the Investor, population and change in relation to the Preliminary Design. The environmental condition data that were available from the approved LOT 2 Environmental Impact Study (hereinafter: the 2007 Study) and other study documentation made for the needs of the spatial planning documentation in the previous period were used in this Application for Extension of the Environmental Permit. In places where the route deviates from the route in the 2007 Study, the expert team analysed the data from the study and in some places updated them with more recent data from the field.

In addition to the 2007 study, bases (topographic maps M1: 25.000, orthophoto) as well as all available project documentation were used.

Table 1: List of sections with available project documentation1

LOT	SECTOR	SECTION according to ToR	SUBSECTION	km	Project
LOT 2 DOBOJ SOUTH (KARUŠE) – SARAJEVO SOUTH (TARČIN)	KARUŠE – DONJA GRAČANICA	1.KARUŠE – MEDAKOVO	Karuše – Medakovo	8.5	Preliminary design June 2014 (IPSA)
		2.MEDAKOVO - OZIMICA		17	
		3.OZIMICA – POPRIKUŠE		18	Preliminary design April 2014 (IPSA)
		4.POPRIKUŠE – NEMILA		5.5	Preliminary design December 2017 (IPSA)
		5.NEMILA – DONJA GRAČANICA	Nemila - Vranduk	5.7	Preliminary design August 2018
			Vranduk – Ponirak	5.3	Main design July 2017 (Integra)
			Ponirak – Southern exit from the Zenica tunnel	2.7	Main design March 2017 (integra)
			Southern exit from the Zenica tunnel – Zenica North	1.7	Preliminary design February 2016 (Integra)
			Donja Gračanica/Zenica North – Tunnel Pečulj	2.3	Preliminary design April 2014 (IPSA)
	DONJA GRAČANICA – KAKANJ	6.DONJA GRAČANICA - DRIVUŠA	Donja Gračanica - Klopče	5.8	Main design June 2011 (Inocsa, Energoinvest, tzi)
			Klopče - Drivuša	2.3	Main design February 2011 (Inocsa, Energoinvest, tzi)
		7.DRIVUŠA - KAKANJ	CONSTRUCTED		
	KAKANJ – VLAKOVO	8.KAKANJ - TARČIN			Operating permit
	VLAKOVO – TARČIN				Operating permit

1.1. NAME AND ADDRESS OF OPERATOR

Name of Investor	**Public Company Motorways of the Federation of Bosnia and Herzegovina, ltd. Mostar**
Abbreviated Investor's name	**PCMW FBiH**
Legal form	**Public company**
Address of the company	**Head Office in Mostar, Adema Buća Street no. 20** **88000 Mostar** **Office in Sarajevo, Hamdije Kreševljakovića St. no. 19** **71000 Sarajevo**
Manager	**Adnan Terzić, B.Sc.**
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1.2. EXCERPT FROM THE PLANNING ACT

Law on Physical Planning and Land Use at the Level of the Federation of Bosnia and Herzegovina (Official Gazette of FBiH number 02/06, 72/07, 32/08) regulates the planning of land use at the level of FBiH through preparation and adoption of planning documents and their implementation. This law establishes the obligation to prepare planning documents for areas of significance for the Federation - spatial plans for areas of special features. Article 17 of the aforementioned law establishes special areas for which the Spatial plan for the areas of special features of FBiH is adopted, among others, for corridors and international traffic facilities. The motorway on the Corridor Vc is designated an area of special features of significance for the Federation of BiH (Official Gazette of the FBiH, no. 56/08) and in accordance with the law, the Spatial plan of the area of special features of significance for FBiH is adopted for it.

The spatial basis of the plan was adopted by the Federation Government, but without a defined motorway route at the Blagaj and Počitelj locations (locations are not subject to this application), and by the FBiH Parliament, specifically at the session of the House of Representatives held on 30 March 2010 and the session of the House of Peoples held on 25 March 2010.

The preliminary draft plan was discussed at the 17th session of the FBiH Government, held on September 5, 2011, when it was defined in the form of Draft and submitted to the FBiH Parliament for consideration and adoption. The same was adopted as a basis for preparation of the proposal of the Plan at the 7th session of the House of Representatives of the FBiH Parliament on 27 October 2011 and the 6th session of the House of Peoples of the FBiH Parliament on 10 November 2011.

The draft spatial plan was provided to the public for consideration for 30 days, during which two public discussions were held, in Mostar and Sarajevo. Upon completion of the public consideration, the Draft Plan was prepared, and discussed and finalized by the FBiH Government at its 28th session on 28 December 2011, and adopted by the House of Representatives of the Parliament of the Federation of Bosnia and Herzegovina on 29 December 2011.

After the adoption of the Draft Plan by the House of Representatives, there was a break in the plan approval procedure until 2017. The House of Representatives of the Parliament of the Federation of Bosnia and Herzegovina, at its 17th session on 25 January 2017, adopted Amendments to the Draft Spatial Plan, after which the House of Peoples of the Parliament of the Federation of Bosnia and Herzegovina, at its 18th session of 09 February 2017, adopted the Draft Spatial Plan with the amendments of the Government of the Federation of BiH , which become an integral part of the plan.

The spatial coverage of the Spatial Plan is given by the axis coordinate points and covers a strip of average width of 500 m in all sections, and it was changed to 2000 metres by the first amendment.

According to the Spatial plan of the area of special features Motorway on the Corridor Vc, the motorway sections, which are subject of this Application, are:

- Section 2: Doboj South (Usora) – Zenica North (Donja Gračanica) km 57+337 – 121+365
- Section 3: Zenica North (Donja Gračanica) – Zenica South (Drivuša) km 121+365 – 131+683

Spatial plan of the Federation of BiH for the period 2008-2028

The Spatial Plan of BiH has not been adopted yet, at the time of writing this text, the plan is still at the stage of draft plan. The spatial basis was adopted by the FBiH Government on 5 May 2011, and by the FBiH Parliament on 19 May 2011. The basic concept of the spatial development which, inter alia, defines the development of road traffic, is an integral part of the Spatial Basis. It is planned to develop road infrastructure in two directions: the first direction involves construction of new motorways and fast roads to connect with neighbouring countries and to connect with urban areas within FBiH, and the second direction involves projects to improve the existing road network by reconstruction and maintenance of individual sections, according to defined priorities. The Spatial Plan of the Federation considered the motorway route based on which the 2007 Study was made, since amendments were adopted only in 2017, and activities on the adoption of the Federation Spatial Plan are currently paused.

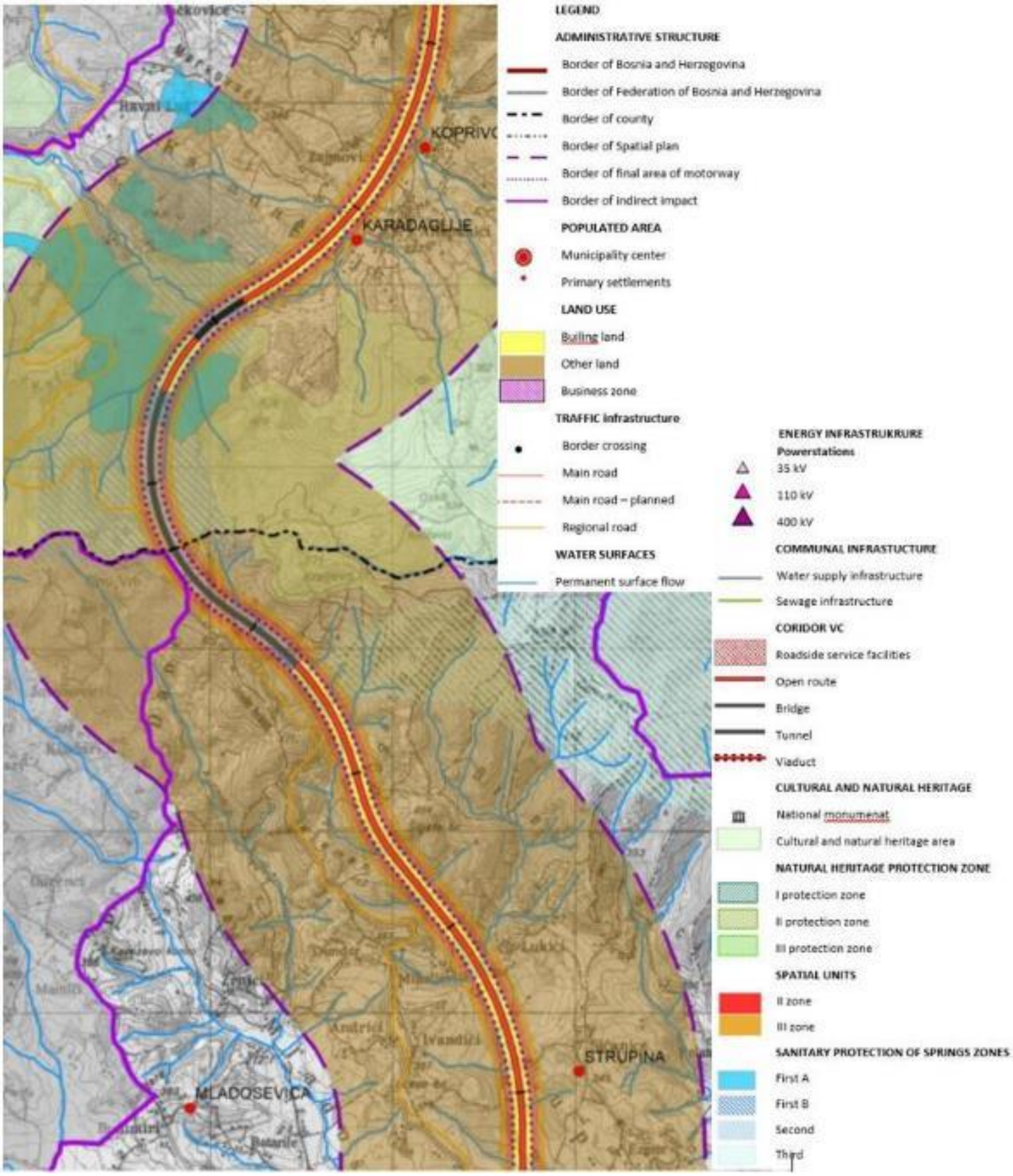

Figure 1: Excerpt from the Spatial plan of the area of special features of significance for FBiH "Motorway on the Corridor Vc" - view of the Crni Vrh tunnel area on section Medakovo - Ozimica1

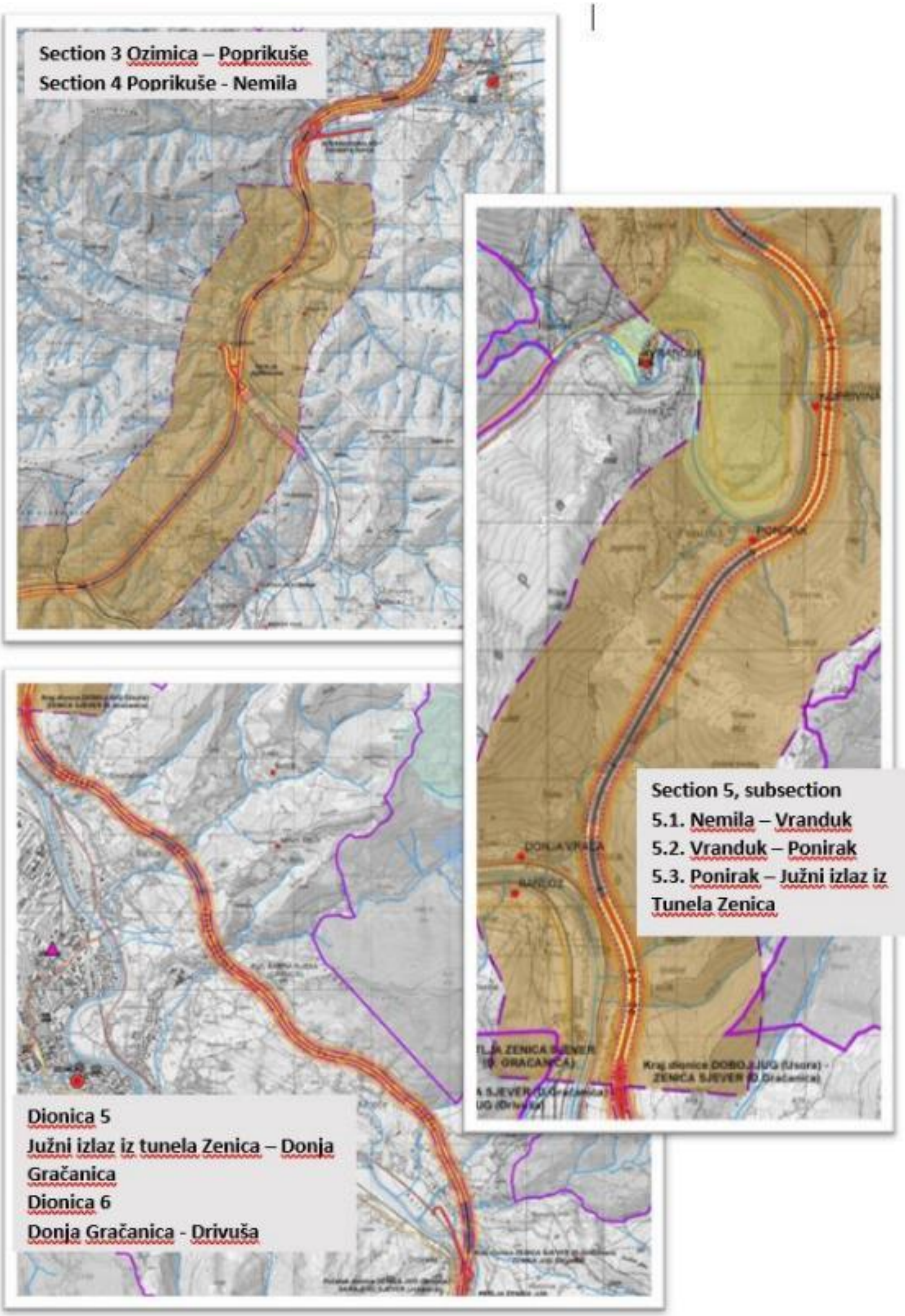

Figure 2: Excerpt from the Spatial plan of the area of special features of significance for FBiH "Motorway on the Corridor Vc" - view of the sections that are the subject of the Application2

2. DESCRIPTION OF THE PROJECT

2.1. DESCRIPTION OF THE WIDER LOCATION

For Bosnia and Herzegovina, realization of construction of the Corridor Vc has multiple significance. First, because it would be the first international route that would run through its territory and in this way integrate it in the international modern transport network. Also, this route provides Bosnia and Herzegovina with a high-quality access to the Adriatic Sea through the Ploče port in Croatia and opens an access to the area of Central and North-Eastern Europe on the north side.

The motorway in Corridor Vc (motorway A1 in FBiH) is part of the central transport corridor through Bosnia and Herzegovina, from the northern to the southern border with the Republic of Croatia and in our country makes the backbone of the road transport system. For the most part, this motorway extends over the valleys of the Bosna and Neretva rivers, where it occasionally comes into contact with the existing network of main, regional and local roads, as well as the main railway line in Corridor Vc, B. Šamac-Sarajevo-Mostar-Čapljina.

The Corridor Vc is divided into four LOTs:

- LOT 1 : Section Donji Svilaj - Doboj South (Karuše).
- LOT 2 : Doboj South (Karuše) - Sarajevo South (Tarčin), without section Kakanj- Blažuj.
- LOT 3 : Section Sarajevo South - Mostar North
- LOT 4 : Section Mostar North - Border South

The subject of this application is LOT 2: Doboj South (Karuše) – Sarajevo South (Tarčin), which is divided into four sectors for which an environmental permit has been issued:

- Karuše – Donja Gračanica
- Donja Gračanica – Kakanj
- Kakanj – Vlakovo
- Vlakovo – Tarčin

The sectors are divided into eight sections according to the Terms of Reference for preparation of this application:

Section 1: Karuše – Medakovo
Section 2: Medakovo – Ozimica
Section 3: Ozimica – Poprikuše
Section 4: Poprikuše – Nemila
Section 5: Nemila – Donja Gračanica
Section 6: Donja Gračanica – Drivuša
Section 7: Drivuša – Kakanj
Section 8: Kakanj – Tarčin

The planned route of the motorway in the Corridor Vc, LOT 2, passes through the central part of BiH, passes through the municipalities of Usora, Tešanj, Maglaj, Žepče, Zenica and Kakanj of the Zenica-Doboj Canton. In Sarajevo Canton, the LOT 2 route runs through the municipalities of Ilidža (from Vlakovo) and Hadžići (to Tarčin). In the Central Bosnia Canton/County, the adopted route passes through the municipality of Kiseljak. The following figure shows the project location (Motorway on the Corridor Vc) with specially indicated sections of LOT 2.

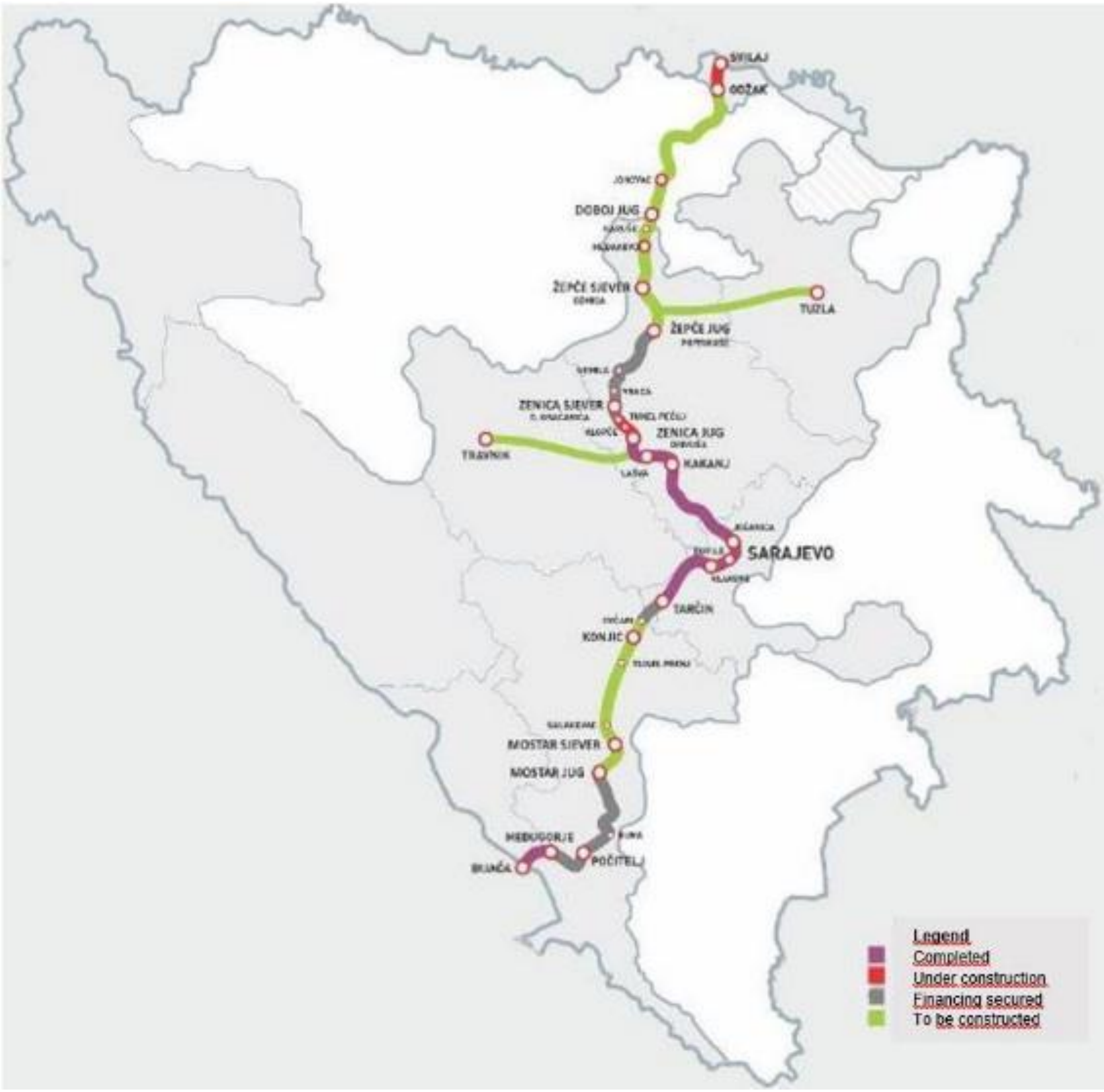

Figure 3: Corridor Vc through Bosnia and Herzegovina3

2.2. DESCRIPTION OF THE NARROWER LOCATION

Section 1 Karuše - Medakovo *(chainage[1] km 62+500 to 67+000)*

The Karuše interchange, over which the town of Teslić and other surrounding settlements are connected to the motorway, is planned at the crossroads with the road M4 Doboj-Teslić. The route further continues southward as predominantly open route, following the course of the Usora River, and passing near the settlements of Makljenovac, Alibegovići, Tešanjka and Žabljak on the west side, and the settlements of Matuzići and Kraševo on the east side. At the Medakovo junction, the route intersects with the existing regional road R474, at which location the TMCC Medakovo is planned.

[1] The chainages in this description are taken over from the Spatial plan of the area of special features of significance for the Federation of BiH and correspond to the graphic enclosure no. 2 - The wider layout plan, following the text and more detailed descriptions of the chainage correspond to projects in accordance with Table 1 of this application

Section 2 Medakovo - Ozimica *(chainage km 67+000 to 88+150)*

Next, the route keeps following the Usora River course southward, and passes near the settlements of Čifluk, Medakovo, Tugovići, Ripna, Jablanica and Kardaglija. South of the settlement of Kardaglije, the route passes over the Glava River by a structure approximately 340 m in length and continues to the Crni Vrh tunnel 1.8 km in length. Further the route follows the Strupinska Rijeka course as open route, passing near the settlements of Novi Šeher, Grabovica and Ljubatovići up to the Ozimica interchange.

A modification in relation to the 2007 Study is on this section, specifically at the location before the entrance of the Crni Vrh tunnel, where the route by about 750 m departs from the observed corridor, by first crossing the local road with a bridge of 288 metres to the south at the end of the Kardaglija settlement and then entering the 1.8 km long Crni Vrh tunnel. The Ozimica interchange is also out of the observed 2007 Study corridor.

Section 3 Ozimica - Poprikuše *(chainage km 88+150 to 100+200)*

After the Ozimica interchange, the route continues to the southwest with several bridges and tunnels, passing near the Tatarbudžak settlement, bypasses Žepče to the northwest. After the Varošište settlement north of Žepče, the route changes in relation to the 2007 Study route, approaches the Bosna River, crosses the railway line by a 270 m long bridge and following the railway and near the Papratnica settlement goes further to the bridge Mo 7 (294 m) passing over the Bosna River. Here, the route continues following the Study route and after the second crossing over Bosna enters a tunnel in Brezovo Polje. After exiting the tunnel at this place too the route deviates from the route from the Study, goes west, crosses the railway line, follows the Bosna River windingly and before the Poprikuša junction located in the Golubnjak area. This also represents the end of the section.

The inter-regional junction, connection with the motorway A3 Tuzla-Žepče, is located in the area south of Žepče.

Section 4 Poprikuše -Nemila *(chainage km 100+200 to 105+500)*

According to the preliminary design from 2017, section Poprikuše – Nemila starts with the start of the bridge over the Bosna River, follows the Poprikuše junction, after which it enters the 3.659 km long Golubnjak tunnel. After exiting the tunnel, the route crosses the Bosna River with two smaller bridges and this is the end of the section. The tunnel axis in its southern part deviates from the 2007 Study route. The maximum deviation is slightly less than 400 m.

Section 5 Nemila-Donja Gračanica *(chainage km 105+500 to 123+500)*

Section Nemila – Donja Gračanica is divided into five subsections by projects.

1. Nemila – Vranduk
2. Vranduk – Ponirak
3. Ponirak – Southern exit from the Zenica tunnel
4. Southern exit from the Zenica tunnel – Zenica North (Donja Gračanica)
5. Donja Gračanica (Zenica North) – Tunnel Pečulj.

A more detailed description of the route by subsections will be given in the following text. In this section, the route follows the right course of the Bosna River to the settlement of Nemila. After the Nemila settlement, it shortly crosses to the left bank and then returns to the right bank further passing the settlements of Koprivna and Ponirak. In this part, there is a significant modification in relation to the route from the 2007 Study. Back then, the route went much closer to the national monument Architectural Ensemble - Old Town of Vranduk. After Ponirak, through approximately 2.4 km long Zenica tunnel and over several bridges and Vraca tunnel, the route reaches the Zenica North interchange and runs further by a tunnel and viaduct to the entrance to the Pečulj tunnel. After the Vraca tunnel, the route has descended closer to the Bosna River in relation to the route from the 2007 Study, which went more over the hill slope.

Section 6 Donja Gračanica-Drivuša *(chainage km 123+500 to 131+500)*

The section starts with the entrance to the Pečulj tunnel in Donja Gračanica. The position of the tunnel is slightly changed in relation to the 2007 Study. The route further follows the settlements of Ričice, Klopče and Perin Han. After the bridge near the Drivuša interchange, the route fits into the already constructed part of the motorway. Most of this section has already been constructed.

Figure 4: View of sections and subsections on a topographic map4

2.3. TECHNICAL DESCRIPTION OF THE PROJECT

SECTION 1 (Karuše – Medakovo) and SECTION 2 (Medakovo – Ozimica)

IPSA INSTITUT developed a single Preliminary Design for these two sections in 2014. The preliminary design was made for the route that was the subject of multi-criteria analysis of three variant solutions, of which one was the route from the 2006 preliminary design. The route mainly follows the corridor and route that were considered in the 2007 Study except in the part of the Crni Vrh tunnel, where it went out of the corridor and at the Ozimica interchange site, where it also went out of the observed corridor in one part.

Section 1 (Karuše – Medakovo) according to the preliminary design goes from chainage km 0+000.000 to the Medakovo interchange at chainage km 3+400.000. Section 2 (Medakovo – Ozimica) goes from chainage km 3+400.000 to the Ozimica interchange at chainage km 25+600.000, where the next section starts according to the other project.

Description of the route

At the very beginning of the route Doboj South – Ozimica, the selected variant is integrated with the route of the motorway Johovac – Doboj South, which was previously made at the level of main design. The integration of the route necessitated a change of the bridge Tešanjka 2. Also, immediately above the Hrastik tunnel, there is a power transmission line that cannot be relocated, which causes the correction of the route at the connection with the previous section.

Further in the continuation, for the most part the route is in conflict with riverbeds of the Trebačka and Strupinska rivers, which requires regulation of the said riverbeds in large length. There are also conflicts with the existing local traffic network, which resulted in relocation of some roads and their passing through and above the motorway route. In the boundary area of the municipalities of Tešanj and Maglaj, the motorway route reaches the Crni Vrh hill, where a tunnel is planned approximately 1800.00 m in length.

The approximately 25 km long route passes through three municipalities:

1. From km 0+000.00 to km 14+800.00 it is in the territory of Tešanj municipality.
2. From km 14+800.00 to km 21+200.00 it belongs to the Maglaj municipality
3. From 21+200.00 to the end of the route in this section km 25+766.25 it belongs to the Žepče municipality.

Due to different limitations (populated areas, structures, rivers, power transmission lines, existing roads) in some places from the Crni Vrh tunnel the route deviates from the route from the adopted 2005/2006 preliminary design. At the very beginning of the route Doboj South – Ozimica the selected variant is integrated in the route of the motorway Johovac – Doboj South, which was made at the level of main design. After integration in the section Johovac - Doboj South, in the direction of chainage at the beginning the route is designed in a right curve of radius 3000 m. The bridge Tešanjka 2 of a total length of 190 m is also designed in that curve. From km 0+560.00 - 0+780.00 the route passes through a hill. Since the area is quite populated in this part, there is a road communication, the designer's choice was a cut & cover system, where the hill will be excavated and the tunnel structure constructed, covered up and brought back to the original condition. Further the route passes through populated places (Tešanjka, Medakovo, Alispahići, N. Šeher, Ljubatović, etc.) and unpopulated areas and in many places it is in conflict with the existing rivers. River regulation would be vitally needed in the entire area, which will have a positive effect on safety from possible flooding of surrounding areas in the future. On the other hand, construction of the regulation has limited the route to a narrow strip and caused many conflicts with the existing and newly designed roads, which increases the price of construction itself.

The route from km 14+000.00 to km 15+800.00 is planned in a tunnel. The tunnel is approximately 1800 m in length and after exiting the tunnel km 15+800.00 the route is designed to the south, where it ends at km 25+766.25. The route fully meets the technical regulations and requirements given in Terms of Reference and is aligned with adjacent sections: Johovac – Doboj South and Ozimica - Poprikuše.

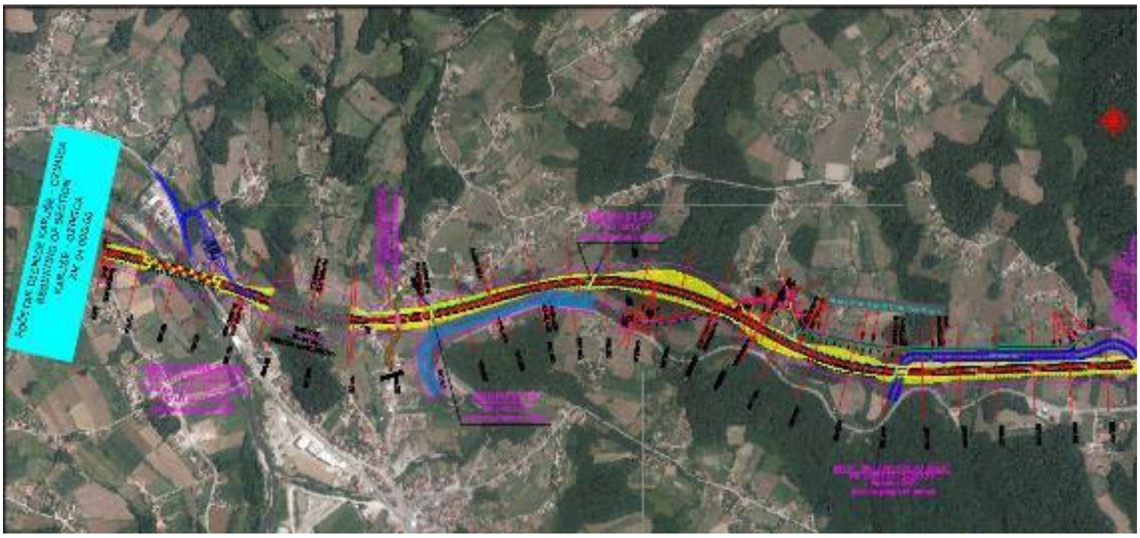

Figure 5: Start of the section5

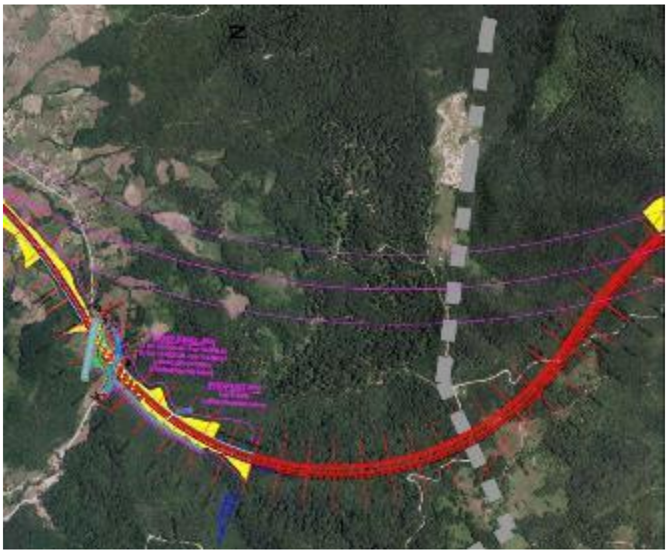

Figure 6: Tunnel Crni Vrh6

Level line

The level line is not continuous but is wavy depending on the terrain and physical constraints (overpasses, underpasses, different types of passes, regulations, flood water levels). 17 vertical curves are designed on the route, of which 10 concave and 7 convex. The minimum applied gradient is 0.32 % (L=360m), and the maximum gradient of 3% (L=3567.27) is applied in the tunnel. The minimum radius of vertical curve is 12 000 m. At the beginning and at the end, the level line is integrated with the adjacent sections.

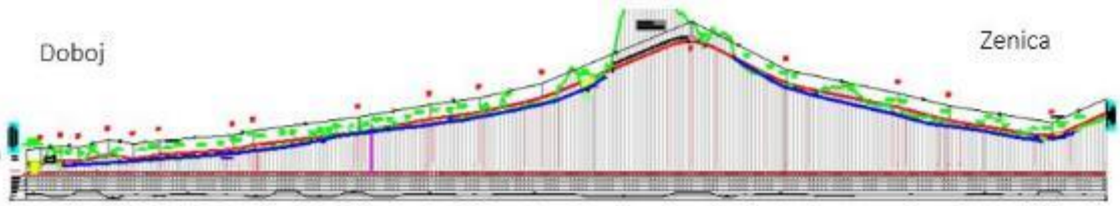

Figure 7: Longitudinal section of the main route7

In the tunnel part, the left side of the tunnel is separated from the main axis in terms of layout plan and level line, and in this part it is independent in order to satisfy the tunnel design rules.

The applied technical elements of the route are the following:

- Route length: 25 766.25m
- Length of curves: 19 032.16 m or 73.86 %
- Length of straight lines: 6734.09 m or 26.14%,
- Minimum length of transition curve, L = 90 m
- Minimum radius of horizontal curve: 750 m
- Max. gradient of level line: 3.9 %
- Min. gradient of level line: 0.32%
- Minimum radius of vertical curve, concave: 12000 m
- Total length of bridges: 783 m

Embankments, cuts

The route is defined by rather high heterogeneousness in terms of geotechnical and geological conditions in the field. Based on these data, when excavating and filling the motorway base, gradients of side slopes will be from 1:1.5 for embankment to the range from 1:1 to 10:1 for cuts. Characteristic is the variety of materials forming the terrain: clay, layers of coal to solid rocks.

All material for embankments will be obtained from borrow pits, or the neighbouring quarries, and the location should be determined by the competent authorities of the neighbouring municipalities. Precise earthworks, geotechnical works will be clearly defined after final preparation of the geotechnical study. Embankment slopes shall be covered with humus, and where necessary, considering the geological structure of the terrain, a separating layer of geotextile shall be placed.

Pavement

Pavement is taken based the calculation of expected traffic and type of terrain. Its corrections are possible in the main design.

a. Pavement, on route

- SMA AB 11......................5.0 cm
- BNS 22 sA =....................6.0 cm
- BNS 32 sA =....................7.0 cm
- CS.................................25.0 cm
- Subbase - MNS................17.0 cm
- Improved subgrade..........25.0 cm (beam)

b. Pavement, on emergency lane

- AB 16...............................5.0 cm
- BNS sA.............................7.0 cm
- Subbase.......................... 48.0 cm

Route drainage

It is planned as a combination of surface and closed drainage with standard: ditches, gutters and culverts, and drainage pipes, gullies, inspection shafts.

Hillside water in embankments are collected by concrete ditches, MB-40, in width that will be determined by the hydraulic calculation. Culverts are planned on the route on existing watercourses, permanent or intermittent and newly regulated rivers.

Interchanges

Two interchanges are designed on the section: interchange Medakovo, km 3+300.00 and interchange Ozimica, km 24+750.00. Both interchanges are designed as trumpet type, with central radius R = 50 m. Max. downward/upward gradient 6.0 %. Toll gates - toll stations will certainly be designed within these interchanges, after which connection to the main road will be planned.

Interchange pavement structure looks like this:

- AB 11s = 6 cm
- BNS 22s = 1o cm
- Subbase = 40 cm
- Total = 56 cm

Entry and exit lanes are with standard length 250 m (190+60).

Along the Medakovo interchange, there is a conflict with the regulation of the Tešanjka River, which intersects it at several places (culvert L=41.4m). The total length of the Tešanjka River regulation in the interchange zone is L=323.4m.

Along the Ozimica interchange, there is a conflict with the regulation of rivers and streams, which intersect it at several places. The regulation of the Ozimica River in the interchange zone is L=523 m, regulation of Goliješka River L=92 m and regulation of the Sarajlića stream L=552 m.

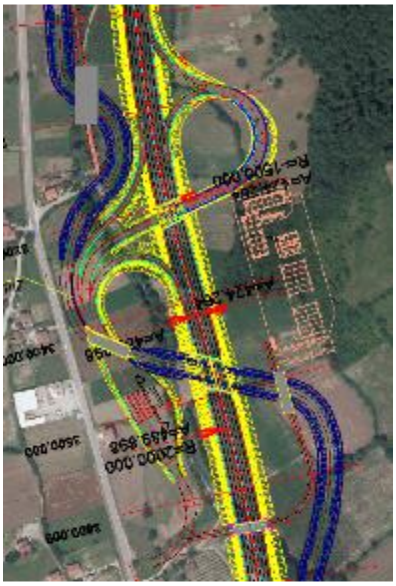

Figure 8: Interchange Medakovo8

Figure 9: Interchange Ozimica9

Roadside Service Facilities - RSF

Two RSFs are designed on the route on both sides of the motorway, at km 7+650.00 RSF Grabovica, which belongs to category A[2], and at km 20+200.00 RSF Tugovići, which belongs to category C[3]. The rest area is formed on a plateau with an area of approximately 2.0 ha.

The pavement structure for both types of RSF is as follows:

- AB11, d=5cm,
- BNS 22, d=8 cm
- Subbase layer, d=30 cm, limestone
- Subgrade minCBR =10%

At the location of petrol station:

- concrete slab d=20cm,
- cement stabilization, d=15 cm
- Subbase layer, d=40 cm, limestone
- Subgrade minCBR =10%

On roadside service facilities, drainage is planned as a combined system, i.e. surface system and closed system (sewage). The surface drainage system consists of:

- Concrete gutter 0.5m MB40
- Segmental ditch 1.0m MB40

Structures

A total of 59 structures are designed on the main route, of which:

- 13 bridges
- 20 underpasses
- 3 overpasses
- 23 culverts

[2] *This category of rest area has separate parking spaces for passenger and goods vehicles, lighting, petrol station with shop, drinking water and public toilet for the disabled and has a baby changing facility and a restaurant located in a separate building.*

[3] *This category of rest area contains parking areas (separate for passenger and goods vehicles and for buses and caravans), waste baskets and containers, public lighting, water (drinking fountain), toilette, benches and tables, and a playground for children is also desirable.*

Table 2: Structures in sections 1 and 2[4]2

RB	OBJEKAT	STACIONAŽA PO CENTRALNOJ OSOVINI	RASPONI	DUŽINA
1	Most Tešanjka 2	L: 0+112,82 - 0+302,45 D: 0+127,67 - 0+318,03	27+4x34+27 =190	190
2	PP Tešanjka	0+819,52	9.7	35
3	Propust P1	0+912,92	3	53
4	Propust P2	1+357.8	2	43
5	Most Marenovićevo Brdo	2+227.75 - 2+257.75	30	30
6	Most Bedaci	2+871,4 - 2+901,4	30	30
7	PP Barići	3+048,67	9.7	35
8	Most Medakovo 1	3+296.5 - 3+319.0	22.5	22.5
9	Most Medakovo 2	3+463,45 - 3+493,45	30	30
10	PP Hadžići	3+640	9.7	35
11	PP Novo Selo	4+196.5	10.9	33
12	Most Kerići	4+642.8	11	62.3
13	PP Križani	5+021,06	9.7	34
14	Most Križani	5+471,5	11	85
15	PP Brijestovi	5+560	10.9	36
16	Propust P3	6+142	2	48
17	PP Kadušići	6+160,04	7.1	33
18	Most Javrboci	6+347.5	11	50
19	PP Javrboci	6+700	7.1	32
20	Propust P4	6+813	2	44
21	Propust Bride	7+128	5	38
22	Propust Gušća	7+197	5	43
23	Most Horvatovići	7+444.40 - 7+464.4	20	20
24	Most Tugovići	7+801 - 7+821	20	20
25	Propust P5	8+184	2	36
26	NP Hrgovci	8+247.5	40	40
27	Propust Hrgovci	8+540	5	40
28	Propust P6	9+150	3	42
29	PP Brezik	9+395,41	9.7	41
30	PP Bašići	9+767.18	9.7	38
31	Propust P7	10+106	2	45
32	PP Selimovići	10+409.53	9.7	38
33	Propust P8	10+880	2	38
34	Propust Koprivci	11+472	5	55
35	Propust P9	11+650	2	58
36	PP Koprivci	11+734,67	9.7	37
37	PP Alispahići	12+305,76	9.7	45
38	Most Kiseljak	D: 13+283,28 - 13+549,92 L: 13+225,00 - 13+483,81	24+8x30+24 =288	288
39	Propust P10	13+850	2	60
40	Propust P11	16+200	4	60
41	NP Kremen	16+725		110
42	Propust P12	17+200	Φ1.5	43
43	Propust P13	17+770	4	59
44	PP Ivandići	18+089,35	9.7	38
45	Propust P14	18+330	4	58.5
46	Propust P15	18+850	2	44
47	NP Čakrame	19+652	46.6	46.6
48	PP Galovac	20+732	9.7	34
49	Propust Galovac	20+960	5	66.5
50	PP Jurišići	21+950,89	9.7	35
51	PP Ljubatović	22+770,89	9.7	38
52	Propust Ljubatović	22+911.72	5	186.5
53	Propust P16	23+200	2	52
54	PP Liješnica	23+225,66	9.7	36
55	Propust Liješnica	23+310	5	60
56	Most Brežde	24+166.50 - 24+186.50	20	20
57	PP Brežde	24+246,79	7.1	37
58	Most Ozimice	L: 24+584 - 24+746 D: 24+589 - 24+751	14+7x22+14 =182	182
59	PP Perkovići	25+156	10.9	37

Traffic Maintenance and Control Centre - TMCC

One centre is planned on the route, which will be located in the area of the Medakovo interchange at km 3+700.00. Access to the TMCC is provided from the local road that is connected to the Medakovo interchange, thus allowing rapid response of professionals on the motorway.

Regarding environmental protection, in accordance with the laws governing this matter, the project itself provides the following protection measures of technical nature:

- A closed system for draining the water from pavement is planned (construction of drainage system)
- Construction of separators, or treatment devices for water from the drainage system
- Construction of noise protection structures

According to requirements of hunting clubs, larger structures are planned for passage of larger animals (deers, roes, etc.).

[4] *The table shows type of the structures on the routhe, chainage, range and the lenght of the structure*

SECTION 3 (Ozimica – Poprikuše) (chainage km 0+000.000 to 12+800.000)

After exiting the tunnel at this place too, the route deviates from the route from the Study, goes west, crosses the railway line, follows the Bosna River windingly and the section ends before the Poprikuša junction located in the Golubnjak area.

The inter-regional junction, connection with the motorway A3 Tuzla-Žepče, is located in the area south of Žepče.

Limitations in space

In the section from Ozimica to Poprikuše, the motorway runs mainly over a hilly terrain for the most part of the route, and at the end of the route it descends to the area of the riverbed of the Bosna River and railway line. The route conflicts mainly with the riverbed of the Bosna River and railway line corridor, which runs along the Bosna riverbed. In these parts, the route is on structures which are mainly with greater lengths up to approximately 500.00 m.

The existing limitations in space are:

- Hilly parts (Tupanovac, Tatarbudžak, Ravne Njive)
- Bosna River
- Existing main road M-17
- Railway line
- Existing populated places (Varošište, Ravne Donje, Šećin Han)

In relation to the route from the preliminary design, in the first part from Ozimica to Tatarbudžak the proposed route is mainly within the strip planned for possible route modifications, in the continuation from Tatarbudžak to Poprikuše the route has undergone major changes and the deviations between route axes are up to approximately 800 m.

The new route from Tupanovac descends towards the Bosna River and uses milder terrains, while the route from the preliminary design mainly uses hilly terrains with crossings over the Bosna River from one side to the other. In addition to the said limitations, it should be noted that the route from the Preliminary Design was previously adopted by the Žepče municipality, while consent of the municipality should be requested for the modified route.

The layout plan of the motorway route in the zone of conflict with the said part and the relationship between the route in the Preliminary Design and the deviation of the optimized route are presented below.

Figure 10: Route on the topographic map10

Description of the route

Horizontal elements

From the beginning (Ozimica) to Tatarbudžak, the optimized motorway route variant is mainly in the route corridor (in the strip of 100 m left and right of axis) that was previously adopted by the local community. From Tatarbudžak, the route descends to the area of the Šećin Han settlement between the main road and railway line route corridors on one side and the riverbed of the Bosna River on the other side.

The route mainly runs further over this corridor to the beginning of the next section. The route passes near the settlements of Varošište, Šećin Han, Brezovo Polje and this section ends in Golubinja.

The Poprikuše interchange, which is solved in the next section, is designed at the very connection of the sections. The beginning of the route fits into section Karuše - Ozimica immediately after the Ozimica interchange. The route continues and in the area of Tupanovac enters Tunnel 1 with length 675.00 m and at a distance of approximately 300 m enters Tunnel 2 l=225.00 m.

Viaducts and open route alternate further on the route up to Gradina, where the route enters Tunnel 3 with length l=385.00 m. After passing the tunnel no. 3, the route descends to the area of the Šećin Han settlement, crosses the bridge over the existing main road and railway line (bridge l=270.00 m right I=310.00 left). After the crossing, the route runs over the field along the railway line, crosses the riverbed of the Bosna River and touches the Kika hill and again crosses the riverbed of the Bosna River, railway line and main road and enters Tunnel 4 (Brezovo Polje).

After exiting the tunnel, the route crosses the riverbed of the Bosna River again, coincides with a part of the main road, which is relocated, and near the existing bridge on the main road crosses with a new bridge over the riverbed of the Bosna River and continues over the bank of the riverbed to the connection with the next section.

In the area of Tatarbudžak to the end of the section, the route is significantly corrected, and in route design care was taken to preserve the structures along the route as much as possible so that the number of those that are demolished is approximately 12 structures.

In this stage of design, in horizontal route design (axis) care was taken to separate axes in tunnel in order to obtain the required relation between the axes of 25.00 m, so that separation of axes was carried out on the route from km 1+300.00 to 3+950.00, from 4+700.00 to km 6+800.00 and from 9+000.00 to 11+500.00. The designer mainly widened the right axis of pavement.

A view of the route on orthophoto bases from the Tatarbudžak area to the connection with the next section in Poprikuše is given below.

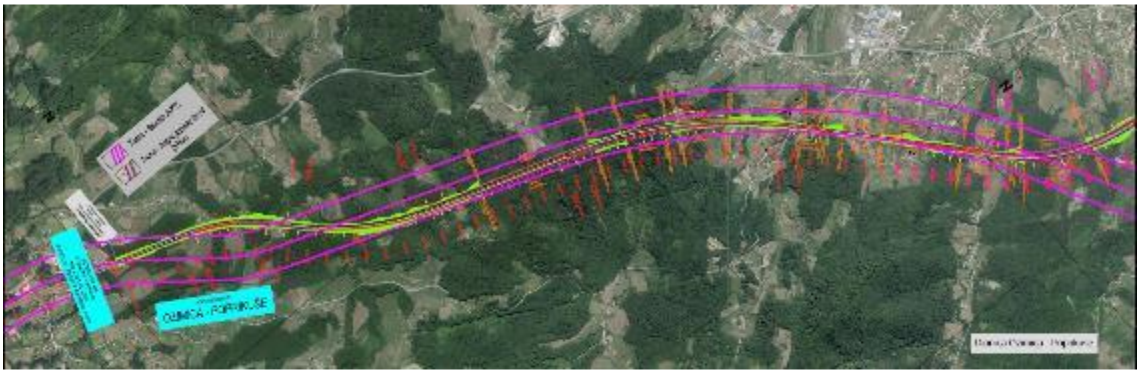

Figure 11: View of the route on orthophoto base - part I11

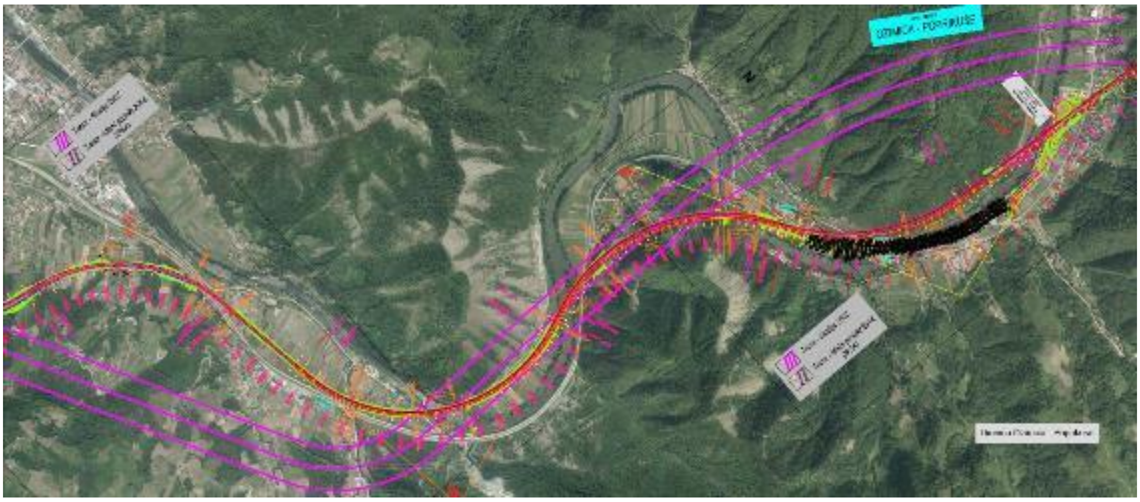

Figure 12: View of the route on orthophoto base - part II12

It is evident in the previous figure that a part of the main road is relocated from the bridge over Bosna in the direction of Žepče, and it is passed through an underpass under the motorway route. The total length of relocation is approximately 870 m. Horizontal elements of the route of the relocated main road are designed for Vc=60km/h.

The following horizontal elements are applied on the route:

- Minimum horizontal radius R=910.00 m
- Minimum transition curve Lmin=100 m
- Minimum straight line between curves L=553.57 m

When designing axes in tunnels, care was taken that tunnels are not with radius of less than 1000.00 m’. The transition curves l=70 m which are applied in part of the T4 tunnel route are for Vc=100km/h, they may be corrected for Vc=120km/h in the main design, if necessary.

Vertical elements

When designing the route in longitudinal section, care was taken to adhere to vertical elements according to the applicable rulebook. The minimum longitudinal gradient of 0.50% is applied on the central axis, while the maximum longitudinal gradient that was applied is 3.88 %.

Longitudinal gradients in tunnels are conformity with requirements from the rulebook and they are i=1.53 % for T1 and T2, i=-1.83 % for T3 and i=0.50 % for T4.

Cross sections

Exploratory works were not carried out for this section and neither was pavement structure designed. For this reason, cross sections were elaborated to a much lesser extent, or section contour line is shown in the profiles It was assumed that side slopes of embankments are with gradient 1:1.5 and of excavations 1:1; there will probably be minor changes in profile gradients in the next design stage.

Structures on the route

A total of ten bridges are designed on the route. Their lengths are different, ranging from 35.00 m’ to the longest of 406.00m’. Larger and more challenging structures are mainly designed over the riverbed of the Bosna River, over the main road and over the railway line.

In addition to bridges, four underpasses 9 – 11 m in width with lengths from 40 to 90 m are also planned. Two box culverts are also planned at the crossing 10-12m’ in width and about 35m’ in length.

Tunnels

Four tunnels from 225.00 to 770.00 m in length are planned on the route.

- Total length of the route ……………… l=12,861.87m’
- Length of bridges…………………………. l= 2,113.50m’
- Length of tunnels on the route……… l= 2,005.00m’

Expropriation of structures

In the motorway route coverage zone, it was established that about 18 residential buildings and 9 ancillary buildings will need to be expropriated in section Ozimica - Poprikuše.

Walls on the route

Retaining structures are mainly positioned in places where the route approaches the railway line or larger structures. Places where the walls are designed are given below:

- Km 7+780.00 to km 8+000.00 length l=220.00 m
- Km 10+940.00 to km 11+045.00 length l=105.00 m

- Km 11+490.00 to km 11+722.00 length l=232.00 m on the left side
- Km 11+510.00 to km 11+711.00 length l=201.00 m on the right side

The total length of walls l=758.00 m.

The end of this route has been modified in relation to the Preliminary Design from 2014 during development of the Preliminary Design of section 4 Poprikuše - Nemila. The changes are shown in Figures 13 and 14.

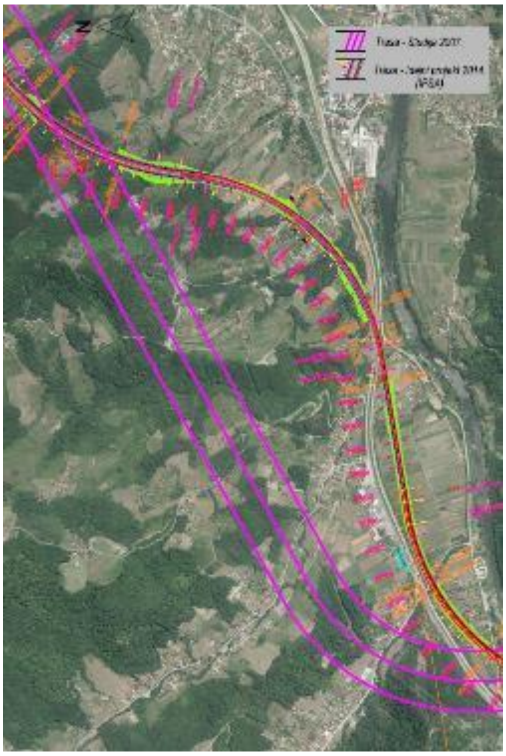

Figure 14: Changes in section 3 in relation to the 2007 Study14

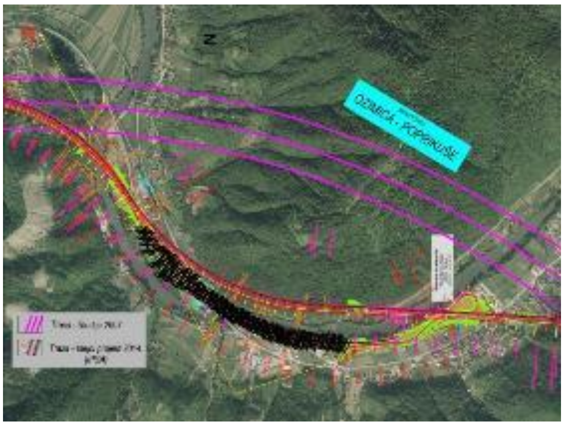

Figure 13: Changes in section 3 in relation to the 2007 Study13

Section 4 (Poprikuše – Nemila) (chainage km 7+850.000 to 13+300.000)

As already said, the beginning of the motorway section on the Corridor Vc Poprikuše – Nemila was defined through the analysis of the preliminary design from 2005 in the area of the Golubinja settlement with the Poprikuše interchange. Since the Žepče municipality did not give consent for the route in this part of the section, the route was moved to the right bank of the Bosna River and then also to a tunnel in order to avoid passage of the route along the Golubinja settlement, while the Poprikuša interchange is mainly kept at the same location, adjusted to the new route.

With this change of the route, section Poprikuše – Nemila starts at the exit of the Želeće tunnel, where the motorway route is practically immediately located on a structure (bridge Golubinja 1 with length Ll=423.5 m (left bridge) and Lr=476.5 m (right bridge)) because it passes over the railway line and Bosna River. After that, a smaller part of the route will be located on embankment, because the existing difference between the level line and ground will be reduced by backfilling the excavated material from the Golubinja tunnel almost to the level of the main road M17.

Before entering the Golubinja tunnel, the motorway will pass over the main road M17 and local road by viaduct Golubinja 2 with length Ll=138 m (left viaduct) and Lr=138 m (right viaduct).

In order to reduce the height of the structures, or the motorway level line, to the minimum possible measure, deviation of the local road was performed in a length of approximately 134 m in the settlement of Golubinja.

The Poprikuše interchange is situated between the two structures, Golubinja 1 and Golubinja 2.

The interchange is trumpet type within which a side toll gate and TMCC (Traffic Maintenance and Control Center) are planned, as well as a stockpile of the material from the tunnel, with which the area will be levelled with the main road. The connection of the interchange and the main road M17 is solved by a roundabout.

Fitting in the previous section is performed by two S-curves with Rh=1035 and Rh=1200 m.

The beginning of the section is in a straight line L=1035 m in length, along which legs of the Poprikuše interchange are fitted with entry-exit lanes, followed by a right curve with radius Rh=1200 m which enters the Golubinja tunnel. The route is mostly in a straight line in the tunnel, from which it exits with a right curve Rh=1275 m (left pavement) and Rh=1350 m (right pavement) and with S-curve of R=2500 fits into the next motorway section in the Corridor Vc Nemila – Donja Gračanica.

Before the tunnel entrance on the right side of the motorway there is a local cemetery, where care should be taken to complete the motorway profile as soon as possible.

At all times, the spacing between pavement axes is L=25 m, since this part of the route, within which the Poprikuše interchange is also situated, is between two tunnels.

Before entering the tunnel, a ramp is designed in a length of L=100 m (km 8+610.00 - km 8+710.00) for movement from one pavement to another in case of works or an accident, etc. on the bridge or in the tunnel.

The length of tunnel tubes is TL1=3659 m and TD1=3659 m. The level line in the tunnel is two-sided with i_1=0.80 % and i_2=0.51 % and vertical curve of Rv=90000 m. The route from the tunnel comes into conflict with the main road M17 and Bosna River, which it crosses by the Bosna bridge with length Ll=196 m (left bridge) and Lr=204 m (right bridge), and exits in the settlement of Kovanići.

In order to use the material from tunnel excavation, and at the same time shorten the length of the bridges at the Kovanići site as much as possible, it is planned to construct a high embankment with berm of the required width. On the right side, the embankment is protected by revetment with the level half a metre higher than the level of the 100-year high water of the Bosna River.

Intersection with the railway line is solved with another viaduct with length Ll=116 m (left viaduct) and Lr=120 m (right viaduct).

The location between the two bridges with a length of L=100 m (km 12+675.00 – km 12+775.00) is chosen as the only possible place for the ramp over which to move from one pavement to the other in case of works or an accident on the route.

The end of the section, or connection with the next section, is in a circular curve of radius Rh=2500 m. The total length of the section is L=5502.05 m (km 7+750.00 – km 13+252.05).

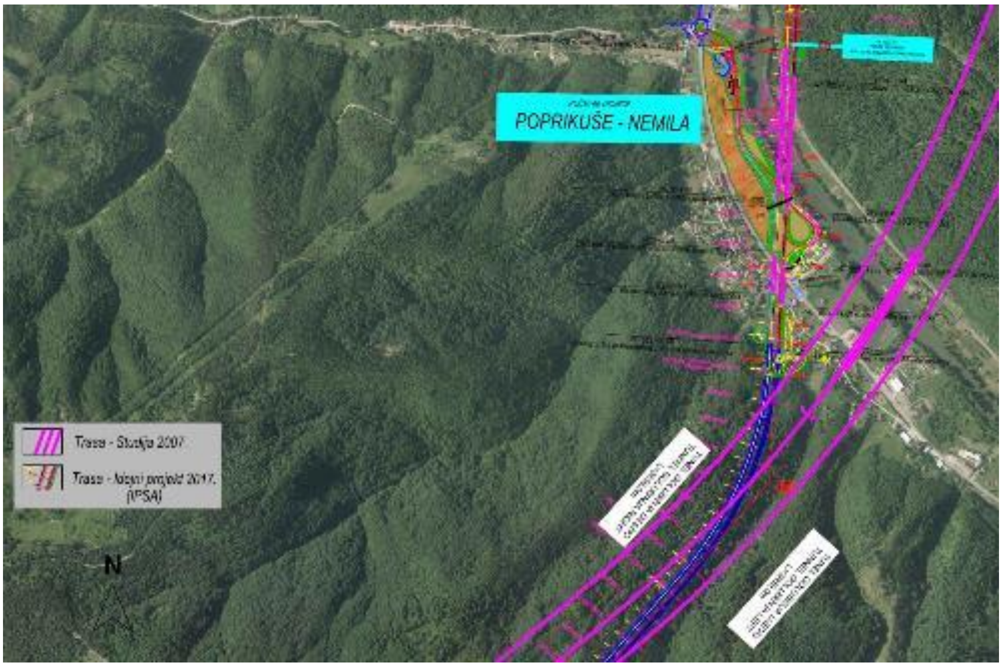

Figure 15: Start of the motorway section Poprikuše – Nemila and Poprikuše interchange15

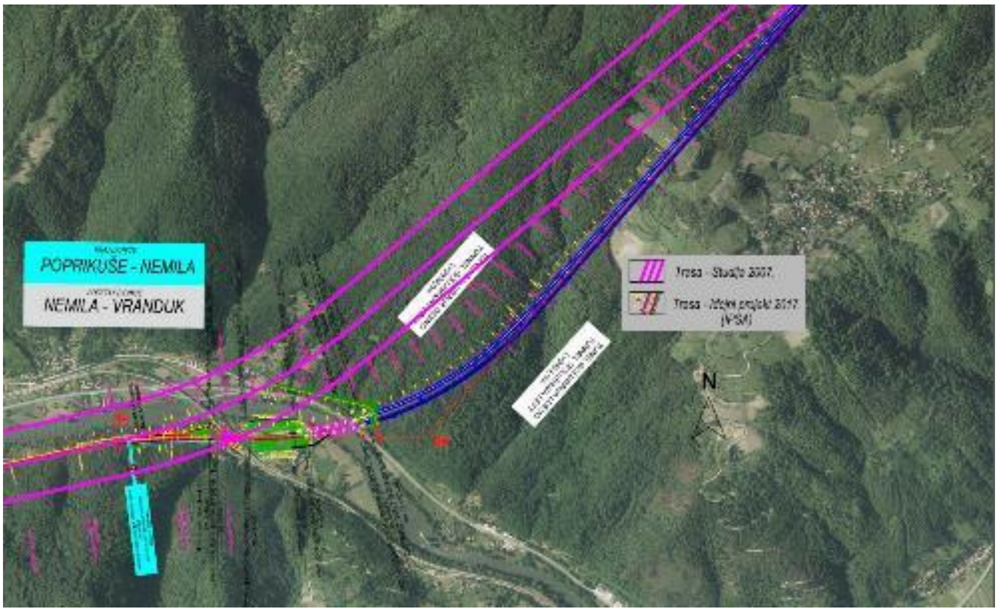

Figure 16: End of the motorway section Poprikuše - Nemila (Kovanići settlement)16

Technical elements of the route are the following:

- Route length L=5502.05m (km 7+750.00 – km 13+252.05)
- Number of curves 3
- Length of curves L=2557.50 m or 46.48%
- Length of straight lines L=2944.55 m or 53.52%, longest straight line L=2001.80 m
- Minimum length of transition curve L=110.0 m (applied twice), while the maximum one is L=325.0 m
- The minimum radius of horizontal curve Rh=1200 m (applied once)
- Stretchiness of the route 5502.05 / 4949.45 = 1.11
- Maximum gradient of level line: 1.48% in 682.51 m

- Minimum gradient of level line: 0.51% in 1548.83 m (right pavement in tunnel)
- Minimum radius of vertical curve Rv=12000 m (right pavement - applied once).

Description of vertical elements (level line):

The central level line of the main route is primarily brought into line with the requirement that the tunnel level line is with two-sided gradient (for drainage during construction), then passages of the roads (local and main M17) and the railway line under the motorway structure, and on the other hand, the need to lower the level line as much as possible in order to reduce the height of structures and automatically to reduce the costs of their construction.

The level line is wavy, i.e. with alternating concave and convex vertical curves. A total of three (3) vertical curves were designed, specifically one (1) concave and two (2) convex ones.

The minimum applied level line gradient is in conformity with the tunnel drainage requirements and amounts to i_{min}=0.51%, while the maximum applied gradient is i_{max}=1.48 %. The vertical radii that are applied on central axis are R_{min}=14000 m and R_{min}=12000 (right pavement) for concave and R_{min}=20 000 m for convex curve.

Also, since the length of the tunnel is L=3659.0 m (over 200 m), the calculation speed is Vc=100 km/h in the tunnel, so the transverse gradient in curves in the tunnel is q=3.5 % for Rh=1200 m. The vertical curve in the tunnel is R=90 000 m.

The pavement structure is taken over from the Main Design for the route on the Corridor Vc, section: Nemila – Donja Gračanica (since the Terms of Reference does not require development of a separate project for pavement structure):

- Wearing course SMA 11s, PmB.....4cm
- Base course BNS 22s 7cm
- Base course BNS 32s 9cm
- Cement stabilization CS..................20cm
- Subbase...25cm
- Total...65cm

Structures on the route

Due to the terrain configuration and a number of intersections of the motorway route with the riverbed of the Bosna River, railway line and main road M17, there are many structures on the motorway route. The structures on the route are given below.

Table 3: Structures on the route3

No.	Structure name	Obstacle	Length of the left driveway (m)	Length of the right driveway (m)
1	Golubinja 1	River Bosna	423,50	476,50
2	Golubinja 2	Main road	138,00	138,00
3	Bosna M3	River Bosna	196,00	204,00
4	Kovanići	Railway	116,00	120,00

Embankment side slope gradients are designed 1:1.5 (where necessary with berm depending on the embankment height or for disposal of excess material from the tunnel excavation), while cut slope gradients range from 1:1.5 to steeper slopes 1:1 and 2:1 (the general solution was with a 3 m berm for each 10 m of cut height). Protective mesh is planned on slopes within cuts.

All material for embankments can be obtained from borrow pits - tunnel excavation as excess material, although a part can be taken from the excavation from open route, where necessary.

Embankment slopes should be covered with topsoil, material from the route, in a thickness of 20 cm.

Drainage

Drainage of the main route is divided into external and internal drainage. In external drainage, rainwater is collected from slopes and hillsides by catching water to edge ditches located above cut slopes and in embankment toe and taking it to culverts and further to the recipient. For internal drainage water from pavement is collected in gutters and conducted to treatment devices in a controlled manner, and then further to the recipient.

On the route itself, one (1) box culvert is designed at the location Km 12+960.80 with dimensions 2.5x2.5m and length L=69.0m

Regulations

Regulation, or relocation of stream bed, is planned in a length of approximately 145.0 m at chainage km 12+650.00.

Section 5 (Nemila – Donja Gračanica (Zenica North))

During development of main designs, the subject section Nemila - Zenica North (Donja Gračanica) is divided into five subsections.

- subsection I – Nemila – Vranduk
- subsection II – Vranduk – Ponirak
- subsection III – Ponirak - Southern exit from the Zenica tunnel
- subsection IV – Southern exit from the Zenica tunnel -Zenica North (junction D. Gračanica)
- subsection V – Zenica North (Donja Gračanica) – Tunnel Pečulj

Subsection 5.1 Nemila – Vranduk (chainage km 0+000.000 to 5+700.000)

In this subsection, the route starts north of the Nemila settlement. The route is designed in a side cut on the right bank of the Bosna River. In the area of the Nemila settlement itself, it coincides with the existing main road and it is planned to relocate the same. Apart from a certain number of retaining structures, there are no significant structures on this subsection. Regulation of the Bosna River is also planned.

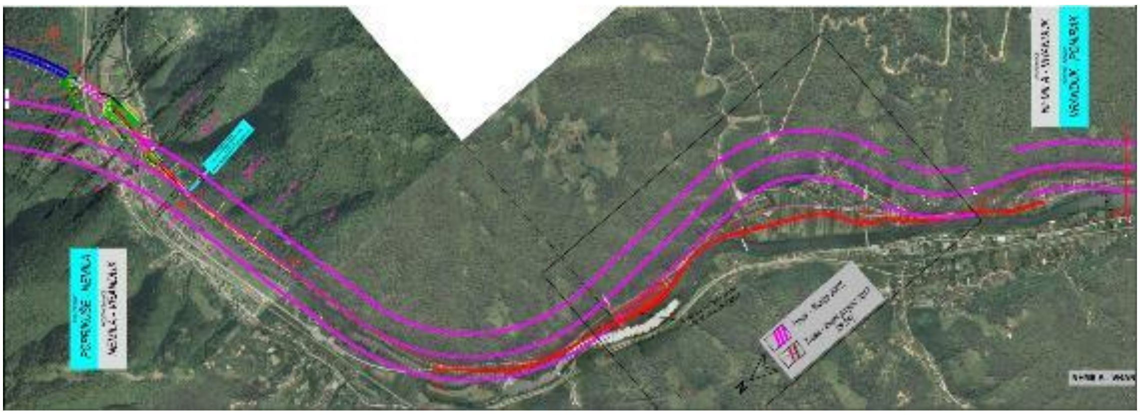

Figure 17: View of subsection Nemila – Vranduk on orthophoto base17

In a part shown in the following figure, this section is considerably altered in relation to the section from the study and it descended from the hill slope to M17 and the Bosna River, and it coincides with the main road in one part.

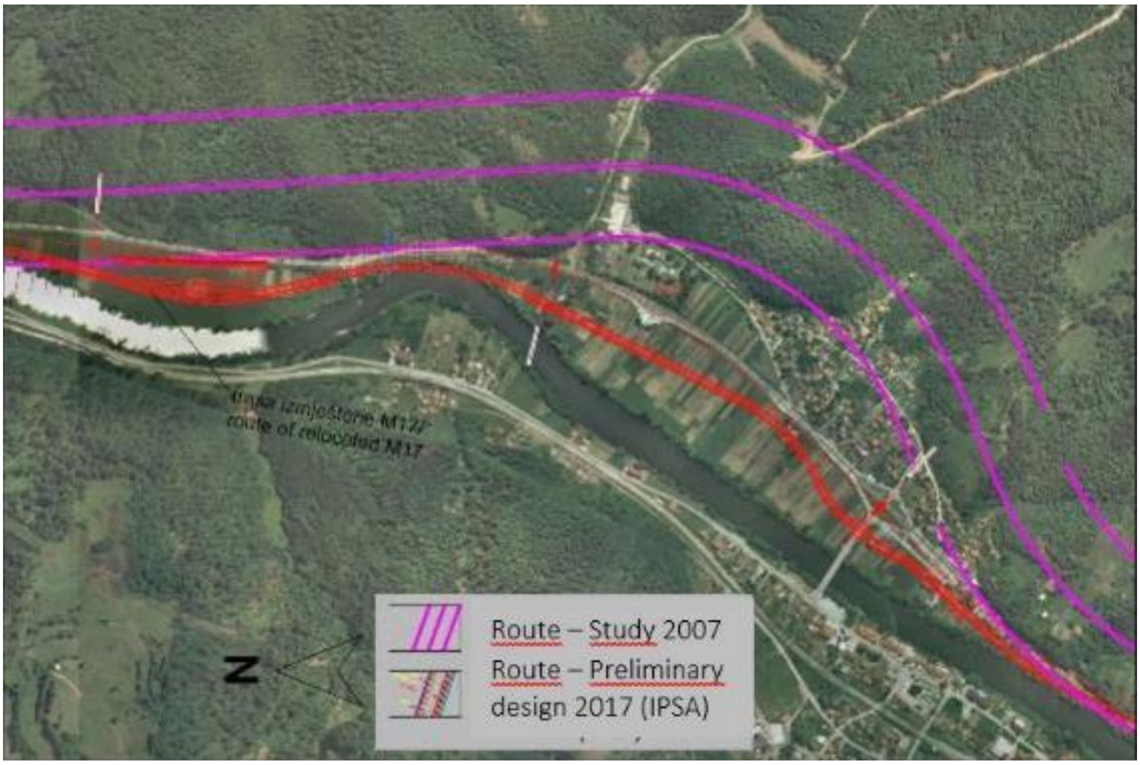

Figure 18: View of the change of the Nemila - Vranduk subsection route in relation to the 2007 Study18

Subsection 5.2 Vranduk – Ponirak (chainage km 0+000.000 to 5+309.300)

The route of subsection II starts on the southeastern side of the Stara Stanica (Old Station) settlement on slopes of Stranata Vlasača hillside. Passing next to the settlement of Stara Stanica, the motorway route stretches southward to the Vranduk area. On this stretch, from the beginning of subsection II (km 0+000.00) up to the Vranduk area km 1+225.00 (including the last approximately 800 m of subsection I) the left and right motorway pavements are separated in plan view and vertically.

Further southeastward, between the slopes of Stranata Vlasača and Suvodolska Kosa hillsides, the motorway route with two bridges *Vranduk 1* and *Vranduk 2* passes over an area with many limiting factors, such as: the future hydroelectric power plant Vranduk (presently under construction) [5], its turbine hall and headrace tunnel, the existing railway line, the Bosna River, the existing main road M17, the existing regional road. Then, the motorway route passes through Suvodolska Kosa hillsides by the Vranduk tunnel, further to the southeast over the slopes of the Krša hillside toward the Koprivna settlement. The motorway route further runs with three smaller viaducts east of the Koprivna settlement over the slope of the Osoja hillside. Passing close to the Koprivna settlement, the motorway route further extends southwards towards the Ponirak settlement.

The motorway is designed with two pavements separated by central reservation, which will have two driving lanes 3.75 m in width and one emergency lane 2.50 m in width each. Emergency

[5] *At the time of writing this Application, construction of HPP Vranduk was suspended*

lane is not designed in the two tubes of the Vranduk tunnel, because the tunnel length is greater than 200 m'. The cross section of one Vranduk tunnel tube is two traffic lanes 3.50 m in width + two marginal strips 0.35 m in width.

Because of the very demanding and complex configuration of the terrain and the mentioned limiting factors, a total of six structures were designed on subsection II:

- One tunnel Vranduk with length of the left tunnel tube l=456 m and of the right tunnel tube l=312 m.
- Two bridges Vranduk 1 and Vranduk 2 with total length on the left pavement l=720 m and on the right pavement l=730 m.
- Three viaducts Crni Potok, Koprivna 1 and Koprivna 2 with total length on the left pavement l=284.22 m and on the right pavement l=281.78 m.

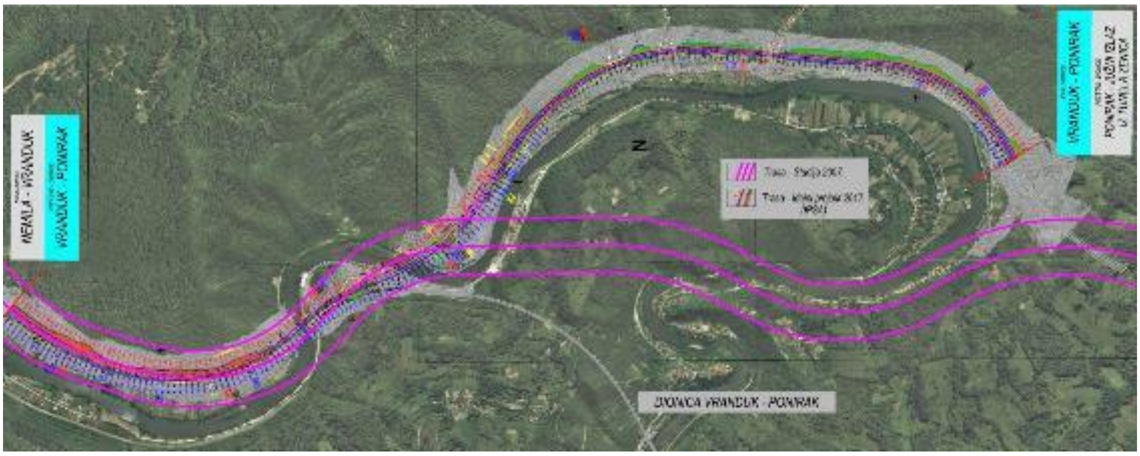

Figure 19: Subsection Vranduk - Ponirak

In this part, the route is significantly modified in relation to the 2007 Study route, when it passed much closer to the architectural ensemble Vranduk. Now the route is moved away to the right bank of the Bosna River.

Subsection 5.3 Ponirak – Southern exit from the Zenica tunnel (chainage km 0+000.000 to 2+662.44)

Subsection III Ponirak-Southern exit from the Zenica tunnel, which is the subject of this project documentation, is designed in the length of l=2.662.44 m (chainage on central axis). The beginning of the subsection is at km 0+000.00 (Ponirak settlement) and the end of the subject subsection is at km 2+662.44 (D. Vraca settlement) on the central motorway axis.

As for the motorway route mapping, generally axis and level line are mapped on the central axis and central level line of the motorway. Only in the zone of tunnels, motorway route was mapped in a way that we have the central axis and central level line and separately mapped the axis and the level line for the left and right motorway pavements.

Subsection III route starts on the southeast side of the Ponirak settlement, where after approximately 136 m of open route it enters the Zenica tunnel. The route extends in the southwest direction through the Zenica tunnel up to the settlement of D. Vraca, where the tunnel exit is situated. The exit portal of the Zenica tunnel for the left tube is at km 2+610.00, while the end of subsection III on the left pavement axis is at km 2+650.00. The exit portal of the Zenica tunnel for the right tube is at km 2+556.00, while the end of subsection III on the right pavement axis is at km 2+674.43.

The length of open route on the left pavement axis is 175.29 m, while the length of the left Zenica tunnel tube is 2474.32 m. The length of open route on the right pavement axis is 255.10 m, while the length of the right Zenica tunnel tube is 2419.33 m.

The motorway is designed with two pavements separated by central reservation, which will have two driving lanes 3.75 m in width and one emergency lane 2.50 m in width each. Emergency lane is not designed in the two tubes of the Zenica tunnel, because the tunnel length is greater than 200 m. The cross section of one Zenica tunnel tube is two driving lanes 3.50 in width + two marginal strips 0.35 m in width.

All technical elements of the motorway are defined according to the Terms of Reference and rulebooks for the category and significance of the subject motorway, for the design speed Vd = 120 km/h.

Description of horizontal route elements

Observing the previously said limiting factors, the motorway route for subsection III is drawn on central axis with two horizontal curves of radii R1=1000 m; L1=154 m, L2=150 m and R2=1100 m; L1=220 m; L2=220 m.

Description of vertical route elements

Level line of subsection III is drawn on the central motorway axis, in the middle of the left and right motorway pavement. The applied gradients of level line are: I1=2.23%, I2=2.82%, I3=2,70%. Vertical curves of radii R1V=50 000 m (concave) and R2V=23 000 m (convex) are designed. The axis distance between the left and right tunnel tube is designed with the width w=25 m. Widening of the central reservation is from 3 m to 16.50 m at the tunnel entrance and exit portals.

Structures on the route of subsection III

The *Zenica tunnel* is designed with two tunnel tubes, each having two traffic lanes of width 3.50 m + marginal strip 0.35m in width. The planned calculation speed for the tunnel is Vc=100 km/h. The beginning of the left tunnel, or portal structure is at chainage km 0+135.68, and the end of the tunnel, or portal structure is at chainage km 2+610.00 and the length of the left tunnel tube is L=2474.32 m.

The beginning of the right tunnel, or portal structure is at chainage km 0+136.67, and the end of the tunnel, or portal structure is at chainage km 2+556.00, and the length of the right tunnel tube is L=2419,33 m.

Other structures on the route

The *Ponirak underpass* is situated on subsection III at chainage 0+105.96 km (on central axis). The underpass allows passage under the motorway structure to the existing local road, which represents the connection of the Ponirak settlement with its hinterland located under the Drenovac hill. The structure is situated immediately before the entrance of the Zenica tunnel, where the left and right axis are significantly spaced apart, which means that the width of the central reservation at the underpass site is approximately 14.00 m. The underpass consists of two frame structures of approximate lengths 12.80 m, which allow passage of the left and right motorway lane over the local road, between which there is the central part consisting of retaining walls that support the motorway embankment. The opening at the site of central reservation of the motorway is secured using protective concrete barriers. The clear span of the underpass is 12.00 m, and the total length is approximately 42.00 m.

The local road in the Ponirak settlement

Since the motorway passes through the settlement of Ponirak, there was a need to relocate the existing local road in the settlement. The existing road is relocated in the length of 125.19 m, in which process it is integrated in the existing road, and passes under the motorway structure through the Ponirak underpass. The normal cross-section consists of two pavements 2 x 2.50 m in width, two gutters 0.50 m in width, and shoulders or berms 0.5m in width.

Pavement structure

The pavement structure dimensioning design is made on the basis of the relevant parameters, traffic load, climatic, topographic and geotechnical characteristics of soil and the material in subgrade, available resources (natural and artificial materials), as well as the appropriate work execution technology.

Traffic lanes on the motorway and tunnel (driving and overtaking lane):

- Split mastic asphalt SMA 11s, PmB 45/80-65 + Er.	d=4 cm
- AGNS 22s, PmB 45/80-65 + limestone aggregate	d=7 cm
- AGNS 32s, B 35/50 + limestone aggregate	d=9 cm
- CNS (cement-stabilized course)	d=20 cm
- NNS unbound base course 0/45 mm	d=25 cm
- CBR of subgrade 10%	
- Total	d=65.0 cm

Motorway emergency lanes

- BB 11k, B 50/70 + Kr.	d=4 cm
- AGNS 22A, B 50/70 + Kr.	d=7 cm
- NNS unbound base course 0/45 mm	d=54 cm
- CBR of subgrade	10%
- Total	d=65.0 cm

Bridges and viaducts

- Split mastic asphalt SMA 11s, PmB 45/80 + Er.	d=4 cm
- BB 11k, PmB 45/80 + Kr.	d=4 cm
- Total	d=8.0 cm

Local roads

- AHNS 16, B 50/70 + Kr.	d=7 cm
- NNS unbound base course 0/45 mm	d=30 cm
- CBR of subgrade	10%
- Total	d=37.0 cm

External drainage

Parallel external channels are designed along the structure of the subject motorway route, in places where the terrain locally gravitates toward the structure. They are designed so as to protect the route structure from catchment area water of a 20-year return period. Parallel external channels are designed with a trapezoidal cross section with width of base 60 cm and minimum height 60 cm. The channel slope gradient is designed 2:1. Channel bottom and slopes are lined with crushed stone in concrete. The mass of stone is about 10 kg and it is placed on a layer of concrete C35/45 so that the minimum thickness of concrete is 10 cm. The total thickness of lining is 30 cm.

Internal drainage

Drainage of pavement surface is provided by a minimum pavement transverse gradient of i=2.50%. The internal drainage system is designed with one central collector in the central reservation and gullies are connected to it by gully connections. Gully connection that passes through the road structure is laid in a layer of concrete C25/30 d=10 cm, and the top fill is made of the same concrete d=15 cm in thickness. The gully connection is attached to the central collector over inspection shaft.

Water drained from the pavement is collected immediately on the edge of the pavement surface in concrete gutter. Gutter is with dimensions 75 cm and cross fall i=15%, of monolithic construction. The collected water from gutter is discharged through the gully system (gully, connection pipe to collector), and then is retained in the collector and conducted to the separator of petroleum products.

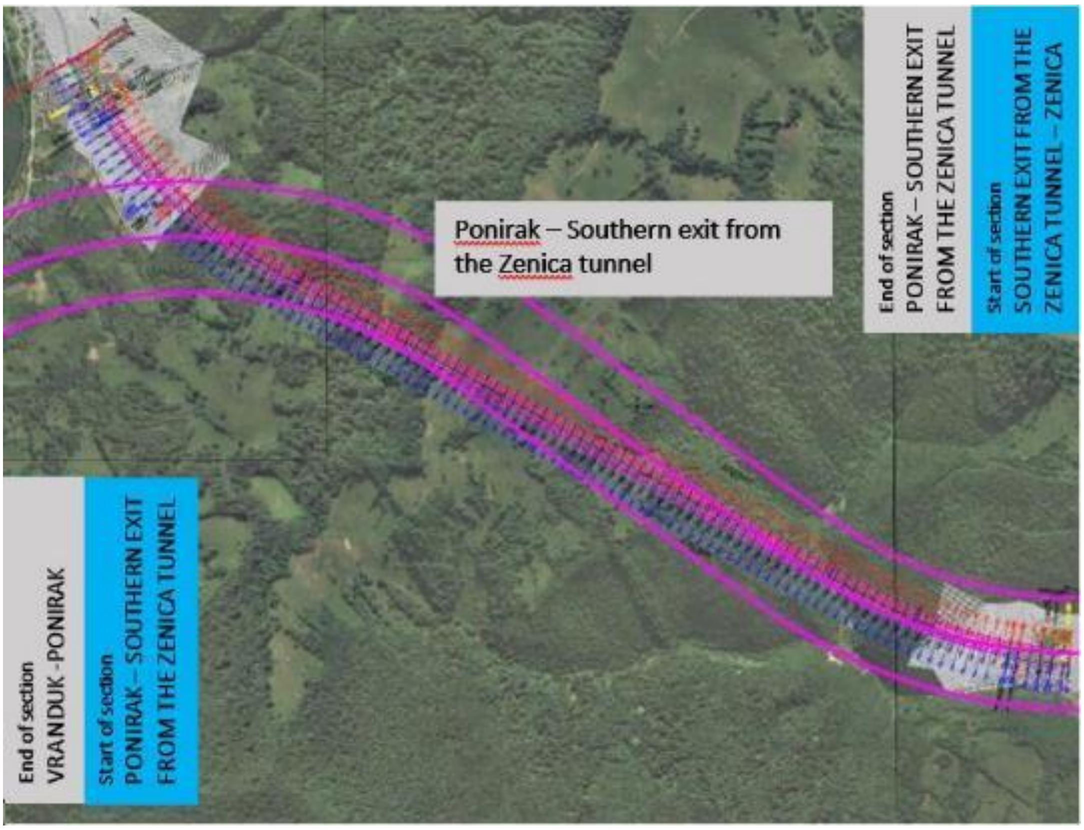

Figure 20: Subsection Ponirak - Southern exit from the Zenica tunnel 19

Subsection 5.4: Southern exit from the Zenica tunnel - Zenica North (chainage km 0+248.000 to 1+943.350)

The newly designed subsection of the motorway route starts from the location of southern exit from the Zenica tunnel - Zenica North (junction Donja Gračanica) L=1.81km in length. The topographic conditions are relatively unfavourable because the route passes through a hilly terrain.

The route does not come into conflict with the Bosna River, or with the existing road M17. Due to the proximity of settlements, the route was designed so as to try to avoid conflict with existing structures, while two cemeteries located on the subsection route are avoided.

From the chainage 1+700 km to the chainage 1+943 km the route intersects a landslide.

On the designed motorway section, it is planned to construct one tunnel (Vraca) and two viaducts (Hecića Do and Jelovik), while the rest of the route is planned to be designed with cuts and side cuts in the existing terrain.

The basic technical solutions of the motorway

The motorway is designed with two, separated by central reservation, pavements, which will have two traffic lanes and one emergency lane each. After exiting the Vraca tunnel, the route is laid over the southwestern slope of the Gaj hillside, up to the Donja Gračanica junction, which also represents the end of the subject subsection.

The length of the open route on the left is 1120.35 m, while lengths of the structures on the left (viaducts and tunnels) are 693.00 m. The length of the open route on the right is 1305.35 m, while lengths of the structures on the right (viaducts and tunnels) are 508.00 m.

The normal profile on the viaducts within the designed subsection corresponds to the normal profile on the open motorway route (two traffic lanes + emergency lane), while in the two tubes of the Vraca tunnel, emergency lane is not designed because the length of the tunnel is greater than 200 m.

Description of the route

Observing the previously said limiting factors, the motorway route is drawn with two horizontal curves of radii R1=1100 m; L1=L2=130 m and R2=1010 m; L1=L2=115 m. The horizontal route axis is drawn in the middle of the central reservation.

The level reference line of the motorway subsection is drawn on the left and right internal edge of asphalt. The applied level line gradients are: i1=2.68% and i2=3.00%. The longitudinal gradient of 3.0% is defined as the input data from the design of the previous motorway section, and as such is used when laying the level line. Vertical curves of radii R1V=27000 m (convex) and R2V=14000 m (concave) are designed. When laying the motorway level line, care was taken to ensure that retaining walls are not higher than H=14.0 m.

After exiting the Zenica tunnel, a turning bay was designed at chainage km 0+163.

The axis distance between the left and right tunnel tube is designed with the width w=25 m.

The distance between the exit portal of the Zenica tunnel and entrance portal of the Vraca tunnel is L=138.0 m for the left pavement, and l=245.0 m for the right pavement. The designed length of the left tunnel tube of the Vraca tunnel is L=495.0 m, and of the right tunnel tube is l=310.0 m. On the stretch between the tunnels, the route is in a cut with protection of cut slopes by a combination of RC wall and grillage, while the embankment is solved by retaining walls with the crown at the level of the level line. On the stretch from the exit of the Vraca tunnel to the beginning of the Hecića Do viaduct, the route is in side cut with protection of cut slope by a combination of shotcrete, anchored nettings and hex green, and RC anchored grid (columns and beams). The embankment is also solved by retaining walls with the crown at the level of the level reference line.

On the chainage 1+347.00 – 1+455.00 the viaduct "Hecića Do left" is designed in the length l=108.0 m, and on the chainage 1+363.00 – 1+471.00 the viaduct "Hecića Do right", is designed in the length l=108.0 m. In the extension of the route on the chainage 1+616.00 – 1+706.00, in the length L=90.0 m the viaducts Jelovik left and right are designed.

From chainage 1+700 to 1+943.35 (end of the subject subsection) the route intersects a landslide. The landslide is separately solved by applying a system of anchored RC columns and beams, retaining walls and drainage systems.

Tunnel Vraca

The tunnel is planned as a two-lane tunnel with two tunnel tubes, with spacing between pavement axes at least 25m, and it is planned to construct the two tubes at the same time for full motorway profile. Within the tunnel, widths of traffic lanes of 2x3.50 m are adopted with marginal strips 2x0.35 m.

The tunnel is aired by natural ventilation.

The length of the left tunnel tube, including portal structures, is 495.00 metres, while the length of the right tunnel tube, including portal structures, is 310.00 metres.

The planned tunnelling method is according to principles of the New Austrian Tunnelling Method NATM.

Viaduct Hecića Do

The viaduct is situated at approximately 1+400 km of the route and it crosses the Donje Vrace valley with the maximum depth of 22.0m under the level reference line of the newly designed motorway at the Hecića Do site.

The motorway is designed for full profile, so the viaduct is designed as a dual structure, i.e. a separate structure 108 m in length for each direction of the motorway. The direction in which the viaduct extends is inclined in relation to hill slopes (contour lines) so the left and right viaducts are sheared by 16 metres. Thus, the first abutment of the left viaduct UL 1 is situated at chainage km 1+347.00, and first abutment of the right viaduct ULD1 is situated at chainage km 1+363.00.

Viaduct Jelovik

The viaduct is situated at approximately 1+650 km of the section and it passes over a water-warn ravine of a maximum depth of 20.0 m under the level line of the newly designed motorway at the Jelovik stream site.

The motorway is designed for full profile, so the viaduct is designed as a dual structure, i.e. a separate structure 90 m in length for each direction of the motorway. The direction of extending of the viaduct is perpendicular to hill slopes (contour lines) so supports of viaducts are parallel in transverse terms.

Rainwater drainage

Hillside (clean) and internal water from asphalt are separated from one another by a technical solution. By a system of channels, hillside water is collected and drained into culverts, by which it is transversely evacuated outside of the road structure.

Polluted water is transported by a closed drainage system to grease traps, where impurities are removed by sedimentation, and then clean water is evacuated to appropriate places.

At the bottom of side slope, next to berm, another channel is designed, which separates clean water from side slope from unclean water, and conducts it to a culvert.

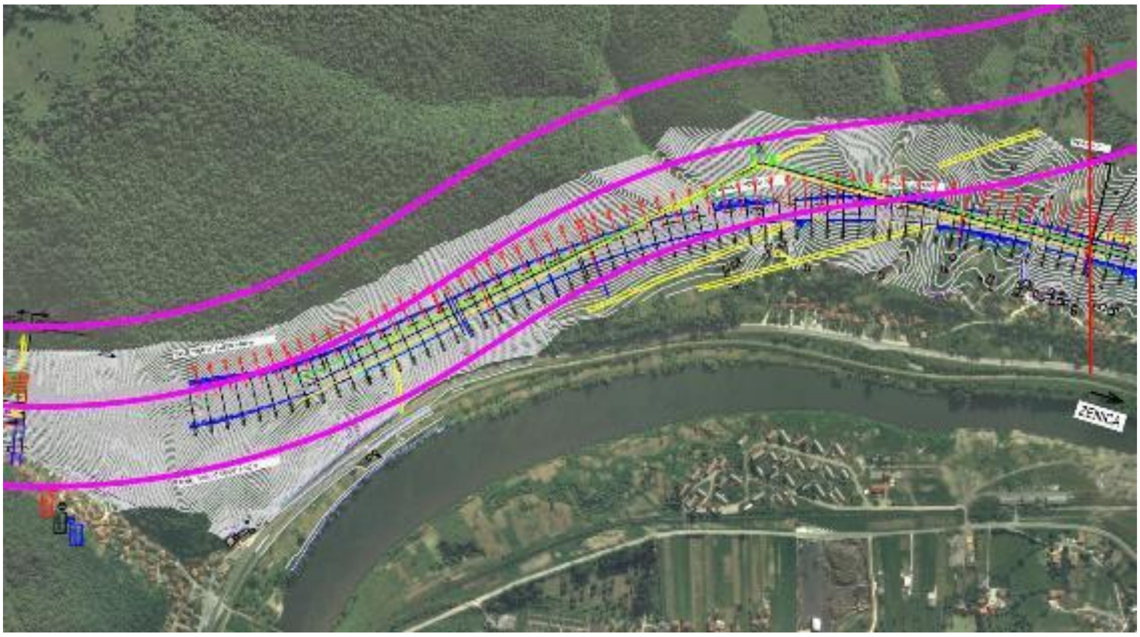

Figure 21: Subsection Southern exit from the Zenica tunnel - Zenica North20

Subsection 5.5: Zenica North (Donja Gračanica) – Tunnel Pečuj

Horizontal elements

This project treats the motorway route from the Donja Gračanica interchange to connection with the Pečuj tunnel. The route is designed on a sloping ground and considering that there is another tunnel from the interchange to the Pečuj tunnel, axes of the route are separated in the part before and after tunnel entrances in order to achieve a distance between axes of approximately 25.00m'. The route is geometrically designed with separated axes, and efforts were made to bring the route as close as possible again in the part between the tunnels in order to minimize the width of the strip that should be expropriated in the part passing through the settlement. The horizontal elements correspond to the calculation speed Vc=120 km/h. From the beginning to the Gračanica interchange, the route is in embankment and side cut and on the part passing over the roundabout a structure approximately 80.00 m' in length is constructed on the motorway. After passing over the roundabout, the route runs through a cut and enters a tunnel that is approximately 420.00m' in length. Immediately after the tunnel, the route passes over a populated place by a viaduct, the viaduct is approximately 380.00 m' in length. After passing the viaducts, the route runs over side cuts to the entrance to the Pečuj tunnel. The left tunnel tube of the Pečuj tunnel should be extended in relation to the structure that was made for the main design level in order to avoid conflicts with the cemetery left in the slope. Horizontal elements of the route are designed for Vc=120km/h considering that the minimum horizontal radius Rmin=850.00m'. Horizontal radius applied in tunnels is 1000.00m’, and 1200.00m’ in the Pečuj tunnel. The minimum transition curves applied are Lmin=100m’.

The Donja Gračanica interchange is located on a gently sloping ground. It is designed in a diamond shape with roundabout below the motorway route. The roundabout "Rotor" is designed in the cut under the motorway route and interchange legs are connected to it. The legs at the connection to the roundabout are designed with minimum horizontal curve of 30.00m'. The applied radii are not adequate to the speed Vc=40km/h, but in agreement with the Investor it was concluded that, considering that the speed in the roundabout is lower in the main design stage, if it is not possible to achieve a minim radius of 45m', through the solution in the traffic design the speed in legs will be limited in accordance with the applied radii, i.e. the speed will be lowered to Vc=30km/h.

Vertical elements

The vertical gradients applied on the main route are in accordance with the calculation speed Vc=100km/h. From the Gračanica interchange, the route ascends at a gradient of 3.0% and before entering the tunnel no. 1 it changes and descends at a gradient of 3.32%, while on the viaduct immediately before entering the Pečuj tunnel the route is in an ascent of 5.0%. The route on the viaduct is 5.0%, which was not possible to avoid considering that the intention was to reduce the structure and heights of the piers on the structure. The interchange legs are designed in conformity with the rulebook and the gradient of 6.0% was applied for descending legs, while the gradient of 5.0% was applied for entry legs. The designer took over the approach road from the Investor from connection to the position of toll gates, a longitudinal gradient of 1.31% is planned further in the toll part, and a gradient of 6.0% from toll to connection to the roundabout. It would be good if the longitudinal gradient could be reduced to approximately 5.0% in the main design development stage.

Structures on the route (bridges and viaducts)

- Viaduct over the roundabout left l=70.00m’ / right l= 82.00m’
- Viaduct no. 1 left and right l=380.00m’

Tunnels

- Tunnel no. 1 L=422.00 m left tube I=420.00 m right tube
- Tunnel Pečuj – belongs to the next section

Interchange Donja Gračanica

In terms of position, the interchange is located in the slope part that is not populated, the terrain is predominantly hilly and conditions for developing interchanges of standard shapes are very difficult. Based on the existing condition, a solution with a roundabout under the motorway route and diamond-shaped interchange legs. Due to the conditions of connection to the route, the legs are not symmetrical, but the geometric elements of legs are satisfactory for Vc=30km/h. Considering that the interchange is located on a slope descending towards the main road, the legs descending from the direction of Zenica and entry legs in the direction of Doboj are in cut, while the legs descending from the direction of Doboj and entry legs in the direction of Zenica are on embankments. Pursuant to the agreement with the Investor, the route was not elaborated further from the toll gate toward the connection to the main road.

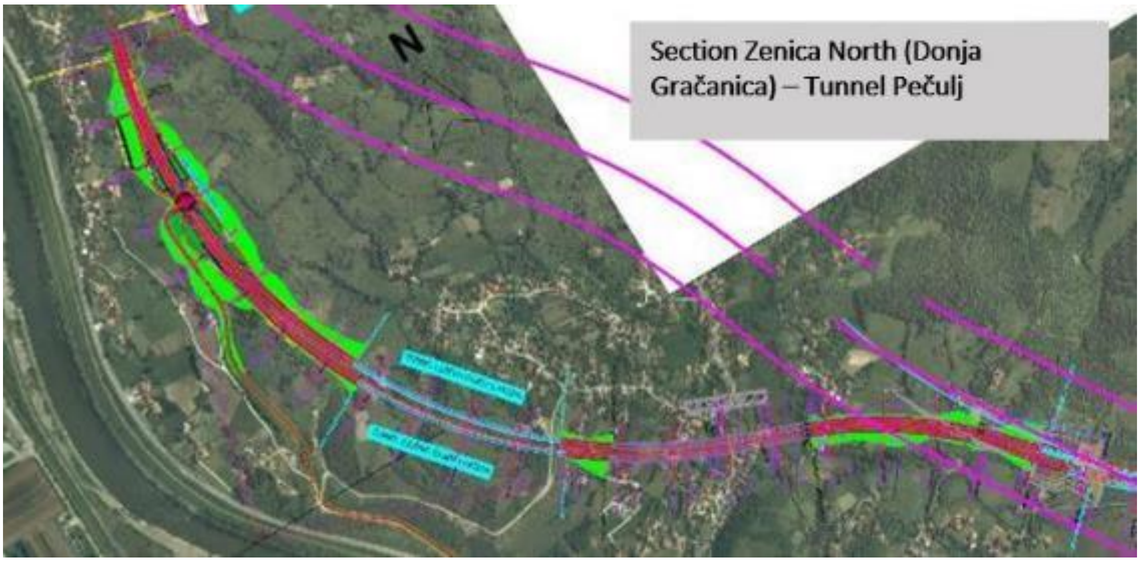

Figure 22: View of the subsection V route and view of the Donja Gračanica interchange21

The longitudinal sections of legs are harmonized so that the allowable gradients of 5% are applied for entry leg, and 6% for descending leg.

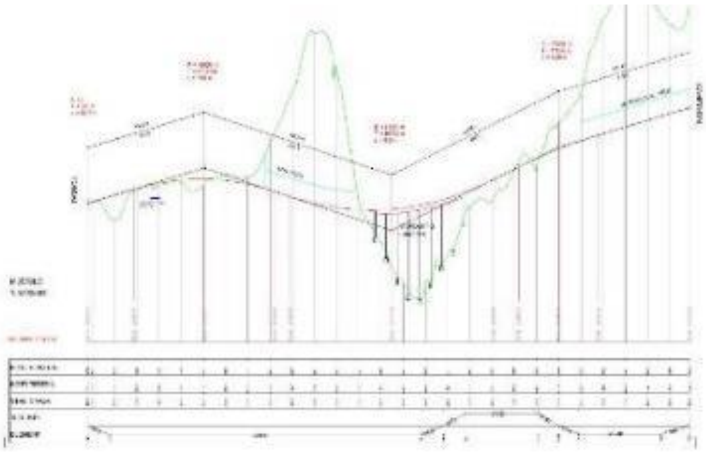

Figure 23: View of the longitudinal section of the main route right axis22

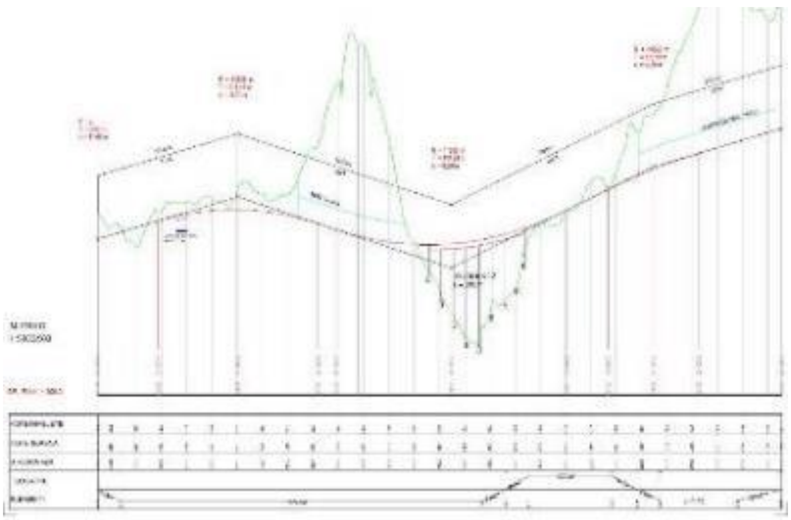

Figure 24: View of the longitudinal section of the main route left axis23

The figure above presenting the section on orthophoto base shows the modification of the route from the preliminary design of April 2014 in relation to the 2007 Study route. The route has come closer to the Bosna River but still it is not in conflict with the river, main road M17 and railway line. The Donja Gračanica interchange is located on undeveloped terrain, but the rest of the route is situated in a rather populated area, which is solved by a viaduct, and the connection with M17 is rather demanding in this part.

Section 6 (Donja Gračanica – Drivuša)

Subsection 6.1 Donja Gračanica - Klopče

In its beginning, the route of the subject subsection 2: Klopče – Donja Gračanica is the continuation of the section Drivuša – Klopče in the zone of viaduct Perin Han at km 2+680.00, and it ends at km 8+460.00.

The total length of the designed motorway route in the subject subsection is 5.780 km.

The designed motorway route of subsection 2, Drivuša – Klopče is designed by applying spatially harmonized continuous curve shapes of layout plan elements, while satisfying limit elements for Vc=120km/h. The minimum applied horizontal curve radius is R=900m, and the maximum one R=1400m.

In addition to open route, the first half of the subject section is characterized by the presence of one viaduct, while the second half is characterized by the fact that practically there is no open route, but the route consists of a total of three viaducts and two hill tunnels in alternation.

The structures of the subsection 2 route are designed in the following order, by increasing chainage:

- culvert 2x2.25m - km 3+134.50
- viaduct Klopče, Ll=32.243+42.320+32.243=106.806m,
  Lr=31.756+41.681+31.756=105.193m from km 3+967 to km 4+073
- culvert 2x2.25m - km 4+973.50
- underpass km 4+988.40
- viaduct Babina Rijeka, Ll=390.11m, Lr=380.24 m, from km 5+625 to km 6+011
- viaduct Pehare, Ll=388.99 m, from km 6+141.87 to km 6+527.61
- Lr=380.12 m, from km 6+141.87 to km 6+525.27
- tunnel Ričice, Ll=514.10 m, Lr=527.10m, from km 6+689.70 to km 7+210.00
- viaduct Ričice , Ll=168.0 m, from km 7+253.77 to km 7+421.77
- Lr=168.0 m, from km 7+242.89 to km 7+410.89
- tunnel Pečuj , Ll=845.60m, from km 7+447.15 to km 8+291.10
- Lr=875.60m, from km 7+432.50 to km 8+309.75

The width of central reservation in the first part of the route of the subject subsection is 3.00m up to km 5+315.229. From km 5+315.229 to km 6+583.036 widening of central reservation to a width of 21.50m was designed because of construction of separated tunnel tubes of the Ričice and Pečuj tunnels. This width of central reservation is kept to the end of subsection 2.

Official and emergency crossings

For the purpose of maintenance and emergency interventions on the motorway, official and emergency crossings are planned between motorway traffic lanes at chainages:

1. km 6+033.80 – km 6+123.80 official crossing 90 m in length, between viaduct Babina Rijeka and viaduct Pehare.
2. km 6+554.50 – 6+579.50 emergency crossing 25 m in length, between viaduct Pehare and tunnel Ričice.
3. km 7+220.00 – km 7+225.00 emergency crossing 5 m in length, between tunnel Ričice and viaduct Ričice.

Removable safety fence is planned on both sides of all crossings.

Local roads

When designing the motorway route, account was taken of the network of local roads and the provision of access to all settlements and properties, and construction of underpasses or relocation of local roads is planned for all local roads that are in conflict with the route.

In addition to preserving the local road network, these measures also improve the existing traffic conditions, in accordance with recommendations of the Environmental Impact Study.

Rest area

For the purposes of constructing service facilities along the motorway from km 5+000.00 to the beginning of viaduct Babina Rijeka km 5+620.00, construction of a rest area is planned for both motorway directions - two-sided rest area, which is located at a panoramically attractive site with interesting environment and recreational areas.

Longitudinal section

The method of mapping motorway axis and level line is typical of a standard normal cross section of a motorway on a free section, where the motorway axis coincides with the central reservation axis (the so-called "central motorway axis"), and the single level line on the so-defined axis applies to internal pavement edges that coincide with central reservation edges. Twisting of associated pavement slabs is performed around these edges.

The level line of the first half of the subject section is characterized by a long convex vertical curve of radius Rv=50000 constructed by the ascent from the previous subsection of s=5.00% and descent of s = (-3.00)% towards the end of the subsection. The level line of the second half of the subject section is characterized by a constant downward gradient of s=(-3.00)%.

Pavement structure of traffic lanes - route:

- SMB 11 s..4cm
- BNS 22sA.......................................7cm + PmB
- BNS 22sA.......................................7cm + BIT 45
- Cement stabilization....................20cm
- Subbase layer...............................25cm
- Subgrade CBR-final layer..............50cm

Drainage

Considering the character of the road, the Terms of Reference requires a closed drainage system. Water fallen on asphalt surfaces, depending on transverse gradient of asphalt, will be collected by gullies located in gutters; it is planned to install oil and light liquids separators before discharging water from the closed system.

As part of the main design subsection II Klopče- Donja Gračanica, the main design of drainage is also made, covering and treating only the drainage of the route, while the drainage of structures (viaducts and tunnels) is elaborated in detail and presented in the projects of structures.

Water from the associated surrounding surfaces of the motorway and road structure slope is collected by ditches in the embankment toe or in berm, and the positions of ditches and their recipients are defined by this project. The selected types of ditches are in accordance with guidelines for design and they are made depending of the longitudinal gradient of ditch level line.

Since the motorway route of subsection II passes through the basin of the Bosna River, the river network in this part is relatively well developed, so that the designed route intersects stream at three places.

At chainage km 5+805.77 it intersects Babina Rijeka (river), which is passed between piers of the Babina Rijeka viaduct.

Then, at km 7+327.34 the route intersects the Sviće stream, where it is planned to regulate the stream, which is passed between piers of the Ričice viaduct at km 7+344.55.

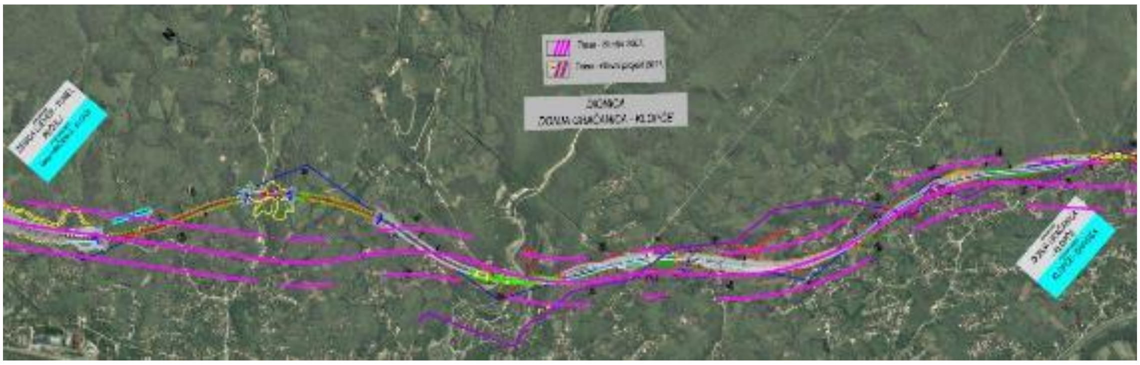

Figure 25: Layout plan of the route of subsection I Donja Gračanica - Klopče on orthophoto, comparison with the route from the 2007 Study24

Subsection 6.2 Klopče - Drivuša

This subsection represents LOT 1 of the Zenica bypass and through the route description it is named from south to north: Drivuša – Klopče.

In its beginning, the route of the subject subsection 1, Drivuša – Klopče, is a continuation of the section Drivuša - Bilješevo in the Drivuša interchange zone, and it ends at km 2+680.00.

The total length of the designed motorway route is approximately 2.680km.

The designed route Drivuša – Klopče is designed by applying spatially aligned continuous curve shapes of layout plan elements, while satisfying limit elements for Vc=120km/h. The minimum applied horizontal curve radius is R=900 m, and the maximum one R=1800 m.

After the exit ramp separates, the route continues to the Drivuša bridge, by which it crosses the Bosna River from km 0+534.00 (start of the bridge) to km 1+189.00 (end of the bridge).

In order to satisfy the necessary motorway dimensions, the bridge is designed as two separated structures, i.e. as the left and the right bridge. The length of the left bridge is 647.32 m and of the right bridge 652.68 m. The normal cross section on the bridge is 0.5+2x3.75+3.50m.

On the bridge over the Bosna River, in terms of layout plan the motorway route is characterized by a left curve of radius R=1800m, from km 0+399.49 to km 1+706.11. The transverse gradient in the bridge part is single-sided and it is q=3.40%.

Relation of the existing local roads is performed in the bridge zone: at chainage 0+980 (Local road 1), between bridge pier positions S11 and S12, then at chainage km 1+093 (Local road 2), between pier positions S14 and S15, which are elaborated by a separated project.

At chainage km 1+103 regulation of the Đulanov stream is performed between pier positions S14 and S15 of the bridge, which is the subject of a separate project.

A gabion wall L=284 m in length is designed behind the Drivuša bridge on the right side of the motorway, from km 1+204.00 to km 1+488.00, as provided in the route layout plan and in cross sections.

The motorway route at chainage km 1+540 intersects the Ciganski stream, where a culvert 2x2.00m is planned. Then at km 1+553.00 the route passes over an underpass through which Local road 4 passes, to which the relocated Local road 3 is connected.

From km approximately 1+655.00 on the right side of the motorway, a gabion wall L=215 m in length is planned.

On the left side of the route from km 1+843.00 to km 1+976.00, in the embankment area, for protection of houses there is a wall of reinforced earth (details given in cross sections), L=133 m in length, then on the right side from km 1+960 to km 2+070 a gabion wall, L=110m.

From km 2+197.45 to km 2+587.45 the motorway route passes over the viaduct Perin Han.

In order to satisfy the necessary motorway dimensions, the viaduct is designed as two separated structures, i.e. as the left and the right viaduct, viewing in the direction of increasing chainage.

The length of the left viaduct is 386.78m, and of the right viaduct 393.22m. In terms of layout plan, on the length of the viaduct the route is in horizontal curve R=900m. The transverse gradient on the viaduct is single-sided q=5.80%.

Deep foundations on bored piles are planned for viaduct piers. The depth of foundations, or the length of piles, and other details of the structures are elaborated in the projects of structures.

In places of end piers it is planned to construct inclined embankment, which should be made before concreting the head beam and constructing the superstructure. Piles of end piers are drilled in the formed embankment to the designed level in the weakened rock.

Before constructing the embankment it is necessary to strip 40 cm thick topsoil layer. Then the embankment is made of stone material (Ø200-300mm) in layers of maximum thickness of 30.0 cm. The embankment shall be compacted to the compressibility modulus value of 45 Mpa at the bottom to 60 Mpa at the top. The modulus of compressibility of the subgrade level as well as of vibrated gravel under the transition slab must be at minimum 80Mpa. The embankment in the zone of bank pier shall be made in conformity with requirements from Volume 1, Part 2: Guidelines for the design of structures DG 1.2.8

Gabion walls protecting the high embankment are planned on the left side of the route before the viaduct from km 2+150, L=83m in length and from the end of viaduct to km 2+690, L=150 m in length.

Subsection 1, Drivuša – Klopče ends at km 2+680.00.

When designing the motorway route, account was taken of the network of local roads and the provision of access to all settlements and properties, and construction of underpasses or relocation of local roads is planned for all local roads that are in conflict with the route.

In addition to preserving the local road network, these measures also improve the existing traffic conditions, in accordance with recommendations of the Environmental Impact Study.

Relocation of local roads, relocation-regulation of streams, underpass at km 1+553.00, bridge Drivuša and viaduct Perin Han, are not the subject of this project. These design solutions are given in main designs of roads outside the route and in main designs of structures.

Longitudinal section

The method of mapping motorway axis and level line is typical of a standard normal cross section of a motorway on a free section, where the motorway axis coincides with the central reservation axis (the so-called "central motorway axis"), and the single level line on the so-defined axis applies to internal pavement edges that coincide with central reservation edges. Twisting of associated pavement slabs is performed around these edges.

From the beginning of the route to km 0+633.50, the level line is at a mild upward gradient 0.3%. The gradient of level line in this part is inherited from the design in the Drivuša interchange zones, further the level line is with upward gradient s=5.00% with which it continues to the next subsection 2 toward Donja Gračanica. This gradient caused the need to design additional traffic lanes for slow vehicles in both directions (both ascending and descending). End chainages of these lanes are determined based on the profile of steady speeds of a reference goods vehicle and in the Drivuša interchange zone they are continued by entry-exit lanes, so that the additional ascending lane is continued by the entry lane from the direction of Zenica, while the additional descending lane is continued by the exit lane for Zenica from the direction of Doboj.

In the beginning of the route from km 0+281.00 to km 0+986.00, concave vertical curve is applied.

Pavement structure of traffic lanes - route:

- SMB 11 s..4cm
- BNS 22sA.......................................7cm + PmB
- BNS 22sA.......................................7cm + BIT 45
- Cement stabilization....................20cm
- Subbase layer................................25cm
- Subgrade CBR-final layer..............50cm

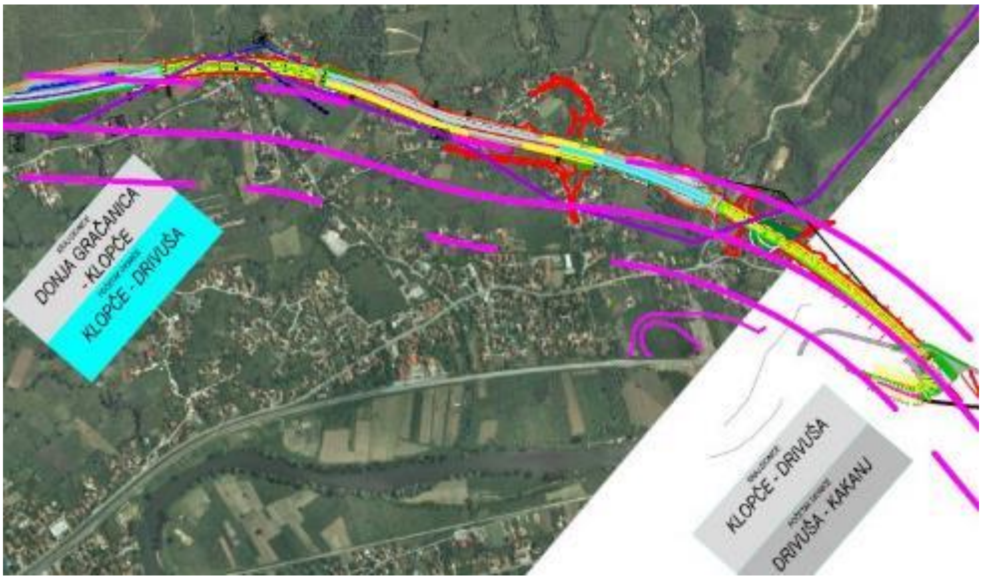

Figure 26: Layout plan of the route of subsection II Klopče – Drivuša on orthophoto, comparison with the route from the 2007 Study25

2.3.1. Load-bearing systems and tunnelling

Tunnel Vraca – section 5 Nemila Vranduk, subsection 5.4. Southern exit from the Zenica tunnel – Zenica North

The planned tunnelling method is according to principles of the New Austrian Tunnelling Method NATM.

Plan and height elements of the tunnel

Plan and height elements of the tunnel are defined by the plan and height mapping of the route.

The beginning of the tunnel, or the portal structure of the left tunnel tube, is planned at chainage km 0+248.00 of the central motorway axis, and end of the tunnel, or of the portal structure, is at km 0+743.00 of the central motorway axis. The beginning of the tunnel, or of the portal structure of the right tunnel tube, is planned at chainage km 0+310.00 of the central motorway axis, and the end of the tunnel, or of the portal structure, is at km 0+620.00 of the central motorway axis.

The level of the reference line at the entrance of the left tunnel tube is 380.30 m a.s.l., while at the exit portal the level of the reference line is 370.23 m a.s.l. The level line is in a fall in the direction of increasing chainage from the entrance portal toward the exit portal. The level of the reference line at the entrance of the right tunnel tube is 379.66 m a.s.l., while at the exit portal the level of the reference line is 373.49 m a.s.l. The level line is in a fall in the direction of increasing chainage from the entrance portal toward the exit portal. The specified level of reference line on the longitudinal section of the Vraca tunnel is the level of the reference line of the internal edge of asphalt of the left and right pavement.

Cross section of tunnel tube

Two tunnel tubes are constructed at a minimum distance of pavement axes of 25 metres. Pavement width in the tunnel is chosen on the basis of the Terms of Reference requirement for width of lane and marginal strip, so the total width of pavement is 2x3.5+2x0.35=7.70 metres. Inspection paths are planned on each side min. 85 cm in width and raised from the traffic surface of the tunnel by 15 cm. Ducts of installations for the necessary tunnel equipment are situated under the inspection paths. The tunnel cross section is rotated following the transverse gradient of the pavement. The tunnel is rotated around the pavement axis, by the angle value corresponding to the transverse gradient of pavement.

Forecast of the distribution of rock mass categories along the VRACA tunnel route

The forecast presence of particular rock mass categories along the route of the left and right tube of the Vraca tunnel is shown in the next table. The quality of the base rock mass that is not weakened by tectonic action will range within the usual limits for similar rock masses and geological conditions, i.e. in the range from category II to category III. In fractured, cavernous and fault zones, rock mass will be significantly deteriorated and will range from category IV to V. Occurrence of speleological structures (caverns, caves) that are not subject to classification is also expected along the route, and they will require individual treatment during excavation and stabilization of excavation, which will depend of their size and position in relation to the underground excavation.

Table 4: Overview of rock mass categories (forecast) (left tunnel tube)

Left tunnel tube ($L_{LTT,TOT}$ = 495.00 m)		
Category II	0 m	0 %
Category III	0 m	0 %
Category IV	295 m	59.6 %
Category V	176 m	35.5 %
open excavation	24 m	4.8 %
Total tunnel length	495 m	100 %

Table 5: Overview of rock mass categories (forecast) (left tunnel tube)

Right tunnel tube ($L_{RTT,TOT}$ = 310.00 m)		
Category II	0 m	0 %
Category III	0 m	0 %
Category IV	150 m	48.4 %
Category V	136 m	43.9 %
open excavation	24 m	7.7 %
Total tunnel length	310 m	100 %

FORECAST SUPPORT SYSTEMS

Support system for RMR category IV

According to the geomechanical classification, this category corresponds to RMR ratings 21 - 40. The following is necessary for application of an appropriate support system:

- Excavation to be performed in two stages: advancing 1.0 to 1.5 m; support to be completed immediately after excavation;
- Crown (calotte): use shotcrete 15 cm in thickness; perform systematic anchoring by rock bolts made of deformed reinforcing bars, Ø 25 mm in diameter, 4.0 m in length, spaced at e/t = 1.5/1.5 m and protect the excavated "clear" profile by steel mesh Q 131; in some places apply about 10% of self-drilling grouted rock bolts IBO R 25 N Ø 25/14 mm;
- Walls (sides): apply shotcrete 10 cm in thickness; perform systematic anchoring with rock bots made of deformed reinforcing bars, Ø 25 mm in diameter, 4.0 m in length, spaced at e/t = 2.0/2.0 m and protect the excavation in "clear" profile by steel mesh Q 131.
- Invert: shotcrete 20 cm in thickness and double steel mesh Q 221;

Support system for the RMR category V

- According to the geomechanical classification, this category corresponds to RMR ratings of less than 20. The following is necessary for application of an appropriate support system:
- Excavation is to be performed in two stages: advancing 0.5 to 1.5 m; support to be completed immediately after excavation;
- Crown (calotte): use 20 cm thick shotcrete; perform systematic anchoring with self-drilling grouted rock bolts type IBO R 32 N, Ø 32/18.5 mm, length 4.0 m, spaced at e/t = 1.5/1.5 m and protect excavated "clear" profile with double steel mesh Q 221; lattice girders spaced at 1.0 m;
- Walls (sides): apply shotcrete 15 cm in thickness; perform systematic anchoring with self-drilling grouted rock bolts type IBO R 32 N, Ø 32/18.5 mm, length 4.0 m, spaced at e/t = 1.5/1.5 m and protect excavation in "clear" profile by double steel mesh Q 221; lattice girders should be spaced at 1.0 m;
- Invert: shotcrete 20 cm in thickness and double steel mesh Q 221

2.3.2. Materials used

The construction of the motorway will result in consumption of large quantities of energy sources, sanitary and technical water, as well as various materials required for construction of the road and supporting facilities.

In terms of energy sources, electrical power, as well as petroleum and petroleum products will be used during road construction.

Construction will also require water, specifically:

- sanitary water for drinking and hygiene of workers on the construction site, and
- technical water as a raw material for production of concrete, then for washing and maintenance of machinery, devices and means of work.

For construction of the motorway as an infrastructure facility, and of associated structures (bridges, retaining walls), and for regulation of a part of the river, the following materials will be used:

1. Stone materials, which will be used for different purposes and qualities, and are thus divided into the following groups:

- Stone material (categories V and VI, max. 300 mm grain, material that can be worked with in winter conditions and rainy periods) from borrow pit and from the route for construction of road embankment.
- Stone material (categories III and IV) for construction of the riverbed regulation dike.
- Stone material for construction of subbase of crushed material (limestone 0/50 mm).
- Stone material for construction of shoulders covered with sand, gravel, stone chippings, thickness 5 cm.
- Stone material to fill drainage with filter material of appropriate strength, stability, purity and grain size distribution.
- Stone material to fill drainage ditches with fine crushed stone behind walls.
- Stone lining - dry penning 299x0.35.

2. Concrete and concrete elements. These materials have multiple purposes in road construction, requiring the need for fresh concrete and concrete elements. The following are planned by the project:

- Concrete bedding MB40 under drainage pipe,
- Production of segmental ditches MB40,
- Production of concrete curbs
- Concreting the foundations of thresholds and wall with concrete MB30
- Concreting walls with concrete MB 40

3. Asphalt and bituminous mixtures - used for pavement structures. They are required for the following purposes:

- Construction of upper courses of bituminous materials (BNS 22A) of various thicknesses
- Production of asphalt concrete (wearing course) of volcanic aggregate
- Construction of asphalt gutter, width 50 cm and 75 cm

4. Steel in the form of:

- reinforcement meshes,
- fences, meshes for protection etc.

5. Wood for formwork

6. HDPE foils

7. PVC pipes of various profiles for drainage and rainwater drainage
8. Resin, adhesives, pastes
9. Road marking paints
10. Paper

The quality of the materials used should be in accordance with European standards (see CEN Construction Directive 89/106/EEC).

2.3.3. Land use conditions during construction and operation of the motorway

The works that will take place during construction of the motorway can be divided into the following groups:

- construction of the route
- construction of connections and intersections
- construction of bridges and support walls
- execution of the riverbed regulation works

As part of the said groups, the following categories of works can be distinguished:

- preliminary works
- earthworks and foundation work (concrete works)
- execution of traffic structure
- drainage
- construction and trade works
- road equipment
- other works.

Organization of construction site is defined by legal regulations, law on construction and its by-laws. Recommendations for the field of traffic are also given by Guidelines for design, construction, maintenance and supervision on roads of the Federation of BiH.

The construction site organization plan specifies:

- Marking of construction site (board with data on the project, designer, contractor and Investor);
- Securing the construction site area and individual structures (plastic strips, different types of fences);
- Securing the structures intended for environmental protection;
- Description of safety measures during working hours and out of them;
- Method of informing the responsible person on extraordinary environmental events;
- Instruction for procedures in extraordinary environmental events out of the working hours and
- Others, depending on the nature of the construction site.

Before starting the construction works, in keeping with legal regulations, the Contractor shall develop the construction site organization plan. The construction site organization plan must be developed in accordance with the project based on which the building permit is issued, and must contain all the necessary data about communication paths on the construction site and points of access to the public infrastructure from the construction site, including also description of points of access to public roads, about warehouses, stockpiles, workshops, office for site management and engineer/supervising engineer, changing rooms and sanitary premises for workers, as well as other data relevant for safe and reliable operation of the construction site. The construction site organization plan must be approved by the Investor before the start of construction work.

Before starting the works, the plan of construction site arrangement must be approved by the Investor. Considering that it is planned to perform construction in part of the area of public roads, the construction site organization plan should ensure safe traffic flow. It is also necessary to ensure the safety and protection of health of passers-by, as well as safety and protection of health of workers at the construction site. Also, in an area where overhead or underground public infrastructure lines are installed, such as sewage, water supply system, power supply network, telecommunications network, and other municipal facilities, the construction site organization plan shall ensure their uninterrupted operation.

At all times during construction, the construction site must be organized so as to ensure uninterrupted and safe execution of all works, so that there are no risks of injuries and health problems for workers and other persons. All passages and accesses to the construction site must be free, wide enough, regularly cleaned and maintained, and properly illuminated. Any vertical rods and other obstacles protruding from the ground or ceiling must be bent or protected and marked so that the workers cannot be injured. Construction site rules shall be posted at visible places at all entries to the construction site, and in all rooms used by workers.

When works are carried out on or immediately next to a public road, the traffic organization plan should ensure safe flow of traffic, as well as safety and protection of health of passers-by and workers on the construction site.

3. DESCRIPTION OF THE ENVIRONMENT THAT COULD BE AFFECTED BY THE PROJECT

3.1. DEMOGRAPHIC AND ECONOMIC CHARACTERISTICS

3.1.1. Population[6]

The last census in Bosnia and Herzegovina was in 2013. The observed route passes through 13 municipalities: Doboj South, Usora, Tešanj, Maglaj, Žepče, Zenica, Kakanj, Visoko, Ilijaš, Sarajevo – Novi grad, Ilidža, Kiseljak, Hadžići.

The observed area is shown as an area of unfavourable demographic characteristics (negative population growth rate, unfavourable age structure, vital characteristics below the average achieved in spatial coverage). Only strategic projects that generate overall development can contribute to demographic development of this area, primarily counting on positive migration. In this regard, construction of the Corridor Vc has a key function.

Table 6: Population projection in the planning period by municipalities4

Ser. no.	Municipality/ Town/ City	Population according to 2013 Census	Population projection in the planning period	Average population age	Area km^2	Population density people/km2
1.	Doboj South	4.137	4.240	35.76	10	414
2.	Usora	6.603	6.191	39.53	50	132
3.	Tešanj	43.063	44.846	35.35	156	276
4.	Maglaj	23.146	22.650	38.12	290	80
5.	Žepče	30.219	30.387	36.30	210	144
6.	Zenica	110.663	109.111	38.38	558	198
7.	Kakanj	37.441	37.806	37.12	377	99
8.	Visoko	39.938	40.894	37.53	231	173
9.	Ilijaš	19.603	19.956	37.08	309	63
10.	Vogošća	26.343	26.675	37.01	72	366
11.	Sarajevo–Novi grad	118.553	117.210	38.99	48	2.470
12.	Ilidža	66.730	67.396	37.52	149	448
13.	Kiseljak	20.722	20.694	38.04	164	126
14.	Hadžići	23.891	24.140	37.13	273	88
	TOTAL	**571.052**	**572.196**	**37.42**	**2.897**	**197**

Table 7: Projection of population in the narrower influence area according to the Spatial plan of the area of special features on Corridor Vc5

Ser. no.	Municipality/ Town/ City	Number of settlements in the direct influence area	Population projection in immediate influence area
1.	Doboj South		2.205
2.	Usora	5	3.975
3.	Tešanj	13	11.737
4.	Maglaj	4	3.617
5.	Žepče	23	24.207
6.	Zenica	23	91.037

[6] *Projection taken over from the Spatial plan of the area of special features Motorway on the Corridor Vc*

Ser. no.	Municipality/ Town/ City	Number of settlements in the direct influence area	Population projection in immediate influence area
7.	Kakanj	25	23.580
8.	Visoko	28	25.664
9.	Ilijaš	11	13.127
10.	Vogošća	6	15.745
11.	Sarajevo–Novi grad	2	132.381
12.	Ilidža	6	79.646
13.	Kiseljak	8	2.521
14.	Hadžići	14	4.305
TOTAL		**169**	**433.747**

3.1.2. Settlement structure

Within the observed area, settlements are divided into five categories

- 0 – 2,000 people – Category IV
- 2,001 – 5,000 people – Category III
- 5,001 – 10,000 people – Category II
- 10,001 – 50,000 people – Category I
- > 50,000 – Category 0

Municipality/ Town/ City	Settlement	Settlement category in 2028	Settlement type in 2028	Municipality/ Town/ City	Settlement	Settlement category in 2028	Settlement type in 2028
ODŽAK	DONJI SVILAJ	IV	Rural	KAKANJ	DONJI LUČANI	IV	Rural
	VRBOVAC	IV	Rural		GORNJI LUČANI	IV	Rural
	NOVI GRAD	IV	Rural		BILJEŠEVO	IV	Rural
	POTOČANI	IV	Rural		SLIVNICE	IV	Rural
DOBOJ-JUG	MATUZIĆI (Municipality centre)	III	Mixed		DUMANAC	IV	Rural
USORA	ULARICE	IV	Mixed		DONJI KAKANJ	IV	Rural
	ALIBEGOVCI	IV	Mixed		TIČIĆI	IV	Rural
	TEŠANJKA	IV	Mixed		MIOĆI	IV	Rural
	ŽABLJAK	IV	Rural		GROCE	IV	Rural
	MAKLJENOVAC	IV	Mixed		KARAULSKO POLJE	IV	Rural
TEŠANJ	KARADAGLIJE	IV	Rural		ČATIĆI	IV	Rural
	KOPRIVCI	IV	Rural		TURBIĆI	IV	Rural
	TREPČE	IV	Rural		POLJICE	IV	Rural
	TUGOVIĆI	IV	Rural		TERMOELEKTRANA	IV	Rural
	RIPNA	IV	Rural		DONJA PAPRATNICA	IV	Rural
	ČAGLIĆI	IV	Rural		KUJAVČE	IV	Rural
	JABLANICA	IV	Rural		DONJI BANJEVAC	IV	Rural
	KRAŠEVO	IV	Rural		DOBOJ	III	Rural
	LEPENICA	IV	Rural		BIČER	IV	Rural
	MEDAKOVO	IV	Rural		KAKANJ (Municipality centre)	I	Urban
	NOVO SELO	IV	Rural		SLIVNICE	IV	Rural
	ČIFLUK	IV	Rural		KARAULSKO POLJE	IV	Rural

Municipality/ Town/ City	Settlement	Settlement category in 2028	Settlement type in 2028	Municipality/ Town/ City	Settlement	Settlement category in 2028	Settlement type in 2028
	TEŠANJKA	IV	Rural		RAILWAY STATION KAKANJ	IV	Rural
MAGLAJ	MLADOŠEVICA	IV	Rural		POPRŽENA GORA	IV	Rural
	NOVI ŠEHER	IV	Mixed		GORA	IV	Rural
	RADOJČIĆI	IV	Rural	VISOKO	KOPAČI	IV	Rural
	STRUPINA	IV	Rural		DONJA VRATNICA	IV	Rural
ŽEPČE	GRABOVICA	IV	Rural		TAUKČIĆI	IV	Rural
	LJUBATOVIĆI	IV	Rural		ARNAUTOVIĆI	IV	Mixed
	ŽELJEZNO POLJE	II	Urban		TOPUZOVO POLJE	IV	Mixed
	GOLUBINJA	IV	Rural		DOBRINJE	IV	Rural
	GORNJA GOLUBINJA	IV	Rural		HLAPČEVIĆI	IV	Rural
	BEGOV HAN	IV	Rural		BRADVE	IV	Mixed
	RAVNE GORNJE	IV	Rural		BUZIĆ MAHALA	IV	Mixed
	SELIŠTE	IV	Rural		OKOLIŠĆE	IV	Rural
	TATARBUDŽAK	IV	Rural		RADINOVIĆI	IV	Rural
	VAROŠIŠTE	IV	Rural		DONJE MOŠTRE	IV	Mixed
	VAŠARIŠTE	IV	Rural		GORNJE MOŠTRE	IV	Rural
	ŽELEĆE	IV	Rural		MULIĆI	IV	Rural
	ŽEPČE (Municipality centre)	II	Urban		BISKUPIĆI	IV	Mixed
	PAPRATNICA	IV	Rural		MUHAŠINOVIĆI	IV	Rural
	RAVNE DONJE	IV	Rural		DONJA ZIMĆA	IV	Mixed
	LJUBNA	IV	Rural		GORNJA ZIMĆA	IV	Rural
	BLJUVA	IV	Rural		SEOČA	IV	Rural
	ORAHOVICA	IV	Rural		KULA BANJER	IV	Rural
	MRAČAJ	IV	Rural		VISOKO (Municipality centre)	I	Urban
	OZIMICA	IV	Rural		VRELA	IV	Rural
	GOLIJEŠNICA	IV	Rural		DOLIPOLJE	IV	Rural
	LUPOGLAV	IV	Rural		ČEKREKČIJE	IV	Rural
	DONJI LUG	IV	Rural		KALOTIĆI	IV	Rural
ZENICA	TOPČIĆ POLJE	IV	Rural		SVINJAREVO	IV	Rural
	KOVANIĆI	IV	Rural		SRHINJE	IV	Rural
	NEMILA	III	Mixed		OZRAKOVIĆI	IV	Mixed
	GLADOVIĆI	IV	Rural		RIBARIĆI	IV	Rural
	VRANDUK	IV	Rural	ILIJAŠ	LUKA	IV	Rural
	KOPRIVNA	IV	Rural		ILIJAŠ (Municipality centre)	II	Urban
	PONIRAK	IV	Rural		KARAULA	IV	Rural
	DONJA VRACA	IV	Rural		KADARIĆI	IV	Rural
	BANLOZ	IV	Rural		PODLUGOVI	IV	Mixed
	LAŠVA	IV	Rural		SOVRLE	IV	Rural
	GORNJA VRACA	IV	Rural		LJUBNIĆI	IV	Rural
	KLOPAČKI VRH	IV	Rural		LJEŠEVO	IV	Rural
	SVIĆE	IV	Rural		BALIBEGOVIĆI	IV	Rural
	NOVO SELO	IV	Rural		MALEŠIĆI	IV	Rural
	ZENICA (Canton centre)	0	Urban	VOGOŠĆA	VOGOŠĆA (Municipality centre)	I	Urban
	JANJIĆI	IV	Rural		KRIVOGLAVCI	IV	Rural
	JANJIČKI VRH	-	-		SVRAKE	IV	Urban
	MUTNICA	IV	Rural		DONJA VOGOŠĆA	IV	Mixed
	GUMANCI	-	-		SEMIZOVAC	IV	Mixed
	GORICA	IV	Rural		NEBOČAJ	IV	Rural

Municipality/ Town/ City	Settlement	Settlement category in 2028	Settlement type in 2028	Municipality/ Town/ City	Settlement	Settlement category in 2028	Settlement type in 2028
	PUTOVIČI	IV	Rural	SA-N. GRAD	BOJNIK	IV	Rural
	TIŠINA	IV	Rural		NOVI GRAD	0	Urban
	PUTOVIČKO POLJE	IV	Rural	ILIDŽA	RUDNIK	IV	Rural
					KOBILJAČA	IV	Rural
					RAKOVICA	III	Mixed
					KAKRINJE	IV	Rural
					VLAKOVO	IV	Rural
					ILIDŽA (Municipality centre)	0	Urban
				HADŽIĆI	VUKOVIĆI	IV	Rural
					DONJA RAŠTELICA	IV	Rural
					TRZANJ	IV	Rural
					GORNJA RAŠTELICA	IV	Rural
					ORAHOVICA	IV	Rural
					VRBANJA	IV	Rural
					JAPALACI	IV	Rural
					SMUCKA	IV	Rural
					DO	IV	Rural
					TARČIN	IV	Mixed

3.2. CLIMATIC AND METEOROLOGICAL CHARACTERISTICS

All maps, diagrams and textual part in this chapter relating to the 10 meteorological stations from Table 6: Coordinates of meteorological stations processed for the period 1961-1990 are taken over from the study "Environmental Impact Study, Volume 01-FINAL VERSION", June 2007 (IPSA INSTITUT), and this will no longer be separately emphasized.Table 8: Coordinates of meteorological stations processed for the period 1961-19906Table 8: Coordinates of meteorological stations processed for the period 1961-19906

The considered area of section LOT 2 Doboj South (Karuše) - Sarajevo (South) - Tarčin, with a total length of 145 km, passes through a zone of temperate continental climate, whose influence comes from the Pannonian Plain. The main characteristics of this type of temperate climate are harsh winters, short spring and warm and humid summer as well as large seasonal temperature differences, which are still not as large as in the mountain range of this climate. Temperatures rise sharply from January to July and slowly fall towards the end of the year to December. The coldest month is January and the warmest is July. Mean January temperatures are mainly negative, while mean July and August temperatures are quite high, leading to large annual temperature fluctuations. The hottest areas are in the northeast, while mean temperatures decrease towards the southwest, along the Bosna River valley towards Sarajevsko Polje. The temperature differences that occur are conditioned by local effects.

Average annual precipitation ranges from 780 l/m^2 to 1300 l/m^2. Precipitation is fairly evenly distributed throughout the year with spring and autumn maximums.

Data from ten meteorological stations for the period 1961 - 1990 were used for analysis of climatological parameters of the subject area.

Analysis for the Zenica meteorological station, analysis period 1998 - 2018, was conducted subsequently.

Table 8: Coordinates of meteorological stations processed for the period 1961-19906

Station	φ	λ	Hs (m)
Doboj	44°44'	18°06'	146
Maglaj	44°32'	18°07'	190
Zavidovići	44°27'	18°10'	210
Zenica	44°13'	17°54'	344
Kakanj	44°09'	18°05'	380
Visoko	44°00'	18°12'	439
Sarajevo-Bjelave	43°52'	18°26'	630
Butmir-Aerodrom	43°50'	18°21'	518
Hadžići	43°50'	18°13'	570
Tarčin	43°48'	18°06'	660

3.2.1. Air temperatures

The mean annual air temperatures, for the analysed period 1961-1990, range from 8.6 to 10.6°C, depending on altitude (Figure 27). The lowest average monthly temperature in the multi-year series was –8.0°C (January), and the highest average monthly temperature was 23.3°C (July). The absolute minimum temperature was –32.2°C and the absolute maximum temperature was 40.0°C (1961–1990).

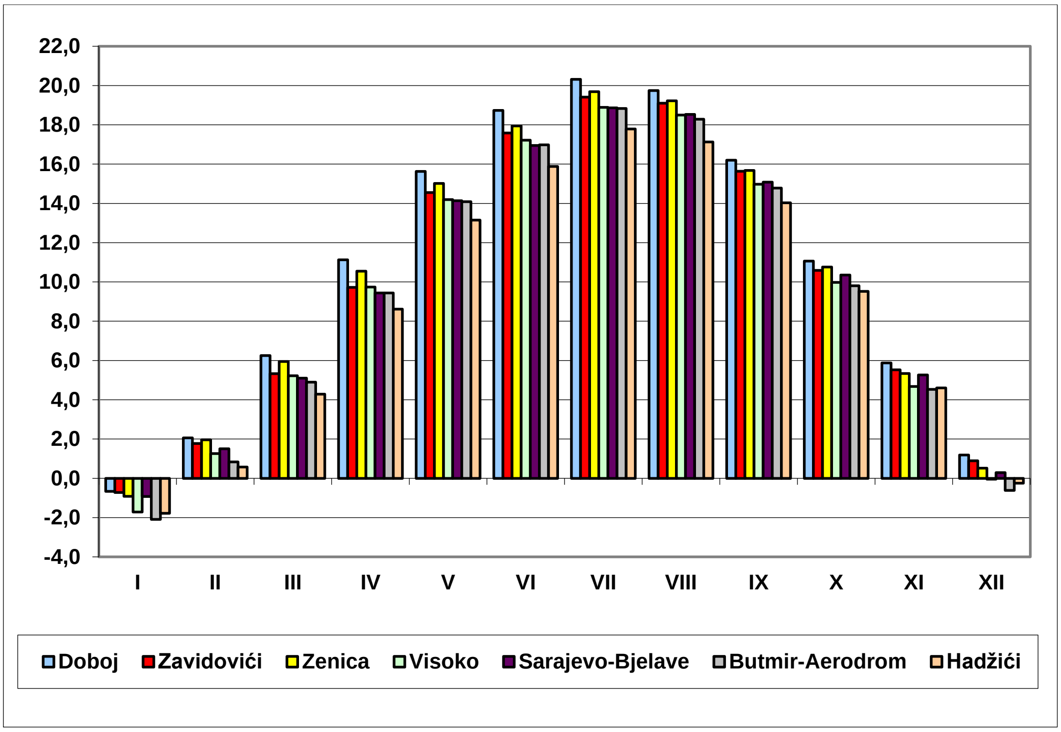

Figure 27: Mean monthly air temperatures (°C) 1961-199026

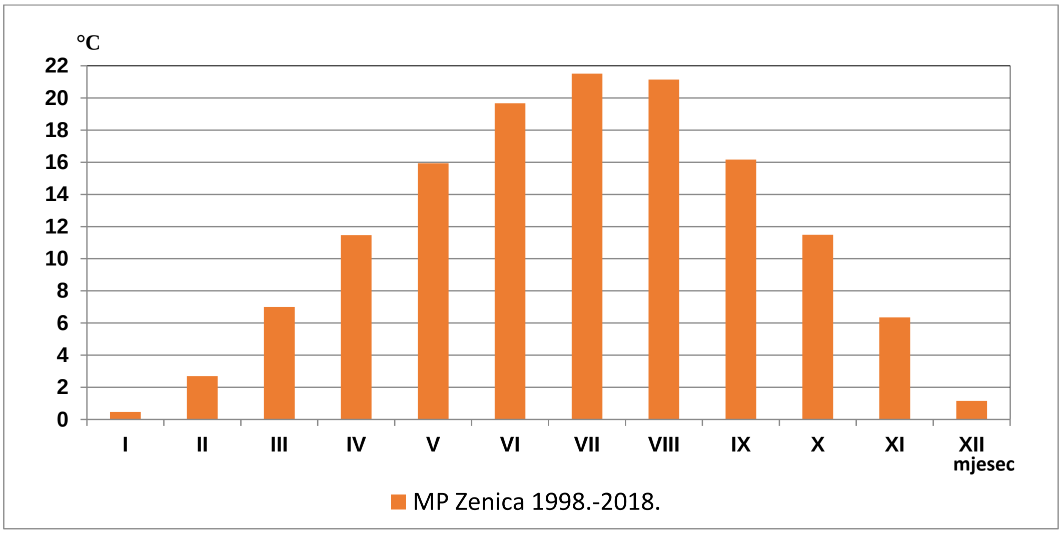

Figure 28: MS Zenica, mean monthly air temperatures (°C) 1998-201827

Mean annual T for the analysed period ***T=11.30°C***

Temperature ranges in the coldest and warmest part of the year are given in Figures 27-33. It is evident that the maximum annual amplitude slightly decreases with altitude and ranges from 72°C (Doboj) to 62°C (Hadžići) in the period 1961-1990.

The values in the graphs are related with a linear trend, which gives the average change in temperature with altitude and change during the year.

A trend of increasing the mean July and mean January air temperatures is evident from the data presented in the diagrams related to MS Zenica, the analysis period 1998-2018.

The temperature distribution is shown by isotherms on the following map (1931-1990).

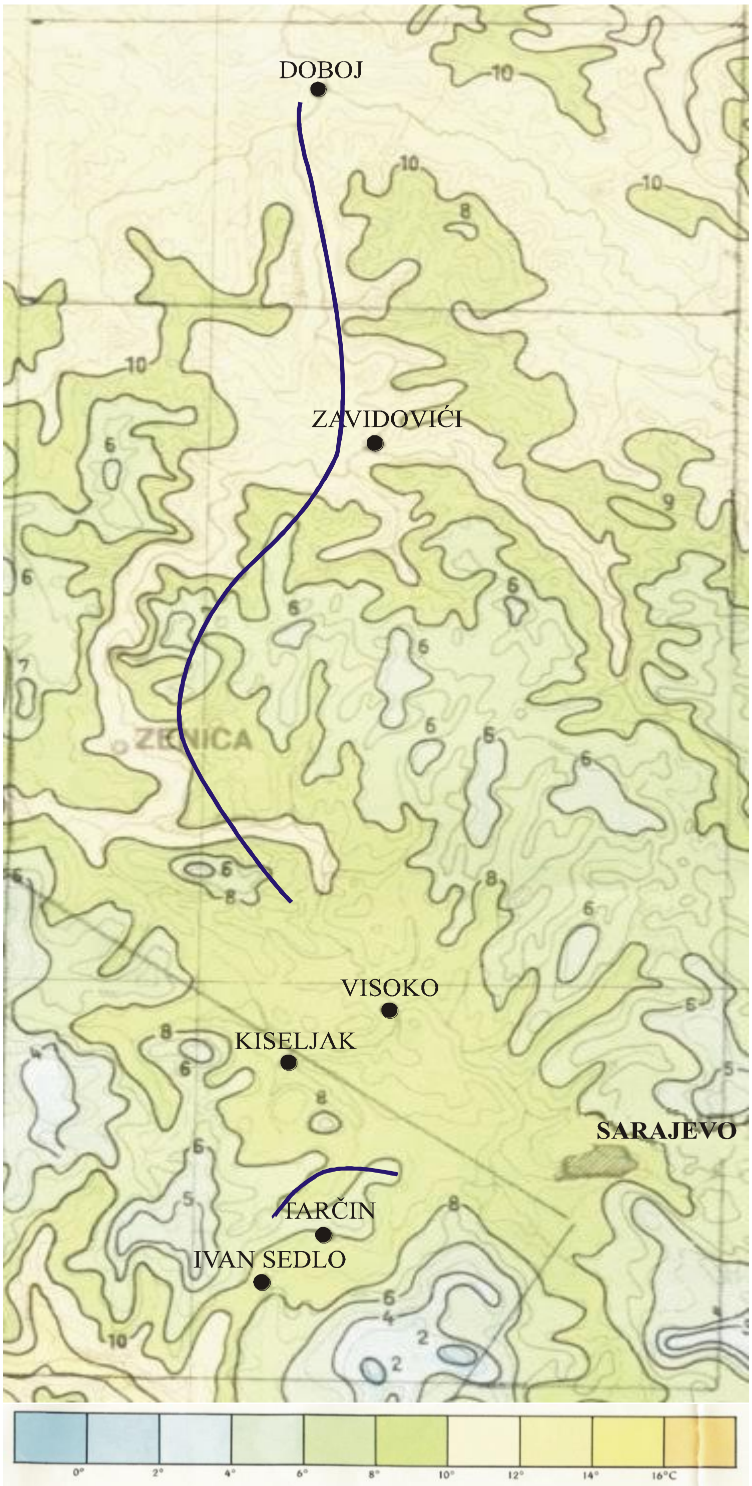

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Figure 29: Map of temperature distribution shown by isotherms (1931-1990).

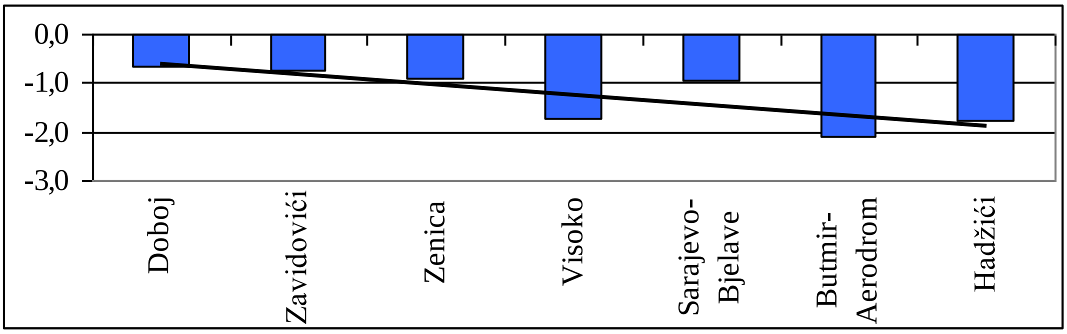


Figure 30: Mean January temperatures (°C)1961-199028

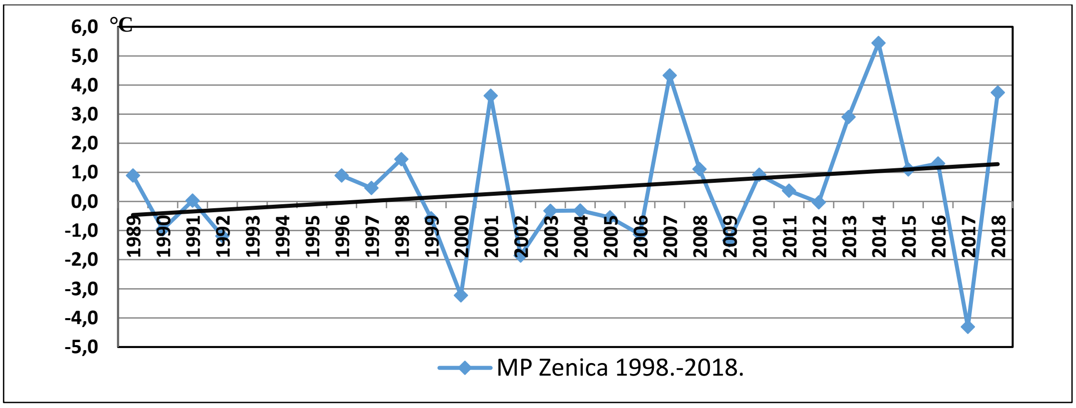


Figure 31: MS Zenica, mean January temperatures (°C)1998-201829

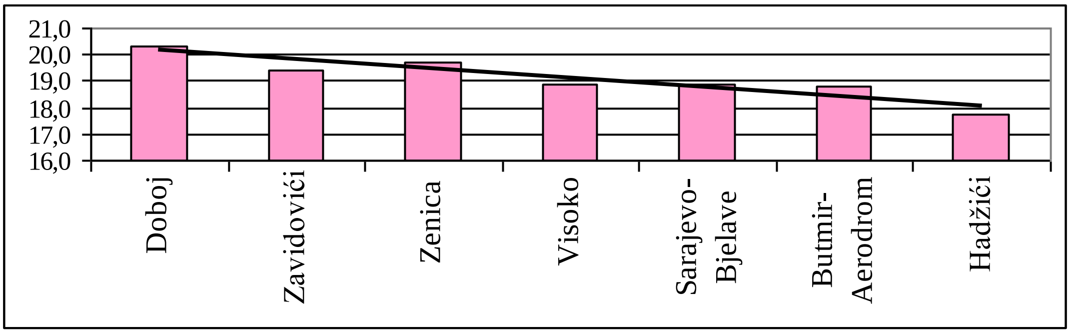


Figure 32: Mean July temperatures (°C)1961-199030

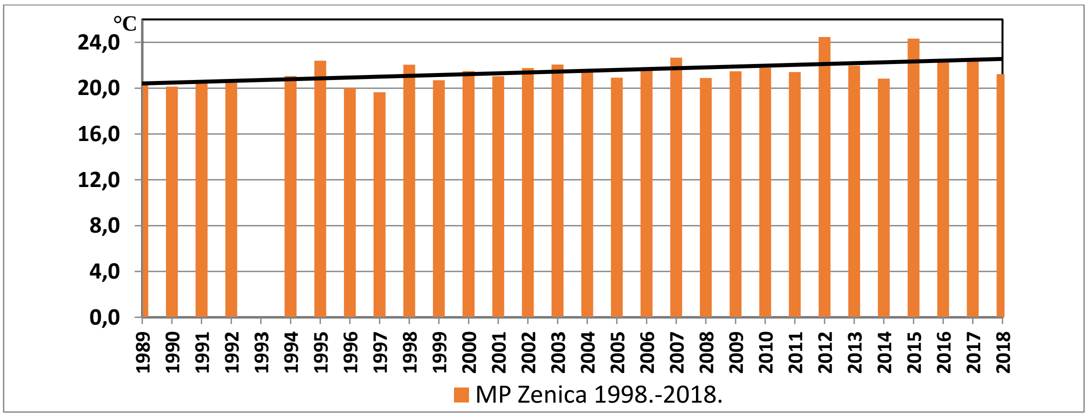


Figure 33: MS Zenica, mean July temperatures (°C)1998-201831

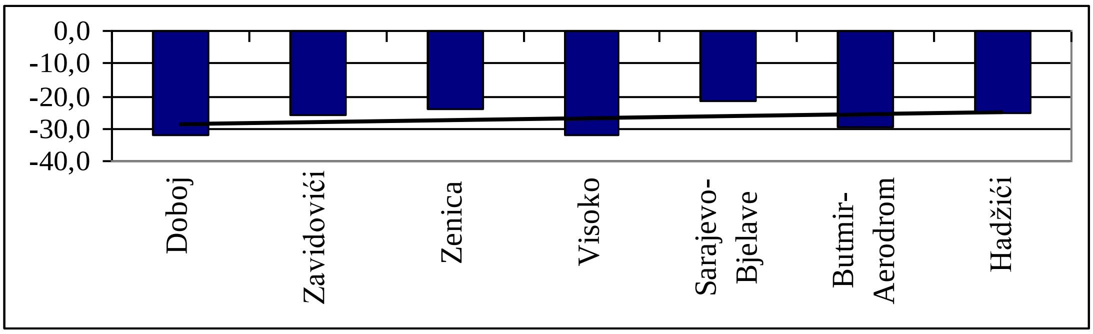


Figure 34: Minimum January temperatures (°C 1961-1990)32

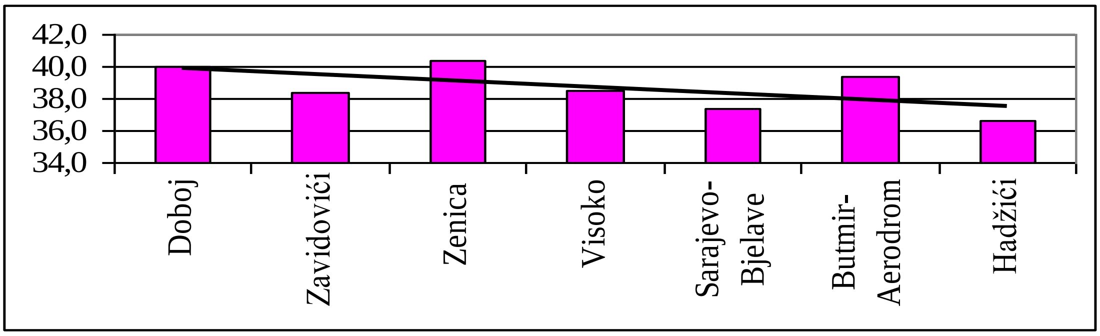


Figure 35: Maximum July temperatures (°C) 1961-199033

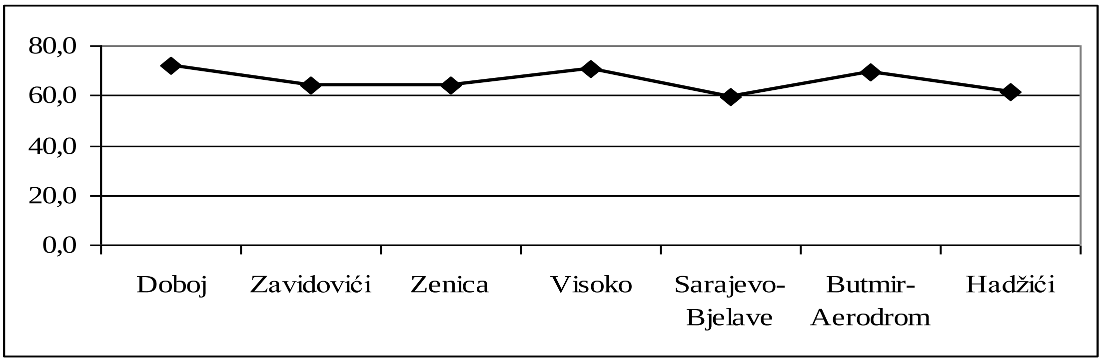


Figure 36: Maximum annual amplitudes (°C) 1961-199034

The total number of days with frost ranges from 80 to 110 per year. On average, the first day with frost is 16 October and on average the last day is 25 April.

Table 9: The first and the last day with frost on average for the measurement period 1961-19907

Meteorological station	On average the first day	On average the last day
Doboj	30 October	12 April
Zavidovići	25 October	17 April
Zenica	27 October	18 April
Visoko	29 October	20 April
Sarajevo-Bjelave	23 October	16 April
Butmir-Airport	16 October	25 April
Hadžići	19 October	23 April

As evident from Table 7, frost is possible along the entire route from October to April, with the average first day with frost in parts gravitating to the zone of temperate continental climate of the sub-mountain type (Hadžići) occurring in the middle of October and at the latest at the end of October in the northern part of the route (Doboj). On average, the last day with frost occurs in parts gravitating to the zone of temperate continental climate of the sub-mountain type (Hadžići) at the end of April, and in the northern part of the route in the middle of April (Doboj).Table 9: The first and the last day with frost on average for the measurement period 1961-19907

The route is also characterized by a large number of days with maximum temperature less than 0°C, which is uniform throughout the route.

3.2.2. Temperature characteristics of soil

The mean and maximum zero isotherm penetration depths are presented on the basis of multi-year results of soil temperature measurements at depths from 2 cm to 50 cm (1981-1990). The zero isotherm penetration depth does not depend only on altitude. The thickness and duration of snow cover at the beginning and end of winter are especially important. Thus, due to the low snow cover, the zero isotherm penetrates to greater depths at lower altitudes too.

The maximum zero isotherm penetration depth in Sarajevo in the analysed period was 54 cm (winter 1986/1987).

The mean zero isotherm penetration depth for Doboj is 18.7 cm and for Sarajevo 31 cm (1961-1990).

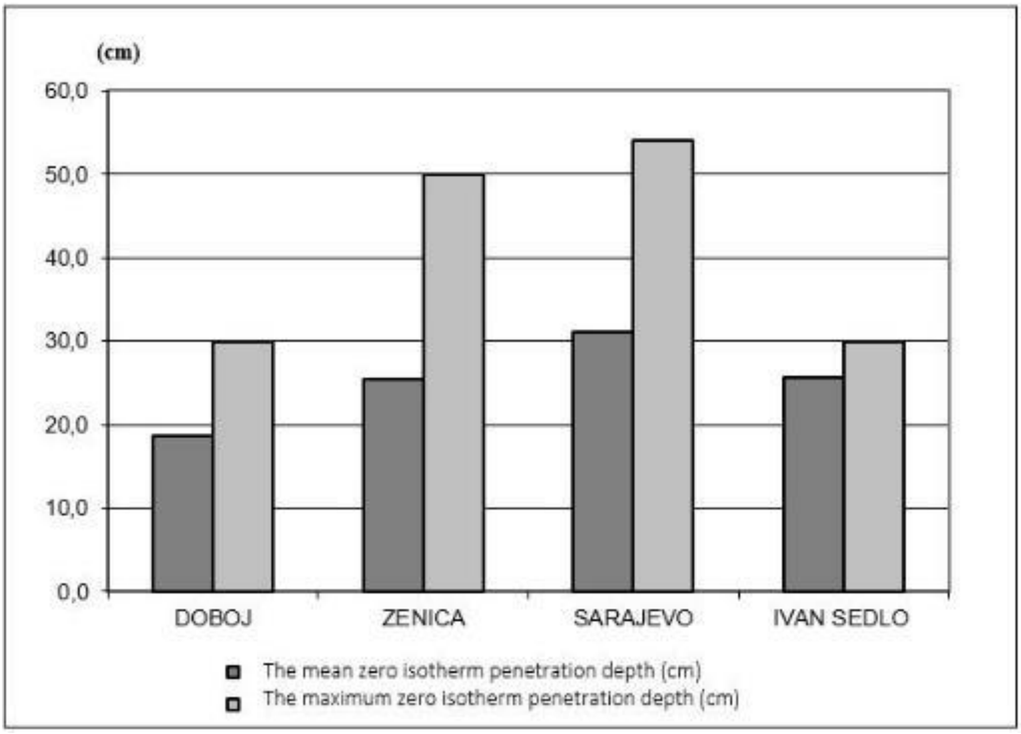


Figure 37: Zero isotherm penetration depth (cm) 1961-199035

The ranges of mean soil temperatures and ranges of maximum and minimum soil temperature are given in figures 35 and 36. The values decrease from the northern to the southern part of the route. For MS Zenica, the diagram of the mean monthly soil temperature for the measurement period 2001-2018 is shown.

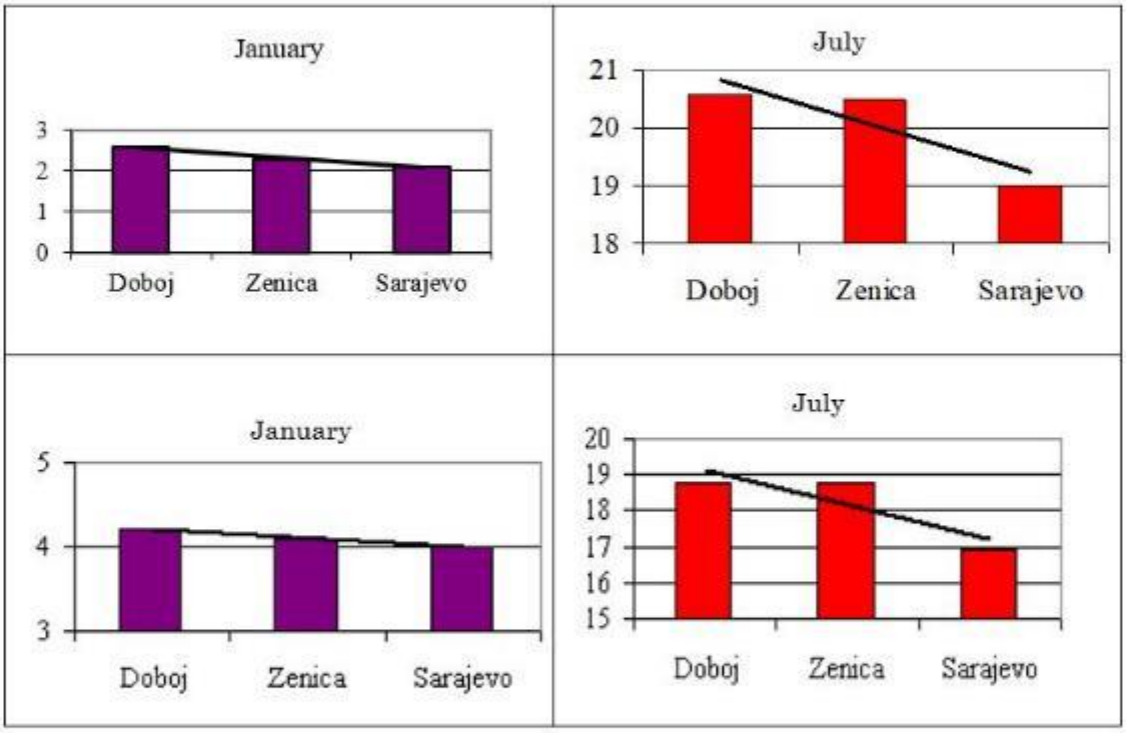


Figure 38: Mean soil temperatures (^{o}C) 1961-199036

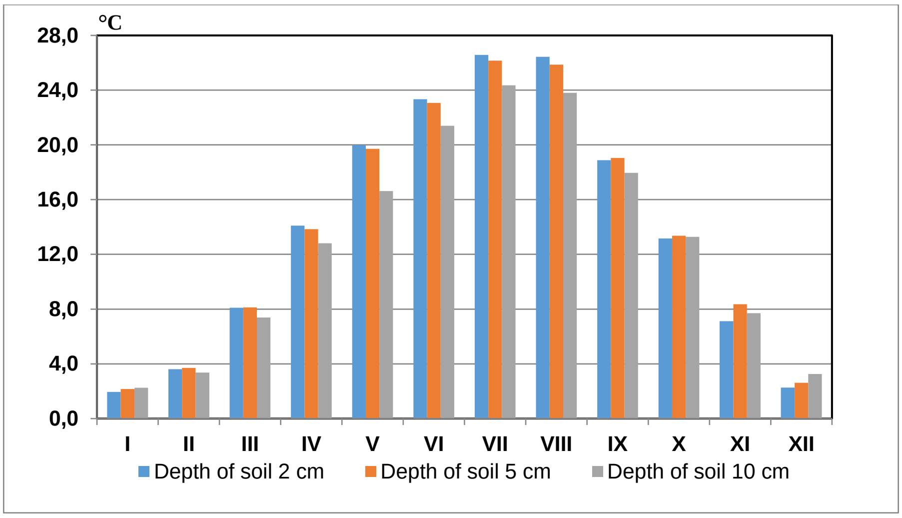


Figure 39: MS Zenica, mean monthly soil temperatures (°C) for the period 2001-2018

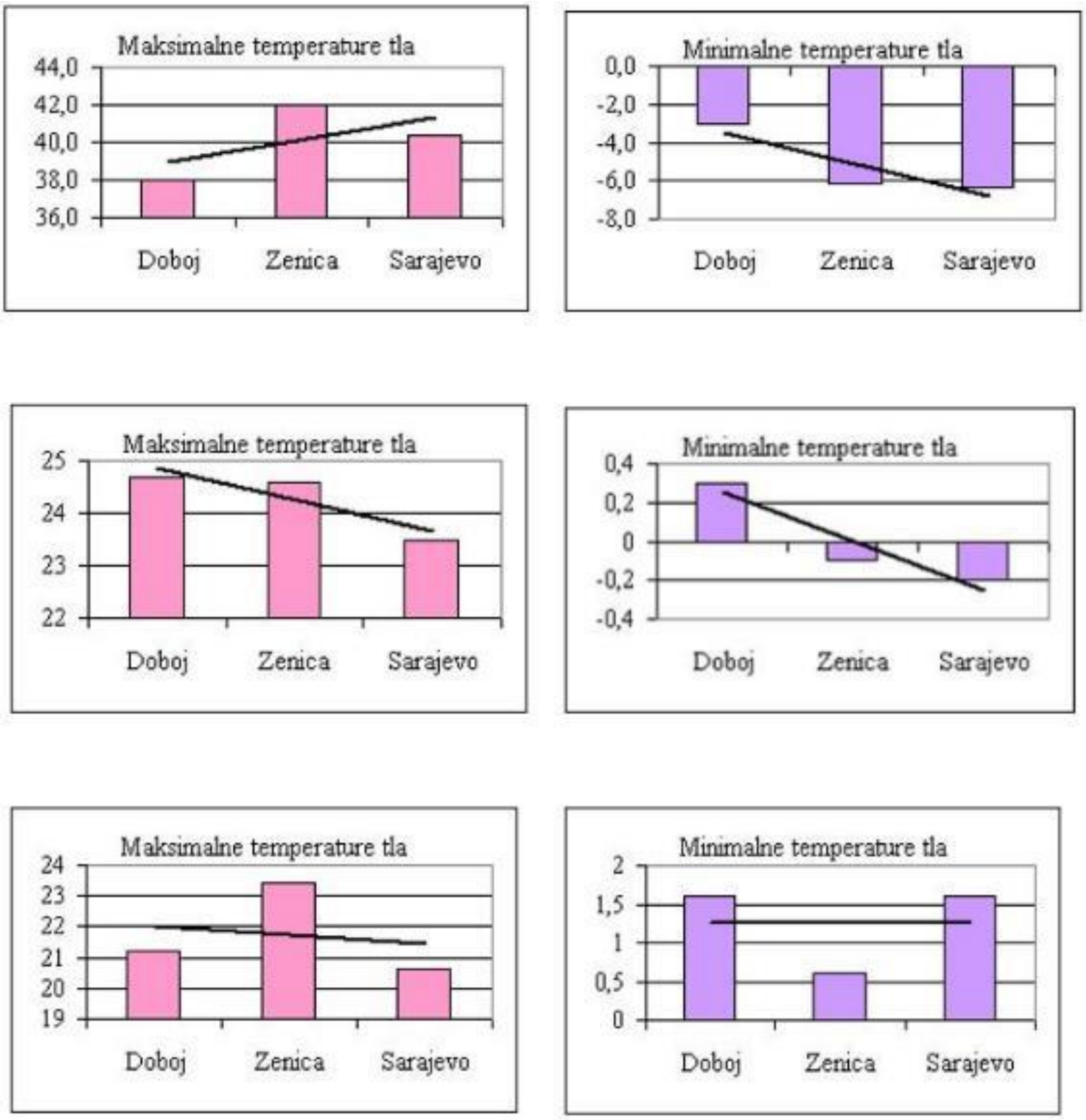


Figure 40: Maximum and minimum soil temperatures (°C) 1961-1990

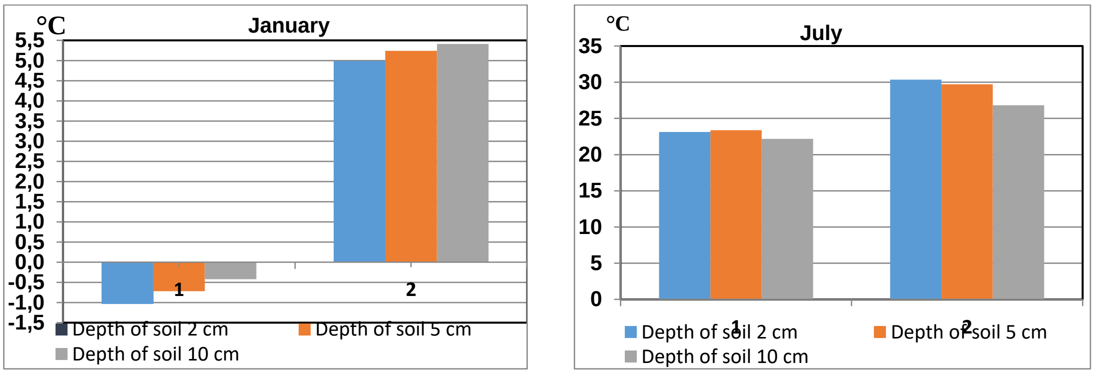


Figure 41: MS Zenica, mean min. and max. soil temperatures for the period 2001-2018 (°C), January and July38

3.2.3. Precipitation

Map on the figure 47 and figures 39 and 40 show that average annual precipitation ranges from 780 l/m^2 (in Zenica) to 1340 l/m^2 (in Tarčin) for the measurement period 1961-1990. The mean annual precipitation for MS Zenica in the period 1999-2018 ranges from 519 l/m^2 to 1201 l/m^2. The annual distribution of precipitation is typical of a temperate continental climate. A uniform distribution of precipitation throughout the year is characteristic. There is a weakly manifested spring maximum in June and autumn maximum in November. Precipitation increases with altitude. The exception is the Zenica region, which has the lowest annual precipitation. The mean annual precipitation is 844 l/m^2 for the measurement period 1999-2018. Maximum daily precipitation ranges from 70 l/m^2 to 100 l/m^2 for the entire analysed area (1961-1990).

Precipitation intensities in this area are very low, especially in the Zenica valley area. The exception is only a short stretch from Hadžići to Tarčin (IDF diagrams are given in ENCLOSURE 3 1961-1990). This statement also concerns the annual number of storms. For example, the Zenica valley has a mean annual number of days with thunder between 20 and 30, the northern and southern part of the route between 30 and 40, while only the part from Hadžići to Tarčin has a mean annual number of days with thunder between 40 and 50 (1961 -1990).

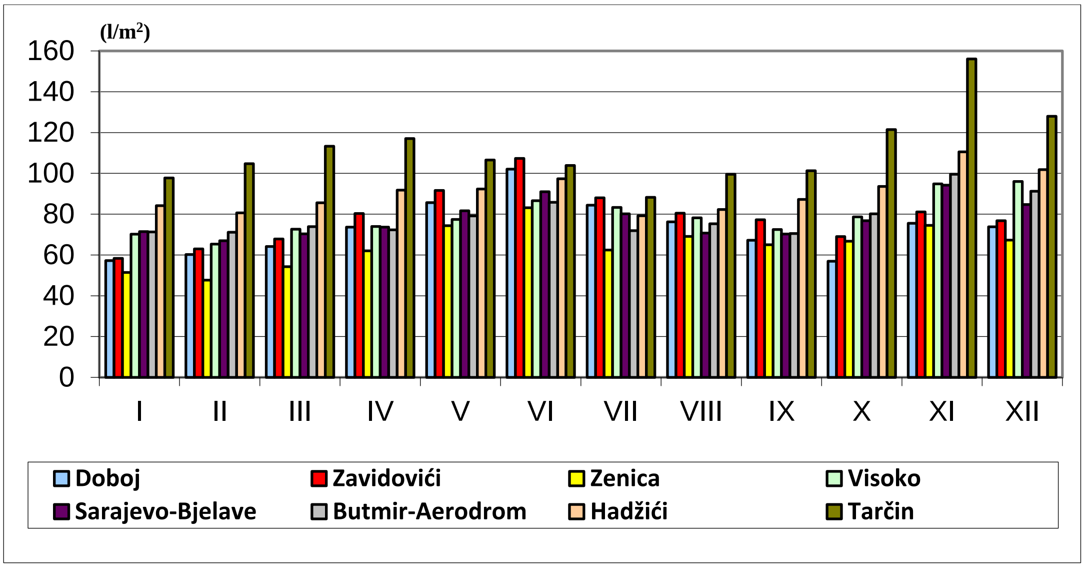


Figure 42: Mean monthly precipitation 1961-1990[39]

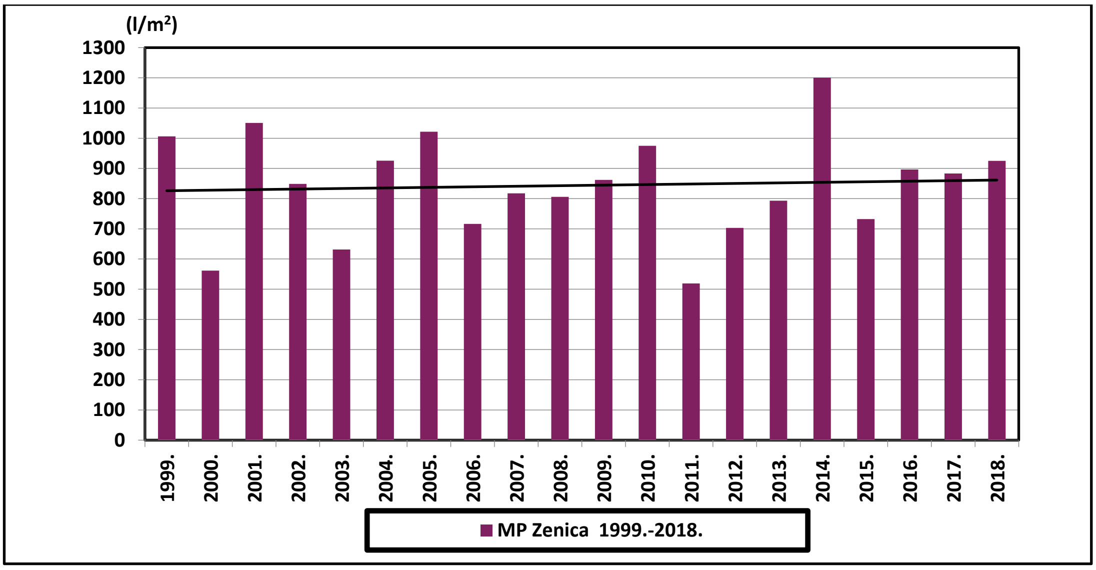


Figure 43: MS Zenica, mean annual precipitation 1999-2018[40]

Mean annual precipitation at MS Zenica for the measurement period from 1999 to 2018 was 843.8 l/m^2.

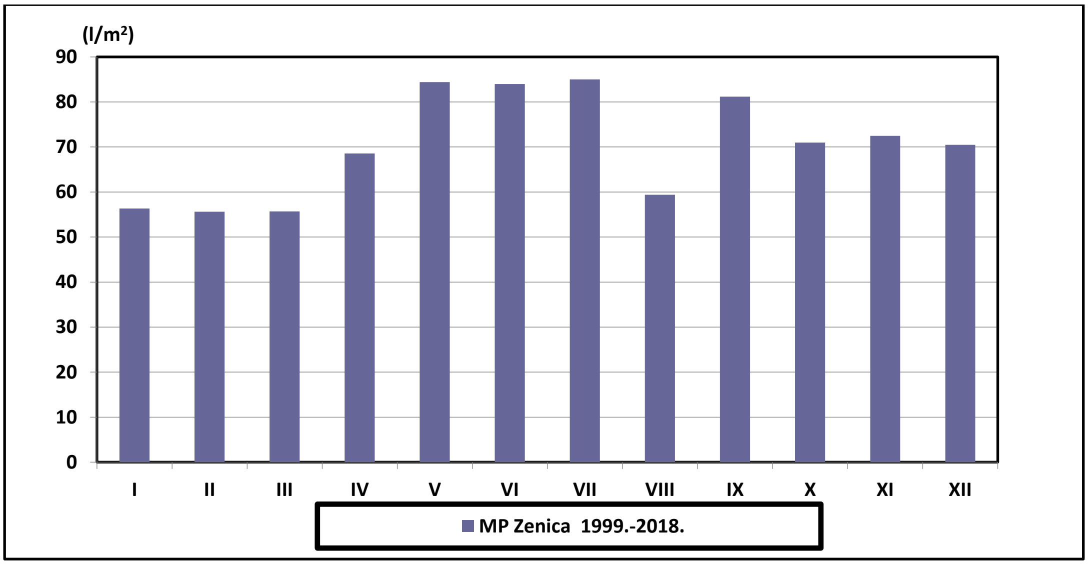


Figure 44: MS Zenica, mean monthly precipitation 1999-201841

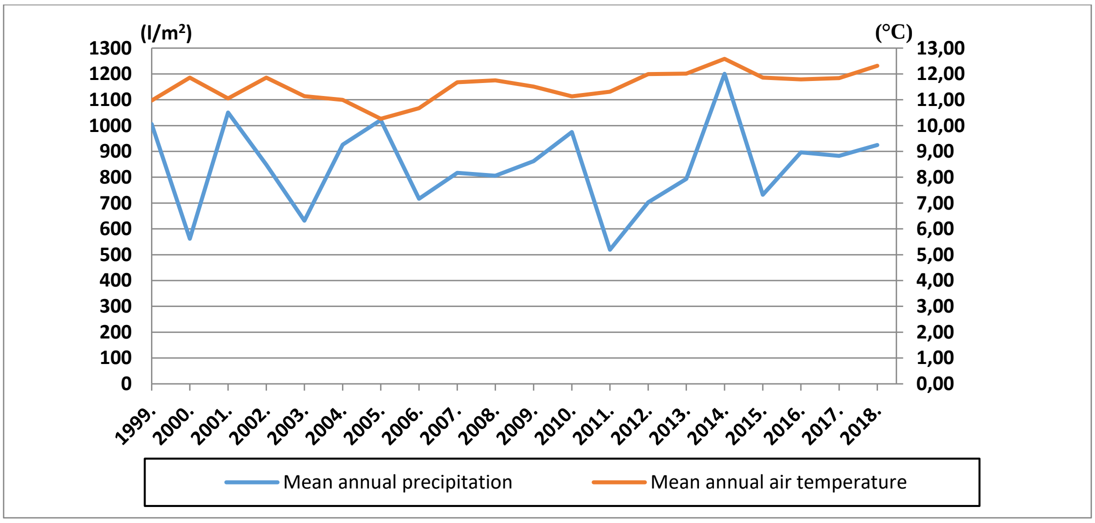


Figure 45: MS Zenica, comparative diagrams of mean annual precipitation and mean annual air temperatures (1999-2018)42

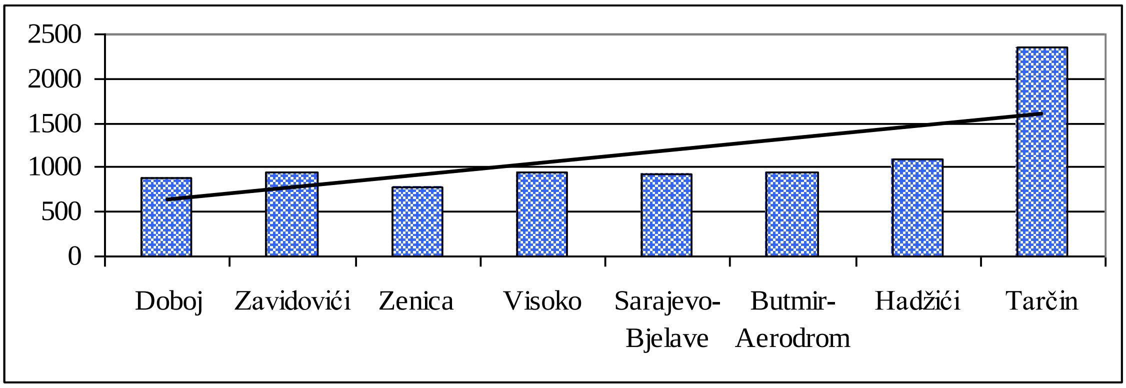


Figure 46: Change of annual precipitation along the route (l/m²) 1961-199043

Snowfall as an occurrence is most pronounced in the winter period. There is no snow at all between June and September. The average annual number of days with snow cover ≥ 10 cm rises with increasing altitude and it is the lowest in Doboj 23 days and the highest in Butmir 33 days.

Figure 47: Main annual precipitation map

Along the Zujevina River valley towards Tarčin, the number of days with snow cover ≥ 10 cm gradually rises at every 100 metres for 8 days.

Distribution of annual number of days with snow cover higher than 1 cm and 10 cm is given on following maps (1961-1990) (figure 49 I 50).

The number of days with snow cover ≥ 30 cm occurs two times in three years, on average, while in the Zenica region that frequency is one time in three years.

The number of days with snow cover ≥ 50 cm occurs one time in three years, on average, while in the Zenica region only one day was registered in 30 years.

The maximum height of snow cover was 72 cm in Doboj (February 1984), and 100 cm at Butmir (January 1967).

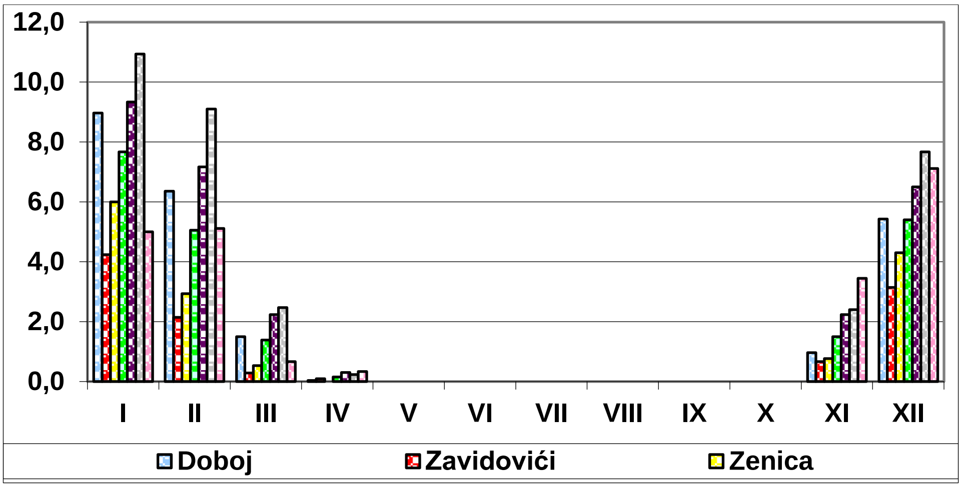


Figure 48: Mean number of days with snow cover ≥ 10 cm 1961-1990[44]

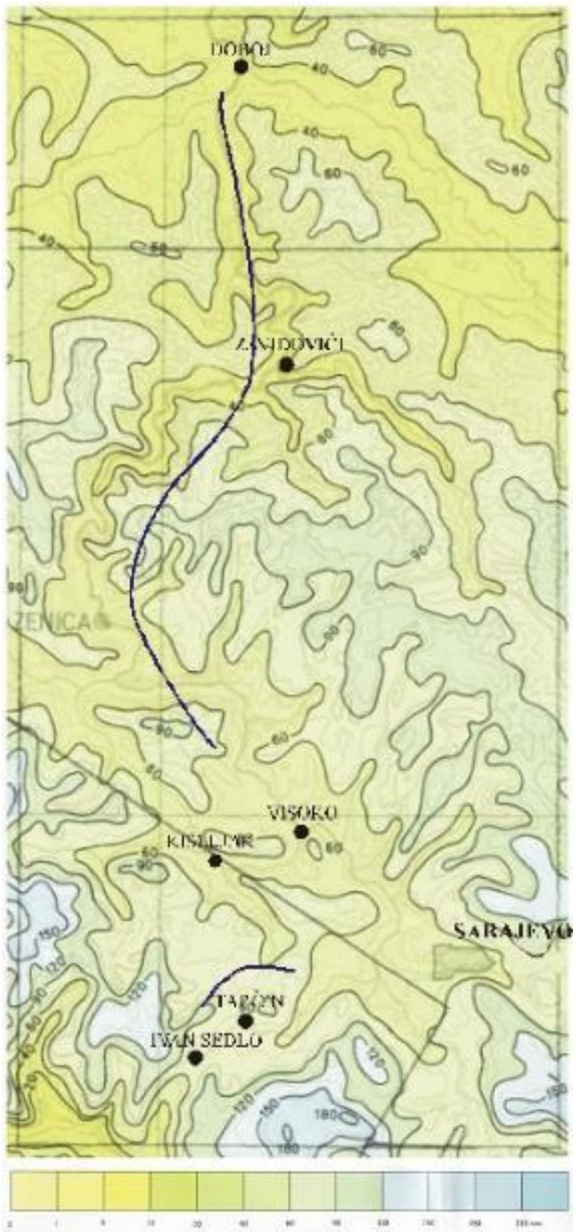


Figure 49: Map f Mean number of days with snow cover higher than 1 cm

Figure 50: Map of mean number of days with snow cover higher than 10 cm

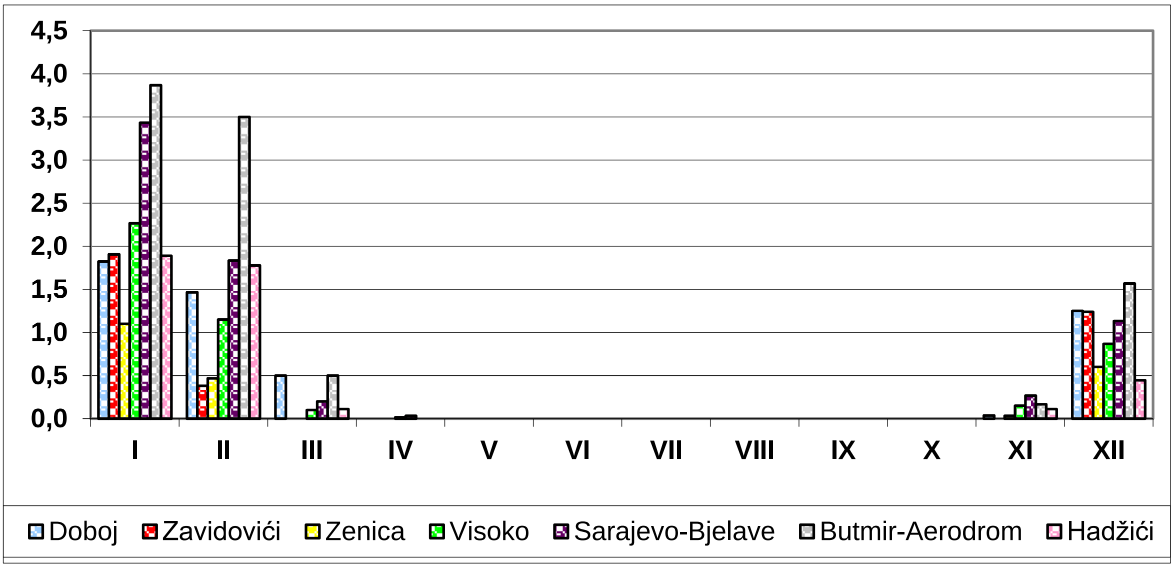


Figure 51: Mean number of days with snow cover ≥ 30 cm, 1961-199045

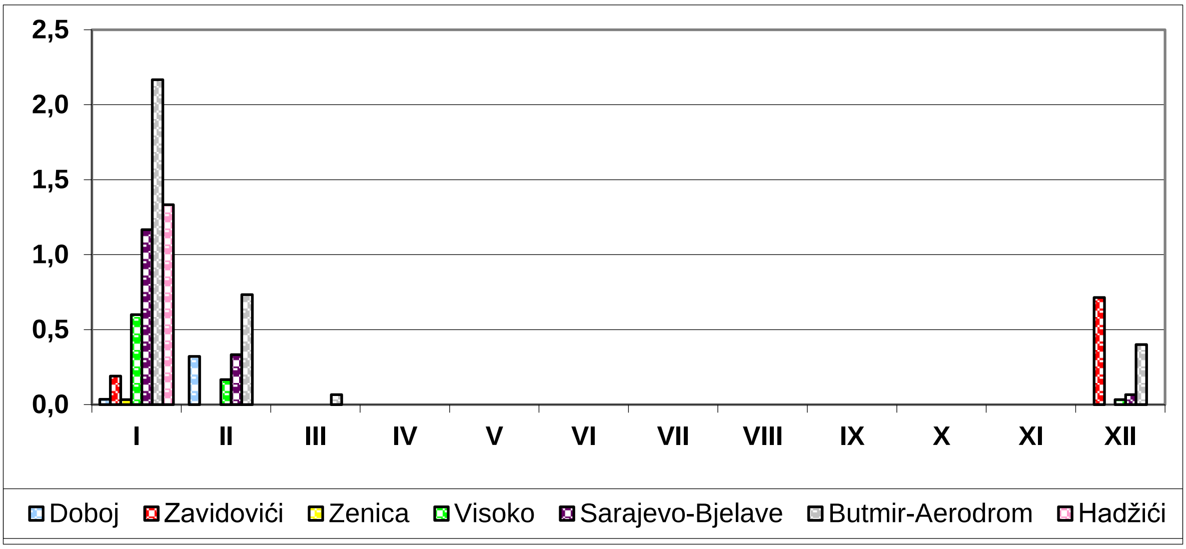


Figure 52: Mean number of days with snow cover ≥ 50 cm, 1961-199046

3.2.4. Icing and depositing of snow

Ice crust and sediment of solid precipitation on traffic areas and vehicles reduce traffic safety. These phenomena are most common at temperatures from -1°C to -10°C. Partial icing occurs at tunnel entrances, on bridges and in cuts, as a result of temperature differences and higher humidity. Frost occurs in cold nights on vehicles and roads, particularly on bridges and viaducts, because cooling is strongest in these places.

3.2.5. Air humidity

The average annual relative air humidity ranges between 71% and 84%. It is highest in winter; mean monthly values range from 73% to 90%. It is lowest in spring and summer months; mean monthly values range from 63% to 80%. The distribution of air humidity values along the route is given in Figure 53, from which it is evident that the highest values are in Zavidovići and the lowest in Hadžići (or Sarajevo-Bjelave). This distribution is a consequence of the temperature inversion phenomenon in the river valley (1961-1990).

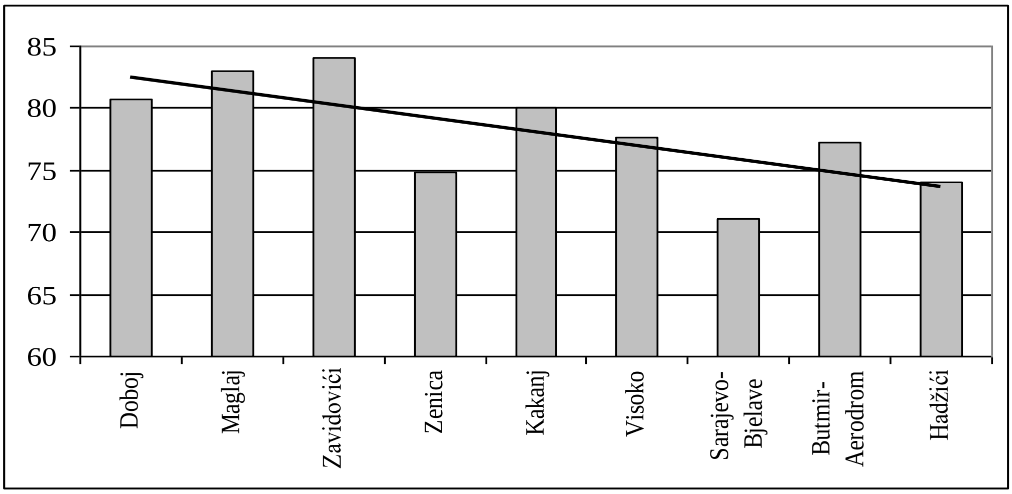


Figure 53: Mean annual values of relative air humidity (%), 1961-199047

The mean annual relative air humidity at MS Zenica for the period 1998 - 2018 is 72.1%. Mean monthly values range from 66.7% in March to 80.7% in December.

The distribution of relative air humidity for MS Zenica (1998-2018) is shown in the diagrams of Figure 54 and Figure 55.

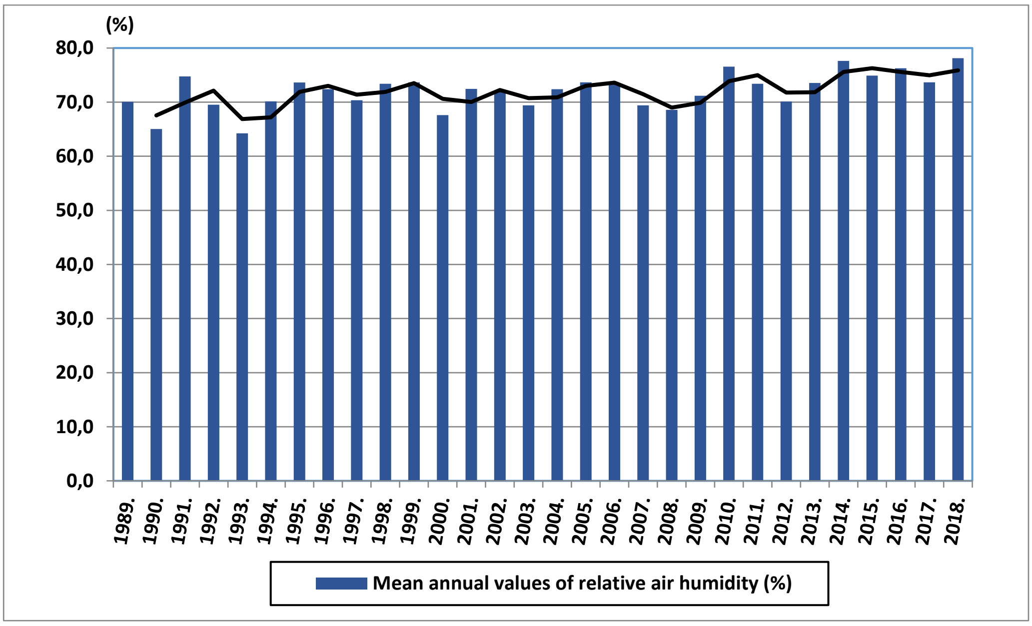


Figure 54: MS Zenica, mean annual values of relative air humidity (%) 1989-201848

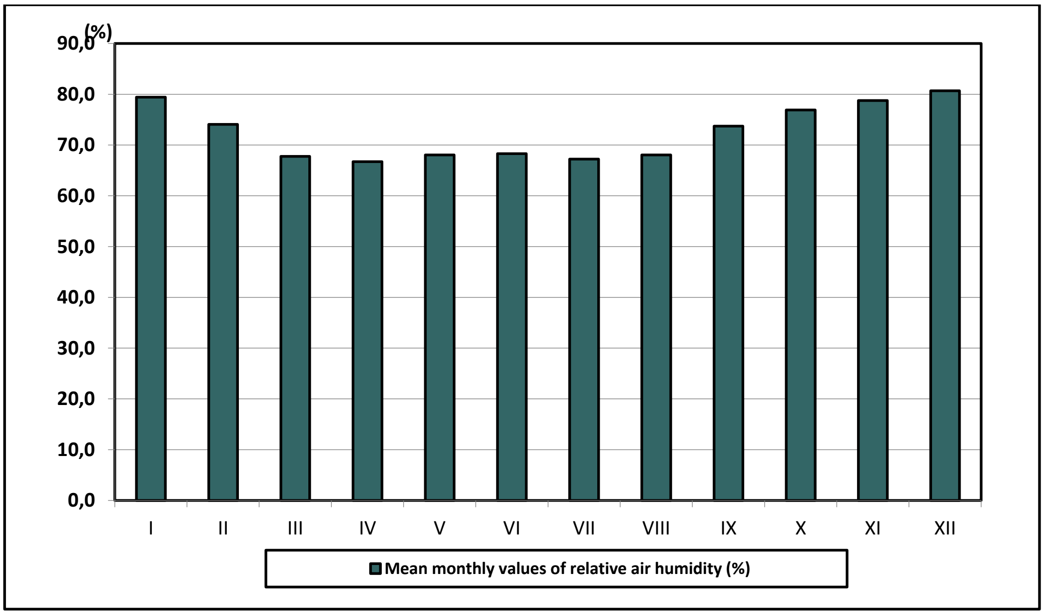


Figure 55: MS Zenica, mean monthly values of relative air humidity (%)(1989-2018)49

3.2.6. Fog and visibility

Fog occurs frequently in the Bosna River valley and is a consequence of temperature inversion, which in the river valley creates a layer of air cooler than on the surrounding mountains. This phenomenon occurs throughout the year, but more frequently in the colder part of the year (Figure 58). The highest annual number of days with fog occurs in the area of Visoko (150). The lowest annual number of days with fog occurs in the area of the Zenica valley (48). In terms of annual distribution, fog is most common in winter months. Figure 53 shows that the annual values are quite uneven, which is an effect of the surrounding relief, depending on the area where the route passes (the measurement period 1961-1990).

According to data from MS Zenica for the measurement period 1988-2018, the mean annual number of days with fog is 23 days. The lowest mean number of days with fog is 1 day (2013 according to FHMI Sarajevo data) and the highest mean number of days with fog is 81 days (1989 according to FHMI Sarajevo data).

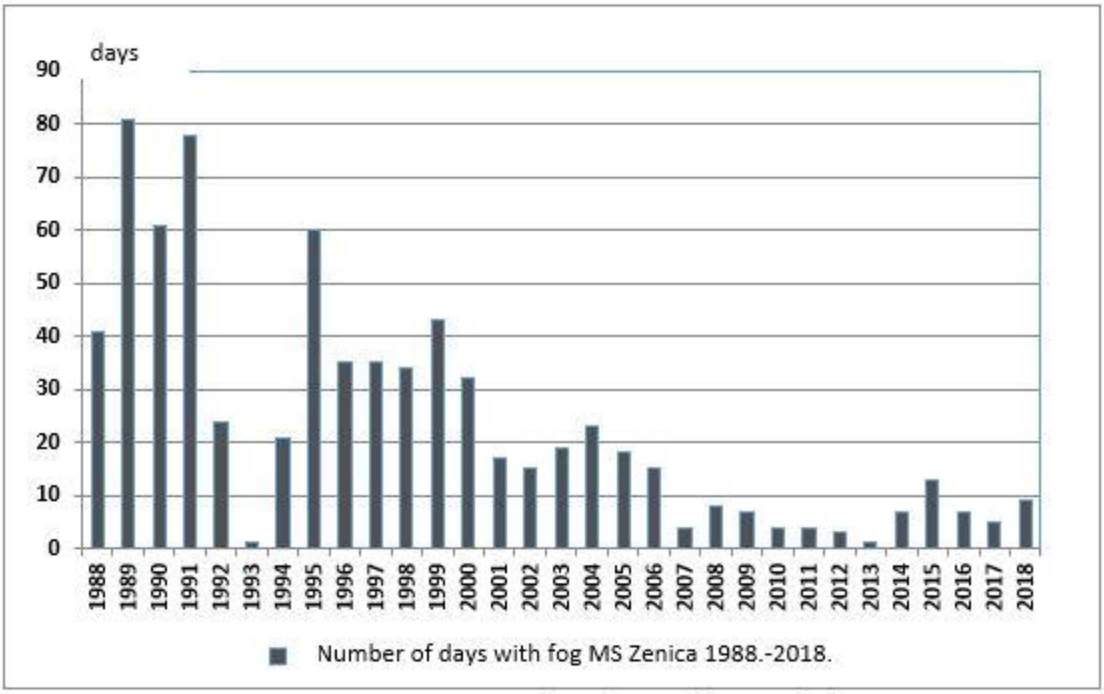


Figure 56: MS Zenica, mean annual number of days with fog 1988-201850

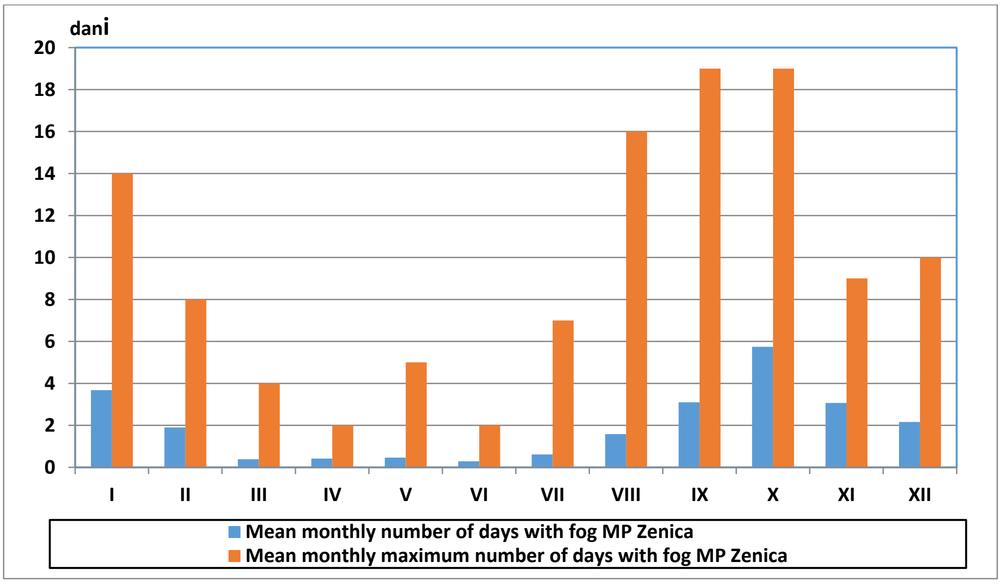


Figure 57: MS Zenica, mean monthly and mean monthly maximum number of days with fog 1988-201851

Exceptionally high values of the number of days with fog are present in canyons (the **Maglaj-Tunnel Vranduk** stretch and the **wider area of the Lašva confluence with Bosna-Visoko**). In these sections there is a high probability of fog occurrence throughout the year, regardless of the season.

This fog is of radiation origin and its intensity can be high in certain weather conditions, so that **visibility** drops even below 100 metres.

It should be noted that, in addition to fog, visibility can also be affected by the direction of the motorway and disposition of structures on the motorway, because the driver can be very often blinded by the sun's rays, and especially in the winter months when the **sun is low**.

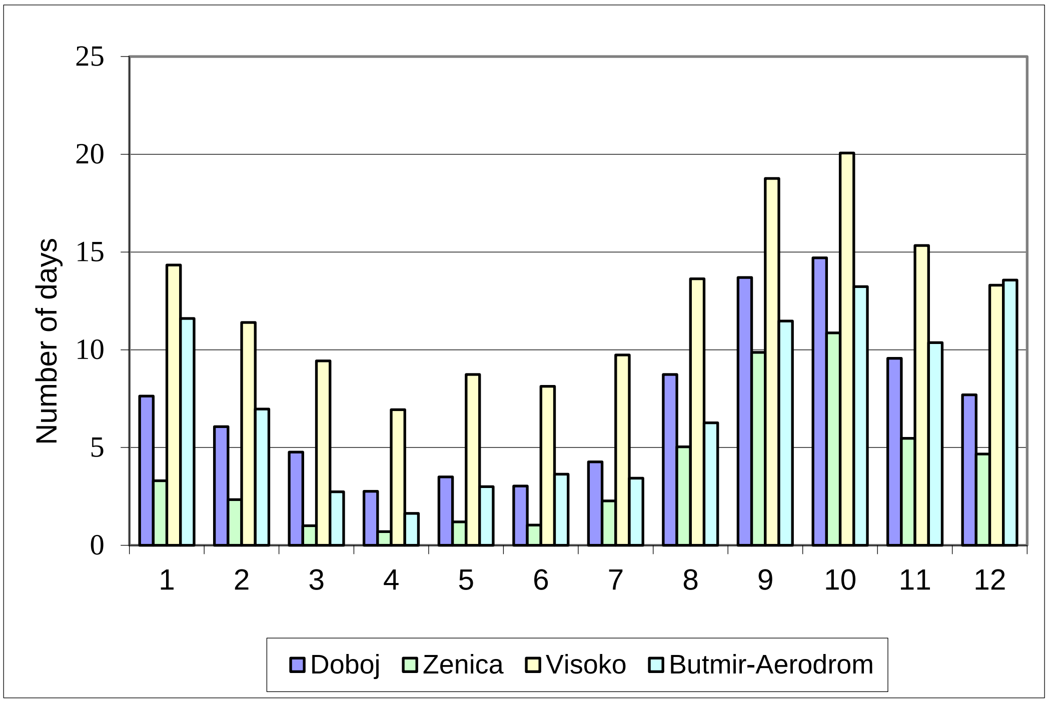


Figure 58: Mean number of days with fog 1961-199052

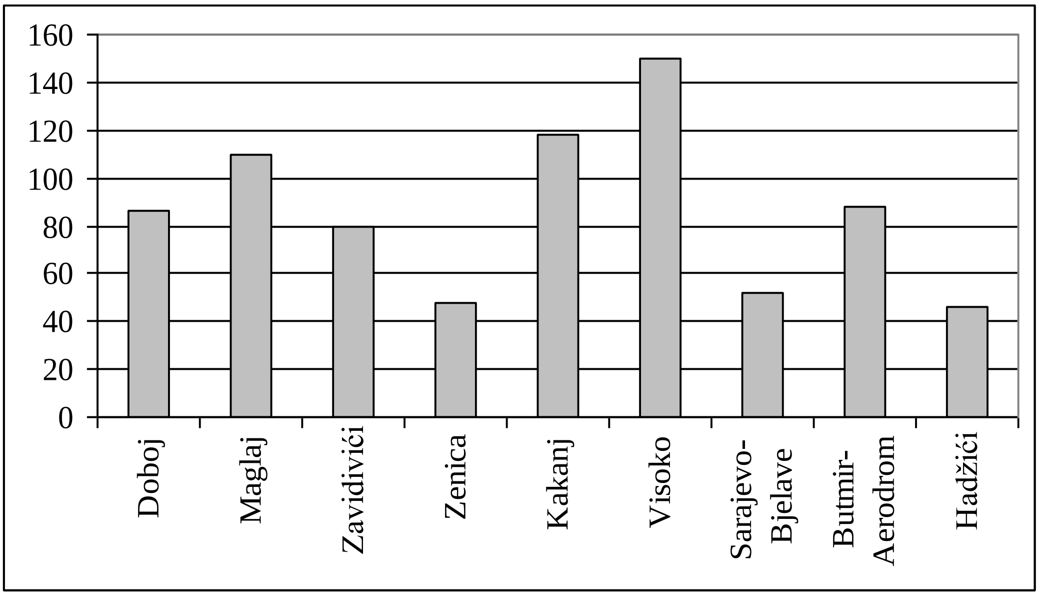


Figure 59: Variation in annual number of days with fog along the route 1961-199053

3.2.7. Wind

The directional distribution of wind frequencies and mean speeds (wind rose) is most dependent on local terrain orography. As can be seen from the attached wind roses for the Doboj, Zavidovići, Zenica and Butmir-Airport meteorological stations, the shape of a wind rose is most determined by the direction of the Bosna River valley. We can see that the most common wind directions are from the north, northeast and from the south.

Based on the above mean wind speeds, it can be seen that the Bosna River valley is not particularly exposed to winds, because it is protected by the surrounding mountains. In fact, the highest wind speeds are registered in the Doboj valley and Sarajevsko Polje.

As can be seen from Figure 54, maximum wind speeds at Butmir-Airport are even over 45 m/s, occurring most often in November and December. Gale force values are possible in all seasons, but Figure 55 shows that they are still most frequent in spring and in November and December.

In the Zenica valley, gale force wind speeds are quite rare and occur slightly more than once in a year. Maximum speeds are just over 20 m/s and are highest in January, April and November (Figure 56).

Regarding the parts of the route between these stations, they mostly run through the canyons of the Bosna River and the wind direction is defined by the canyon direction (most often north-south), but, with regard to maximum wind speeds, they are much lower, considering the effect of the surrounding terrain orography.

It should be noted that the appearance of local **turbulence** is possible here, occurring when air flows around the hill, above it or above a complex of structures. Eddies on the windward and leeward sides of the hill can be very powerful and affect vehicles in traffic. Turbulence occurs behind large vehicles, adversely affecting small vehicles, and also between two lanes with traffic in opposite directions.

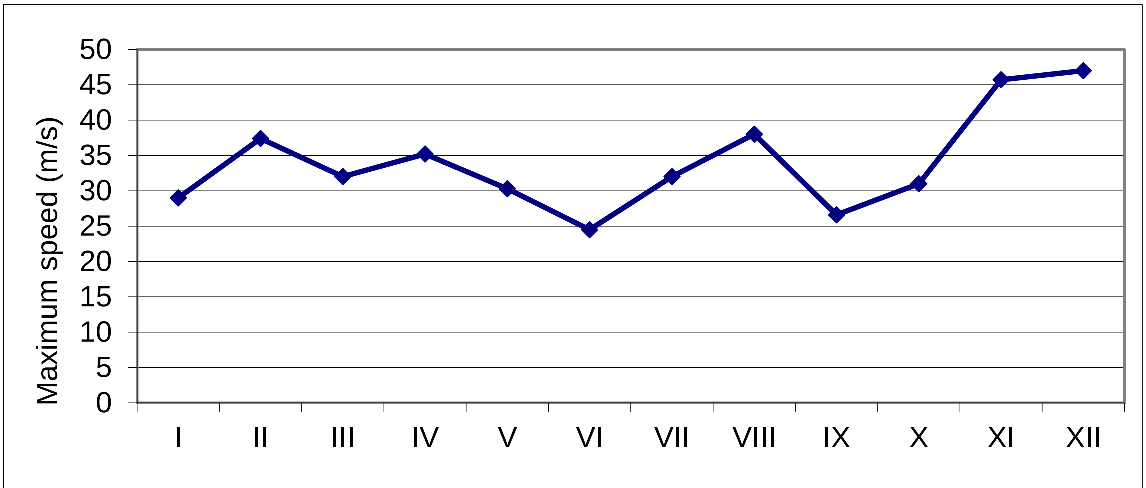


Figure 60: MS Butmir-Airport, annual distribution of maximum wind speeds 1961-199054

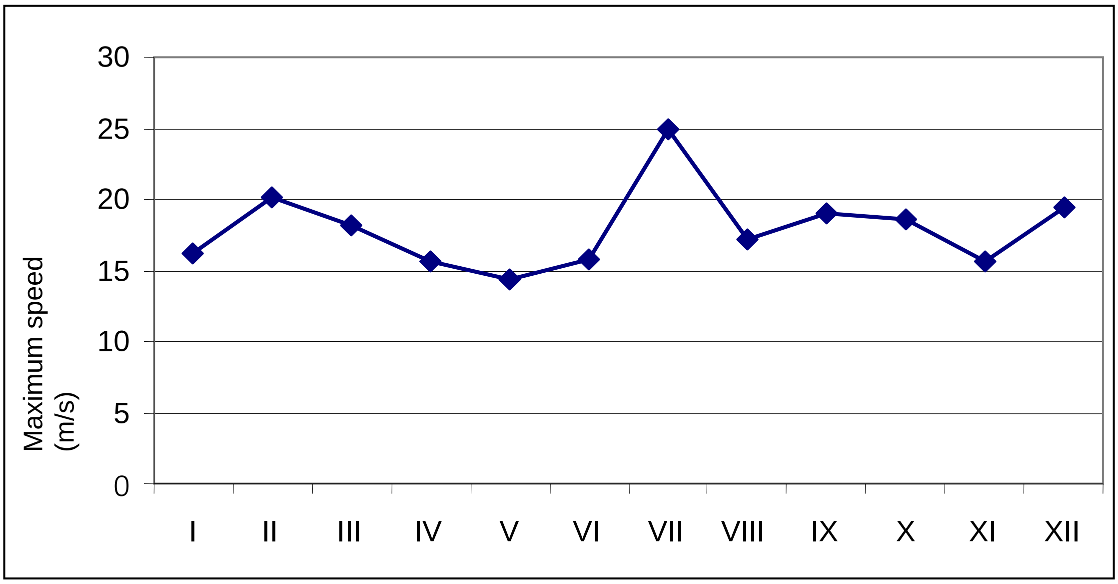
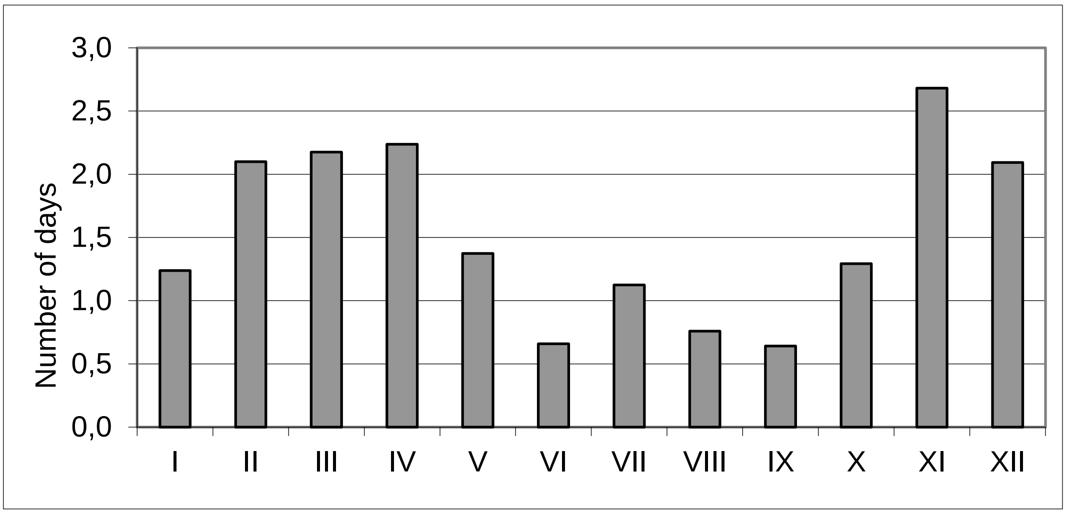


Figure 61: MS Butmir-Airport, average number of days with gale-force wind by months 1961-



199055

Figure 62: MS Zenica, annual distribution of maximum wind speeds 1961-199056

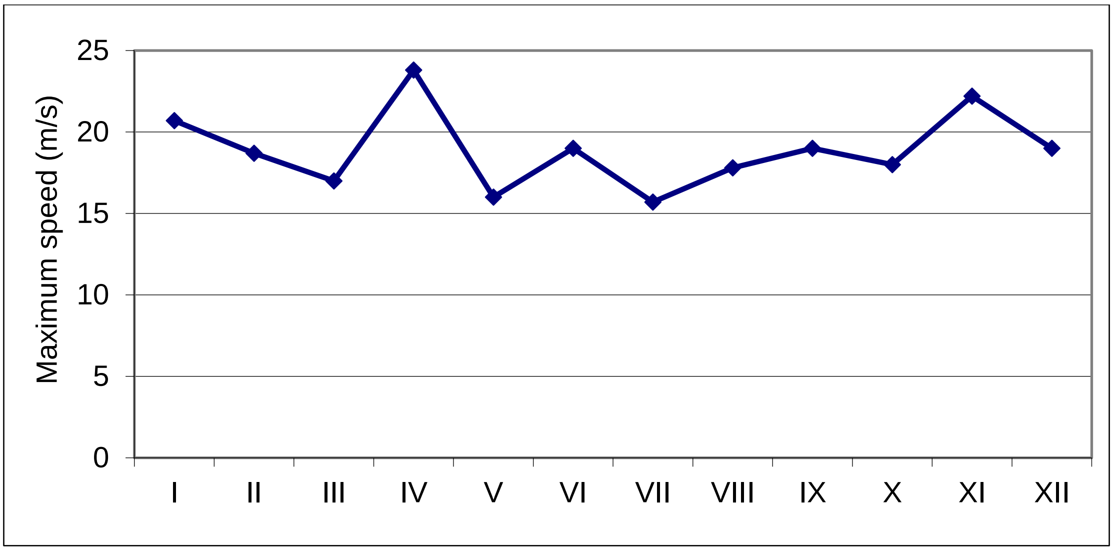


Figure 63: MS Doboj, annual distribution of maximum wind speeds 1961-199057

Table 8: Relative frequencies of mean speeds of individual wind directions at MS Zenica 1989-2018

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	C
Direction frequencies (%)	7.4	2.0	1.9	2.9	3.2	3.4	3.6	7.1	23.6	12.4	8.0	3.0	2.3	3.6	5.2	6.9	3.5
Mean wind speeds (m/s)	2.0	1.1	1.1	1.0	1.1	1.1	1.2	1.2	1.6	1.3	1.3	1.1	1.3	1.5	1.7	1.9	0.0

8

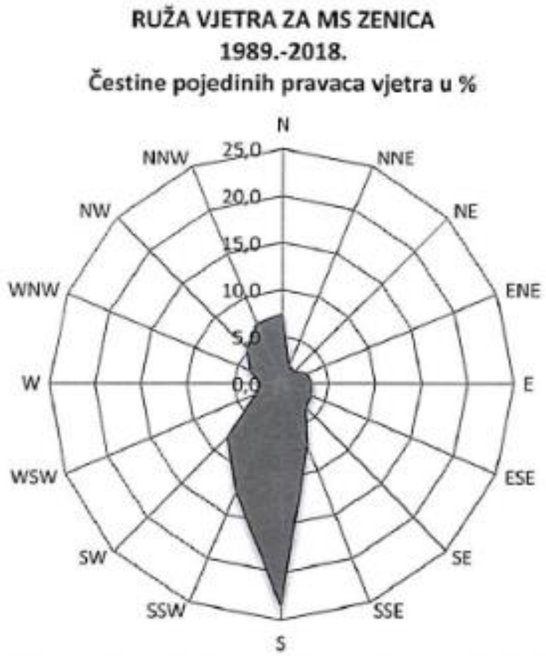


Figure 64: MS Zenica, wind direction frequencies (%) 1998-201858

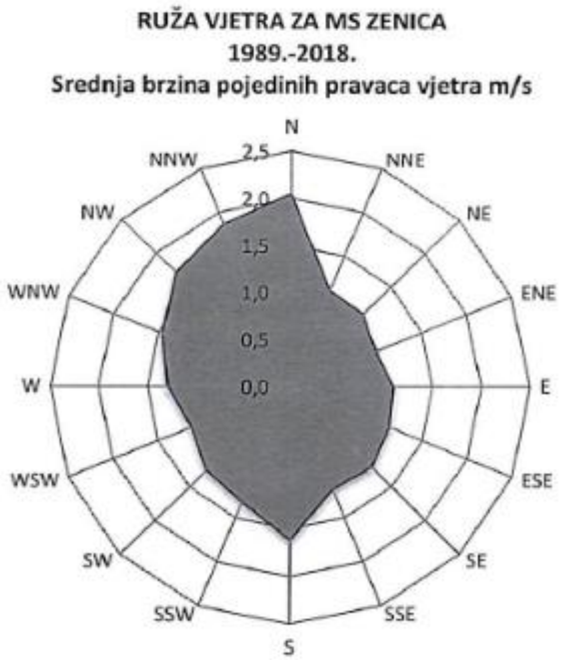


Figure 65: MS Zenica, mean wind speeds (m/s) 1998-201859

3.3. GEOMORPHOLOGICAL CHARACTERISTICS

In geomorphological terms, the relief between Doboj and Tarčin is very diverse and morphometrically uneven. This is due to the variable lithofacial composition, complex tectonic relationships, neotectonic activity and diverse behaviour of rock masses in the surface zone of weathering under the action of exogenous agents. The terrain belongs to the Dinaric mountain system as one of the geomorphological units of the BiH hilly and mountainous relief. Nearly 80% of the terrain is at altitudes above 500 m, except for the Bosna River valley, with altitudes up to 500 m. The relief is mainly characterized by deep river valleys and canyons, as well as mountain ranges at altitudes of about 1000 m. Several paleodepressions filled with Neogene and Quaternary lacustrine sediments are situated between the mountains. The most important ones are the Tešanj, Šeher-Žepče and Sarajevo-Zenica paleodepression. As a whole, the belt along the Corridor Vc, on the Doboj - Tarčin stretch, is characterized by alternation of reservoir, erosional and karst relief types.

On the section between Karuše and Ozimica, in geomorphological terms, the relief is diverse, but morphometrically more or less uniform. It belongs to the valley- and hilly regions of central Bosnia. The ground surface altitudes are from about 160 - 200 m in the valley parts, to above 700 m a.s.l. on peaks of surrounding elevations (Crni Vrh at 732 m a.s.l.).

The slightly undulating slopes of the wider Medakovo area in the northern part and Ozimica in the southern part of the terrain give the general character to the relief. The valleys of the Tešanjka, Trebačka, Karadaglijska, Strupinska and Ozimička rivers are carved between and along them, with gentle and open sides. The Crni Vrh massif, which represents the natural boundary between the Tešanj basin in the north and the Šeher valley in the south, rises in the central part of the terrain.

In genetic terms, the following parts can be distinguished in relief:

- fluvial accumulation relief,
- denudation-accumulation relief, and
- erosion-denudation relief.

The fluvial accumulation type of relief has two different varieties: terrace-accumulation and modern accumulation relief.

The terrace-accumulation relief is older and is hypsometrically higher than the accumulation one. It is manifested by the so-called "folding sills", fragmentarily preserved along the valleys of the Tešanjka, Trebačka, Karadaglijska and Strupinska rivers, and in the Šeher and Ozimica valley.

The accumulation relief is characterized by the dynamic, seasonal change in quantities of transport and deposition of the bed and suspended alluvial and proluvial load along valleys and riverbeds.

The denudation-accumulation relief is characteristic of the part of terrain made of the Paleogene-Neogene polyfacial complex of the Tešanj and Šeher-Žepče basins. The processes of surface alterations in it are manifested by changes in morphological forms, even in a relatively short time. In this connection, this first includes fluvial and then proluvial and denudation processes and phenomena, as is the case at the bottoms of slopes along river valleys or in the areas of Gošća, Bare, Luke, Plandište, Strupina, Ozimica, etc.

Clayey-marly-sandy sediments of a low level of diagenesis, with frequent vertical and lateral variability of lithological composition and susceptibility to surface decomposition processes are most dominant in the structure of the denudation-accumulation relief. Due to these properties, Paleogene-Neogene complexes are susceptible to erosion processes, so microforms formed by linear erosion, such as ravines and torrential deposits at Hrgovci and Karadaglije, and landslides at Toplik, Plandište, Karadaglije, Mihaljevići or Strupina, etc. can be noted even on small surfaces. Within the denudation-accumulation relief, hydrographic network is branched and dense, dominantly of a centrifugal and dendritic type. The branching of the drainage network is also indicative of the fact that distinct erosional and denudation-accumulation processes take place in areas made of Paleogene-Neogene formations.

Erosion-denudation relief is related to "positive" morphostructures, or to parts of the terrain with a trend of neotectonic uplift. This type of relief is represented in high ground areas, dominated by the Crni Vrh massif. It is built of members of the Jurassic polyfacial magmatic - metamorphic - sedimentary complex. In morphosculptural terms, this relief is characterized by high indentation, fragmentation and brokenness of meso- and micro-forms, with height differences reaching over 450 m. As a result of the physical-geological processes and formation of surface covers of deluvial and proluvial origin, deposits of clayey-debris composition are formed on slopes or slopes are bare in some places due to the denudation effect of slope water, as is the case on the south side of the Crni Vrh massif.

In geomorphological terms, the relief between Nemila and Donja Gračanica is diverse and morphometrically uneven. It belongs to the hilly and valley regions of central Bosnia. The ground surface altitudes are about 290-425 m in the Bosna River valley, to the peaks of the surrounding elevations above 800 m a.s.l.

The hilly elevations (Vranduk, Vraca, Srednje Brdo and Golo Brdo) and the Bosna River valley with its tributaries give the main characteristic to the relief.

In geomorphological terms, the relief between Drivuša and Donje Vrace is dominated by slopes and valleys. The ground surface altitudes are about 300 m in the Bosna River valley, to the peaks of the surrounding high grounds above 900 m a.s.l. - Klopačke Stijene. Cuts of the right tributaries and streams of Bosna, such as Gračanička River, Dobra Voda, Babina River, Stijenčice, Vratački stream, and Đulanova River and Mutnica, are the main feature of the slope relief. These watercourses cut into the slope like grooves and transversely intersect the route. The main road Sarajevo - Zenica is situated along the Bosna River valley.

The morphology of the terrain on subsection Drivuša - Klopče is conditioned by the geological structure and substrate composition and the character and intensity of the neotectonic processes.

3.4. GEOLOGICAL, ENGINEERING-GEOLOGICAL AND GEOTECHNICAL CHARACTERISTICS

The geological column from Paleozoic to Quaternary is represented in the geological structure of the terrain.

Paleozoic formations consist of phyllite and phyllitoide (^{2}PZ), quartz – sericite shale with lenses of lydite and quartzite (^{3}Pz), quartz-porphyrite (πq), dolomite, limestone and marble of Devonian (D), and Permian conglomerate, sandstone and slate (P).

Permian Triassic (P,T) is made of shaly marly limestone.

Most of the subject terrain is composed of **Mesozoic formations**. They are completely developed and characterized by great facial diversity.

Lower Triassic (T_1) is developed within the Seis sediments and undivided lower Triassic (T_1). Seis sediments are represented by sandstone, claystone and marlstone, while undivided formations of Lower Triassic are composed of quartz–micaceous sandstone, claystone, marl and limestone.

Middle Triassic (T_2) is developed in the Anisian and Ladinian stage. The Anisian sediments (T_2^1) are represented by different types of limestone and dolomite, while Ladinian sediments have a rather uneven composition, represented by chert and volcanogenic-sedimentary formation (tuff, sandstone, silicified claystone, chert, limestone and dolomite).

Transitional horizon of Middle and Upper Triassic (T_{2+3}) is of limestone development. Massive limestone is represented.

Upper Triassic (T_3) is represented by massive microsparite.

Transitional formations of Triassic and Jurassic ($^2T,J$) are represented by chert, subordinately claystone and marly micrite and silicified micrite.

Jurassic (J) is widely distributed, from Doboj to Nemila. It is mainly represented by volcanogenic-sediment series ($J_{2,3}$) composed of sandstone, breccia, claystone, graywacke sandstone, chert, marly limestone, marl and different igneous rocks: peridotite, serpentinite, granite, gabbro-peridotite, spilite, dolerite and gabbro of different varieties.

Transitional horizons of Jurassic and Cretaceous (J,K) are composed of flysch formations. The Nemila ($_1J,K$) and Vranduk series ($_2J,K$) are identified within flysch sediments. The Nemila series is built up of silicified claystone, sandy silicified calcarenite and limestone, while the Vranduk series is composed of marly limestone, calcarenite and marl. In addition to flysch sediments, a series of conglomerate, coarse-grained sandstone, breccia, marl and massive limestone is also identified as a Jurassic-Cretaceous transitional member. These sediments occupy small areas of the terrain.

Upper Cretaceous (K_2) has variable facial development. Thinly stratified marlstone, sandy marlstone, sandstone, breccia and limestone are represented in the lower part. “Carbonate flysch”, composed of massive limestone and limestone breccia, and subordinately pelite-aleurolite and marl, represents a special facies within the Upper Cretaceous flysch.

Cenozoic (Kz) is represented by sediments of Paleogene, Neogene and Quaternary.
Paleogene formations identified include massive to banked limestone, aleurolite, claystone and in some places limestone of **Paleocene-Eocene (Pc,E)**.

Oligo-Miocene sediments, as transitional between Paleogene and Neogene, are established within five series:

- Ol,M - “red series” of the Šeher-Žepče basin: conglomerate, sandstone and marl;
- ^{1}Ol,M - basal zone: conglomerate, sandstone and clay with occurrences of coal;
- ^{1,2}Ol,M – tufaceous limestone, conglomerate and sandstone;
- ^{2}Ol,M - tufaceous limestone, and
- ^{3}Ol,M - “multi-coloured” series: conglomerate, sandstone, marl and clay.

Neogene (N) is represented by Miocene and Pliocene sediments. The **Older Miocene complex ($M_{1,2}$)** is characterized by great facial diversity with economically interesting occurrences of coal in Sarajevo-Zenica and Šeher-Žepče basins. In addition to coal seams, within this complex there are conglomerate, sandstone, clay, marlstone, and limestone.

Middle Miocene (M_2) is represented by “overlying limestone zone” (sandy limestone with overlying coal seam) and "transition zone" (thinly stratified marl and sandstone) in the Sarajevo-Zenica basin. A series of conglomerate, sandstone and marl, which is called “Lašva series” in the Sarajevo-Zenica basin, is identified as transitional formation between Middle and Upper (younger) Miocene complex.

Younger Miocene complex (M_3) is represented by “Koševo series” composed mainly of clay, marl and coal.

Pliocene and Plio-Quaternary formations (Pl_1; Pl,Q) are made of sand, gravel and clay, and there is also coal in Pliocene sediments.

Quaternary (Q) has significant distribution. Quaternary formations are represented by various genetic types and they are: Lacustrine sediments (j), in wider area of Tarčin, are represented by tufaceous brecciated limestone, conglomerate and sand. Diluvial formations (d) occupy a significant area, but they are especially identified in the area of Zenica. They are composed of clayey debris of different grain size distribution. Two levels of river terraces, composed of gravel and sand, are established in river valleys. Alluvial formations of riverbeds are also composed of gravel and sand, while facies of flood area is composed of fine-grained sand, dust and clay.

On section Karuše - Ozimica, the Mesozoic and Cenozoic stratigraphic column in hiatus from Jurassic to Quaternary is represented in the geological structure of the terrain.

Mesozoic deposits (Mz) make up most of the terrain, which entirely lies on Jurassic deposits.

Jurassic ($J_{2,3}$) is represented by volcanogenic-sedimentary formation of claystone, marl, pelite-aleurolite, sandstone and different igneous-metamorphic rocks: listvanite, serpentinite, spilite, gabbro-peridotite and peridotite. The Jurassic formation is distinctly folded and tectonically disturbed. Although generally of Dinaric strike, or northwest - southeast, the Jurassic deposits are characterized by decametric, even metric fluting. This means that position elements change over short distances, so that, from the Dinaric strike, the layers "turn" to the east-west strike, or even perpendicular to the Dinaric directrix. Such is the case in the Crni Vrh area. The attitude is also different, with dips being highly variable, and from 30 to 40°, dip angles become steep more than 60°, and in some places even vertical. Generally, Jurassic deposits are bedded with dip of about 40°, with bedding planes dipping southward or, in some places, northward.

This complex is characterized by both syngenetic or younger protrusions of ultrabasic (peridotite) and basic (gabbro-peridotite), but also acidic (spilite and listvanite) magmatic intrusions, alternating with metamorphosed serpentinite and sedimentary deposits. The contacts of individual magmatic - metamorphic bodies on the one side, and sedimentary alterations on the other, are tectonic or superpositional.

The thickness of the Jurassic magmatic - metamorphic - sedimentary complex could not be determined because the relation to older members was inaccessible or covered. On the other hand, they are transgressively overlain by different younger deposits, so this relationship too is not precisely identifiable, because the geological boundaries are erosional - discordant or tectonic.

Cenozoic (Kz) is represented by sediments of Paleogene, Neogene and Quaternary, which form the northern and southern part of the terrain, while Quaternary deposits are distributed in some places.

Among Paleogene formations, massive and banked limestone of Paleocene-Eocene (Pc,E) is established. Paleocene - Eocene deposits form the basis of the terrain in a limited extent. The carbonate Pc, E complex generally extends east - west, so almost perpendicularly to the route and structures, and the layers lie subhorizontally. The thickness of this limestone is less than 100 m.

Oligo-Miocene sediments (Ol, M,) form a stratigraphic transition between Paleogene and Neogene.

They are identified in the formation of the so-called "red series" of the Šeher-Žepče basin as conglomerates, marl and sandstone. They are found in the Mihaljević area and in the final part of the section near Ravni Lug.

This series transgressively overlies older, mostly Jurassic deposits with which it is in an erosional-discordant contact. The Miocene sediments are superpositionally continued on them to the south. The thickness of Ol, M deposits is about 200 m.

Neogene (N) is represented by sediments of Miocene complexes (older M1, and younger M2,3). These deposits are characterized by facial diversity, with occurrences of coal within pelitic clastite. In addition to coal seams, marl and clay mostly occur within the older part of this complex (M1,2), while younger Miocene deposits (M2,3) are represented by the so-called "Žepče series" consisting of conglomerate, sandstone and marl in vertical and lateral alternation. Quaternary (Q) deposits are represented by diverse genetic types of surface covers. They have a significant, although discontinuous, distribution.

Diluvial deposits (dl - mark 37) are separately identified in the areas of Krčevine, Bećirovača, Luke, Plandište, Karadaglije, along the Strupinska River, and from Bezići to Ozimica. They are composed of debris of different grain size distribution with variable content of sandy-clayey components. The thickness of the diluvial cover does not exceed 5.0 m.

Alluvial deposits (al - mark 39), deposited along riverbeds, are made of gravel, sand and loam. Alluvial deposits are most widely distributed at bottoms of the widely open valleys of the Tešanjka and Trebačka rivers, along the stretch from Medakovo, upstream to Jasik, and around Bare, then between Brezik and Galovac, and finally, in a wide area around Ozimica. The thickness of these deposits is about 5.0 m on average, and in some places they can be much thicker. Such is the case in the Ozimica area, where alluvial sediments are about 10 m thick.

Proluvial deposits (pr) are also identified in the ground in a limited extent, specifically around Luke and Plandište. These fan-shaped accumulations of clayey debris, gravel and sand are deposited by occasional torrents along their own beds. The thickness of proluvial deposits is estimated to about 3.0 m, up to a maximum of 5.0 m.

Tectonic composition

Along section Medakovo - Ozimica, the terrain is characterized by a complex structural-tectonic structure. This area belongs to the belt of Inner Dinarides. Specifically, it occupies the areas of the Tešanj and Šeher - Žepče basins. From the areas belonging to basin's tectogenetic subunits, the terrain rests against the Melange unit from the ophiolite zone of the Inner Dinarides.

Ophiolitic "melange"

The structural - facial unit "melange" of Jurassic age with magmatic intrusive and metamorphic rocks, and sedimentary olistolites, is characteristic not only in composition but also in that the fold forms are almost not observed at all or are very difficult to observe. This is due to the intense tectonization of the rock masses, so that even the primary stratification in sedimentary members is masked or altered to such an extent that it cannot be reliably distinguished from lineations, foliations or cleavages. Primary relationships within the sediments as well as primary contacts between the intrusives are preserved only in places. Also, larger structural forms are complicated by secondary folds of high folding index and parallel type of cleavage, with high occurrence frequency. The cleavage directions generally coincide with the strike of foliations, and these, along with faults, are generally oriented east-west, i.e. perpendicularly or diagonally to the route.

In terms of construction conditions, these facts have a less adverse effect than if the ruptures and discontinuities were extended along the route, in which case the widths of fault zones would be greater, therefore less favourable. The positions and relationships of major fault zones, relative to the route and structures, are shown separately on maps and sections.

The Paleogene - Neogene Šeher - Žepče basin

The sediments of this basin discordantly overlie the ophiolitic "melange", forming folded structures. This part of the terrain is dominated by the Jelinak - Selište syncline, with Miocene deposits lying at the bottom of it and older Oligo-Miocene or Jurassic deposits on its limbs. The rupture system of the ground base within the basin complex reflects the neotectogenetic undulation of strike and dip in the synclinal structure.

The Neogene Tešanj basin

Sediments of this basin discordantly overlie Paleogene clastic - carbonate deposits, forming gently folded structural forms. The rupture system of the ground base, like in the Šeher-Žepče basin, also reflects a weakly manifested neotectogenetic undulation in a gentle synclinal structure. The most distinct discontinuities in these masses are, in fact, bedding planes. Textural pattern corresponds to stratification, while in cover masses, texture is irregular and weakly complex.

In the area of Zenica, members of the Mesozoic, Tertiary and Quaternary stratigraphic column are dominant in the geological structure of the terrain.

Mesozoic deposits (Mz) make up most of the terrain.

The so-called "Nemila" (^{1}J, K) and "Vranduk" (^{2}J, K) series are superpositionally identified as the oldest Jurassic-Cretaceous (J, K) transition members. The Nemila series consists of silicified claystone and sandstone, as well as silicified calcarenite and limestone. These thinly bedded and schistose deposits are characterized by pronounced folding and tectonic fragmentation. They have a limited extent, form the footwall of the Nemila overthrust. Hanging-wall contact to older ^{2}T, J strata. On the other side, the contact to deposits of the "Vranduk" series is also tectonic, along the vertical fault that perpendicularly intersects the route. The thickness of ^{1}J, K "Nemila" layers in the ground is about 100 m.

The "Vranduk" series (mark 4b) consists of platy and thinly bedded marly limestone, calcarenite and marl. These deposits are most dominant along the route, i.e. they form the base of the terrain on most of the route. By their position in the ground, they extend perpendicularly to diagonally to the route and structures, with very variable attitude, from sub-horizontally bedded to very steep layers (60°). Contacts with other geological members are tectonic - with the "Nemila" one in the north and with Oligo-Miocene deposits in the south. The thickness of the "Vranduk" series does not exceed 250 m.

The Oligo-Miocene (Ol, M_1) banked conglomerates in alteration with stratified sandstone and clay with occasional occurrences of coal (in enclosures mark 15a) represent the basal series of the Sarajevo - Zenica Paleogene-Neogene basin. They extend in the southern part in the Donja Gračanica junction area (end of the section). These clastic rocks are intensely tectonized and folded into metric and decametric plications with the general strike northwest - southeast, but with steep (50°) to almost vertical dips of layers. The contact to the flysch-like Jurassic-Cretaceous complex in the Gologlava massif is a fault contact. The thickness of Oligo-Miocene clastic rocks in the terrain is about 250 m.

Quaternary (Q) deposits are represented by diverse genetic types of surface covers. Although with small thickness, they have a significant distribution.

Diluvial deposits (dl) are particularly identified in the areas of Vjetrenica, Vranduk and Gračanica. They are built of debris of different particle size distribution with variable content of sandy-clayey components. The thickness of diluvial cover is about 5.0 m.

Alluvial deposits (al - mark 39) are deposited along the Bosna riverbed. They are made of gravel, sand and loam. Alluvial deposits are most widely distributed over the bottom of more open parts of the Bosna valley, in both banks. The thickness of these deposits is about 5.0 m on average, and in some places they can be much thicker.

Proluvial layers (pr - mark 40) are also identified in the ground in a limited extent, specifically around Nemila (Potputnica) and Gračanica. These fan-shaped accumulations of clayey debris, gravel and sand are deposited by occasional torrents along their own beds. In the zone of Potputnica, the thickness of proluvial deposits is estimated at around 2.0 - 3.0 m, while proluvial materials around Gračanica have the maximum thickness of 5.0 m.

Finally, screes (s - mark 41) are present in some places, especially on the slopes of Srednje Brdo (Middle Hill). They are composed of cohesionless rock debris. They have a small thickness and limited distribution.

In the area Donja Gračanica - Drivuša - geological structure of the investigated terrain on subsection Klopče - Donja Gračanica consists of Jurassic Cretaceous, Upper Cretaceous sediments, Oligo-Miocene polyfacial complex and Quaternary sediments.

The Jurassic-Cretaceous sediments of the so-called "Vranduk" series are represented by platy and thinly-bedded marly limestone, calcarenite and marl. Depending on their position in the terrain, they extend NW - SE to E - W with very variable attitude, from subhorizontally bedded to very steep layers. Contacts with Upper Cretaceous or Oligo-Miocene deposits are tectonic or erosional-transgressive.

Upper Cretaceous - Senonian flysch clastic deposits ($_1K_2^3$) occur mainly in the lower parts and are represented by gray-greenish sandy marlstone, coarse sandstone, limestone breccia and detrital limestone. Most of this subsection is laid in these sediments. Oligo-Miocene polyfacial complex (3Ol, M) - the so-called multi-coloured series. This series is developed as a single continuous belt. Lithologically it is represented mostly by marly-clayey-sandy sediments with layers of contaminated coal, coaly shale and conglomerate. Clay that makes up nearly 70% of this zone is usually contaminated by various ingredients, so it is sandy, coaly or abounds in multi-coloured concretions. Sandstone is mostly bound by clay cement, and marl is usually sandy.

Miocene sediments (M) are represented by stratified, banked to pseudo-massive sandy limestone with coal beds and thinly stratified marl and sandstone.

Quaternary (Q) formations are represented by diverse genetic types of surface covers, with significant distribution.

Diluvial formations (dl) are the most common type of cover. Along this section, the diluvial deposits have the character of colluvial deposits. They are made of debris of different grain size distribution with variable content of clayey components.

The thickness of the diluvial - colluvial cover is highly variable, from only a few metres to fifteen metres.

Alluvial formations (al) are deposited along the riverbed of the Bosna River. They are made of gravel, sand and loam. Alluvial deposits are most widely distributed in the initial part of this section. The thickness of the alluvial deposits, together with the terrace deposits, averages 4.0 to 12.0 m.

3.4.1. Engineering geological and hydrogeological features of rock masses

Engineering geological characteristics

Based on the findings to date, the following categories of surface cover and geological substrate can be identified along the motorway route:

- Surface covers:
    - technogenic deposits
    - alluvial cover
    - eluvial - diluvial cover

Technogenic deposits extend in the road structure of the existing main road and other road communications and smaller dumps from construction of individual and residential buildings. The material composition of the embankment is very heterogeneous, since it consists mainly of materials from excavations carried out in different geological environments and of filled material, gravel and debris, during construction of local roads.

The alluvial cover is positionally raised above the riverbed and occupies the space of the floodplain. The following lithological members participate in the composition of the alluvion: Humic sandy clay, dark gray in colour; sandy clay, brown in colour, homogeneous, of plastic consistency; gravely clay; silty sand, fine-grained, dark gray in colour, highly wetted, soft; silts, dark gray to black in colour, with characteristic smell, water-saturated, soft; gravel, heavily clayey, with rare pebbles over 10 cm in diameter; gravel, sandy with large pebbles over 10.0 cm in diameter. The structure of alluvium has a proper zoning, since with increasing depth, humose loam is underlain by sandy clay of uniform composition with scattered transitions to gravel clay, followed by gravel directly overlying the geological substrate. Humic, loose sandy clay in the surface parts of the terrain. Humus is underlain by sandy clay, usually of a homogeneous composition of plastic consistency, which in some places makes transition to clayey fine-grained sand, and rarely contain fine-grained debris.

Gravel is present in the deeper parts of alluvial deposits. It directly overlies geological substrate.

Terrace materials are identified in certain parts of the Tešanj valley as relics of the old riverbed of the Tešanjka River. Two terrace levels are established. Individual terrace levels are separated by relatively steep terrace cliffs. The structure of the terraced sediments is covered by gravels and sands, which are masked in the surface by sandy clays of variable thickness. Terrace materials have favourable geomechanical properties and represent a solid base for construction of building structures.

Eluvial - diluvial covers are represented in the form of thin covers over older sediments. By material composition, three categories of these covers are distinguished; clay, and sandy and gravelly clay and diluvial clay, aleurite and blocks.

Clay as thin cover overlies the sediments formed by weathering of the lithological members they overlie. Therefore, the material composition of this cover depends on the petrographic composition of substrate. The deeper parts of the cover, with clayey composition, correspond to eluvial products, and the upper parts to eluvial - diluvial ones.

Generally, they can be said to be unfavourable because most landslides are registered in such environments. They can be of a plastic and solid consistency, and can also be in a mushy, liquid state. Although this is an unfavourable working environment, it can be used for construction, subject to mandatory prior detailed investigations depending on the type of designed structures.

In hydrogeological terms, clay is an impermeable environment, except the porous surface layer, where smaller amounts of water can accumulate.

Geological substrate

This category includes the lithological complexes and lithological members described in Chapter 3. In terms of the state of geological substrate, its jointing and weathering, two distinct categories are identified:

- geological substrate weathering crust and
- undisturbed geological substrate

The weathering crust of geological substrate is directly below the alluvial and colluvial deposits, in the form of alternating lithological members of different material composition and degree of weathering.

The undisturbed geological substrate is represented by four lithological complexes and four lithological types, and these are:

- Lithological complex (1): claystone, marlstone, pelite-aleurolite and sandstone ($J_{2,3}$)
- Lithological Complex (9): coal, marl and subordinately limestone, aleurolite and conglomerate ($M_{1,2}$)
- Lithological complex (15): conglomerate, sandstone and marl ($M_{2,3}$)
- Lithological complex (15a): conglomerate, sandstone and marl (Ol, M)
- Lithological type (5a): limestone (Pc, E)
- Lithological type (22): serpentinite ($J_{2,3}$)
- Lithological type (23): spilite ($J_{2,3}$)
- Lithological type (28): diabase ($J_{2,3}$)

Terrain stability

The diversity of rocks and rock masses, or identified basic mapped units participating in the structure of the terrain, indicate complexity both in terms of structural heterogeneity and system anisotropy. Based on the above, as well as developed engineering geological maps and sections, the rock masses were classified and defined as real environments in which the future motorway would be constructed. Specifically, the terrain was categorized according to the degree of stability and threat from modern exodynamic and technogenic processes and phenomena.

The basic criteria for establishing individual stability categories were:

- Material composition and properties of certain genetic categories of surface covers and geological substrate,
- Regularity of occurrence and dynamics of development of modern geological processes, primarily landslides,
- Frequency of landslides occurring on and around the designed route,
- Gradient of natural slopes,
- Impact of surface water and groundwater
- Climate factor

Based on the presented criteria, three categories of terrain, shown on maps and longitudinal profiles, were identified:

- first category: unstable terrains;
- second category: conditionally stable terrains,
- third category: stable terrains.

The first category: unstable terrains - are identified within the landslides registered during the engineering geological mapping of the terrain. The landslide that directly jeopardizes the stability of the planned variant solutions is identified. Depths to slip surfaces can be relatively easily established based on experiential knowledge, and according to the mechanism of movement it belongs to landslides of consequent type with depth to slip surfaces from 3.0 to 5.0 m, and according to movement speed, it belongs to slow to very slow occurrences, which can be relatively easily and quickly repaired.

Second category: conditionally stable terrains are located on sloping terrain made of eluvial - diluvial cover. In natural conditions, terrains of this category are generally stable, and in the conditions of earthwork, inadequate cutting of slopes or their excessive loading can cause the soil material to break off and slide down over the substrate. Given the relatively small thickness of the surface cover, these movements would have a local character, but natural slope stability analyses should be previously carried out in deep cuts in order to design the gradient of artificially formed slopes and ensure general and local stability of the terrain.

Third category: stable terrains - are most dominant along the motorway. Within the terrain, they are found in valleys composed of alluvial sediments. No problems are expected in this category of terrain regarding stability during the execution of earthworks, so in terms of stability they are assessed as suitable for construction. These terrains are made of clayey - sandy and gravelly deposits, with very gentle slopes (0 - 30), without significant impact of groundwater or surface water flooding. The motorway route in the low-lying part of the terrain will be located in embankments of different heights; in these areas only the bearing capacity of embankment substrate, settlement and stability of the embankment structure should be taken into account.

3.4.2. Seismotectonic characteristics

The most important and the most active epicentre areas in territory of BiH are: Treskavica - Sarajevo; Foča; Zenica - Travnik; Jajce - Bugojno; Banja Luka; Tuzla; Žepče; Livno; Drinovci; Ljubuški; Mostar; Dokanovići; Stolac; Ljubinje; Dabarsko polje; Nevesinje and Drežnica. Within the Basic neotectonic map of SFR Yugoslavia (Scale 1: 500.000), the territory of BiH from southwest toward northeast is divided into three tectonic zones: (i) fault zone; (ii) fold-fault zone and (iii) fold zone. An overview of only those seismic zones that that cover the wider area of the studied corridor is presented here.

Fold-fault zone:

The main causes of neotectonic, or contemporary tectonic manifestations within this zone can be related to megablocks activities on regional (epidermal) longitudinal faults. A special characteristic of this zone is that unstable parts are not sharply limited by faults; tectonic trenches and horsts are with fault zones crossed like steps. The area of Žepče - Teslić, Sarajevo-Zenica basin and the area of Treskavica – Kalinovik are included in this zone.

Area Žepče – Teslić

This area is located between the Bosna river and fault Žepče - Pribinić. It is considered as unstable, seismically active. The longitudinal fault that extends northwestward from Žepče toward Teslić is significant. However, a transverse fault Doboj - Teslić extends within limited space in middle of this area, in the Usora River valley. Occurrence of earthquakes, thermal and mineral water indicate that these faults are deep. The unstable area is classified into seismic zone VII of the MCS scale and it occupies the area of Žepče – Zavidovići - Novi Šeher – Lugovi - Papratnica. Five earthquakes, of which two were with intensity VII on the MCS scale, have been registered in this area. However, a moderate earthquake occurrence frequency should be expected along the Bosna River, from Papratnica and Žepče to Dubravica.

Sarajevo-Zenica basin

Sarajevo-Zenica basin represents the most unstable area in the fold-fault zone. The deep graben formed along the Busovača fault is a distinctive structure. The Busovača fault is especially interesting in the corridor zone because this fault is known to have been active not only before

Neogene but also during Neogene and during younger periods, Subsidence of the northeastern block along this fault during the Neogene caused sedimentation of the thick Miocene deposits in the southwest part of the Sarajevo-Zenica basin. This fault is still active and so was in the geological past (from Mesozoic to Quaternary). In addition to stratigraphic facts, the great depth of this geological fracture is also indicated by the numerous occurrences of thermal, thermo-mineral and mineral water. In addition to the vertical displacements of the Sarajevo block, horizontal displacements are also in progress, resulting in rock mass compression, to which the entire Dinarides are subjected, especially during the Neogene. Directed pressure in consolidated blocks causes the occurrence of combined pressures. These combinations cause diagonal positions of folds in relation to fault strike. Along the Busovača fault, the epicentre line is noticeable on the stretch Sarajevo-Zenica- Travnik -Jajce- Mrkonjić Grad. From the seismic-tectonic point of view, this is an active fault with periodical sudden equalization of stresses, which results in earthquakes. Thus, for example, 14 earthquakes with intensities of up to 7 on the MCS scale were registered in the Zenica city area. That is why, during micro-zoning for individual structures, geophysical investigations should be carried out and attention should be paid to correcting soil seismicity, especially because of presence of landslides and possibility of occurrence of new slope instabilities.

Area of Treskavica - Kalinovik

Seismic activities of the Treskavica-Kalinovik area are related to the Durmitor thrust established by gravimetric measurements. This unstable area increases the seismicity of Sarajevo and its surrounding area. The Sarajevo city area belongs to the intensity zone 7 of the MCS scale and it is related to the epicentral area of Treskavica. A zone with intensity 8 on the MCS scale is established in the area of Treskavica. It extends north of Kalinovik and includes the Treskavica mountain. The isoline of MCS intensity 8 has a shape of extended ellipse and approximate orientation NNW-SSE. A zone also with MCS intensity 8 extends to the north of this area to Vogošća and Semizovac. Part of this area overlaps with the Sarajevo-Zenica basin, and it is shaken by its own earthquakes. 32 earthquakes are registered in the area of Sarajevo, although earthquakes of Treskavica are slightly attenuated towards the city. According to available data, the region of Sarajevo has earthquakes more frequent than one in 25 years, while the land area of Ilidža has a slightly less frequent occurrence of earthquakes – one in 15-50 years, intensity up to 7 on the MCS scale. Fold zone (is beyond the scope of the studied area of Corridor Vc, from Svilaj to Tarčin).

Instead of conclusion, it should be noted that defining the seismic characteristics a locality requires adequate investigations to be carried out, which is an obligation in next project documentation development stages.

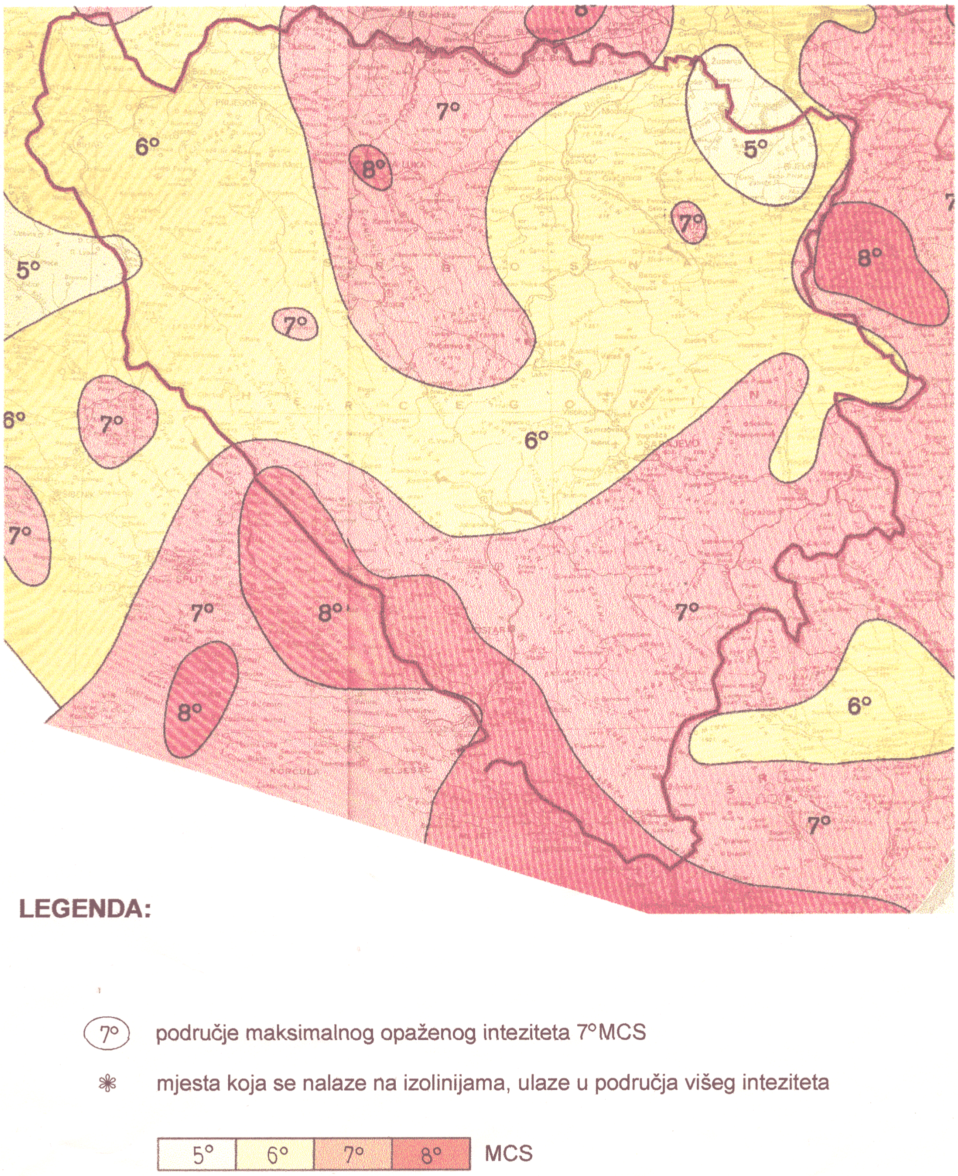


Figure 66: Seismological map of Bosnia and Herzegovina for the return period of 100 years60

3.5. HYDROGEOLOGICAL CHARACTERISTICS

Following the adopted motorway route on the Corridor Vc in the coverage area, it can be established that the subject area is mainly characterized by hilly and mountainous relief, in which the Bosna River is the dominant watercourse with many larger or smaller tributaries draining the catchment area concerned. On the Corridor Vc, the section LOT 1 ends and section LOT 2 begins at the Karuše site, situated in close proximity of the confluence of Usora with Bosna, intersecting this tributary at several locations.

Considering the size of the linear facility in question, the studied area cannot be considered as a single aquifer, but as a combination of rocks of different hydrogeological characteristics alternating in the geological plan and section. Consistent with individual lithological types with variable and uneven physicochemical properties, water permeability characteristics are manifested to a lesser or higher degree in the subject rock material, or in the lithological complex of fracture, fracture-cavernous, or intergranular porosity.

Consistent with the hydrogeological characteristics of the rock material, the motorway route crosses over or touches the aquifer environment of the fracture, fracture-cavernous and intergranular porosity, where aquifers with free level are generally formed, but also confined aquifers of varying degrees of discharge, or water abundance. According to data from previously conducted hydrogeological investigations and operational pumping of water intake facilities, it is established that quaternary (Q), alluvial aquifers (rocks of intergranular porosity) exist as the most dominant aquifer environment, taking into consideration the exception of water-saturated limestone formations on some LOT 2 sections. Other rock complexes in the surrounding area have the characteristic of a secondary aquifer, from which water is usually supplied to a smaller number of individual residential buildings.

Having regard to the above-mentioned, we concentrate on marking the critical areas on the map of limitations related to water resources according to the sensitivity and vulnerability of aquifers or groundwater of the studied area. The orange hatching indicates the aquifer area through which the motorway can pass, but subject to taking all necessary measures to prevent and minimize the negative impact on groundwater, in order to prevent or completely eliminate the negative effects. This means that it is an absolute priority for the proposed route to find such design solutions and to design an external and internal drainage system that will take maximum account of the method and degree of protection of aquifers in the considered area.

An overview of hydrogeological characteristics of the terrain and groundwater sources by chainages along the route on the LOT 2 section is given in the 2007 Study.

3.6. HYDROGRAPHIC CHARACTERISTICS

The Bosna River with its smaller and larger tributaries is the main watercourse on the LOT 2 section of the motorway. Of its larger tributaries, it is necessary to point out the Lašva River, and of smaller tributaries, the following rivers: Tešanjka, Liješnica, Strupinska River, Kardaglijska River, Ozimica, Trebačka River, Gračanička River, Nemilska River and Lepenica.

Data on the characteristics of particular watercourses are presented in the Environmental Impact Study - Lot 2 from 2006, and the data will not be repeated here in detail.

Overview of watercourses crossed by the motorway route

In order to define the possible negative impacts of the motorway on surface waters, or on their flow regime and quality, watercourses that are part of the hydrographic network found in the motorway passage zone are presented here. The overview of watercourses is given by sections on LOT 2. Considering that information from different project development stages (preliminary and main designs of sections and subsections) was available to the producer of this document, the information below is concerned with assessment in accordance with the available data.

SECTION 1 (Karuše – Medakovo) and SECTION 2 (Medakovo – Ozimica)

For these two sections, IPSA INSTITUT produced a single Preliminary Design "Sector 1: Doboj South (Karuše) - Ozimica" in 2014. According to the design, or Volume I - Hydrology, hydrological data base, hydraulics and watercourse regulation, 16 sections are planned on this section (2 for Tešanjka River, 5 for Trebačka River, 5 for Strupinska River, 1 for Lješnica, 1 for Ozimica, 1 for Sarajlića stream and confluence of Golijaška River with Ozimica) with a total length of 16771.25 m. Box culverts with the necessary riverbed training to the confluence with the final recipient are also planned in places where tributaries of these watercourses intersect the routes of the motorway or of local roads.

On bridges over watercourses such as the Usora, Tešanjka and Trebačka rivers, the lower edge of the structure is designed so as to be spaced at least 1.2 m above the level of high water of the 100-year return period, or 1.00 m above the level of high water of the 500-year recurrence period.

The drainage system on bridges is closed type and is an integral part of the closed drainage system of the entire route.

The following are important bridges within the motorway section Doboj South (Karuše) - Ozimica:

- Bridge Tešanjka 2 from km 0+112.82 to km 0+302.45, L=27+4×34+27=190m
- Bridge Kiseljak from km 13+263.26 to km 13+549.92, L=24+8×30+24=288m
- Bridge Ozimica from km 24+564.00 to km 24+746.00, L=14+7×22+14=182m

In addition to these, the bridges of the Tešanjka River, Trebačka River and Liješnica River should also be given attention. These are integral reinforced-concrete prestressed bridges with a 30 m span over the Tešanjka River, reinforced-concrete bridges of 11 m and 20 m over the Trebačka River and a bridge within the Medakovo interchange for passage of an interchange leg.

- Bridge Matanovićevo Brdo from km 2+227.50 to km 2+257.75, L=30m
- Bridge Bedaci from km 2+871.40 to km 2+901.40, L=30m
- Bridge Medakovo 1 from km 3+296.50 to km 3+319.00, L=23m
- Bridge Medakovo 2 from km 3+463.45 to km 3+493.45, L=30m
- Bridge Kerići at km 4+642.80 L=11m
- Bridge Križani at km 5+471.50 L=11m
- Bridge Javrboci at km 6+347.50 L=11m
- Bridge Horvatovići from km 7+444.40 to km 7+464.40 L=20m
- Bridge Tugovići from km 7+801.00 to km 7+821.00 L=20m
- Bridge Brežđe from km 24+166.5 to km 24+186.5 L=20m

SECTION 3 (Ozimica – Poprikuše)

This section was modified in the period after development of the Environmental Impact Study while the Conceptual Design was prepared in 2014. A more detailed description of the route modification is given in Chapter **2.3. Technical description of the project.**

A total of ten bridges are planned on the route, with different lengths ranging from 35.00 m to 406.00 m for the longest. Larger and more challenging structures are mainly designed over the riverbed of the Bosna River, over the main road and over the railway line. According to available data, regulation of the Bosna River is not planned on this stretch.

Table 10: Bridges over watercourses on this section are the following

S.n.	Structure mark	Chainage	Spans	Width	Length	Obstacle
1.	PR1	7+328	10	10	35	Culvert for Ljubne river
2.	MO6	D: 7+997_8+027 L: 7+985_8+015	60	12.4	30	Culvert for Papratnica river and local road
3.	MO7	D: 8+380_+674 L: 8+360_8+616	33+6x38+33 33+5x38+33	12.4	294/256	Bosna River, local road
4.	MO8	D: 9+400_9+756 L: 9+388_9+794	32+7x38+32+26 32+9x38+32	12.4	356/406	Bosna River, railway, local road
5.	MO9	D: 10+655_10+833 L: 10+645_10+823	32+3x38+32	12.4	176	Bosna River and local road
6.	MO10	D: 11+700_12+068 L: 11+725_12+093	32+8x38+32	12.4	368	Bosna River

Section 4 (Poprikuše – Nemila)

Due to the terrain configuration and a number of intersections of the motorway route with the riverbed of the Bosna River, railway line and main road M17, there are a number of structures on the motorway route. Two bridges are planned on the Bosna River:

- Bridge "Golubinja 1" with the length of the left pavement 423.50 m, and of the right pavement 476.50 m;
- Bridge "Bosna M3" with length of the left pavement 196.00 m, and of the right pavement 204.00 m.

Regulation, or relocation of stream bed, is planned in a length of approximately 145.0 m at chainage km 12+650.00.

Section 5 (Nemila – Donja Gračanica (Zenica North))

This section is divided into five subsections.

Subsection I: Nemila – Vranduk - Apart from a certain number of retaining structures, there are no significant structures on this subsection. Regulation of the Bosna River is also planned.

Subsection II Vranduk – Ponirak – The route in this section is in conflict with the Bosna River, and that is solved by designing two bridges, "Vranduk 1" and "Vranduk 2", with total length on the left pavement l=720 m and on the right pavement l=730 m.

Subsection III Ponirak – Southern exit from the Zenica tunnel - The motorway route on subsection III is not in conflict with the Bosna River. The route crosses the Ponirak torrential stream at 0+063.17 km. Except the Ponirak torrential stream, there are no pronounced concentrated watercourses.

Subsection IV: Southern exit from the Zenica tunnel - Zenica North (junction Donja Gračanica) - The route is not in conflict with the Bosna River.

Subsection V: Zenica North (Donja Gračanica) – Tunnel Pečuj - The route is closer to the Bosna River but still not in conflict with the river.

Section 6 (Donja Gračanica – Drivuša)
Section is divided into two subsections:

Subsection I Klopče – Drivuša – on this section the route crosses the Bosna River by the Drivuša bridge from km 0+534.00 (bridge start) to km 1+189.00 (bridge end). In order to satisfy the necessary motorway dimensions, the bridge is designed as two separated structures, i.e. as the left and the right bridge. The length of the left bridge is 647.32 m and of the right bridge 652.68 m.

At chainage km 1+103 regulation of the Đulanov stream is performed between pier positions S14 and S15 of the bridge.

The motorway route at chainage km 1+540 intersects the Ciganski stream, where a culvert 2x2.00m is planned.

Subsection II Klopče- Donja Gračanica – Considering that the motorway route of subsection II passes through the basin of the Bosna River, the river network in this part is relatively well developed, so that the designed route intersects streams at three places;

- At chainage km 5+805.77 it intersects Babina Rijeka (Babina River) which is passed between piers of the Babina Rijeka viaduct;
- At chainage km 7+327.34 the route intersects the Sviće stream, where it is planned to regulate the stream, which is passed between piers of the Ričice viaduct at km 7+344.55;

- At chainages km 3+134.50 and km 4+973.49, the route intersects streams, which is solved by box culverts.

In addition to permanent watercourses, the route also intersects many intermittent watercourses for which culverts are planned of different sizes, depending on design flows.

Minimum impact on groundwater and surface water is ensured by the motorway structure itself (viaducts, bridges, culverts).

3.7. SOIL AND AGRICULTURAL LAND

The soils in the area intended for the construction of part of the Vc motorway route within LOT 2 are part of the Dinaric geomorphological massif with characteristics of a hilly and mountainous area and a very diverse geological base. Most of the area is above 500 m a.s.l. except the Bosna River. The area is strongly influenced by the temperate continental climate, which is largely under the influence of the Pannonian Plain. This climate is characterized by harsh winters and warm summers, with decreasing mean annual temperature towards southwest, following the Bosna valley towards Sarajevsko Polje.

These conditions resulted in formation of very different types of agricultural land, differing in the degree of development, depth of solum, quality of habitats where vegetation development is possible and resistance to adverse environmental impacts and human activities.

A brief overview of natural and production characteristics of the soil types identified in the observed area are given below.

1. Lithosol, soils with profile mark Ai-mC

These are young undeveloped soils, in evolutionary terms they are in initial development stages. Humus accumulates in them sporadically, cannot be seen by the naked eye, it is known as sierozem-humus. The mineral part of these soils is almost indistinguishable from the original substrate.

Lithosols are formed on sloping terrain of hilly and mountainous areas of BiH and are highly permeable to water. This characteristic causes the small amount of humus being formed on them to be lost due to water erosion. They are mostly inhabited by pioneer vegetation.

2. Calcomelanosol or black soils on limestone or dolomite, soils with profile mark Ah-mC and Ah-IC.

Calcomelanosols are soils in the class of humus-accumulative soils, with shallow profile without transitional AC horizon. They are highly permeable. These soils are markedly black in colour from accumulated humus, which is poorly mineralized under xerothermal soil formation conditions, so it accumulates. Over time, it becomes mineralized and bound to clay particles, forming the organo-mineral complex very important for survival and further evolution of the soil.

These are dry, permeable and warm soils primarily prone to aeolian erosion in places where they lose grass cover.

3. Rendzina or humus-carbonate soils with Ah-IC type profile

Rendzinas are skeletal soils formed on physically weathered dolomite, loose carbonate sediments, marly limestone, marl, carbonate sandstone, conglomerate, breccia, moraine deposits, and chutes. They have transitional AhIC horizon, they are much deeper than black soils and for agriculture more important soils, formed in hilly areas. They retain water well and have a more favourable physiological profile.

Due to the lower profile depth, these soils do not have an overly wide capability for agricultural uses, they are suitable for fruit growing and viticulture, and are excellent forest habitats.

4. Ranker or humus silicate soils with profile composition Ah-mC (or Ah-IC if formed on hard substrate)

Rankers are soils of steep slopes on silicate, basic or ultrabasic rocks. These are soils of the hilly and mountainous areas of BiH, they are light loam, well permeable and aerated, and have a fairly stable structure.

The productive properties of these soils depend on their depth, which in most cases is limiting for normal plant growth. Their limiting factors are also the low water capacity and physiological dryness, rankers on serpentine and sandstone are least productive. They are usually forest habitats, partly used as arable land for growing potatoes, oats, rye and barley.

5. Vertisol or smonica (clay soil), soils with Ah-AhIC-IC profile

These soils have a very deep humus-accumulative horizon that sometimes extends over the entire profile. Smonicas have a very high content of clay fractions in their composition, with dominance of the montmorillonite fraction. Their physical properties are unfavourable due to the high content of clay and Mg in the adsorptive complex. When dry, they are hard and compact, intensely swell when wet.

Low permeability is the factor leading to erosion on slopes of these soils. Cold soils that are difficult to cultivate, leave a very short interval for cultivation. They are potentially very fertile and are among the most important agricultural soils in our region, predominantly found in valleys which are centres of agricultural production.

6. Calcocambisol or brown soils on limestone and dolomite, soils with Ah-Brz-Cn profile structure.

Calcocambisols are soils of hilly and mountainous areas of BiH formed on hard limestone and limestone-dolomitic rocks, having B horizon in which clay particles accumulate through a long and very slow process. In terms of texture, these are heavy soils, they have a favourable water-air regime due to their good structural properties.

They are not particularly rich in plant nutrients. Due to the high content of clay, they are not so prone to erosion, except when they are on steep slopes. They are most suitable for vineyards as warm and dry soil, excellent forest habitats.

7. Eutric cambisol or eutric brown soil with Ah-Bv-IC profile structure

These are soils whose adsorption complex has more than 50% base saturation, in their profile there is an intense process of formation of clay minerals, to the surface of which iron oxides are bound, giving them the specific brown colour, especially in Bv horizon, after which they are named. In terms of mechanical composition, they are medium-heavy soils, of stable structure and fairly well aerated.

In terms of production, these are medium quality agricultural soils on which all crops present in our region are cultivated.

8. Dystric cambisol or acidic brown soil with Ah-BV-Cn profile structure

These soils also have a distinct brown colour as a result of clay mineral accumulation in Bv horizon and binding of iron oxides on their surface. They are abundant in the mountainous areas of BiH, at altitudes above 700 m.

These soils have a lower base adsorption complex saturation degree, which is related to acidic parent soil on which they are formed as well as climatic conditions of the area where they are found. In physical terms, they are lighter, these are usually lighter loams with good permeability.

They are typical forest soils, in agriculture they are used as meadows and pastures. They are good for growing potatoes, oats, rye and barley, and have very limited use in fruit production.

9. Luvisol or illimerized soil, soils with Ah-E-Bt-IC profile

Luvisols are soils from the class of eluvial-illuvial soils, which involves the displacement of undestroyed clay minerals from one soil horizon and their deposition in deeper layers.

They occur in the zone of humid to semihumid climate, they are abundant in BiH in areas above 700 m a.s.l., they are naturally typical forest soils. They are intensively used in fruit and crop production because they are often found in favourable relief forms. They have rather favourable physical characteristics, with good fertility.

10. Pseudogley or soil with stagnating upper or surface water and profile type Ah-Sw-Sd (primary pseudogley) or Ah-Eg-Btg-C (secondary pseudogley)

Pseudogleys are compact clayey soils with mixed humus and clayey horizon, they occur in humid and semihumid climate with precipitation above 700 mm per year on slightly undulating hilly terrain up to 600 m a.s.l.

The main characteristic of these soils is surface gleization through the effect of surface stagnating water. They have pronounced reduction processes in soil profile and unfavourable physical and chemical characteristics.

In the natural, unimproved state, pseudogleys give low yields of agricultural plants, unlike improved soils of this type, which give high and stable yields.

11. Fluvisol or alluvial soil

Alluviums are undeveloped soils formed by the processes of flooding and deposition of transported material along rivers and streams. As young soils, alluviums do not have differentiated genetic horizons. The material from which they are made is of very diverse composition, it contains humus, clay and loam, but also large fractions, sand and gravel.

Their physical and chemical characteristics vary greatly depending on the type of the deposited material, which also causes large differences in production properties of these soils. Some of the alluviums protected from frequent flooding are among the best and most fertile agricultural land.

Table 9 gives the individual part of these soil types on the entire route for LOT2 in the 500 m wide belt, according to the data from the 2007 study. Although these values have changed since 2007 due to completion of certain sections, the provided data is still an important reference for better understanding of the role of soil in studying environmental impacts.

Table 11: Overview of parts of individual soil types on the entire LOT 2 corridor Vc route9

Table 11: Overview of parts of individual soil types on the entire LOT 2 corridor Vc route9

Soil type	ha	%
Lithosol	21.7	0.4
Calcomelanosol	67.6	1.4
Rendzina	40.6	8.3
Ranker	79.1	1.6
Vertisol	113.3	2.3
Calcocambisol	25.7	0.5
Eutric cambisol	1,384.7	28.5
Distric cambisol	1,213.1	24.9
Luvisol	465.4	9.6
Pseudogley	163.5	3.4
Fluvisol	928.6	19.1
Total	4,867.1	100.0

The overview table of parts of soil types in the area of LOT 2 suggests that eutric and distric cambisols are most abundant on the planned road route, with a very significant presence of fluvisol, which highly corresponds to the character of the relief and climate, which, as stated in the introductory part, has the characteristics of a humid or semi-humid climate.

The influence of hilly terrain and diverse geological base is also significant, where much of the area planned for construction is in the river valley with frequent flooding as a result of seasonal variations in level of the Bosna River and its tributaries.

Figure 67: Part of the route of LOT 2 with a complex of agricultural land in the river valley (Source: Google Earth)61

3.8. FLORA AND FAUNA

3.8.1. Flora

During development of the 2007 Study, those treating the aspect of flora performed detailed surveys of the area and contacted forestry representatives in the municipalities of Tešanj, Žepče, Zenica, the Public Company ŠPD of Ze-Do Canton and the Public Company Sarajevo Forests Ltd. All existing literature concerning the study area was also consulted.

The EUNIS habitat type classification, which represents a comprehensive pan-European system promoting the harmonization of descriptions and data collection across Europe using habitat identification criteria, was used to identify significant vegetation units in the study area. This classification covers all habitat types from natural to artificial, from terrestrial to freshwater and marine ones. For the purposes of the EUNIS habitat type classification, habitat type is defined as: "plant and animal communities as the characterizing elements of the biotic environment, together with abiotic factors operating together at a particular scale". All the factors included in the definition are elaborated in the descriptive working framework of habitat classification. The database includes EUNIS habitats and Annex I habitats from the EU Habitat Directive. Annex 1 of Directive 92/43/EEC represents a list of "types of natural habitats of interest to the community, whose conservation requires the establishment of special conservation zones".

Section 1 Karuše – Medakovo

Communities of ecosystems of xerothermic forests of eastern hornbeam and pubescent oak Querco- Ostryetum carpinifoliae

EUNIS Habitat code G1.7C1

Plant communities of eastern hornbeam and pubescent oak are present on several sites, such as Penavino Brdo on the right side of the route, at a distance of 1 km from the starting point, and Matanovićevo Brdo on the right side of the route at a distance of 1.5 – 2.0 km from the starting point. Fragments of this vegetation can be found on both sides of the route going further towards Medakovo (2.0 to 4.0 km from the starting point) at an average distance of 50 – 100 m from the route. Terrain slope is up to 20° on the east and southwest exposures. Bedrock is limestone, and soils are represented by a complex of organomineral calcomelanosols and rendzinas. This community represents a permanent stage in the development of thermophilic vegetation. From an ecological point of view, this community has continuity with thermophilic forests of hedge maple (*Acer obtusatum*) and eastern hornbeam.

Typical species in this community are: eastern hornbeam (*Ostrya carpinifolia*), whitebeam (*Sorbus aria*), snowy mespilus (*Amelanchier ovalis*), hairy rock-cress (*Arabis hirsuta*), *Mercurialis ovata*, dwarf sedge (*Carex humilis*), pale birthwort (*Aristolochia pallida*), and erect clematis (*Clematis recta*). Of the species from the alliance and order that have the highest values, the following are found here: manna ash (*Fraxinus ornus*), warty spindle tree (*Evonymus verrucosus*), buckthorn (*Rhamnus catharcticus*), smoke tree (*Cotinus coggygria*), liverwort (*Anemone hepatica*), scented Solomon's seal (*Polygonatum odoratum*), hairy rock-cress (*Arabis turrita*), Cornelian cherry (*Cornus mas*), pink barren strawberry (*Potentilla micrantha*), various-leaved fescue (*Festuca heterophylla*), ivy (*Hedera helix*), Nottingham catchfly (*Silene nutans*), fragrant hellebore (*Helleborus odorus*), and others.

Communities of shrubs *Crataego-Prunetum* and *Evonymo-Thelicranietum sanguineae* are developed as degradation stages of mesophilic and thermophilic forests in this zone.

Forest ecosystem communities of white willow Salicion albae

EUNIS Habitat code 91A0

Hygrophilic forests are developed in the immediate riparian zone of the Tešanjka River along the entire route section. It mainly forms a narrow strip that is more or less discontinuous due to very evident human impact. Several plant associations of this community can be distinguished in this strip. The most important species is white willow (*Salix alba*).

The community *Saponario - Salicetum purpureae auct*. is developed in parts of this area located near highly nitrified habitats.

The most common species in hygrophilic willow communities are: white willow (*Salix alba*), brittle willow (*Salix fragilis*), purple willow (*Salix purpurea*), black alder (*Alnus glutinosa*), bittersweet nightshade (*Solanum dulcamara*), black poplar (*Populus nigra*), fluttering elm (*Ulmus laevis*), blackberries (*Rubus fruticosus* and *Rubus caesius*), guelder rose (*Viburnum opulus*), bugleweed (*Lycopus europaeus*), moneywort (*Lysimachia nummularia*), mint (*Mentha longifolia* and *Mentha rotundifolia*), butterbur (*Petasites hybridus*), false brome (*Brachypodium silvaticum*), self-heal (*Prunella vulgaris*), and some others.

Hygrophilic communities of shrubs (*Humuletum lupuli* and *Humulo-Rubetum fruticosae*) frequently grow near forests and shrubs with willows.

Section 2 Medakovo - Ozimica

Community of ecosystems of xerothermic forests of eastern hornbeam and pubescent oak Querco–Ostryetum carpinifoliae

EUNIS Habitat code G1.7C1

Plant communities of eastern hornbeam and pubescent oak are present on several sites on this part of the route: Salkovića Brijeg on the left side of the route at a distance of about 250 m from the route and 800 m from the starting point, and in the zone of Križanovo Brdo on the right side of the route at a distance of about 100 m from the route and at a distance of 1.0 to 1.5 km from the starting point. Terrain slope ranges between 10° and 30°, on the east and southwest exposures. This vegetation is also developed in the zone of the Strahovac hill (400 m a.s.l.) on the left side of the route and Brezik hill (288 m a.s.l.) on the right side of the route immediately next to it, and at a distance of 5.0 to 5.5 km from the starting point of the section. It is also well developed in the wider area of Jablanica, Kardaglije and Točilo, where it covers significant areas.

Bedrock is limestone, and soils are represented by a complex of organomineral calcomelanosols and rendzinas. This community represents a permanent stage in the development of thermophilic vegetation. From an ecological point of view, this community has continuity with thermophilic forests of hedge maple (*Acer obtusatum*) and eastern hornbeam. Typical species of this community are: eastern hornbeam (*Ostrya carpinifolia*), whitebeam (*Sorbus aria*), snowy mespilus (*Amelanchier ovalis*), hairy rock-cress (*Arabis hirsuta*), *Mercurialis ovata*, dwarf sedge (*Carex humilis*), pale birthwort (*Aristolochia pallida*), and erect clematis (*Clematis recta*). Of the species from the alliance and order that have the highest values, the following are found here: manna ash (*Fraxinus ornus*), warty spindle tree (*Evonymus verrucosus*), buckthorn (*Rhamnus catharcticus*), smoke tree (*Cotinus coggygria*), liverwort (*Anemone hepatica*), scented Solomon's seal (*Polygonatum odoratum*), hairy rock-cress (*Arabis turrita*), Cornelian cherry (*Cornus mas*), pink barren strawberry (*Potentilla micrantha*), various-leaved fescue (*Festuca heterophylla*), ivy (*Hedera helix*), Nottingham catchfly (*Silene nutans*), fragrant hellebore (*Helleborus odorus*), and others.

Communities of shrubs *Crataego-Prunetum* and *Evonymo-Thelicranietum sanguineae* are developed as degradation stages of mesophilic and thermophilic forests in this zone.

Forest ecosystem communities of white willow Salicion albae

EUNIS Habitat code 91A0

Hygrophilic forests are developed in the riparian zone of Trebačka River at a distance of 2 km from the starting point in the form of narrow and discontinuous strip, as well as near the banks of the Strupinska River between the villages of Čakrame and Ljubatovići. Very small fragments of this vegetation are found along the banks of the Ozimica River and Sarajlića stream at the very end of this section.

The most common species in hygrophilic willow communities are: white willow (*Salix alba*), brittle willow (*Salix fragilis*), purple willow (*Salix purpurea*), black alder (*Alnus glutinosa*), bittersweet nightshade (*Solanum dulcamara*), black poplar (*Populus nigra*), fluttering elm (*Ulmus laevis*), blackberries (*Rubus fruticosus* and *Rubus caesius*), guelder rose (*Viburnum opulus*), bugleweed (*Lycopus europaeus*), moneywort (*Lysimachia nummularia*), mint (*Mentha longifolia* and *Mentha rotundifolia*), butterbur (*Petasites hybridus*), false brome (*Brachypodium silvaticum*), self-heal (*Prunella vulgaris*), and some others.

Hygrophilic communities of shrubs (*Humuletum lupuli* and *Humulo-Rubetum fruticosae*) frequently grow near forests and shrubs with willows.

Basophilic pine forests on serpentines (Pinetum silvestris-nigrae serpentinicum)

Pine forests belonging to the order Erico-Pinetalia and the alliance Orno-Ericion are developed in the zone of Šiljati Vrh on the left side of the route and immediately next to it at a distance of 10.0 to 12.0 km from the beginning of section. The soil formed by decomposition of serpentine rocks is prone to significant leaching of alkalis, so that the composition of the plant cover changes in parallel with this process. The low vegetation layer in these forests is dominated by heath (Erica) and various grasses, mainly species from the genus of autumn moor grass (*Sesleria*). Heath dominates in pine forest communities with heath (*Pinetum silvestris-nigra typicum*). Because Erica carnea does not grow optimally in extremely dry habitats, this typical sub-association of pine forests grows on the northern or eastern slopes as well as on the slopes above streams. On slopes with lower gradients, these forests are also developed on south and west exposures. Humus layer is well developed, at least 20 cm, and often even more. It has compact structure and it serves to vegetation as a source of moisture to some extent.

Typical species of this sub-association are *Galium lucidum, Genista januensis, Daphne blagayana,* and *Vicia villosa*. *Daphne blagayana* is related to wetter habitats. The species *Galium lucidum* and *Vicia villosa* grow equally in other pine forest sub-associations as well as oak stands of xerophilic type. However, Aquilegia vulgaris is very rare on serpentines in Bosnia, it is mostly found in mesophilic beech forests.

The species associated with this community are: *Cytisus heuffelii var. maezius* and *Lathyrus pratensis var. densifolius*. These taxa have the same height as heath, so that they become prominent with their compact growth and narrow leaves. In addition, the following species are also found here: *Potentilla malyana* and *Galium vernum*, as well as *Peucedanum oreoselinum, Brachypodium pinnatum, Epimedium alpinum, Scabiosa leucophylla, Spirea ulmifolia, Rosa pendulina, Potentilla alba, Chrysanthemum corymbosusm*, and others. The beginning of acidification of the thick layer of humus is observed by the occurrence of acidophilic elements, of which the most common species here are *Vaccinium myrtillus, Sieglingia decumbens,* and *Danthonia calicina*.

The sub-association *Pinetum silvestrisnigrae seslerietosum latifoliae* is developed on warm, highly skeletal and rocky slopes. This sub-association makes transition to rock vegetation, because *Sesleria latifolia var. serpentinica*, and other species only begin to develop optimally through suppression of pine stands, which have low density in these habitats anyway. Since this community grows on very skeletal soil, its stands contain many serpentinophytes, where *Sesleria latifolia* also belongs. That is why one can find here the species *Halacsya sendtneri*, serpentine fern *Asplenium cuneifolium*, *Notholaena marantae*, and other species associated with rocks, such as: *Festuca sulcata, Stachys chrysophaea, Calamintha alpina ssp. Hungarica, Euphorbia montenegrina, Genista januensis, Galium purpureum, Silene longiflora, Seseli rigida, Carex humilis, Bromus pannonicus, Centaurea micranthos*, and others.

Another stage of black pine forest, dominated by various grass species, primarily *Festuca sulcata*, occurs on the warmest, very steep slopes facing south or west. The substrate is shallow, moderately skeletal, and the layer of humus formed by decomposition of organic remains is only a few centimeters deep. It is dry and powdery. The layer of low vegetation is very scarce and apart from *Festuca sulcata*, the species *Festuca vallesiaca, F. Amethistyna, Bromus pannonicus, Calamagrostis varia,* as well as *Euphorbia montenegrina, Dorycnium germanicum, Alyssum murale* and others, sporadically grow.

Section 3 Ozimica – Poprikuše

In terms of protection of natural values, the serpentine site of Borja mountain, bounded by Mala Usora and its alluvial deposits in the north, and Velika Usora in the south, has the greatest significance on the planned motorway section. East of Usora, the serpentines continue along a narrow strip that widens near Maglaj and extends towards the Bosna River near the settlement of Mosturići. On the left bank of this river, serpentines form the Kobiljača hill (490 m) and Moševački Šiljak (417 m), at the foot of which is the classic habitat of the *Halacsya sendtneri* species. On the right bank, serpentines continue eastward towards Brusnica and the Rakovac stream. The highest elevations here are the Čerkez (600 m) and Čolopek (550 m) hills, from which they extend further to Ozren.

The serpentine complex around Žepče is connected to the Borja mountain. It starts east of the Blatnica stream, and extends all the way to the Bosna River, where it ends in the area between Žepče and Želeća. The serpentine complex is particularly developed in the Papratnica area, immediately next to the proposed route and on its left side in a kilometre from the starting point of this section between 7.0 and 8.0 km of the route. **The serpentine complex near Žepče is protected by the decision of the competent municipal bodies of the Municipality of Žepče.**

On serpentines, as well as all other substrates belonging to extreme habitats, characteristics of flora are manifested only on bare substrate, on rocks or on roughly decomposed, skeletal detritus, or on substrates on which properties of parent rock can have a direct influence on plant life. With the development of vegetation and accumulation of humus, which takes place here in parallel, the connection with parent substrate is increasingly lost, living conditions become increasingly milder and more favourable. Mesophilic species gradually emerge, gradually completely suppressing pioneer vegetation. Serpentinophytes, serpentinomorphoses, and all features of vegetation are formed in this way.

The relict serpentinophytes include species that are also strictly linked with serpentine in other areas, so that their distribution has a mosaic pattern, since it follows serpentine sites. These taxa are spatially isolated from their relatives so that they belong to old Tertiary plants, or to paleoendemics that presently occur only on serpentines as refugial habitats. They are linked with bare substrate. These include: *Halacsya sendtneri* (Boiss.) Dörfl. This species is widespread on the serpentines of Bosnia, Serbia and Albania. It was described in 1847 near Maglaj, and later also found in Bosnia in the Gostović area (K. Maly 1920), as well as in the valley of Župeljeva. The species *Potentilla visianii Panč*. is isolated and without close relatives, so it is considered as one of paleoendemic species. The range is similar to the previous species. It is limited to serpentine areas in Bosnia, Serbia and Albania.

These paleoendemics are continued by the species found on serpentine substrate, but not geographically isolated from related taxa.

Typical (exclusive) serpentinophytes are: *Scrophularia tristis K. Maly* which in ecological terms has very specific demands. It grows as a pioneer species on the disturbed base of serpentine rock creeps in Bosnia. Species *Sesleria latifolia (Adam.) Degen. var. serpentinica Deyl*. is linked with bare serpentine substrate. Sometimes it occurs in low-density pine stands.

Due to the very pronounced microclimatic conditions, xerophilic forms of vegetation occupy the largest areas of plant cover on serpentines. Rocky grounds and rock creeps also have xerophilic character, and forests of black and Scots pines and sessile oak are of the same character.

Serpentines are susceptible to erosion and falling. This process is particularly emphasized at sites where deforestation has taken place. This is why large areas of skeletal soil, or exposed rock and rocky grounds, are often found at these sites. Plant species that are most important for serpentine flora develop on them.

Xerophilic forests are formed by basophilic communities of black pine and sessile oak. Mesophilic forests on serpentines in Bosnia are formed by communities of Illyrian beech forests, of which sessile oak and common hornbeam forests are represented, followed by beech mountain forests, and beech and fir forests. Of the beech forest communities, beech and fir forests have the widest distribution, while others have limited range. They are mostly developed around streams. Due to the considerable acidification of substrate, there are a large number of acidophilic species in beech forests on serpentines. After suppressing the tree layer, these vegetation forms transform into heaths.

The distribution of vegetation on serpentines is most influenced by exposure and terrain morphology. On this dark stone, which heats up almost to 50°C and 60°C in the summer, the terrain exposure naturally has a key influence on vegetation composition as well as on soil development, on differences in moisture and on other factors related to this phenomenon. Equally important are the distribution of vegetation and terrain slope, as well as the characteristic of serpentine to quickly be susceptible to leaching of alkalies. Gentle slopes warm up more slowly than steep ones, and they are less susceptible to erosion. In this way, soil that provides better living conditions to plant cover in terms of moisture than skeletal substrate can freely develop.

The Bosnian serpentine zone lies in the climatogenic zone of beech forests. However, due to the specific conditions of substrate, the natural development of vegetation is considerably impeded, and the variety in the vegetation cover is also caused by the alteration of climatically and edaphically conditioned communities. That is why there is no specific pattern of vegetation on serpentines. Mesophilic forms of vegetation that are supposed to be present in higher areas are found near streams, at valley bottoms, and are replaced by xerophilic groups of plants towards height, on steep slopes.

Serpentine vegetation has the most typical development in dissected terrain, where xerophilic communities are distributed on steep slopes, up to peaks consisting only of sharp ridges. Forest stands are also found on complexes with gentle relief, where the zones around peaks are developed over larger areas. They are present on the western part of the complex near Žepče. The forests there consist of beech and fir, together with spruce at higher altitudes. However, the composition of vegetation is rapidly changing here depending on the relief.

Xerophilic oak forests on serpentines forests of sessile oak with heath *Erico-quercetum petraea (k. et l.) ht*.

Just as pine forests are developed on locations where air humidity content is higher than in extremely dry habitats, so is the type of sessile oak forest with heath restricted to similar habitats.

On this section, this vegetation is developed in the area of Suvi Križ and Vučijak at 8.0 km from the beginning of the section on the right side of the proposed route, as well as on Pavlovo Brdo on the left side of the route, several hundred metres away from it.

There are no significant differences in the floristic composition within the pine and oak forests in the heath layer. Species that are typical of xerophilic forests on serpentines, and are especially prevalent in the sessile oak forests, are: *Epimedium alpinum, Potentilla alba, Galium vernum, Betonica officinalis, Poa pratensis*. Of acidophilic elements often present are *Vaccinium myrtillus, Calluna vulgaris, Potentilla erecta*, and others, which can be found already in the layer with heath under black pine.

Heaths

On some serpentine complexes, heaths occupy large areas, as is the case in the area around Žepče, and especially in the zone of Varošište and the Kamenitovac elevation (288 m) on the left side of the proposed route. These heaths belong to the community *Genisto-callunetum Horv*. The following can be found in their composition: *Agrostis vulgaris*, which sporadically covers the spaces that are free from growth between groups of heathers, then *Sieglingia decumbens, Veronica officinalis, Achillea millefolium, Lotus corniculatus, Rubus candicans, Aira capillaris, Carex pallescens, Polygala vulgaris, Trifolium campestre*, and in some places also *Betula pendula*, while the most prevalent of Genistae is *Genista ovata*.

Vegetation on rocks and rocky grounds

The plant cover on rocks and rocky grounds is very similar in its floristic composition, which is natural, because these habitats essentially do not differ in living conditions. In addition, serpentines are easily mechanically weathered and broken down into larger stone blocks and small detritus, so that there are no larger rocks here. Rocky grounds, especially on larger slopes, are susceptible to erosion, and are themselves largely the result of erosion following deforestation. This vegetation is developed on the locations like the vegetation of rock creeps near Žepče and is in direct contact with it.

Vegetation on rocks

Vegetation on rocks is very similar to the low-vegetation flora in black pine forests. The vegetation units in which *Halacsya sendtneri* grows as the dominant element are on the rocks. The vegetation units in which this species grows form communities typical of dry rock vegetation on serpentine complexes of the Balkans. The species that form the vegetation of rocks and rocky grounds partly belong to the communities of the alliance *Bromion erecti, Festucion vallesiacae*, as well as the sub-alliance *Orno-Ericion serpentinicum*. The species typical of serpentine habitats *Euphorbia montenegrina, Anchusa barrelieri, Allysum murale*, etc. are also considered as characteristic and differential species of this alliance. This category also includes many other species that abundantly occur on serpentines, such as *Silene longiflora, Centaurea stoebe ssp., micranthos, Thlaspi avalanum, Satureja hungarica, Thymus jankae var. subacicularis*, etc. This type of vegetation is especially well developed on this section, on steep slopes in the zone of Kametiovac on the right side of the road, and in the zone of Kik (551 m) on the left side of the road at 8.0 to 9.0 km from the beginning of this section.

The species of the *Festuco-Brometea* class mostly dominate here, but the species of the *Orno-Ericion serpentinicum* alliance keep pace with them. It is very significant that most rock vegetation species within the *Festuco-Brometea* class belong to the *Festucion vallesiacae* alliance, while rocky grounds are dominated by representatives of the *Bromion erecti* alliance, where the representatives of the *Mesobromion* sub-alliance are mostly more frequent. Representatives of the alliance *Bromion erecti* and *Festuca vallesiaca* equally occur on the rocks where *Halacsya sendtneri* is not present, while representatives of the alliance *Festucion vallesiacae* dominate in stands of this species.

Representatives of this alliance are more tolerant to drought: they are also more exposed to greater temperature fluctuations as well as summer droughts, much more so than communities of the *Bromion erecti* alliance.

Forest ecosystem communities of white willow Salicion albae

EUNIS Habitat code 91A0

Hygrophilic forests are developed on this section in the form of a discontinuous belt in the riparian zone of the Bosna River and its tributaries in the zone from Brezovo Polje to Golubinje It mainly forms a narrow strip that is more or less discontinuous due to very evident human impact.

The community *Saponario - Salicetum purpureae auct*. is developed on parts of this area that are located near highly nitrified habitats on this section.

The most common species in hygrophilic willow communities are: white willow (*Salix alba*), brittle willow (*Salix fragilis*), purple willow (*Salix purpurea*), black alder (*Alnus glutinosa*), bittersweet nightshade (*Solanum dulcamara*), black poplar (*Populus nigra*), fluttering elm (*Ulmus laevis*), blackberries (*Rubus fruticosus* and *Rubus caesius*), guelder rose (*Viburnum opulus*), bugleweed (*Lycopus europaeus*), moneywort (*Lysimachia nummularia*), mint (*Mentha longifolia* and *Mentha rotundifolia*), butterbur (*Petasites hybridus*), false brome (*Brachypodium silvaticum*), self-heal (*Prunella vulgaris*), and some others.

Hygrophilic communities of shrubs (*Humuletum lupuli* and *Humulo-Rubetum fruticosae*) frequently grow near forests and shrubs with willows.

Communities of ecosystems of hygrophilic forests and shrubs of alder

EUNIS Habitat code 91E08*

Phytocenoses of hygrophilic forests and shrubs of alder occupy relatively small areas in the studied area, mainly forming a narrow, often discontinuous belt along watercourses. In the studied area, they are established along the Bosna River and its tributaries in the zone between Brezovo Polje and Golubinje.

These communities occur on flat terrain on alluvial deposits of different ages. The soils are of fluvisol type. Communities of these forests and shrubs have great ecological significance for representativeness and conservation aspects of the area and, on the other hand, play a role in primary flood control in this area.

The composition of black alder communities include: meadowsweet (*Filipendula ulmaria*), thistle (*Cirsium oleraceum*), moneywort (*Lysimachia nummularia*), horsetail (*Equisetum palustre* and *E. Maximum*), sedges (*Carex gracilis* and *Carex brizoides*), dead-nettle (*Lamium maculatum*), nettle (*Urtica dioica*), purple loosestrife (*Lythrum salicaria*), bedstraw (*Galium palustre*), false brome (*Brachypodium silvaticum*), self-heal (*Prunella vulgaris*), speedwell (*Veronica serpyllifolia*), and some others.

Section 4 Section Poprikuše – Nemila

The community of ecosystems of oak – hornbeam forests Querco - Carpinetum betuli

EUNIS Habitat code G1.A1A

Typical habitats of this community in the area of this section are found in the zone between 1.0 and 3.0 km from the beginning of the section, at the locations of Budakovac, Ravno Brdo and Golubinjska Šuma. This community with a very wide distribution is also present in the wider area of Topčić Polje, Gusta Jabuka, Hrašće, Nemilsko Brdo, Kragunjka, to Nemila (from 3.0 km to 8.0 km of this section) where it is associated with the communities of hornbeam and oak Carpino betuli – Quercetum roboris, and represents the most productive forests in this area. The vertical organization of ecosystems is manifested through the presence of the layer of high and medium-high trees, layer of shrubs and the layer of herbaceous plants.

Significant plant species within this community are oak (*Quercus petraea*), hornbeam (*Carpinus betulus*), wild cherry (*Prunus avium*), common maple (*Acer campestre*), Tatarian maple (*Acer tataricum*), European wild pear (*Pyrus pyraster*), fluttering elm (*Ulmus campestre*), common spindle (*Evonymus europaea*), European privet (*Ligustrum vulgare*), as well as wood anemone (*Anemone nemorosa*), lungwort (*Pulmonaria officinalis*), mountain melick (*Melica nutans*), Solomon's seal (*Polygonatum multiflorum*), European wild ginger (*Asarum europaeum*), wood sedge (*Carex sylvatica*), greater stitchwort (*Stellaria holostea*), spring crocus (*Crocus vernus*), barrenwort (*Epimedium alpinum*), dog's tooth violet (*Erythronium dens-canis*), and others such as *Carex pilosa, Potentilla micrantha, Festuca heterophylla, Viola sylvestris, Aremonia agrimonioides, Symphytum tuberosum, Luzula pilosa* and *Euphorbia amygdaloides.*

Forest ecosystem communities of white willow Salicion albae

EUNIS Habitat code 91A0

Hygrophilic forests are developed in the riparian zone of Bosna River, and particularly in the zone between Topčić Polje and Hrašće at the Ada site (5.8 km from the beginning of this section). It mainly forms a narrow strip that is more or less discontinuous due to very evident human impact. Several plant associations of this community can be distinguished; one of them is the community in which white willow (*Salix alba*) plays a dominant role. In addition to this community, the communities of brittle and white willow *Salicetum albae – fragilis* are also developed here.

The community *Saponario - Salicetum purpureae auct*. is developed in parts of this area located near highly nitrified habitats.

The most common species in hygrophilic willow communities are: white willow (*Salix alba*), brittle willow (*Salix fragilis*), purple willow (*Salix purpurea*), black alder (*Alnus glutinosa*), bittersweet nightshade (*Solanum dulcamara*), black poplar (*Populus nigra*), fluttering elm (*Ulmus laevis*), blackberries (*Rubus fruticosus* and *Rubus caesius*), guelder rose (*Viburnum opulus*), bugleweed (*Lycopus europaeus*), moneywort (*Lysimachia nummularia*), mint (*Mentha longifolia* and *Mentha rotundifolia*), butterbur (*Petasites hybridus*), false brome (*Brachypodium silvaticum*), self-heal (*Prunella vulgaris*), and some others.

Communities of ecosystems of hygrophilic forests and shrubs of alder

EUNIS Habitat code 91E08*

Phytocenoses of hygrophilic forests and shrubs of alder occupy relatively small areas, mainly forming a narrow, often discontinuous belt along the Bosna River on the stretch from Topčić Polje to Hrašće (3.5 km to 5.5 km of the section).

These communities occur on flat terrain on alluvial deposits of different ages. The soils are of fluvisol type.

All communities of these forests and shrubs have great ecological significance for representativeness and conservation aspects of the area and, on the other hand, play a role in primary flood control in this area.

The composition of black alder communities include: meadowsweet (*Filipendula ulmaria*), thistle (*Cirsium oleraceum*), moneywort (*Lysimachia nummularia*), horsetail (*Equisetum palustre* and *E. Maximum*), sedges (*Carex gracilis* and *Carex brizoides*), dead-nettle (*Lamium maculatum*), nettle (*Urtica dioica*), purple loosestrife (*Lythrum salicaria*), bedstraw (*Galium palustre*), false brome (*Brachypodium silvaticum*), self-heal (*Prunella vulgaris*), speedwell (*Veronica serpyllifolia*), and some others.

Section 5 Nemila – Donja Gračanica

The community of ecosystems of oak - hornbeam forests *Querco- Carpinetum betuli* (EUNIS habitat code G1.A1A) are also developed throughout the length of this section, on both sides of the proposed route, while the typical hygrophilic communities which were also typical of the previous sections are developed along the Bosna River valley. Ecosystems of hygrophilic forests and shrubs of willows and poplars, which are already described for previous sections, successively alternate on alluvial soils along the watercourses in this zone. They include:

- ecosystem of forests of white willow *Salicetum albae*
- ecosystem of white and brittle willow *Salicetum albae-fragilis*
- ecosystem of forests of willows and poplars *Salici – Populetum*
- ecosystem of white and black poplar *Populetum nigro-albae*
- ecosystem of forests of almond willow *Salicetum triandrae* and
- shrubs with purple willow *Salicetum purpureae*

Black alder forests normally occupy the wettest habitats within this biome and often follow watercourses, thus going deep inland. They are differentiated into several communities.

The hygrophilic vegetation belt is continued by the belt of mesophilic forests, which most frequently grow on milder slopes and much more developed soils as compared to the previous vegetation. This vegetation belongs to the order of deciduous forests from the order *Fagetalia Bleč. et Lkšić* 70 (mountain beech forests) with association *Fagetum moesiacae montanum Bleč. et Lkšić* 70 and alliance *Carpinion betuli Oberd*. 53 with associations *Carpinetum betuli-orientalis Lkšić et al*. 75 (meso-thermophilic forests of hornbeam and oriental hornbeam) and *Querco-Carpinetum betuli Ht et al*. 74. On this section, this vegetation is developed in the area of the Vepar hill, on the stretch from D. Vrace to D. Gračanica on the left side of the proposed route.

Section 6. Donja Gračanica – Drivuša

Community of ecosystems of xerothermic forests of eastern hornbeam and pubescent oak Querco–Ostryetum carpinifoliae

EUNIS Habitat code G1.7C1

Plant communities of eastern hornbeam and pubescent oak are present on the stretch from the D. Gračanica settlement, to Ričice, Kopila, Klopče, to Perin Han, on terrain slopes from about 10° to 30°, on southwest and northeast exposures. Bedrock is limestone, and soils are represented by a complex of organomineral calcomelanosols and rendzinas. This community represents a permanent stage in the development of thermophilic vegetation. From an ecological point of view, this community has continuity with thermophilic forests of hedge maple (*Acer obtusatum*) and eastern hornbeam.

Typical species of this community are: eastern hornbeam (*Ostrya carpinifolia*), whitebeam (*Sorbus aria*), snowy mespilus (*Amelanchier ovalis*), hairy rock-cress (*Arabis hirsuta*), *Mercurialis ovata*, dwarf sedge (*Carex humilis*), pale birthwort (*Aristolochia pallida*), and erect clematis (*Clematis recta*). Of the species from the alliance and order that have the highest values, the following are found here: manna ash (*Fraxinus ornus*), warty spindle tree (*Evonymus verrucosus*), buckthorn (*Rhamnus catharcticus*), smoke tree (*Cotinus coggygria*), liverwort (*Anemone hepatica*), scented Solomon's seal (*Polygonatum odoratum*), hairy rock-cress (*Arabis turrita*), Cornelian cherry (*Cornus mas*), pink barren strawberry (*Potentilla micrantha*), various-leaved fescue (*Festuca heterophylla*), ivy (*Hedera helix*), Nottingham catchfly (*Silene nutans*), fragrant hellebore (*Helleborus odorus*), and others.

Communities of shrubs *Crataego-Prunetum* and *Evonymo-Thelicranietum sanguineae* are developed as degradation stages of mesophilic and thermophilic forests in this zone on most of this section on both sides of the proposed route.

Forest ecosystem communities of white willow Salicion albae

EUNIS Habitat code 91A0

Hygrophilic forests are developed in the riparian zone of the Bosna River and its tributaries. It mainly forms a narrow strip that is more or less discontinuous due to very evident human impact. Several plant associations of this community can be distinguished; one of them is the community in which white willow (*Salix alba*) plays a dominant role. In addition to this community, the communities of brittle and white willow *Salicetum albae – fragilis* are also developed here.

The community *Saponario - Salicetum purpureae auct*. is developed in parts of this area located near highly nitrified habitats.

The most common species in hygrophilic willow communities are: white willow (*Salix alba*), brittle willow (*Salix fragilis*), purple willow (*Salix purpurea*), black alder (*Alnus glutinosa*), bittersweet nightshade (*Solanum dulcamara*), black poplar (*Populus nigra*), fluttering elm (*Ulmus laevis*), blackberries (*Rubus fruticosus* and *Rubus caesius*), guelder rose (*Viburnum opulus*), bugleweed (*Lycopus europaeus*), moneywort (*Lysimachia nummularia*), mint (*Mentha longifolia* and *Mentha rotundifolia*), butterbur (*Petasites hybridus*), false brome (*Brachypodium silvaticum*), self-heal (*Prunella vulgaris*), and some others.

Hygrophilic communities of shrubs (*Humuletum lupuli* and *Humulo-Rubetum fruticosae*) frequently grow near forests and shrubs with willows.

As already described for previous section, on this section too hygrophilic vegetation of the forest ecosystem community of white willow *Salicion albae* (Habitat code 91A0) and the community of ecosystem of hygrophilic forests and shrubs of alder (Habitat code 91E08*) develop along the bank of the Bosna River and its tributaries Dobre Vode, Babina Rijeka, and Đulahova Rijeka.

3.8.2. Fauna

Data on composition of animal species in the analysed area of the motorway Vc route (Lot-2) were collected on the basis of interviews and consultations with the local population, while hunting clubs of existing municipalities were consulted for additional data on the state of game animal populations. Data on game animals are included in the composition of fauna making, as such, the main and most distinctive part of fauna in scientific and expert terms.

During preparation of the study, those who elaborated the fauna and hunting aspect contacted the representatives for hunting in the Public Company ŠPD of Ze-Do Canton and the hunting clubs: "Borja" Teslić, "Jeleč" Žepče, "Klek" Zavidovići, "Zmajevac" Zenica. Data from National Museum in Sarajevo and consultations with hunting clubs and local inhabitants were used during treatment of data about fauna on LOT 2 sections. The IUCN Red List and the recommendations of Council Directive 92/43/EEC were used for the analysis of significant species.

The main characteristics of fauna composition on the studied part of the motorway route are conditioned primarily by the degree of development and degradation of plant cover. Taking a global view, the entire area is characterized by pronounced anthropogenic impact, which is reflected primarily in the construction of settlements that had a direct impact on retreat of fauna into wild parts of the ecosystem. Composition of the established animals species was analysed on the basis of field studies conducted in August and September 2005. The analysis has taken into account the species protected by some of the legal acts in Bosnia and Herzegovina, emphasizing their importance under the provisions of the Convention on Biological Diversity (Rio de Janerio, 1992), IUCN Red List and global protection of species (IUCN, 2000), Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds, Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and wild fauna and flora).

Within the field studies (field visit) and based on the available data, 26 bird species have been registered over the last 50 years, of which the following species are protected by Annex II and Annex III of Council Directive 79/409/EEC: *Picus canus, Columba palumbus, Larus ridibundus, Venellus vanellus, Dendrocopos major, Scolopax rusticola, Chilodonias niger* and *Bubo bubo*.

More than 20 species of mammals, with low population density and already fragmented habitats, have been registered on the studied part of the motorway route.

An overview of the composition of fauna or occurrences of some of the most distinctive forms in the composition of fauna are presented by sections.

Section 1 Karuše – Medakovo

Land forms with negligible faunistic importance are less present in the composition of animal forms in the analysed area of the motorway project. Endemic species (Hydropsyche dinarica) are registered within insect fauna. In the larval stage, they are related to the aquatic system of Usora, and as imago to the banks. Rare bird species are encountered along the banks. Presence of rare specimens of amphibians (frogs) is observed in wetland areas.

Section 2 Medakovo - Ozimica

Mammals

The investigated part is characterized by denser settlements and adequate natural features. Species of hare, fox, squirrel and wild boar are individually registered as part of the mammalian fauna. Habitats of these species are only partly related to the motorway section.

Birds

Birds are typical of this area, and the most important species include pheasant and quail. From the owl family, *Tyto alba, Cuculus canorus, Asio atus*, Eurasian wryneck *Jynx torquilla* can be encountered flying over in the area near Tešanj (Crni Vrh).

Section 3 Ozimica – Poprikuše

Mammals

The mammal fauna with characteristic representatives of the previous section, but with slightly denser populations, is partly developed from the beginning of the section on both sides of the planned motorway to km 34+000.00.

Birds

The following species are found in the surroundings of Žepče: *Picus canus*, European roller *Coracias garrulus*, swift *Apus, Columba aenas*.

Section 4 Section Poprikuše– Nemila

Mammals

In the zones of partially preserved small forests, mammals are represented in terrestrial fauna with rare specimens of squirrels and rabbits.

Birds

In addition to standard species, a marked presence of pigeon *Columbia palumbus* is observed here in the region of Nemila on Jezeračka mountain.

Section 5 Nemila – Donja Gračanica

The route on this section passes near the present main road and animal forms occur individually, represented by species related to such areas. In the area of Vranduk from km 50+000 – 51+ 000, the following bird species are registered: *Cuculus canorus, Otus scopus* and *Larus ridibundus*.

Section 6 Donja Gračanica – Drivuša

In its initial part, the area of this section passes through populated areas, and in the area of the Drivuša junction it is directly linked with the Bosna River watercourse. In this part in the area of Zenica (km 60+000 – 64.000) presence of the following birds is registered: *Pluvialis apricaria, Corcius garrulus, Larus ridibundus* and *Otus scopus*.

Table 12: Overview of the most dominant part of fauna on the considered sections10

SECTION	SITE	FAUNA
1 KARUŠE-MEDAKOVO	Penavino hill on the right side of the route 1.5 - 2 km from the starting point	Rare bird species, squirrels, hares
	River Usora km	Endemic species of Hydropsyche dinarica (*Trichoptera*)
2 MEDAKOVO - OZIMICA	The entire part of the route in plant communities of Salkovića brijeg, Križanovo brdo, Šiljati vrh, Tešanj – Crni vrh	Birds: Eurasian wryneck, quail, pheasant; squirrels, hairs, foxes and wild boars
	Trebačka River 2 km from the beginning of the section, Strupinska River between the villages of Čakrame and Ljubatovići	Birds, insects linked to water in the larval stage
3 OZIMICA - POPRIKUŠE	km 24+901.587 to 34+000[7]	Birds: Europen roller, swift, pigeon, qual, pheasant; Mammals: squirrels, hares, foxes and wild boars with dense populations
	The area of Žepče	Birds
4 POPRIKUŠE - NEMILA	km 38+617.44 to 39+618	Rare specimens of birds, squirrels, hares, foxes
	Jezeračka mountain -Nemila	Birds: species of pigeon *Columbia palumbas*, which is a protected species according to the IUCN Red List and according to Bird Directive
	Bosna River	An important place within the aquatic fauna belongs to the densely populated cyprinid fish species, composition of other aquatic fauna is dominated by dipterous insects, oligochaete, and leeches as typical inhabitants of polluted running water
5 NEMILA – DONJA GRAČANICA	Vranduk	Birds: seagull, pigeon, Otus scopus and Cuculus canorus. The seagull species registered in this area is a protected species under European Directive - Anex II - III, rare specimens of small game
6 DONJA GRAČANICA - DRIVUŠA	Riparian zone along the Bosna River	Rare specimens of birds, ducks, Aquatic fauna: well developed cyprind fish fauna, aquatic species of insects, rare specimens of crayfish, leeches, snails
	Zenica	Birds: seagull, *Pluvialis apricaria, Corcius garrulus* and *Otus scopus*

[7] *According to Spatial plan of the area of special features Motorway on the Corridor Vc*

3.9. LANDSCAPE

The project of the motorway route should not disrupt the landscape through which it passes, but it should be harmoniously integrated into surrounding natural features, such as existing autochthonous forest plant communities, groups or individual specimens of tree and shrub species. The most harmonious organic connection between the motorway and the landscape is when the motorway route corresponds to the character of its basic natural components - relief of the environment, riverside contour lines, water surfaces as well as edges of forest massifs.

Section LOT 2 of the motorway route in Corridor Vc through Bosnia and Herzegovina is located in the Bosna River basin throughout its length, specifically in the right part of the basin from Doboj South to upstream of Žepče, from where it crosses to the left valley side. In morphological terms, the wider area through which the route passes is classified into two morphological classes of relief: from 30 m to 100 m and from 100 m to 300 m. The first relief class includes the area along the alluvial plain and the immediate valley floor of the Bosna River. The slopes of the more pronounced morphological units in the route zone belong to the higher relief class (100 - 300 m), on which most of the route is located. This is practically manifested by a large number of tunnels and viaducts over the perimeter of these morphological units.

Four basic landscape categories are characteristic of the landscape of the wider spatial entity:

- Natural landscape
- Cultivated landscape
- Built landscape
- Cultural and historical landscape

4.9.1. Natural landscape

The natural landscape category includes areas in which interventions have not been made and which have been preserved in their natural form in maximum degree. The natural landscape is usually located in the hilly area where landscape interventions are negligible. These areas are very sensitive to changes due to the urbanization, industrialization and economic development processes. That is why it is necessary to identify and adequately protect them. This category of natural landscape, which is mostly represented by open spaces that have preserved their natural character, includes forest massifs, river valleys, elevations of the spacious water area.

Spatial structure of the landscape should express the combination of the physical and spatial qualities of its components: parterres, meadows, depressions, slopes, forest communities, river valleys, etc. Different characteristics of natural elements of the composition practically determine their possible uses in the landscape composition, consistent with their function and purpose.

Forests

A large number of forest communities, which give identity to this area, are found within the narrower and wider coverage of the motorway. In varying degrees, they are subjected to anthropogenic impacts and are often intersected by agricultural land.

Forest vegetation has a high influence on composition of the free area in which it is located. When selecting the method and style of landscape design, it is necessary to a maximum degree to respect the decorative and biological characteristics of forests in order to organically and biologically integrate them into newly designed vegetation. The fully justified use of existing vegetation is important in suburban areas when forming park forests. The existing vegetation will serve as the basis - skeleton for the newly designed vegetation, enriching it in aesthetic and colour terms.

In the motorway zone of the Corridor Vc LOT2, forests are characterized by the presence of heterogeneous forest phytocoenoses. The heterogeneity of forest communities should be respected when selecting plant species for landscape design, in order to preserve the gene pool and appearance of the existing environment. Individual sections of the motorway route are characterized by the following forest communities:

- Sector Doboj South (Karuše – Žepče) is located on hilly terrain with predominantly deciduous forests of: sessile oak, common hornbeam and beech.
- Sector from Žepče to Drivuša crosses the Bosna River in several places. On the slopes above the Bosna River there are various oak forests, of sessile oak, sessile oak and common hornbeam, pubescent oak and oriental hornbeam, forests of pines, beech, beech and fir.

4.9.2. Cultivated landscape

The cultivated landscape encompasses areas that have been preserved from major interventions and where the preserved and recognizable identity of rural structure is present. These are urban entities which have a lower degree of urban development (villages, small settlements), which fit into the existing landscape environment, making a harmonious whole with it. Agricultural areas make the dominant content of cultivated landscape. Within the motorway route, agricultural areas are mainly located in valleys of the rivers: Bosna, Lašva, Lepenica, Tešanjka, etc. In some parts, the rural landscape has been changed by fragmentation of properties or illegal construction without adequate infrastructure, resulting in the loss of its original values.

The appearance of the rural landscape is disrupted by frequent construction of buildings that are not adjusted to the natural features of the space or are located in valuable and protected areas.

4.9.3. Built landscape

This type of built landscape is characterized by the urban structure of newly developed settlements. This applies to towns along the motorway route, industrial facilities or extension of existing residential or industrial facilities. Such interventions cause devastation of the existing landscape, so in some cases it is not possible to establish what type of existing landscape is involved.

The consequence of such spontaneous and unprofessional actions is the emergence of unnatural urban entities, e.g. along the motorway route, settlements are concentrated in valleys of the Bosna and Lašva rivers and have a tendency to merge.

This tendency of settlements to merge along the route causes the existing landscape to lose its original identity and appearance of settlements to be disrupted.

Water surfaces

Water surfaces are one of the important components of landscape and occupy a significant place in space design. The specific flora in their immediate vicinity is rich in diversity of plant species, multitude of forms, colours and shapes, which gives a special aesthetic and visual tone to the area. The use of aesthetic qualities of water surfaces and the natural characteristics of their environment can help create an attractive setting aimed at passive and active recreation. The valleys of the Bosna and Lašva rivers make the area along the motorway route particularly valuable in composition of flora and aesthetic features.

Settlements

The system of settlements in the vicinity of the motorway route is dispersed in most cases. Most of the settlements are rural in nature and fit into the existing landscape. This type of settlements is found within the urban areas of Zenica, Tešanj, Maglaj and Žepče, mainly in the outskirts.

4.9.4. Cultural and historical landscape

The cultural and historical landscape developed over a long period of time and is contained within building units that have a monumental value. The motorway area on the observed Corridor Vc section LOT 2 is rich in cultural and historical values that differ in function and purpose. In fact, they belong to the group of special-purpose structures so that in this respect they should be protected by carefully selecting adequate landscape protection and conservation measures. Landscape protection measures (reconstruction, revitalization, restoration, conservation, recomposition, etc.) should be chosen in a way that will not disrupt the main character of the cultural and historical building units.

In the influence area of the planned Corridor Vc LOT2 section, there are many structures that are part of the category of cultural and historical heritage, for example:

- heritage structures in the urban area of the town of Tešanj (mosque, clock tower, old town) have significant aesthetic, scientific and environmental value,
- the most valuable urban ensemble of national importance (old town, mosque) - Maglaj,
- urban-rural ensemble of national importance - Vranduk and Varošište,
- historical town ensemble - Zenica etc.

3.10. PROTECTED PARTS OF NATURE

The environmental impact study for LOT 2 from 2006 defines the Borja mountain serpentine deposit and the serpentine complex around Žepče as protected areas. Considering that this section has not changed significantly, the text from the study is taken in full:

"Section 2. Medakovo - Ozimica (chainage km 4+000 to 24+901.587)

Section 3. Ozimica – Poprikuše (chainage km 24+901.587 to 38+617.434)

In terms of protection of natural values, the serpentine deposits of Borja mountain, bounded by Mala Usora and its alluvial deposits in the north, and Velika Usora in the south, has the greatest significance on the planned motorway section. East of Usora, the serpentines continue along a narrow strip that widens near Maglaj and extends towards the Bosna River near the settlement of Mosturići. On the left bank of this river, serpentines form the Kobiljača hill (490 m a.s.l.) and Moševački Šiljak (417 m), at the foot of which is the classic habitat of the *Halacsya sendtneri* species. On the right bank, serpentines continue eastward towards Brusnica and the Rakovac stream. The highest elevations here are the Čerkez (600 m a.s.l.) and Čolopek (550 m a.s.l.) hills, from which they extend further to Ozren.

The serpentine complex around Žepče is connected to the Borja mountain. It starts east of the Blatnica stream, and extends all the way to the Bosna River, where it ends in the area between Žepče and Želeća. The serpentine complex is particularly developed in the Papratnica area, immediately next to the proposed route and on its left side between 7.0 and 8.0 km of the route. This area is protected by the Decision of the Municipal Council Žepče."

The Spatial plan of the area of special features of significance for the Federation of BiH "Motorway on the Corridor Vc" also defines two zones that are in conflict with the motorway route:

1. Part of the Regional Nature Park "Crni Vrh". According to the planning documentation of the Maglaj and Tešanj municipalities, a small part of the Regional Nature Park "Crni Vrh" is included in the direct impact zone of the motorway. Since the motorway route on this section is mostly carried out as a tunnel profile, there will be no negative impacts on the protected area. The forests above the tunnel profile in the scope of the plan are treated as protected forests, mixed beech and fir forests (*Abieti - Fagetum illyricum*). The route is in conflict with the protected area in the chainage from km 13150.00 to km 14800.00 of Section I Karuše – Ozimica.

2. Kraljevo Brdo - protected zone of basophilic pine forest on serpentines (*Pinetum silvestris-nigrae serpentinicum*). The most significant impact is reflected in the disruption of vegetation and habitats of plant species and their communities that are characterized by high conservation values. The route is not in direct conflict with this protected zone, but passes at a distance greater than 400 m. The closest point of the route is at chainage km 16450.00 of section I.

3.11. CULTURAL AND HISTORICAL HERITAGE

In the area of the municipalities through which the motorway on the Corridor Vc, LOT 2, passes, the following assets are legally protected as national monuments by the Commission for Preservation of National Monuments of Bosnia and Herzegovina.

- Architectural ensemble - the Old Town of Tešanj in Tešanj, FBiH
- Architectural ensemble - the Vozuća Monastery in Vozuća, Zavidovići Municipality, FBiH
- Movable asset - plaque of Grand Judge Gradeša, property of the Zenica City Museum, FBiH
- Architectural ensemble - the Old Town of Vranduk in Vranduk, Zenica Municipality, FBiH,

There are no known and protected sites of cultural and historical heritage on the motorway route itself and its immediate vicinity.

3.12. HUNTING

With its data being largely managed by hunting clubs, hunting game stands out as a special segment within consideration of fauna composition. During preparation of the study, the data on hunting game were obtained from: Public Company ŠPD of Ze-Do Canton, "Borja" Teslić, "Jeleč" Žepče, "Klek" Zavidovići, "Zmajevac" Zenica.

The proposed route variant on LOT 2 will undoubtedly cause physical separation of populations of the said species, i.e. it will limit free migration of game. From field visits and according to the data available to hunting clubs in municipalities, the composition of hunting animals by sections is as follows:

Section 1 Karuše – Medakovo

At this section, the route variant includes habitats of small game. The species living in the area affected by the proposed variant, and which are important for hunting economy are primarily: hare (*Lepus europaeus Pallas*), grey partridge (*Perdix perdix L.*), pheasant (*Phasianus colchicus L.*), quail (*Coturnix coturnix L.*), and varous species of wetland birds (wild ducks and gees, coots etc.). Of large animals, these are roe deer (*Capreolus capreolus L.*) and wild boar (*Sus scrofa L.*). Of other game species, there are also stone marten (*Martes foina Erxleben*), fox (*Vulpes vulpes L.)* and badger (*Meles meles L.*)

Section 2 Medakovo - Ozimica

On this part of the planned motorway, there are small game habitats.

Section 4 Poprikuše – Nemila

In addition to small game, sporadic occurrences of large game are registered in this part: roe deer and wild boar.

Section 5 Nemila – Donja Gračanica

Dominant in this section are habitats of large game, which is also the most numerous in this area. Wild boar and roe deer are especially common here. Small game is also represented here, but with fewer individuals (hare, pheasant and partridge)

Section 6 Donja Gračanica – Drivuša

Habitats of large game are registered. The most common species are: roe deer, wild boar, slightly less commonly wolf, and exceptionally also bear. Crossings over communications are frequent, roe deer and wild boar, also wolf, regardless of the fact that they are not frequently observed (which is understandable). Of small game, there are badger, fox, marten and wild cat, and hare.

3.13. INFRASTRUCTURE

3.13.1. Water management infrastructure

Water supply system and water infrastructure

The motorway route has met all set criteria, by avoiding route design through the areas of planned water reservoirs, as is the case with the planned reservoir of Toplice and the water protection area of the Tešanj and Maglaj municipalities. The level reference line of the route is also aligned with the maximum backwater levels of the planned hydropower facilities on the Bosna River. In addition, attention was paid to the impact of the motorway on the primary facilities of the urban water supply systems of Zenica and Žepče. The route is aligned with the locations of reservoirs and treatment plants of these urban systems. The passage of the motorway route through rural areas, in which a large number of smaller individual and rural water supply systems exist, can be marked as conflict points. This primarily concerns the areas of the Maglaj and Kiseljak municipalities. The problem of route passing over lower-capacity water supply pipelines is registered in these areas, indicating the need to apply certain technical solutions for relocating these pipelines through grade-separated passages intended for relocation of local roads.

The current state of water supply and wastewater disposal systems

The existing water infrastructure systems are identified, by significance in the following order:

- Primary facilities and network of the urban water supply system of the city of Zenica.
- Primary facilities and network of the urban water supply system of the town of Žepče.
- Water supply system of settlements in the contact area of the Žepče and Maglaj municipalities.
- Identification of spatial scopes important for protection of water resources in the contact area of the Maglaj and Tešanj municipalities.
- Identification of primary facilities of the Tešanjka water supply system.

The conducted identification of water management facilities and systems established two main groups:

- The first group consists of facilities and systems whose location definition is primary in relation to the adopted motorway route. Consequently, in horizontal or vertical terms, the adopted route had to bypass the locations of this group. It consists primarily of existing and planned water reservoirs and significant water sources with established protection zones, as well as existing primary water supply facilities. Based on all the information so far, these locations are avoided through project documentation.
- The second group consists of facilities and systems, whose horizontal and vertical position is important in terms of its relocation or reconstruction. This groups includes smaller rural water supply systems, and pipelines of larger water supply systems. Designers shall find adequate technical solutions as part of development of designs in order to avoid damaging them and to avoid interrupting water supply to population during construction and operation of the facilities.

3.13.2. Electric power supply

Power supply facilities, high voltage substations and distribution transmission lines are present. The existing high-voltage power transmission lines 400 kV, 220 kV, 110 kV and 35 kV intersect the motorway corridor area at several places.

- Power transmission line 400 kV Tuzla – Banja Luka
- Power transmission line 35kV TS Jelah – TS Matuzići Doboj South
- Power transmission line 110 kV from TS Misurići Maglaj to TS Bukva
- Power transmission lines 35 kV Zavidovići – Žepče – Maglaj and Maglaj – Zenica
- Power transmission line 110 kV TS 220 kV Zenica 2 - TS 110 kV Zenica 1
- Power transmission lines 220 kV for Tuzla and Kakanj
- Power transmission line 110 kV Zenica 2 – Cementara, Zenica 2 – TS Sjever

3.13.3. Gas transport

In the observed area of municipalities through which the motorway route passes, there is an installed gas pipeline through the area of Kakanj and Zenica municipalities. In a length of 54 km in the area of Kakanj Municipality, the main gas pipeline Semizovac - Kakanj - Zenica passes close to existing main road M-17 (on the right side in the direction of Zenica) and near the settlements of Karaula and Donji Kakanj crosses to the right bank of the Bosna River. and over the Mioč saddle passes to the area of the Municipality of Zenica, that is, to the settlement of Perin Han.

3.13.4. Telecommunications

The analysed area uses the services of two separate fixed and mobile telephony systems: HT Mostar and BH Telekom. A part of the observed area is covered by the Eronet network. Within the more immediate influence area of the motorway corridor route, BH Telekom has the following base stations in operation: Tešanjka, Jablanica, Novi Šeher, Ozimica. Multiple conflict points between the lines and the motorway route require smaller-scale reconstructions, which can be reduced to local reconstructions and protection at the points of intersection with the motorway, which also applies to all other telecommunication lines.

3.14. IMPACT BY ROADSIDE SERVICE FACILITIES

Along the motorway there will also be supporting facilities, such as:

- toll gates,
- roadside service facilities,
- traffic maintenance and control centres.

On motorways, toll is collected and controlled at toll gates located at motorway entry and exit points. At an entry point, the user is given a toll ticket which is presented to the cashier at one of the exists, where toll is paid according to the vehicle type and motorway distance used. There is also the option of using a prepaid magnetic card, which helps avoid stopping and restarting the vehicle, thus reducing time and energy loss. The number of lanes and toll gates is determined by the traffic flow rate at the toll gate site. Toll collection is performed under canopies in control booths located next to traffic lanes. The central control of individual toll gates is located in the central building together with staff support facilities.

There are four types of roadside service facilities (rest areas):

- Type A – parking area + public toilette + petrol station + restaurant + motel
- Type B – parking area + public toilette + petrol station + restaurant
- Type C – parking area + public toilette + petrol station
- Type D – parking area + public toilette

Traffic safety control for each individual section is performed from the complex of maintenance and control facilities. The complex consists of:

- Safety control facility
- Motorway maintenance facility
- Storage of gritting materials (salt)
- Petrol station
- Power block

The safety control facility is the central building of the complex staffed 24 hours a day. In addition to the video surveillance rooms, this facility also houses motorway emergency response units (ambulance and fire service), workshops, restaurant, changing rooms, and other support facilities.

The motorway maintenance facility integrates the location of road maintenance equipment and vehicles, and repair and maintenance workshops. The storage of road gritting salt is a semi-closed facility made of materials resistant to the aggressive effects of stored salt, with a container for de-icing liquids and a storage area with access gate for goods vehicles.

Petrol station with car wash is intended for internal use for motorway maintenance vehicles. In terms of fire control, the power block is separated and consists of a boiler room and a workshop, generator and UPS rooms, and transformer substation with power cells.

A common characteristic of these facilities is the presence of people, employees and passengers, which results in the generation of municipal waste and sewage.

4. DESCRIPTION OF THE NATURE AND QUANTITIES OF EXPECTED EMISSIONS FROM PLANTS AND FACILITIES INTO THE ENVIRONMENT (AIR, WATER, SOIL) AND IDENTIFICATION OF SIGNIFICANT ENVIRONMENTAL IMPACTS

4.1. EMISSIONS RESULTING FROM PROJECT IMPLEMENTATION

4.1.1. Estimation of emissions during road construction

The most intensive environmental impacts are expected during construction of the road, but these impacts are short-term, i.e. their duration is limited by the duration of the works.

In this respect, during the execution of the works, emission of dust into the air will result from the movement of work machines and transport vehicles, excavation and movement of large earth masses during construction of cuts and embankments, which can have adverse effects on the surrounding vegetation, population and workers. Also, emissions into the air are possible due to the traffic and operation of transport and construction vehicles, as well as rising of dust when handling raw materials, emissions of smoke and particulate matters and exhaust gases as products of combustion of motor fuel, and placement of asphalt mass on the road route leading to the emission of volatile organic compounds (VOC), which have a significant percentage of polycyclic aromatic hydrocarbons (PAHs) in their composition.

Exhaust gases of diesel engines mainly contain oxides of carbon, nitrogen and sulphur, unburnt hydrocarbons and soot particles. Air pollution results from the operation of construction and transport machines, which, bearing in mind the subject location, is more significant by parameters of suspended solids than by exhaust gases (NOx, CO, SO2 etc.) due to the proximity of major roads as well as the dust generated by trucks and other machinery on the construction site. Considering the ability of the dust to settle, it is possible to expect sedimentation of larger particles of dust (> 50 microns) at distances of up to 50 m and finer particles (up to 20 microns) up to 200 m, and even 500 m (10 microns), or up to 800 m (<10 microns). These harmful impacts should be prevented by proper handling of construction machinery, using machines in good technical order, and filling the fuel only at the location dedicated for that.

These site activities inevitably create an increased level of noise and vibration in the work area, which can adversely affect locals and construction site workers. This influence is inevitable, but it is local and short.

In addition, road construction involves excavation of large quantities of inert (earth) waste, which needs to be adequately disposed of. In addition to inert and construction waste, production and municipal waste is also expected because of the movement and stay of workers on the construction site. This waste will be transported to the locations that will be agreed with representatives of the local unit.

Emissions into soil and groundwater include substances such as lubricants, fuels and oils from transport and construction machinery, and various hazardous liquid substances due to improper handling or damage, then untreated wastewater from the construction site and road that can contaminate soil and groundwater by leaking. Also, improper disposal of waste on green and other surfaces during road construction can contaminate the surrounding soil and groundwater. Besides, a more significant impact is also the physical loss of land (removal of surface layer), especially of forest land due to road construction, and destruction of land and creation of erosive surfaces. It is the obligation of the Contractor to remediate the affected land and reinstate it.

In the process of excavation, filling and construction of road, during the execution of works near the banks and in the riverbed itself, there will also be turbidity of the water as a result of washing out of fine fractions of soil with clouding of surface flow. For these reasons, it is necessary to plan protection measures when handling various machine oils and lubricants, petroleum derivatives as well as collection of oils and lubricants with prevention of any risk to the river and its banks. There will not be any uncontrolled wastewater emissions during construction if the contractors comply with all measures defined by the project, while respecting good construction practices.

4.1.2. Estimation of emissions during road operation

Water draining from pavement surfaces contains a number of harmful substances in concentrations that are often above maximum allowable for discharge into watercourses. These are primarily fuel components such as hydrocarbons, organic and inorganic carbon, nitrogen compounds (nitrates, ammonia). The so-called heavy metals such as lead (additive to fuels), cadmium, copper, zinc, mercury, iron and nickel represent a special group of elements. Solid substances of different structure and characteristics that occur in the form of settlable, suspended or dissolved particles also represent a significant part. It is also possible to register substances that result from the use of specific corrosion protection materials. A special group of highly carcinogenic materials are polyaromatic hydrocarbons (benzopyrenes), which are the product of incomplete combustion of fuels and used motor oil. Particular attention is given to the immediate vicinity of rivers, as well as the planned bridges over the rivers, which further indicates the possibility of pollution of the water of these rivers.

Considering that guidelines for motorway design define the need for controlled drainage of rainwater from traffic surfaces and its treatment in grease traps, these impacts should be eliminated.

Quality of air in the environment largely depends on the distance of the point at which the air is observed from the pollution source, as well as on air flows and configuration of the terrain. It can generally be said for an approximately level configuration of terrain that concentrations of pollutants decrease relatively fast with distance from the source due to the process of diffusion of pollutants in the air, which causes dilution of the concentration. The air space along the motorway is loaded with a continuous line source of pollution consisting of harmful gases and particles from burnt motor fuel and raised dust of already sedimented harmful substances. However, considering the modernization of motor fleet in the future and significant restrictions in terms of quality of exhaust gases, decrease in pollutant concentrations should be expected regardless of the increase in load.

A number of harmful substances in concentrations that may be significant in terms of possible consequences are present in the soil immediately next to the road. These are primarily fuel components such as hydrocarbons, organic and inorganic carbon, nitrogen (nitrates, nitrites, ammonia), and the already mentioned so-called heavy metals. Traces of these elements can be registered even at larger distances from the road axis and in terms of environmental issues they can represent a particular problem. This fact is primarily determined from the data that heavy metals from the soil are directly absorbed into agricultural crops and through their use they are deposited in animal and human organisms.

Considering that the road passes near major receptors (wider urban area of settlements), the impact of noise can be significant also in the stage of road operation.

4.2. IDENTIFICATION OF ENVIRONMENTAL IMPACTS OF THE PROJECT

Construction of road infrastructure in any case means a change and interruption of established natural or cultural flows, and represents a major project in the environment with long-term consequences. Success of any solution aimed at protecting the environment involves fully analysing and defining all the categories of negative impacts. In this sense, the priority is always given to the obligation to define negative impacts in relation to the basic natural factors: climate, water, air, soil, flora, fauna, landscape, which represent a fully arranged and self-regulating mechanism, viewed from the prism of the ecosystem theory. All the processes within the elements of this complex system are based on the dependence of each other, whether organic or inorganic elements are involved, in which sense any plant and technological process with its specific characteristics in certain circumstances can lead to disturbances of the mutual relations.

Potential negative environmental impacts of project implementation are usually determined and evaluated within two stages: the stage of construction works and the stage of operation of the facility. However, before these two stages, there is also the pre-construction stage, which involves the time of planning and design of the infrastructure corridor. In this period, no significant actions take place in the field that would lead to disruption of environmental characteristics of the space. Mandatory geological and hydrogeological surveys carried out at this project stage are short and are unlikely to have a negative impact on the environment. However, selection and design of project solutions at this stage can have a lasting impact on the area through which the road passes. In the design stage, it is necessary to ensure that design solutions do not cause permanent and harmful consequences during construction works. Infrastructure corridors always, without exception, disrupt the harmony and integrity of landscape because they pass through large areas.

The largest negative environmental impacts occur during construction of the motorway, however, their temporal and spatial character is mainly limited. The most significant permanent negative environmental impacts can be defined through the use of land in the form of land expropriation, and the impact of the motorway as a barrier in space, visual change of space, etc. The impacts that are directly related to motorway construction involve temporary dispossessing of land and removal of vegetation for placement of equipment and machinery, periodical and final storage of earth material, emissions of polluting substances and increased noise level during the execution of works, etc. Impacts in the operation period can be defined as the impacts resulting from traffic flow and motorway maintenance, such as emissions of exhaust gases and dust, emissions of noise, wastewater running off the road and containing pollutants, etc. During motorway operation, adverse impacts are expected to be lower than in the construction stage. Positive effects reflected in improvement of social and economic benefits, resulting from improvement of traffic conditions in general and better spatial connection, are also expected in this stage.

Although with low probability of occurrence, significant environmental impacts both in the construction stage and in the stage of motorway operation can be caused by incidental (accidental) pollutions that cannot be predicted either spatially or temporally. Accidental pollutions are usually caused by explosions, fires, then pollutions resulting from improper handling of vehicles and machinery, as well as spilling of oil and lubricants on the surrounding ground, in the event of damage to goods vehicles in the motorway operation stage, and accidents caused by the human factor (fatigue and negligence of drivers, etc.) and force majeure (lightning strike, extremely adverse weather conditions). Such impacts can cause major and serious consequences of a regional character.

Descriptions of the possible negative impacts of construction on certain environmental elements in the following stages are given below:

- Construction stage and
- Motorway use (operation) stage.

The observed impact corridor is 250 m on both sides from the axis of the adopted motorway route on Corridor Vc.

4.2.1. Social impacts

4.2.1.1. Population and settlements

In construction stage

The almost complete mechanization of motorway construction causes great noise and vibration in the work area, but also in prefabrication areas (crushing and separating plants, concrete plants, asphalt plants) and on roads where vehicles move; significant emissions of pollutants into the air (CO, sulphur, soot, CO2) and dust being raised during work and movement of machinery and vehicles occur concurrently. The local population is directly exposed to these impacts. A particular problem and risk for the population can be the application of blasting for excavation in rock material - especially in open space (on the route, in quarries-borrow pits) and to a lesser extent in tunnels. In addition to the danger of life, there are intense but short effects of vibration, noise and emission of harmful substances - products of explosion and large amounts of rock dust. The seismic action of explosion can have a special effect.

Certain residential buildings, parts of settlements and sometimes entire settlements will be directly physically endangered by the execution of construction works (not only in the expropriation zone, but also in the area where construction roads / temporary roads pass), which may result in evacuation of population.

The occupation of space for the purpose of motorway construction will result in the partial or complete change of the traditional lines of movement of the local population (use of normal roads - pedestrian paths, field roads for agricultural machinery and roads for mixed traffic), which will reduce the quality (usual rhythm) of life.

A particular risk is the proximity or overlapping of the traditional routes of the local population and the construction routes of contractors, due to interference and disturbance, conflict and increased probability of accidents.

Since works on some parts are carried out near or even immediately next to the existing major (main and regional) roads, there is a high risk to normal traffic flow and danger to traffic participants, but also to contractors.

The economic power of the local population becomes weaker through the loss of land, or interruption of economic activity through agriculture, cattle breeding and forestry.

Obstacles created by motorway construction lead to an increase in travel time from place of residence to place of work, shop, school, health and other services.

There is also a possibility of spreading contagious diseases, socially deviant behaviour, immoral lifestyle, thefts etc. by the employees of contractor towards the local population.

In possible accidents, the lives of employees, local population (but also of animals) are seriously jeopardized.

In operation stage

Impacts in the operation stage are defined as:

- Increased emissions of noise and harmful substances into the air on the structures in the immediate vicinity of the motorway, and the risks of accidents can have a negative impact on the nearby population and the environment.
- The use of the motorway will have a direct impact in terms of change of the established social patterns in the case of passing near populated places. Traditional systems and functions of settlements, as well as communication among residents in certain parts of the route will be disrupted and interrupted. Alternative routes for local traffic may

become longer after the construction of the motorway, which has a direct impact on the business operations and non-motorized traffic. Whether urban or rural areas are involved, efforts should be made to maintain existing traffic flows.
- Normal connections between villages and land properties can be cut off and separated in rural areas, so that care should be taken to ensure free flow of traffic by constructing overpasses or underpasses.

The construction and operation of the planned motorway will provide economic, social and health benefits to the population and local community in the area. Experiences of similar projects show that the project will also have numerous positive effects on the society by creating conditions for raising the standard of population in almost all fields (education, health care, additional employment).

In case of unemployment and poverty in the project area, labour resources will not be reduced. If those employed for the project are from the group of unemployed or if employment has a positive effect on unemployment, then the project creates social benefits due to reduced social welfare or support to the unemployed. This is the case in the project for construction and subsequent operation of the motorway in question.

The following social benefits will result from additional employment:

- Increase in the number of jobs during implementation of the investment (temporary effect);
- New jobs as a result of the economic development resulting from implementation of the investment, or from operation of the motorway.

Reduction of developmental disparities between regions

Project impact on the reduction of developmental disparities between regions results mostly from the expansion of access to technical infrastructure. Activities completed in the scope of the project have a positive impact on increasing investments throughout the region. Two aspects are of key importance for reducing the difference in the level of development between regions:

- Construction of infrastructure is a basic element for the development in the region and residents consider it a requirement. Lack of infrastructure leads to degradation in the region and the departure of people to more developed areas.
- Another element in reducing developmental disparities between regions is concerned with the close link between infrastructure and adequate communication of the population. The project enables business development in the field of traditional organic production and cattle breeding services, as well as opportunities to make use of tourism potentials. Poor road infrastructure has caused great damage and represents a major obstacle to the development of the area. This discourages potential investors from development activities in the areas lacking basic infrastructure.

Other social effects

The most significant social effect of the project implementation is the normalization of life in the observed region. This effect is reflected through:

- Reducing the trend of population moving from villages to urban areas;
- Settlement of new population in prospective rural areas;
- Avoided business losses due to continuous production/services;
- Recreational benefits:
- Development of tourism.

4.2.2. Impact on microclimate

In construction stage

The change of microclimate in the zone and during the works is not particularly observable, except with respect to increased air warming and emissions of pollutants into the air, which leads to the effect of a 'cloudy' atmosphere and consequences in the form of higher air temperatures.

In operation stage

The microclimate of individual areas in Bosnia and Herzegovina is very complex. This observation also concerns particular areas along the motorway route. Although the route mostly passes through the river valley, the microclimate of individual valleys, river mouths and canyons is substantially different. That is why the impact on microclimate is complex.

The impact on temperature is reflected in increase in temperature of asphalt surface, which normally absorbs sun rays well so that the temperatures of both the surface and environment increase (in the immediate area). This causes a decrease in the value of the relative humidity in the area and evapotranspiration. As a result, very often under conditions of high temperature above the road, there is a typical air shimmering that creates a mirage effect, which can affect visibility while driving.

Increased heating also leads to vertical flow of air above the road, which in principle can affect even the precipitation regime, as well as the increased occurrence of local air turbulence. In addition to temperature effects, this phenomenon is certainly also influenced by the shape and distribution of individual structures on the motorway (tunnels, viaducts, larger structures along the road and the like).

Essentially, these effects are reduced to the narrow area around the motorway itself.

4.2.3. Impact on waters

Construction of the motorway causes changes in the environment along the route in varying degrees, depending on the method of construction and operation. Some impacts on waters can be avoided at the design stage, by appropriate design solutions such as external and internal drainage, watercourse crossings by bridge structures, providing that the openings are adequate for flow of established high waters, and providing sufficient freeboard between the high water level and the lower bridge structure. watercourse training, landscaping of buffer zone, and by designing traffic barriers along the route at sites marked as vulnerable and sensitive from the aspect of water resources. Negative impacts on the quality of groundwater and surface water can be avoided by proper construction site organization and implementation of prevention measures during construction and during the operation stage by maintaining the constructed facilities for internal drainage and treating wastewater from roads.

Contamination in case of accidents poses a risk, especially of those involving heavy vehicles transporting hazardous cargoes (traffic accidents, breakdowns), due to temporal and spatial unpredictability.

Specific environmental impacts can be expected at the points of conflict of sensitive areas with the motorway - aquifers and banks of watercourses along which the motorway is designed and/or which are intersected by the motorway, and surface water phenomena (water sources) within and without the water supply system. Chapter **3.6. Hydrographic characteristics** provides a description of the conflict locations of watercourses with the planned motorway route, by sections.

In construction stage

The most intense impacts on waters are expected at this stage, especially at the intersections of the planned motorway route and watercourses, as well as in areas where the route is located next to watercourse banks. This particularly concerns the locations of junctions which are situated near watercourses, where large-scale works are expected. In all these sites along the motorway, construction works can particularly cause turbidity of surface watercourses, but also their filling up and pollution with various harmful substances.

Descriptions of possible negative impacts of construction on waters are given below:

- Backfilling/filling up watercourse beds with construction material due to negligence of the contractor can cause silting of the bed, water contamination, increase in water level in the upstream part or even complete filling of the bed with stone material.
- Execution of construction works like blasting in rock massif, excavation, destruction and stripping of topsoil, disposal of material, etc. can lead to disturbance or cutting of natural groundwater recharge routes. In the same way, occurrence of soil pollution is also possible, and such turbid or otherwise polluted water can easily infiltrate underground;
- Contamination of the surrounding soil, banks and water surfaces due to uncontrolled/accidental leakage of fuels, lubricants and oils from construction machinery or vehicles because of their faulty operation or negligence of workers, due to improper filling of fuels and improper disposal of wastewater from the construction site may lead to groundwater pollution;
- Dumping different waste from the technological process or construction complex (liquids, particles and solid waste) on the banks or directly into beds of rivers can lead to water pollution and propagation of pollution along the course;
- Discharging used water (technological and hygienic) into water courses, or into the soil can lead to diffusion of hazardous pollutants and biological agents;
- Changing the hydrological regime in marshes and ponds in the wider motorway area threatens the complex ecosystem.

In operation stage

Negative impacts on waters can be expected in the following cases:

- Pollution of surface water and groundwater by discharging untreated water that flows from the road;
- impacts due to the occurrence of incident situations in the form of fire, explosion or damage to the wastewater collection system and discharge of polluted water to the soil/waters;
- impacts in the event of technical failures on contaminated water collection and drainage systems and irregular and/or inadequate maintenance of the road and stormwater drainage systems;
- in case of accident of a goods vehicle transporting larger quantities of environmentally harmful and hazardous substances, when there is an impact load, which spreads to much greater distances than in normal use of the road, in case of penetration underground. Such accidents usually happen in poor weather conditions, which further complicates the intervention. Due to their temporal and spatial unpredictability, such situations pose the greatest threat to groundwater and water sources,
- in case of accidents caused by human factor (driver fatigue, careless driving), which can cause the vehicle to skid off and overturn, petroleum and petroleum products and other

harmful substances to spill into the environment, which may result in environmental accidents of a larger scale.

4.2.4. Impact on air

In construction stage

During execution of construction works, the quality of air in the subject area will inevitably be disrupted. During construction, disruption of air quality will result from:

- impact of exhaust gases from trucks and machinery that will be used in the construction of the motorway,
- impact of particulate matters (dust) that will be raised from the construction site, transport roads during passage of trucks and machinery,
- impact of particulate matters from temporary stone aggregate stockpiles.

Quantification of these impacts will depend primarily on the dynamics of works, or on the numbers of machines and trucks that will be used in construction of the motorway. Increased impact on air quality is expected in those parts of the motorway where larger structures, planned as integral parts of the motorway, will be constructed (tunnels, viaducts).

Application of blasting for excavation in rock material - especially in open space (on the route, in quarries - borrow pits) and to a smaller extent in tunnels, causes emission of harmful substances - explosion products (CO2, oxides, acids) and large amounts of stone dust.

Table 13: Overview of potential quantities of motor fuel and lubricants by sections11

SECTION:	Consumption of fuel and lubricants:
KARUŠE - MEDAKOVO	2.300.000 kg diesel fuel; 69.000 kg oil and lubricants
MEDAKOVO - OZIMICA	7.240.000 kg diesel fuel; 218.000 kg oil and lubricants
OZIMICA - POPRIKUŠE	3.884.000 kg diesel fuel; 117.000 kg oil and lubricants
POPRIKUŠE - NEMILA	2.320.000 kg diesel fuel; 70.000 kg oil and lubricants
NEMILA – D.GRAČANICA	3.460.000 kg diesel fuel; 104.000 kg oil and lubricants
D.GRAČANICA - DRIVUŠA	1.990.000 kg diesel fuel; 60.000 kg oil and lubricants

Table 14: Quantities of pollutants during operation of machinery12

		Bulldozer	Excavator	Loader	Truck	TOTAL, kg/year
Number of work days per year		140	140	140	239	
Number of work hours per day		6.5	6.5	6.5	3	
Number of work hours in a year		910	910	910	717	
Engine power, hp		200	200	200	200	
Fuel consumption, kg/hp per hour		0.23	0.23	0.23	0.23	
Fuel consumption, kg/year		41860	41860	41860	32982	
						298461
Calculation of pollutants	kg/kg of fuel					
NOx	0.05280	2210.2	2210.2	2210.2	1741.4	15758.4
SO_2	0.00057	23.9	23.9	23.9	18.8	169.8
Total particulate matters	0.00103	43.1	43.1	43.1	34.0	307.2
CO	0.01379	577.2	577.2	577.2	454.8	4115.4
CO_2	3.15000	131859	131859	131859	103893	940151
Hydrocarbons	0.00172	72.2	72.2	72.2	56.9	514.4

In operation stage

During operation of the motorway, the quality of air along the motorway will be deteriorated due to the continuous pollution consisting of waste gases and particulates of burnt motor fuel and raised dust of harmful substances already deposited on the pavement. This impact is expected in the immediate vicinity of the motorway, and this impact weakens with distance away from the motorway.

The past analyses of waste gases resulting from the operation of car engines show the presence of even several hundred harmful organic and inorganic components. For most of them, sufficiently acceptable laws that could describe their occurrence are still unknown, and not all of them are equally harmful to the environment. In this respect, all analyses related to the issue of air pollution today are based on several indicators for which numerical data can be obtained with acceptable accuracy.

Earlier, it was believed that *carbon monoxide (CO)* is the only representative of air pollutants, but today it is not so. Namely, in addition to carbon monoxide, it is considered very important to include in these analyses nitrogen oxides, sulphur oxides, hydrocarbons, lead and soot particles. The increase in the number of diesel engines has particularly increased the significance of nitrogen oxides, which is also emphasized by the shift to unleaded petrol. Studies have also shown that nitrogen oxides, considering the allowable values, are often closer to or above the limit than it was the case with carbon monoxide. As a result of all this, the following are adopted as relevant air pollution components for the analyses within the scope of this study research: carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO2), sulphur dioxide (SO2), hydrocarbons (CxHy), lead (Pb) and soot particles (CC).

Any analysis related to negative impact of air pollutants must, in principle, cover the wide range of current knowledge related to this issue, for the simple reason that largely inconsistent views on the character of the negative impacts are still present, and it is only in this way that a reliable view of still open questions in this area can be obtained. In this sense, the knowledge describing the character of these impacts can be systematized today primarily with regard to humans, animals, plants and materials. Bearing in mind the character of the motorway that is the subject of this research as well as the character of the spatial units in its impact zone, it was considered necessary to define the impacts of individual pollutants in more detail. In the context of these facts, it is necessary before all to point out that today there is a very small number of studies that integrally address the negative interactions of individual air pollutants. Existing experience shows that in principle these impacts are summed up, but that the increased impacts (synergism) are equally possible and that the neutralization of individual impacts is present.

Nitrogen oxides - The effects of nitrogen monoxide on humans are similar to the effects of carbon monoxide; namely, oxygen is forced out of blood, which jeopardizes the tissue supply. High concentrations of nitrogen monoxide in blood cause death. However, the concentrations of nitrogen monoxide occurring in the atmosphere are hardly harmful, but their significance as an air pollutant is important primarily due to the formation of nitrogen dioxide (NO2), which is more toxic and especially harmful for respiratory organs. The limit values that are legally prescribed are also derived from these conclusions. The effects of nitrogen oxides on plants are manifested primarily through the effects of nitrogen dioxide. Its harmful effect is reflected primarily in the waxy appearance of leaves, necrosis and premature falling. Considering these impacts, it is presently considered in the world that all plant species are protected from the effects of nitrogen oxide for long-term concentrations of 0.03 mg/m3.

Hydrocarbons - The combustion process in car engine results in the occurrence of numerous hydrocarbons. Specific analyses of their effects are related primarily to five groups (paraffins, naphthenes, olefins and alkynes, aromatics, oxidized hydrocarbons). What characterizes their negative impact is certainly the fact that polycyclic aromatic hydrocarbons are attributed carcinogenic effects. The correlation between the presence of hydrocarbons in the air and the incidence of carcinogenic lung diseases has already been proven today. The effect of hydrocarbons on plants is quite complex and is reflected in a large number of problems. High concentrations cause necrosis of flowers and leaves and lower leaf loss and difficulties at flowering. Very sensitive plants also react at very low hydrocarbon concentrations. The impact of hydrocarbons on building materials is not reliably proven.

Sulphur dioxide - Considering the issue of sulphur dioxide as an air pollutant, it should be emphasized that traffic is only a minor cause of its occurrence. With regard to the effects of sulphur dioxide on humans, it should be noted that, when combined with fine dust, it has a pronounced harmful effect on mucous membranes (eyes) and respiratory tract. The effect of sulphur dioxide on the plant world is significant and is reflected primarily in the degradation of chlorophyll and withering away of certain tissues. Species of evergreen forests have shown to be particularly sensitive to sulphur dioxide, being damaged at concentrations as low as 0.05 mg/m3. Of all air pollutants, sulphur dioxide has the most pronounced effect on structures. Sulphur dioxide in combination with moisture acts as a sulfuric acid, and has a destructive effect on organic matter as a result. As these reactions can occur even at the lowest concentrations, it is certainly important to consider these phenomena related to historical and artistic value of particular structures. Any damage caused in this way increases with increasing temperature, humidity and light intensity. Functional dependencies that would correlate these phenomena do not exist yet, and in this sense, it is difficult to evaluate the negative consequences.

Lead and its compounds - Considering the issue of lead and its compounds, it is quite certain today that people consume through food much greater amounts of it than they receive through respiratory organs, i.e., from the atmosphere. Permanent exposure to lead contamination leads to chronic poisoning that primarily manifests as loss of appetite, stomach problems, fatigue, dizziness, kidney damage and fainting. However, the dilemma of acceptable limits of lead concentration in the atmosphere still remains. The result of these facts is also the "temporary" character of maximum allowable lead concentrations in some countries. In terms of vegetation, toxicity of lead is low. Concentrations of lead in plants are highly correlated with the content of lead in the soil. Otherwise the presence of lead in plants reduces their ability to grow and their enzyme activity. Lead toxicity to vegetation is low.

Three steps in the process of movement of pollutants (originating from traffic) in nature are:

I Emission, which depends on a number of different factors:

For individual vehicle:

- Engine type and power;
- Fuel type and composition;
- Combustion efficiency;
- Presence of emission control equipment;
- Driving mode

For total traffic:

- Number of vehicles;
- Structure of vehicles by type and age;
- Driving modes;
- Road characteristics.

II Dispersion, which depends on:

- Prevailing wind direction;
- Climate conditions;
- Roadside vegetation;

- Topography and
- Distance from the road.

III Reception means impact on human health, plant and animal life, and structures

Concentrations of pollutants along the route are dependent mainly on the quantity of emission (from traffic and from background sources), meteorological parameters and ground configuration.

The highest negative impact can be expected in the motorway sections which are designed in the immediate vicinity of settlements, especially if high traffic volume is expected, on sections designed on slopes or next to interchanges or tunnel portals. The *Rulebook on limit values of air quality (Official Gazette of the FBiH, no.12/05)* became effective in 2005. Among other things, this rulebook regulates limit values of air quality for the purpose of protecting people in the Federation of BiH. This Regulation was developed according to instructions of the European Commission and the World Health Organization (WHO). Article 4 of the Rulebook defines air quality as the concentration of pollutant in the air, expressed in micrograms per cubic metre, reduced to a temperature of 293 Kelvin and a pressure of 101.3 kPa.

According to provisions of Article 5 of the Rulebook, air quality samples (during period of monitoring random statistical value) are determined with at least two parameters:

1. annual average - arithmetic mean of air quality at a given location of properly taken samples throughout the year, which represents a parameter of long-term action and total exposure of the receptor to air mixed with pollutants; and
2. statistical parameter that represents high concentrations during the year and is a parameter of short-term action of high pollutant concentrations that can cause acute impact on health.

The air quality limit values for protection of human health are considered to be met if the prescribed limits given in the following table are met:

Table 15: Limit air quality values in FBiH - for the purpose of protecting human health13

Pollutant	Sampling period	Average annual value (µg/m3)	High value (µg/m3)
SO2	1 hour	90	500 a)
SO2	24 hours	90	240 b)
NO2	1 hour	60	300 c)
NO2	24 hours	60	140 b)
PM 10	24 hours	50	100 b)
UPM	24 hours	150	350 b)
Smoke	24 hours	30	60 b)
CO	8 hours		10000
O3	8 hours		150 d)

a) Must not be exceeded more then 24 times in a calendar year.
b) Must not be exceeded more then 7 times in a calendar year. (98th percentile).
c) Must not be exceeded more then 18 times in a calendar year.
d) Must not be exceeded more then 21 times in a calendar year.

4.2.5. Impact on soil and agricultural land

The following is an overview of the facts relevant to understanding the impact of motorway construction on land as an agricultural resource. This review was taken from the 2007 study and is supplemented by comments that are important for a better understanding of this matter. The overview is treated for each section separately and includes soil types present on the particular section, their land capability classification within the 500 m strip (indirect impact zone) and 50 m zone (direct impact zone), land use categories, agricultural land use categories and their classification to a particular agro-zone. The tables presenting these topics are given at the end of this chapter.

Section Karuše-Medakovo

Overview of soil types established for this section is given in Table 14.

This table clearly shows that on the observed section fluvisol is most dominant, with a total of 104.3 ha, or 52.3%, vertisol has the least participation, with 4.5 ha, or 2.4%. The total percentage of fluvisol, luvisol and vertisol (92.4%) suggests that this section is very rich in soils of higher agricultural value, which is confirmed by the data on soil capability classes at this location, as well as on agro-zone to which these soils are classified. An overview of land capability classes for the corridor route strip 500 m in width (indirect impact zone) and 50 m in width (direct impact zone) is given in tables 15 and 16.

Capability class II is most dominant, with 52.6 ha or 45.5%, part of the classes III and IV b is also high, while class IVa land has the smallest occurrence, 0.6 ha or 0.5%. The total part of the most valuable capability classes (II-IV) is 97.8% here, which is at the same time the part of the exclusive agricultural area that will be affected by the planned works in varying degrees.

On the entire route, the land capability class II is most dominant, 10.6 ha or 70.7%, followed by lands of capability class III, making together a high 84.0%, land of capability class IVa is least present, 0.3 ha or 2.0%. The total part of the most valuable agricultural land classes (capability class II-IV) that will be directly affected by the planned works is a high 94% on this section.

Agricultural lands are most dominant with 115.5 ha, that is 21.6%, river courses are least present, which also means high expected impact of construction on soil as the basis of agricultural production.

On this section, in the structure of agricultural land, the most prevalent is arable land, a total of 111.5 ha or 96.4%, orchards are least present, 0.7 ha or 0.6%. This data indicates that agricultural areas in the designed space are mostly being intensely used as arable land.

The agro-zone I soils have the largest part on this section with 112.4 ha or 97.3%, participation of agro-zone II is almost invisible.

These data indicate that the expected loss of land in the area where construction of the Vc Corridor route is designed is significant and manifests itself in all aspects. Land of the best types, the highest-quality capability classes, the best use structure and the most favourable agro-zones will physically disappear where the motorway route is built. An additional difficulty here is that the percentage of loss by these criteria is very high. On the parts of agricultural land that are saved from physical disappearance, long-term exposure to contamination and erosion processes, as well as other adverse impacts, can be expected with certainty. As a kind of mitigating circumstance in this connection, it is important to stress that the total areas where direct physical losses of soil are expected as a result of road construction are relatively small.

According to the available data, on this section the route should not deviate from the one treated by the 2007 Study, so that no additional losses are anticipated in relation to those expected, or in relation to the data treated in this overview.

Medakovo – Ozimica

Overview of soil types on this section is given in Table 14.

On this section the most predominant is luvisol with 311.9 ha. The total percentage of cambisol, luvisol and fluvisol as agriculturally significant types of land is 83.1%, which is indicative of the significant agricultural value of the land on this section and this corresponds to the percentages of high-quality capability classes in the total agricultural land in this area (Table 14).

Most land is the capability class II 226.4 ha or 40.8%, the part of the land capability class III is also high, 142.0 ha or 25.6%. These two categories make 66.4%, and together with the capability class III and IV lands they make 89.4% of all land on this section, which is an indication that this zone is a valuable area in terms of agricultural production potential. The capability class VII is least present, 1.3 ha or 0.2%.

Most land here is from capability class II, 40.7 ha or 63.7%, followed by the capability class III land, together making a high 85.3% of all agricultural land on this section. There is a total of 95% of land of the most valuable classes (II-IV) as compared to all present capability classes. The capability class V land is least present, 0.2 ha or 0.3%. The fact that this is a zone of high-quality capability classes also corresponds to agricultural land uses, where arable land makes the largest part in the total structure of agricultural land.

Arable land is most dominant, 519.0 h or 93.5%, pastures are least present, 0.4ha or 0.1%, which suggests that, in agricultural terms, this area is intensely used for tillage and cultivation.

These characteristics of the area are also closely correlated with the distribution of land by agro-zones.

On this section, land of agro-zone I is dominant, 496.1 ha or 89.4%. Agro-zone II is also significantly represented. This is a high-quality area, important in terms of agricultural production, and it will be significantly affected by physical losses that will result from the road construction.

On this section, the deviation of the route from the one analysed in the 2007 Study concerns only the Crni Vrh tunnel area, so no additional losses are anticipated in relation to those expected, or in relation to the data treated in this overview.

Section Ozimica - Poprikuše

The presence of individual soil types on this section can be seen from Table 14.

Distric kambisols with 285.8 ha or 42.5% are most dominant on this section, while vertisols with 3.2 ha or 0.5% are least present. There is also a significant share of eutric cambisols, which together with distric cambisol make up a total of 80.6% of all soil types determined by surveys. Table 14 provides an overview of the land capability classes for a 500 m wide strip, or for the indirect impact zone.

IVb class land is most dominant, 57.1 ha or 38.4%, the share of capability class II and III land is also high, and they together account for 43.1% of all land in this area. There is a total 91% of land of more valuable categories that are subject to protection under the Law on Agricultural Land, which means that agriculturally valuable land is the primary land here and it is most endangered. The capability class VIII takes the smallest part, 0.4 ha or 0.3%.

Table 14 gives an overview of the distribution of land capability classes in the 50 m zone, or the direct influence zone.

Most land on this section, 6.0 ha or 38.2% is in capability class IVb, there is also plenty of capability class III and IV b land, and the capability class VIII land is least present, 0.1 ha or 0.6%. An important fact here is that the common part of the class II and III land is 42.7%, which is almost identical to the values obtained for the 500 m strip. This indicates that this is a rather valuable agricultural zone, which will be destroyed by the road construction.

Table 17 provides an overview of the distribution of different land classes in the zone planned for construction of section 3, Table 18 provides an overview of parts of individual agricultural land use categories within the total agricultural areas.

Other lands are most dominant on this section, with a total of 357.8 ha or 51.7, while river flows are least present.

Arable land is most dominant with 122.7 ha or 82.3%, pastures are least present, 0.4 ha or 0.1%. These values are an additional confirmation of the agricultural quality of this area, which is also emphasized by the data for the parts of individual agro-zones presented in Table 18.

Agro-zone I land occupies convincingly the largest part on this section, closely followed by agro-zone II soils.

As compared to the route planned by the 2007 study document, a certain deviation is planned in the area of this section, as shown in Chapter 2 Description of the Project.

It is clear that a big impact on agricultural land in this area was expected by the original route designed in 2007. Change of the route in the new variant will certainly have an additional impact that should be quantified by analysing the GIS data from the agropedological database for this area.

Section Poprikuše – Nemila

Overview of soil types present on this section is given in Table 14.

Distric cambisol with 278.0 ha, or 77.1%, dominates on this section, and ranker is least present with 10.4 ha, or 2.9%. Fluvisols, which are an important agricultural resource, are relatively abundant here. The terrain configuration is such that better soils are concentrated only in the valley of Bosna. These soils are influenced by the river, which makes their use difficult, but they are still exceptionally valuable in terms of production.

Table 19 gives an overview of land capability classes in the area intended for construction of this section for a 500 m wide strip.

Most land is in the capability class II, 16.6 or 30.1%, there is also a quite high part of the capability class III land. These two categories make up 52.9% of all agricultural land in the area of this section, representing a high percentage and being related to the soils in the river valley (fluvisol). The total part of the most valuable and legally protected agricultural lands (class II-IV) is a high 75.2% here and it is an indication of a valuable resource that will cease to be available for agricultural use by the construction. The land of capability class VI has the lowest occurrence, 2.0 ha or 3.6%. Table 17 provides an overview of parts of capability classes in the 50 m wide strip, or in the direct impact zone.

On the entire route, the capability class VII land is the most dominant, 1.6 ha or 30.8%, while the capability class III land has the lowest presence, 0.2 ha or 3.8%. There is plenty of land within the capability class II and IV b.

It is important to note that, of the total areas on this section, the soils belonging to the first four capability classes account for 55.7%, which is also the percentage of the expected physical loss of agricultural land that enjoy special protection under the Law on Agricultural Land. The only comforting fact here is that physically there are totally only a few hectares of land that is subject of this analysis.

The following tables provide an overview of land classes, agricultural land categories and the shares of individual agro-zones (Tables 15, 16 and 17).

Other lands are most dominant with 189.0 ha, and river courses least with 6.5 %. The terrain configuration on this section has obviously influenced this distribution of land uses, so that the part of agricultural in total land is relatively small here.

In terms of the structure of agricultural land uses, the most dominant are meadows, with a total of 19.8 ha or 35.9%, pastures are least present with 2.0ha or 3.5%. It is interesting that, although the part of capability classes II and III in agricultural land is high, most of these areas are not intensively used, or as arable land, but these are mostly meadows, which most probably has to do with certain disadvantages of the hydrological regime.

The designed route on this section deviates to a certain extent from the one elaborated in the 2007 Study.

Section Nemila – Donja Gračanica

On section 5 Distric cambisol with 300.4 ha, or 52.8%, is most prevalent, and lithosol, is least present with 21.7 ha, or 3.8%. The configuration of the terrain influenced the development of soils, where the part of less valuable types is largest from the viewpoint of more intensive agriculture, with the concentration of the most valuable lands being in river valleys.

The configuration of the terrain in combination with other land formation and development factors also had a strong influence on the distribution of capability classes on this location, which can be clearly seen from the data in Table 21.

Most land is the capability class VI land, 50.3 ha or 41.7%, there is also plenty of class IV b land, and the capability class VIII land is least present, 0.8 ha or 0.7%.

The total part of very valuable land of the capability class II and III is 13.7%, and they account for a total of 40.4% together with class IV soils. This is important, because the configuration of the terrain is unfavourable for development of higher-quality soils and these areas are located in flatter parts of the area planned for the section, in river valleys.

The capability class VI is most present, with 7.7 ha or 55.8%, capability class II is least present, 0.1 ha or 0.7%. There is also a significant part of the capability class IV b land, which can be found in flatter zones along the river course. These lands together make up 30.4% of all soils in the area of this section. This information is an important indication of the trend of loss of the most valuable agricultural areas, which are also in the most favourable locations. This fact is not so discouraging taking into account that the absolute values of the losses are quite small, but it is unfavourable that due to their proximity to the continuously operating road, the remaining areas will not be suitable for food production, regardless of the quality of the location and properties of the soils present on it.

What is stated for the types of land and capabilities related to the configuration of the terrain is also corroborated by the data on land use categories, where the share of other soils is largest (Table 15).

In the categories of agricultural land use, arable land (Table 18), is dominant, making up a total of 84.9 ha, or 70.4%, and barren land takes the smallest part, 0.8 ha, or 0.6%.

Although the part of agricultural land is relatively small at the site planned for construction of the road section, data on the use structure indicate that it is being intensively used in cultivation of arable crops. Since the part of high-quality soils is low here, the part of agro-zone I in the total values for this category of data is also smaller (Table 18).

In the area of this subsection there is also a change of the original route from 2007, which runs closer to the Bosna River in the new version.

In its new version, the designed route on this subsection is moved towards the Bosna River, however, the character of the terrain here is such that the status of agricultural areas is not significantly changed, considering the fact that this terrain is mostly developed.

Section Gračanica – Drivuša

On this section, renzinas take the largest part, 198.2 ha, or 46.5%, and calcomelanosols take the smallest part with 1.9 ha, or 0.5 %, but the content of eutric cambisol and fluvisol is high, which makes this area valuable in terms of quality of agricultural land. This has an effect on the distribution of agricultural land capability classes, which can be seen in Table 15.

Most land is the capability class VI land, 50.3 ha or 41.7%, there is also plenty of class IV b land, and the capability class VIII land is least present, 0.8 ha or 0.7%. The total part of land of the highest-quality classes (II-IVb) is 40.4%, which means that this too is a valuable area in terms of agricultural production.

Agricultural land is most dominant on this section, with a total of 191.0 ha or 44.9%, river courses are least present, with 10.8 ha, or 2.6%. The largest expected loss on this section will be in the category of agricultural land.

Arable land is most dominant, 146.5 ha or 76.7%, barren land takes the smallest part, 0.5 ha or 0.3%. These values indicate a strong correlation with the above presented data, which is also in correlation with the part of agro-zone I (Table 14).

Most land here is from agro-zone II, 64.1 ha or 53.1%, followed by a high percentage of agro-zone I land.

The zones that will be affected to the largest extent by the loss of the most valuable agricultural land are not marked on the orthophoto of the area planned for construction of the section, considering that it is related to the part of the terrain where the tunnel will be built.

Real losses of agricultural land will occur in areas outside the tunnel. In the new version of the route there is some deviation from the original projection from 2007.

What is the expected loss and of what categories of agricultural land is the data that is important for this terrain and it can be obtained by processing GIS data obtained from the databases of the Institute of Agropedology.

Table 16: Types of soil present in the area of the observed sections14

	Karuše - Medakovo		Medakovo - Ozimica		Ozimica - Poprikuše		Poprikuše – Nemila		Nemila- Donja Gračanica		D. Gračanica - Drivuša	
Soil type	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Rendzina									79.2	14.0	193.2	46.5
Ranker					24.3	3.6	10.4	2.9	34.3	6.0	10.1	2.4
Calcocambisol	14.8	7.4	1.8	0.19							1.9	0.5
Vertisol	4.5	2.4	103.6	11.4	3.2	0.5						
Eutric cambisol			208.1	22.4	256.5	38.1			66.4	11.7	166.4	40.1
Distric cambisol			74.3	8.0	285.8	42.5	278.0	77.1	300.4	52.8		
Luvisol	75.9	38.0	311.9	33.6					21.7	3.8		
Pseudogley			52.6	5.7	41.3	6.1						
Fluvisol	104.3	52.3	177.3	19.1	61.4	9.2	72.0	20.0	66.5	11.7	43.8	10.5
Total	199.5	100	929.6	100.0	672.5	100.0	360.4	100.0	568.5	100.0	415.4	100.0

Table 17: Land capability classes for the 500 m strip, indirect impact zone15

	Karuše - Medakovo		Medakovo - Ozimica		Ozimica - Poprikuše		Poprikuše – Nemila		Nemila- D. Gračanica		D. Gračanica - Drivuša	
Land capability class	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
I					2.1	1.4						
II	52.6	45.5	226.4	40.8	28.4	19.1	16.6	30.1	14.6	12.1	14.6	12.1
III	27.1	23.5	142.0	25.6	35.7	24.0	12.6	22.8	2.0	1.6	2.0	1.6
IVa	0.6	0.5	13.3	2.4	12.1	8.1	4.7	8.6	8.4	6.9	8.4	6.9
IVb	32.1	27.8	114.4	20.6	57.1	38.4	7.4	13.5	23.9	19.8	23.9	19.8
V	3.1	2.7	47.8	8.6	10.4	7.0	4.3	7.8	13.7	11.4	13.7	11.4
VI			9.9	1.8	0.6	0.4	2.0	3.6	50.3	41.7	50.3	41.7
VII			1.3	0.2	2.0	1.3	7.6	13.8	7.0	5.8	7.0	5.8
VIII					0.4	0.3			0.8	0.7	0.8	0.7
Total	115.5	100.0	555.1	100.0	148.8	100.0	55.2	100.0	120.7	100.0	120.7	100.0

Table 18: Presence of agricultural land capability classes in the 50 m wide route corridor (direct impact zone).16

	Karuše - Medakovo		Medakovo - Ozimica		Ozimica - Poprikuše		Poprikuše – Nemila		Nemila- D. Gračanica		D. Gračanica - Drivuša	
Land capability class	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
II	10.6	70.7	40.7	63.7	3.2	20.4	1.0	19.2	0.1	0.7	3.5	15.3
III	2.0	13.3	13.8	21.6	3.5	22.3	0.2	3.8	0.2	1.4	2.6	11.0
IVa	0.3	2.0	1.8	2.8	0.8	5.1	0.4	7.7	0.3	2.2	0.5	2.2
IVb	1.2	8.0	4.4,	6.9	6.0	38.2	1.3	25.0	3.6	26.1	9.2	40.4
V	0.9	6.0	3.0	4.7	1.4	8.9	0.7	13.5	1.5	10.9	4.2	18.4
VI			0.2	0.3	0.7	4.5			7.7	55.8	2.3	10.1
VII					0.1	0.6	1.6	30.8	0.4	2.9	0.6	2.7
Total	15.0	100.0	63.9	100.0	15.7	100.0	5.2	100.0	13.8	100.0	22.9	100.0

Table 19: Land use categories17

	Karuše - Medakovo		Medakovo - Ozimica		Ozimica - Poprikuše		Poprikuše – Nemila		Nemila – D.Gračanica		D. Gračanica - Drivuša	
Land use category	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Agricultural	115.5	21.6	555.1	53.2	149.0	21.6	55.2	14.4	120.6	19.9	191.0	44.9
Forest	47.0	23.7	271.9	26.0	133.0	19.2	88.6	23.0	179.5	29.5	57.0	13.6
Developed	20.4	10.3	84.0	8.1	33.7	4.9	26.3	6.9	38.4	6.3	74.1	17.4
River courses	2.7	1.4	3.2	0.3	17.8	2.6	24.9	6.5	45.3	7.5	10.8	2.6
Other (tunnels)	12.4	6.3	130.3	12.5	357.8	51.7	189.0	29.2	223.4	36.8	91.6	21.5
Total	198.0	100	1044.5	100	691.4	100	384.0	100	384.0	100	425.4	100

Table 20: Agricultural land uses18

	Karuše - Medakovo		Medakovo - Ozimica		Ozimica - Poprikuše		Poprikuše – Nemila		Nemila – D.Gračanica		D. Gračanica - Drivuša	
Agricultural land use categories	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Arable land	111.5	96.5	519.0	93.5	122.7	82.3	19.8	35.9	84.9.	70.4	146.5	76.7
Orchards	0.7	0.6	2.2	0.4	2.2	0.4			6.6	5.5	23.2	12.1
Meadows	3.3	2.9	33.5	6.0	33.5	6.0	33.4	60.5	28.3	23.5	17.5	9.2
Pastures			0.4	0.1	0.4	0.1	2.0	3.6			3.3	1.7
Barren									0.8	0.6	0.5	0.3
Total	115.5	100.0	555.1	100.0	149.0	100.0	55.2	100.0	120.6	100.0	191.0	100.0

Table 21: Distribution of agro-zones19

	Karuše - Medakovo		Medakovo - Ozimica		Ozimica - Poprikuše		Poprikuše – Nemila		Nemila – D.Gračanica		D. Gračanica - Drivuša	
Agro-zone	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
I	112.4	97.3	496.1	89.4	135.5	91.0	41.3	75.0	48.7	40.4	48.7	40.4
II	3.1	2.7	57.7	10.4	11.1	7.4	6.3	11.3	64.1	53.1	64.1	53.1
III			1.3	0.2	2.4	1.6	7.6	13.7	7.8	6.5	7.8	6.5
Total	115.5	100.0	555.1	100.0	149.0	100.0	55.2	100.0	120.7	100.0	120.7	100.0

4.2.6. Impact on flora

In construction stage

The motorway route passes through a complex system of plant communities which form an integral whole with the surrounding area. Impacts that will be reflected on flora during construction of the motorway route will be manifested in the loss of wood mass, depletion of biological diversity, decrease in the number of flora elements, loss of habitats, as well as change of landscape characteristics of the area.

Impacts on flora will occur along the entire road route in full profile with the additional impact of the route during operation. In this part, the vegetation part and all stratal elements will be completely lost.

Impact on the vegetation component is expected along the entire route profile due to the formation of pavement lanes, due to construction of bridges, viaducts, tunnels, interchanges, RSF - roadside service facilities, access roads, construction and organization of construction sites, borrow pits, supporting facilities and stockpiles for disposal of excavated material.

Significant impact on flora will be manifested during construction in the immediate vicinity of the route where construction sites will be located, as well as in the part of access roads to the route itself, as well as by the location of other infrastructure facilities that will be constructed for the purpose of construction of the route and individual structures on it.

Table 22: Overview of losses of flora elements by individual sections20

SECTION	THE MOST SIGNIFICANT IMPACT ON FLORA
1 KARUŠE-MEDAKOVO	Construction site itself and work site in an area of 5 ha (forest vegetation) Access routes for construction of tunnels and bridges (forest vegetation, flood forests along the Tešanjka river courses, and cultivated pastures and plough fields)
2 MEDAKOVO - OZIMICA	Loss of forest vegetation for organization of construction and work sites in an area of approximately 12 ha. Impact on flora elements on access roads along settlements, landed properties, forest stands and riverbeds along the watercourses of the Trebačka River, Strupinski stream, Lješnica and their tributaries.
3 OZIMICA - POPRIKUŠE	Physical loss and endangerment of vegetation cover in an area of approximately 18 ha for organization of construction and work sites. Impact on forest communities, cultivated communities, meadow communities and flood forests along the river courses of the Bosna River and other (smaller) watercourses: Lukošnica, Bljuva, Ljubna, Papratnica.
4 POPRIKUŠE - NEMILA	Physical loss of vegetation cover in an area of approximately 12 ha. Young (undeveloped) forests will be affected in the areas of open motorway route (km 41.5-45). Impact on flood forests along the watercourses of the Bosna River including flora and fauna due to the works immediately in the bed of the river or on its banks; water pollution. Impact on vegetation along access and communication roads.
5 NEMILA – DONJA GRAČANICA	Endangering and physically destroying young coniferous and deciduous forests in the areas of open motorway route. Physical impact on vegetation cover along access roads, and along the Bosna River. During construction, watercourses will be polluted and the flora and fauna of the Bosna River and smaller tributaries will be destroyed.
6 DONJA GRAČANICA - DRIVUŠA	Physical loss and impact on forest communities and communities along river courses due to construction of tunnels, bridges, cuts, access roads. Construction of bridges will physically affect watercourses such as: Dobra Voda, Babina Rijeka, Stijenčica, Mrstava, Mutnica and Bosna River, with the threat of destroying living world by discharging harmful substances.

In operation stage

Impact on flora elements is expected along the route due to exhaust gases from cars. The negative impact of motorway traffic is felt in the zone of 50 - 100 m on both sides of the motorway.

The impact on the flora component during operation will be manifested in the rate of growth of the vegetation cover on reclaimed surfaces. From the aspect of growth rate, the total biodiversity will increase on reclaimed and rehabilitated surfaces (surfaces where machinery, manpower, borrow pits, material stockpiles were located, then cuts, tunnels, strip along river courses etc.).

4.2.7. Impact on fauna

In construction stage

Impacts on fauna will be manifested through direct and indirect impact.

- Direct impact implies the physical loss of particular species in space, whether it is an immediate death caused by works related to the route or a long-term loss caused by cumulative action.
- Indirect impact implies the impact on organisms and species that will be manifested by population decline, migration from the affected space. These impacts are caused by the intensity and manner of the works (increased noise from the operation of machinery and trucks, vibrations, physical pollution of the environment, reduction of natural food sources, loss of habitats, loss of spawning and nesting sites, etc.).

The impacts will affect all groups: birds, mammals, amphibians, reptiles, insects along the whole or part of the route.

Depending on the source of impact, some species like mammals (hunting game) will migrate to other areas/ hunting grounds or ecosystems that will not be affected by the corridor Vc route.

Impacts on birds will be reflected through loss of habitats, lack of food and loss of nesting habitats/ felled trees.

The impacts can be reflected in the decline of species abundance due to environmental change, spatial unmanageability to find food, lack of adequate nesting sites, exposure to predators, increased kills by hunters, etc., which can all lead to permanent loss of the species.

The biggest impacts are expected on large game animals (wild boar, roe deer, hare) that have inhabited the area controlled by hunting clubs. Works on the Corridor Vc route will affect the abundance of these species (decrease in abundance in one area and increase in another) which will require hunting clubs as concessionaires to conduct spring counts but also to revise their annual work/ operation plans.

The impact on salmonid and cyprinid fish species will be manifested through turbidity and pollution of watercourses and through temporary regulation of the riverbeds that will occur during construction of bridges, viaducts, stockpiles and construction and operation of access roads which are located along river courses on almost all sections.

The negative impact on fish species (salmonid and cyprinid species) is expected during construction of bridges, viaducts and training of river banks, resulting in turbidity and pollution of watercourses and change of riverbed and flow regime. These changes will result in loss of spawning habitats and change in seasonal daily migrations of fish species.

Impacts on amphibians and reptiles can be expected during construction of the construction site, construction of bridges, viaducts, cuts, development and operation of access roads, training of riverbeds, etc. which can lead to loss of habitats, physical loss to migration to other areas.

In operation stage

Possible impacts on fauna in the operation stage will be manifested by increased casualties on the route itself, whether of small or of large game animals, and of birds that are in constant or periodical migration along the corridor route.

Impacts on fish species, amphibians and reptiles are possible through pollution from storm and oily water from road surface and in case of accident situations.

4.2.8. Impact on landscape

In construction stage

During construction, the impact on landscape features is limited to the location where the works are performed, or the locations where construction sites are formed. Attention should be certainly paid here to future new borrow pits that will be opened if the capacity of existing borrow pits cannot meet the needs of the construction of such a large facility.

When performing construction works, the visual and aesthetic adverse effects are temporary in nature, and are related to the disruption of the harmonious landscape environment due to formation of excavations, embankments, stockpiles of excavated material, temporary construction site structures, stockpiles of stored materials and elements for installation, etc. However, when forming borrow pits, disruption of landscape features can assume a permanent character.

In operation stage

The motorway construction has the following negative impacts on landscape:

- reduction of existing green areas (landscapes)
- green areas cutting
- environmental pollutant load
- degradation of flora and fauna
- change of the visual image of the area.

4.2.9. Impact on protected parts of nature

In construction stage

One of the significant impacts for the protected area of serpentine complex near Žepče is erosion and falling, to which serpentines are susceptible. This process is especially emphasized on locations where forest is cleared, which will inevitably occur during the motorway construction. This is why large areas of skeletal soil, or exposed rock and rocky grounds, are often found at these sites. Plant species that are most important for serpentine flora develop on them. The motorway construction can additional jeopardize the rare plant species and communities growing in this area. The impacts on these natural landscapes are possible during construction due to increased concentration of exhaust gases and occurrence of acid rain, which would lead to degradation of forest vegetation.

In addition, impacts on protected parts of nature that are registered in the influence area of the planned route when carrying out construction works are possible due to:

- Removal of vegetation and soil layer as a consequence of the motorway construction;
- Degradation of land due to construction works and movement of heavy machinery;
- Deposition of dust that will be raised from the construction site and transport routes when trucks and machinery pass;
- Negative impact of exhaust gases from trucks and machinery on the physiology of plants near construction site.
- Also, during construction works on bridges, development of access roads along river courses and execution of works in riverbeds, the landscape view along river banks and river courses themselves may be disrupted.

In operation stage

The main impact on protected parts of nature through which the motorway passes or with which it is partly in conflict is that the construction and operation of the motorway will disrupt the basic elements because of which the particular natural asset is placed under protection. Therefore, it can be considered that the originality, representativeness, diversity, integrity and aesthetics of the area due to which it was declared a natural asset will be lost to some extent by construction of the motorway and its further operation

4.2.10. Impact on cultural and historical heritage

In construction stage

On the motorway route and in the observed scope of 250 metres from the route axis, there are no monuments protected by the Commission for Preservation of National Monuments, or other registered sites of cultural and historical heritage, so the impact on them can be considered insignificant.

But since the entire territory of Bosnia and Herzegovina has been inhabited since prehistoric times and there are numerous material remains from all historical periods, and since the route is being constructed on so far unexplored terrain, it is possible that chance material finds of movable or immovable heritage will occur, especially the when works are carried out in and near the riverbed of Bosna.

If chance archaeological finds are discovered in the construction stage, a professional protection service should be called in order to keep the found objects from being damaged or disregarded.

Also, indirect impacts on sites near the route related to noise and air pollution due to increased traffic can be applied to cultural and historical heritage sites, but these impacts are also considered insignificant if all the prescribed pollution protection measures are applied.

Indirect impact on structures in the immediate vicinity of cultural and historical heritage is also possible due to noise and vibration during construction site organization, transport and storage of materials, borrow pits and stockpiling of materials, unless protection measures are implemented when organizing works.

In operation stage

Impact on cultural and historical heritage structures during road operation is considered insignificant if the specified measures related to noise protection and environmental protection against pollution are adhered to.

4.2.11. Impact on hunting

In construction stage

Hunting is a general term that also includes activities aimed at ensuring optimal conditions for hunting, breeding and protection of game and preservation of habitat conditions. Hunting is an economic activity aimed at breeding, protecting and using game, developing and equipping hunting grounds and manner of using the space in accordance with the ecological balance and sustainable development principles.

Hunting is an activity of special social interest and importance serving the purpose of sustainable and rational hunt, with a specific treatment of wildlife and nature with hunting economy, protection and improvement of habitats and environment with elements of scientific research.

The impact of construction of the corridor Vc route on hunting as an economic activity will be manifested in decreasing incomes of hunting clubs from the sale of hunting licenses and hunting game shooting itself. Hunting clubs operating in the impact area of the VC corridor route are: "Borja" Teslić, "Jeleč" Žepče, "Klek" Zavidovići, "Zmajevac" Zenica.

During construction works, hunting clubs, the space and game will be directly affected by the execution of works which will adversely affect the condition, presence, abundance of game in the area primarily by being exposed to noise, vibration, presence of machinery, people and other elements that will negatively affect wildlife and hunting in general.

The decrease in game abundance is expected due to the migration of game inland, then fragmentation of habitats, increasing pressure of poachers and hunters on unprotected game.

The impact on birds and their presence and abundance in the area will be manifested through the cutting of vegetation, disruption and loss of habitats and nesting sites.

Letting alone and not disturbing game and birds during nesting is one of the main ecological factors to which birds and game respond by migrating or leaving these habitats.

In operation stage

During the operation stage, it is necessary to monitor the state of return, presence and migration corridors of certain game species in the space that was affected by the Corridor Vc route depending on the source of pollution/ impact - noise, vibration.

Based on the results of field monitoring, hunting clubs will adjust their annual plans and, in accordance with the structure of game and dynamics of their return, undertake adequate protection and improvement measures (determination of prohibition zones, determination of shooting quota, establishment of feeding sites and game shelters).

The monitoring will also include the status of bird species' returns and nesting in parts of reclaimed areas, but also along river courses that were affected by the works.

Bird deaths will be monitored along the entire Corridor Vc route and, in accordance with the established facts - deaths, propose adequate protection measures for individual species.

4.2.12. Impact of noise and vibrations

In construction stage

The almost complete mechanization of motorway construction causes large noise and vibration in the work area, but also in prefabrication areas (crushing and separating plants, concrete plants, asphalt plants) and on roads where vehicles move. The sources of construction noise are the execution of construction works on construction sites (heavy construction machinery, possibly blasting at tunnel construction sites) as well as the noise caused by the traffic of construction machinery related to the execution of works.

Currently, there is no available information on the areas where works will be performed, on equipment and on schedule of works, so it is not possible to make predictions about the noise that will be emitted from the construction site or about its impact on residential communities.

Detailed concepts of construction works, including transport routes, are not available, so it is not possible to predict in detail the levels of traffic flow for these routes. However, as a general requirement of mitigation measures, contractors will be required to use modern equipment with noise silencers and also to adhere to their normal working hours during the day (exceptions may be applied e.g. for individual structures such as tunnels). However, it is best to use equipment that meets the requirements of European Directive 2000/14/EC related to the noise emissions produced by outdoor equipment; e.g. equipment identified by the EC declaration of conformity. it is necessary to limit operation of noisy equipment especially near populated areas as much as possible and/or use screens, e.g. by placing equipment behind natural sound barriers, piles, containers, and the like that can serve as protection, and by placing the equipment further away from settlements.

A particular problem is the application of blasting for excavation in rock material - especially in open space (on the route, in quarries-borrow pits) and to a lesser extent in tunnels, which result in intense but short vibration effects (seismic action of explosion may have a particular effect by transmitting the shock wave through the ground to the environment).

In operation stage

The noise caused by traffic on the roads affects the environment through which the road passes, contributes to the degradation of quality of living and disrupts wildlife. Exposure to noise reduces the quality of life, both psychologically and physiologically. Constant exposure to noise can cause nausea, creates communication problems and leads to increased stress and related impacts on human health. Noise can lead to weakening of the hearing organ with temporary and permanent hearing impairment, it interferes with sleeping, and can contribute to reduction in learning efficiency in children. Vibrations generated by traffic resonance can have harmful effects on structures near the road. This is very important when it comes to cultural and historical structures, which are not designed to withstand such impacts. Wildlife disturbance is caused by frightening of animals from crossing the road used by traffic. Therefore, roads become barriers to the regular migration of wild animals from one area to another

4.2.13. Impact on infrastructure

In construction stage

At places where power transmission lines intersect with the motorway, reconstructions on the power transmission lines may be needed in order to comply with prescribed safety and technical elements.

- Section 5. / Nemila – D. Gračanica /

Power transmission line 110 kV, which connects TS 220 kV Zenica 2 and TS 110 kV Zenica 1 intertwines with the motorway route. In this part the entire route of the power transmission line 110 kV will be realigned.

- Section 6. / D.Gračanica – Drivuša /

As indicated above, the power transmission line 110 kV between TS Zenica 2 and TS Zenica 1 overlaps with the motorway route, so its route will have to be aligned with the motorway route.

It will also be necessary to adjust outlets of the power transmission line 220 kV for Tuzla and Kakanj, then outlets of the power transmission lines 110 kV Zenica 2 - Cementara, Zenica 2 - TS North, going out of the transformer substation 220 kV Zenica 2 located in the settlement of Klopče, 150 metres from the motorway route.

In the settlement of Perin Han, there are two intersections of the power transmission line 110 kV, 35 kV with the motorway route, where the power transmission line route will have to be reconstructed.

In the area of Zenica Municipality (section Perin Han - Crkvica), the gas pipeline route is intertwined with the motorway route, so that the collision points between the gas pipeline and the motorway should be technically solved in this part.

The conflict with existing power facilities (transmission lines) must be resolved through the main design and eliminated through preliminary works.

There is a significant conflict with existing traffic routes of higher categories: main roads and railway line (double-track, electrified) which was solved already at the levels of conceptual designs, and in more detail in the stage of main design.

In operation stage

The planned motorway crosses the routes of existing and planned water supply system lines at several locations. Adequate technical solutions at all intersection points between the motorway route and the existing water supply infrastructure are given through preliminary designs and main designs for sections for which main designs have already been developed.

During the motorway construction stage, the planned works will be carried out according to the design that provides technical solutions at the places of conflict between the motorway route and the existing water supply infrastructure, in a way that eliminates the negative impact on it.

During the motorway operation, negative impacts on this infrastructure are not expected.

5. DESCRIPTION OF MEASURES TO MITIGATE ADVERSE ENVIRONMENTAL IMPACTS

5.1. GENERAL MEASURES TO MITIGATE ADVERSE ENVIRONMENTAL IMPACTS

Measures to mitigate and avoid adverse environmental impacts can be generally categorized as general, specific and technical measures.

General measures mean compliance with all relevant legal provisions in terms of protection of water, air, soil, plants and animals during all stages of implementation of a given intervention in the environment - from design and construction to operation. These measures are a legal obligation and compliance therewith is proved by the process of obtaining the prescribed permits, or in the process of planning and designing the facility, so the final result (environmental, water and operating permits) implies full compliance with national legal provisions.

General measures include:

- Obtaining the necessary approvals for development of the site in question by the competent office for spatial planning, construction and environmental affairs;
- Providing fair compensation for the structures and land that are found to be privately or socially owned, and that are located in the scope of motorway route;
- As part of the approvals issued by the competent municipal services and/or competent ministries, define the conditions according to which permanent control in terms of possible environmental impacts (monitoring) would be conducted during the execution of works;
- As part of the contractual documentation that the Investor signs with contractors, it is necessary to define the conditions by which all the prescribed protection measures should be met in the stage of construction works. The contractor shall develop the Construction Site Organization Plan (CSOP) and adhere thereto;
- Provide the instruments so that those entities that have the professional staff to fulfil the defined tasks in the domain of environmental protection are engaged in the implementation of activities in the field of road construction and maintenance.

Pursuant to the Regulation on construction site organization, obligatory documentation on the construction site and participants in construction (“Official Gazette of FBiH, nos. 48/09, 75/09 and 93/12”), prior to the commencement of works, the Contractor is obliged, in addition to the said Construction Site Organization Plan, (CSOP) and technological diagrams, also to develop the Safety at Work and Fire Protection Study and the Environmental Management Plan.

Measures for mitigation of negative environmental impacts should be conducted continuously in all project stages; from planning and preparation of the project to construction and operation.

The largest number of mitigation measures can be applied during the design stage, because in this stage they can be avoided - by moving the route where possible to avoid exceptionally valuable and sensitive areas, then by using architectural solutions that "blend" with the landscape, by designing physical noise barrier etc. These measures include:

- Planning and establishing new communications structures for settlements where traditional ways of communication are disrupted by the motorway construction. This can be carried out by passages, bridges, viaducts, overpasses. Check that the planned facilities are sufficient to remedy the disrupted communications and whether additional facilities are needed;

- Provide systematic and detailed information to the local population and interested public about the motorway route to make it possible for them to consider all dimensions of potential impacts and to participate in the decision-making process in a high-quality manner. Also, where necessary, organize public discussions in all areas through which the road will pass and with the participation of local leaders and designers answer all questions raised;
- Prepare project documentation that will be the basis for implementing the expropriation process in accordance with the applicable legislation, and make timely payments of compensations in accordance with the national law;
- As part of the Construction Site Organization Plan (CSOP), completely plan the construction site, places for disposal of construction and waste materials, parking places, fuel filling points, etc.;
- Finding a solution that will provide local population with access to plots and other areas located immediately next to the construction during construction of the motorway and support structures;
- When designing bridges, take maximum care of the bridge design in order to integrate it into the landscape in the best possible way. When designing bridge structure, to a maximum extent avoid solutions requiring high and massive elements, on the bridge itself and on the banks alike, and to a maximum extent possible avoid encroaching upon the riverbed itself or canyon sides. From the conceptual design stage onwards, include both an architect and a landscape architect as part of the design team;
- In addition to bridges, a design solution with an included system of measures for integration of the facilities in the environment, should also be developed for the areas of junctions, roadside service facilities, border crossing, toll gates, and TMCCs;
- Tunnel portals shall be designed not to protrude beyond the rock on any part, but to be a part of the rock both structurally and perceptively, and with stone lining of a similar colour as the rock;
- The design solution of roadside service facilities shall respect the surrounding natural space, both in architecture of the structure itself (minimum height of the structure, type of construction materials - use natural stone, colours and textures as much as possible), and in the open space next to the structures (use plant species from the composition of the local flora);
- On outer slopes of hills, wherever possible, design cuts instead of side cuts and embankments. Design side cuts and cuts at the steepest possible gradient, in order to minimize the width of encroachment into the existing terrain;
- Establish water and air quality baseline in the area affected by the project before construction commences in order to conduct monitoring in the further stages of project implementation;
- In parts where the motorway passes near residential buildings and populated areas, provide physical barriers that will protect the population from noise;
- Prior to construction, it is necessary to perform a survey and record any rare and endangered plant and animal communities (especially in the vicinity of river courses), and provide precautionary measures in accordance with expert guidance, in order to preserve these communities if any are registered;
- Prior to proceeding with construction of the motorway, carry out detailed archaeological surveys and develop a study on preliminary archaeological reconnaissance of the terrain, which will establish positions of registered sites and possible new sites that have not been registered so far, given that the route also partly passes through so far unexplored and inaccessible terrain, and establish their relationship with the planned motorway route.
- Develop project documentation in accordance with legal regulations, environmental permit, and with respect to all specific features of the area;

- Develop appropriate operational emergency response plans for any accident situations and procure the necessary equipment.
- As part of the main projects for individual sections, develop separate documents that will specify all points of conflict of the road with the existing infrastructure system: local roads and parts of the water and power supply networks, as well as solving of these points of conflict.

5.2. SPECIAL MEASURES TO MITIGATE ADVERSE ENVIRONMENTAL IMPACTS

5.2.1. Population

In construction stage

- Publicly announce daily traffic situation and provide information to the public on the scope and schedule of construction activities, expected difficulties and access restrictions.
- Minimize any negative impacts such as difficult access, increased levels of noise, vibration and dust, and presence of heavy machinery by adhering to specified measures;
- Restrict movement of heavy machinery during the motorway construction, in order to minimize the area of agricultural soil devastated by the works. To the maximum extent, use the existing network of roads, which should to be repaired upon completion of construction works;
- Use modern machines and vehicles with insulated noise sources (engines; exhaust system), which involves purchase of new machines or measures of installing additional sound insulation, as well as constantly maintaining the proper condition of the sound insulation. In addition, it is recommended to operate machinery only in the period from 7:00 to 18:00 (in all parts of the route which are less than 60 m away from the settlements).

In operation stage

- Population protection measures are implemented through noise, water, land and air protection measures.
- Measures for establishing new communication structures in settlements where traditional modes of communication are disrupted by the motorway will be realized through construction of passages, bridges, viaducts, overpasses.

5.2.2. Microclimate

Considering the complex climate in Bosnia and Herzegovina, as well as the lack of experience with this type of road and absence of appropriate measurements, it is recommended as soon as possible to introduce automatic monitoring of meteorological and air pollution parameters along the entire motorway route, in the preliminary phase, during motorway construction and during operation. On the stretch from Doboj to Tarčin, automatic meteorological stations should be installed at least 20 points on the route, of which at least 5 should be with measurements of all relevant meteorological parameters.

The above-mentioned negative impacts on microclimate can be considerably mitigated by planting green belt in the immediate motorway area.

5.2.3. Waters

Protection of waters should to be taken into consideration already in the project documentation development stage. In this respect, main designs for drainage of water from the motorway structure and related external water, with detailed hydrological and hydraulic calculations, as well as drawings of facilities for collection, transport and disposal thereof, must be developed for all motorway sections. The drainage design must contain at least the following:

- In principle, the facilities for treatment of wastewater from the motorway can be located within the areas defined as sensitive, but before finally selecting the location of the facilities, a detailed hydrogeological map of the more immediate area around the motorway should be consulted. Attention should be paid to ensure that the facilities are not located in aquifer areas where high groundwater levels are established in order to prevent disrupting the hydraulic regime of groundwater flows, disrupting aquifer recharge etc.
- At a minimum, the drainage design shall provide a closed drainage system, with oil and grease separator, and, where necessary, further treatment of water to achieve the water quality in accordance with the regulations;
- The structure of the planned motorway wastewater treatment facilities must guarantee watertightness, or, the wastewater must not be allowed to seep underground;
- Approaches to internal drainage facilities, or separators and lagoons, shall be solved in an efficient way with the possibility of access for vehicles (type tank-trucks for removal of wastewater).

In addition, for all sections of the motorway it is necessary:

- to develop the construction site organization and construction technology and dynamics project, and the main sewerage and stormwater drainage design for all support facilities on the parts of the motorway where they are planned;
- On all locations where the route crosses watercourses, or is located near stream banks, as well as near water sanitary protection zones, thermal water sources or aquifers, it is mandatory to design traffic barriers or concrete blocks (New Jersey) to physically prevent vehicles from rolling off the motorway.
- In the design stage, it is necessary to avoid all possible conflicts with existing water management facilities in the considered Corridor Vc area, and where it is not possible to avoid this conflict, it is necessary to provide adequate technical solutions at the locations where they overlap.
- The watercourse training project, which includes environmentally acceptable structures, that is, the criterion should be to avoid relocating the natural bed, or to design culverts through the motorway structures wherever conditions permit.
- Apply the principles of environmentally friendly practices when designing relocation of beds.

Administrative water protection measures

The set of administrative protection measures includes a number of activities related to the administrative regulation of some phenomena which, if not timely regulated, can cause some negative consequences that are very difficult to bring within acceptable limits. These water protection measures include the following activities:

- As part of the approvals issued by competent institutions (relevant ministries of water management), require permanent control to be carried out during the execution of the works in order to eliminate possible impacts on water;

- Within the contract documents that the Investor signs with the contractors, specifically require enforcement of water protection measures specified in the environmental impact study and implementation of water quality monitoring. In addition, in their activities contractors are required to comply with regulations governing water protection issues;
- Within tender documentation for construction works, require the tenderer to prove that in their company they have an environmental protection department that will ensure enforcement of environmental protection requirements that will be prescribed by the environmental permit.

Special water protection measures
In respect of all the conclusions reached in the impact analysis stage, primarily in terms of implementing adequate protection measures, it is necessary also to define certain actions that must be carried out during the facility operation stage. These measures include the following activities:

- At the level of the municipality or canton, it is necessary to organize and equip an appropriate emergency service, adequately equipped to ensure prompt repair of damage caused by accidents and to prevent large-scale accidents;
- The organization/ company/ body given the charge of managing the operation and maintenance of the motorway must have an Emergency Response Plan in case of accidents. The plan should contain at least the following elements:
    - In case of accidents with vehicles transporting harmful powdered or granular material, traffic should be stopped and a specialized service called to remove the hazardous material and rehabilitate the road surface. The dispersed powdered or granular material must be removed from the road service only by mechanical means (returning to appropriate new packaging, cleaning, vacuuming, etc.), without washing with water.
    - In case of accidents caused by vehicles transporting hazardous liquids, traffic shall be immediately stopped and teams specialized for rehabilitation of damage engaged. The spillage should be removed from road surface with special adsorbents. If the liquid came out of the profile and contaminated soil, rehabilitation is performed by removing soil. All materials collected in this way should be treated using special regeneration methods or should be disposed to sites intended for such materials.
- The planned motorway should be equipped with appropriate road markings and signs covering all types of the necessary prohibitions and information. Traffic signs and road markings should influence traffic participants transporting hazardous substances by reducing speed, prohibiting overtaking of trucks, increasing levels of attention, prohibiting vehicles from stopping on the road etc.

In construction stage

Measures in this stage include

- Special method of blasting in order not to disrupt groundwater flows on the stretches where the route passes near sensitive zones, or zones of unacceptable and high risk to groundwater;
- Tunnelling shall be carried out so as to avoid affecting the direction of groundwater flow and to prevent inflow into surface water;
- All excavation material that will not be immediately used in construction activities must be stockpiled in the designated locations in accordance with the construction site organization project (excess material stockpiles) protected from erosion, as well as

outside of the defined sensitive zones, or zones of unacceptable and high risk to groundwater;

- Vegetation cover shall be preserved to the maximum extent possible, i.e. buffer zones made of plant cover shall be left between the road and water bodies.
- In the vicinity of watercourses, use only clean material for embankment, such as gravel, without earth or other impurities.
- Disposal should not be made in the riverbed and along watercourse banks, or in the sanitary protection zones as well as in the zones identified as aquifers. In case that these sites are found to be on a water domain and public water domain, it is necessary to request water management approval.
- Surfaces sensitive to erosion shall be protected by stabilizing agents and erosion-preventing plants.
- Conduct frequent and controlled disposal of municipal and hazardous waste in the prescribed manner, or prohibit any temporary or permanent disposal of waste material on the surrounding soil, except at the places designated for that purpose by the Construction Site Organization Project, and provide watertight waste containers. At the same time, disciplinary action shall be taken against violators of the established rules of conduct. During the construction, it may be expected that contractors will find registered or unregistered (illegal) dumps of different waste at several places. Depending on the type of waste, all these sites shall be rehabilitated according to specific projects;
- Used water from construction site shall be collected by safe drainage systems, collected in appropriate tanks and treated in the prescribed manner (whether on site or on a remote location) before being discharged into watercourses. On construction sites, it is mandatory to install ecological toilets to be used by workers;
- Machinery storage and servicing areas shall be protected by an impermeable base, outside the zones defined as the zones of unacceptable and high risk to groundwater. Oily rainwater from these areas shall be collected and treated in grit trap and oil and grease separator before being discharged into the recipient;
- Repair of machinery and replacement of oil shall be prohibited in the zones of high risk to groundwater;
- River flow shall be maintained at all times. If access to river channel is required, measures should be taken to divert the water flow past the works;
- Contractors should be prepared for flash floods and sudden rises in water level, and should secure all works (including embankments under construction, formwork, steel, etc.) so that the works are not disrupted by flood flows.
- All construction site areas and other temporary impact zones shall be rehabilitated in accordance with the Rehabilitation Plan, i.e. reinstated depending on the future land use.
- Separate water management requirements shall be requested for the locations of construction site bases, services, asphalt plants, borrow pits and other facilities.
- In case of harmful impacts on water sources used for water supply, in the shortest possible period provide an alternative water supply for the population in the affected area.

In operation stage

- All rainwater from the pavement in the immediate zone of watercourses and in water source protection zones shall be drained by a closed drainage system and treated in the grease and oil interceptor before being discharged into the recipient. The separator shall be designed according to the reference precipitation and characteristics of the sludge being treated. Only treated water shall be discharged into the final recipient in accordance with the applicable legal regulations;

- Regular maintenance of the road rainwater drainage system and facilities. Frequency of extraction and removal of sludge and oil from the grease and oil separator shall be determined during operation. Emptying of the separator shall be organized through the company in charge of road maintenance;
- Erosion control shall be implemented using stabilization means and erosion preventing plants;
- Road de-icing agents (salt, ice-melting chemicals) will be selectively applied at optimal rates and times, following weather forecast and avoiding any excessive application;
- Develop an Emergency Response Plan in case of accidents as defined in the Special Water Protection Measures;
- Within the organizations managing the motorway operation and maintenance, establish an environmental protection service that will perform the following tasks:
    - Monitor and control all actions in the field of environmental protection,
    - Monitor the functioning of the drainage system and regularly monitor the treated discharged water from the treatment facilities,
    - Organize the execution of self-monitoring programmes,
    - Store and analyse data obtained from measurements, take the necessary action in case of exceeding emissions,
    - Send monitoring reports to the competent authorities and inform the public about the state of the environment,
    - Educate employees on the necessary environmental protection measures,
    - Develop an environmental management plan.

5.2.4. Air

In construction stage

- Construction site, places of borrow pit of materials, temporary roads and handling areas shall be dampened during warm, dry and windy weather conditions in order to prevent dust from being raised.
- Transport of gravel, asphalt, stone and earth material and similar materials shall be carried out with tarpaulin covered trucks.
- When blasting for excavations in rock massif, choose the type of explosive that has the least harmful environmental impact. For the use of blasting boreholes use drills with dust collection in plastic bags.
- Install soot separating filters on exhaust pipes of all machines and vehicles with diesel engines;
- Use machinery in good technical order and perform regular maintenance of construction machines, turning them off when not in use;
- With regular (planning periodic) and extraordinary technical inspections of machines and vehicles, ensure maximum proper order and functionality of the motor fuel combustion system, and use (and regularly control) fuel with guaranteed quality standard.

In operation stage

- In case the allowable air quality values are exceeded, act in accordance with legal regulations, or plan additional protection measures.

5.2.5. Soil

In construction stage

Construction of the corridor results in direct, physical destruction of agricultural land, thus permanently losing it from agricultural use. In addition, erosion processes, destruction of the structure and compaction of soil are anticipated to occur within the degradation processes, which will also be accompanied by temporary soil losses through the formation of stockpiles of waste material, establishment of construction sites, construction of access roads, contamination of soil by spilling oil, fuel and lubricants. and blocking access to agricultural plots.

Permanent loss of agricultural land will occur through construction of the road infrastructure and all support facilities. This is the group of activities that most adversely affects the future perspective of agricultural land use. This is not pronounced to such an extent as in other destructive activities where soil is temporarily excluded from agricultural production (degradation and contamination of soil).

Preventive measures are all activities aimed at preventing adverse impacts on soil and agricultural crops. They are enforced by banning the use of leaded fuel, mandatory use of vehicles with catalytic converters, regulating movement speeds in zones of intensive agricultural production (agro-zone I), within the corridor prohibiting the cultivation of crops that accumulate toxic substances in edible parts of the plant. Cultivation of plants in the immediate corridor zone in the controlled conditions of glass and plastic greenhouses is a measure that can greatly reduce the negative effects of external pollutants, however, cultivation of agricultural crops for human and livestock consumption should be avoided in the immediate vicinity of the corridor even if it is done in this way;

In order to implement all preventive measures, it is necessary to regulate this area by introducing appropriate legal solutions and international standards. The action of inspection services to strictly monitor compliance with appropriate measures is also very important in all this, especially when the measures are carried out on the recommendations to be given by the Food Safety Agency.

Mitigation measures are implemented during the road construction stage with the aim of mitigating adverse impacts on soil and plants. They are carried out by removing, stockpiling and preserving the humus layer of soil, maintaining passability of roads and access to agricultural plots, remedying degraded soil, decontaminating contaminated soils and establishing vegetation protection belts.

Removing and stockpiling the fertile soil layer is an important measure to take, bearing in mind that it is almost impossible to avoid destruction of the first agro-zone soils. This is a standard measure normally recommended in books for agriculture students. It is important to take into account the practical aspects of the measure, since if the humus layer is only removed and stockpiled only as a matter of form and not used soon thereafter, this measure is useless as it entails the additional cost of storing and maintaining such material and the gradual loss of humus that it mineralizes or erodes over time and becomes useless.

Ensuring accessibility and passability of agricultural properties is one of the requirements that must be met in the motorway construction stage, which is accomplished by construction of bridges and appropriate passages.

During construction of the road, it will be necessary to carry out remediation of degraded land, thus achieving rehabilitation of erosive processes, preventing the occurrence of water pooling, rehabilitating the surfaces on which temporary structures were built, and where stockpiles for disposal of the stripped fertile soil layer and open borrow pits of filling materials were located.

In places where fuel, oil and lubricant were spilled, decontamination should be carried out by applying sawdust or some other material, where in the case of sawdust, after decontamination it is collected and burned under controlled conditions, and then the decontaminated soil layer is removed and stored to the designated place.

An important measure to be taken during construction of the road is the establishment of vegetation belts, which is especially important for protection of the remaining agricultural lands of capability classes II and III. The vegetation belt should be at least 2.5-3 m high.

In operation stage

During the period of motorway operation, there will be prolonged soil contamination and degradation effects, which is related to the occurrence of fuel combustion products, wear of tires, road surface, incident situations, and road maintenance in winter months.

One of the most important measures to be continuously conducted throughout the road operation period is soil and plant monitoring, which should start by establishing baseline and be operational from the first day of road operation. Conducting monitoring does not mean that in the period after the road construction there will be no need for the measures specified for the period of its construction.

Monitoring provides indication of concentrations of heavy metals, organic pollutants and salts and based on this a system of rehabilitation measures is developed. When circumstances require, rehabilitation measures are carried out in the zone 0-200 m to the right and left of the motorway, by conducting chemical, technical and phytomelioration works.

Prolonged motorway use will certainly lead to documented accumulation of heavy metals in soil and plants. Pollutants accumulated along the roads enter the animal food chain, and reach other ecosystems as animals migrate due to erosive processes. Gritting salt also adversely affects soil primarily by reducing its fertility through changes in reaction, salt concentrations, peptization of soil colloids, and destruction of structure, which ultimately drastically reduce soil fertility.

The impact of traffic and accompanying pollutants on land and the living world is cumulative, which is why it is important to establish baseline correctly and in a timely manner and to develop and implement monitoring of changes in space and time along the motorway route. This makes it easier to manage risk and take appropriate measures in incident situations, without improvisations and inadequate environmental management solutions.

5.2.1. Flora

In construction stage

Prior to construction, it is necessary to perform a survey and record any rare and endangered plant communities (especially in the vicinity of river courses), and provide precautionary measures in accordance with expert guidance, in order to preserve these communities if any are registered;

- Measures for conservation of flora elements will be implemented systematically with a previously developed plan of work and of implementation of environmental monitoring measures.

The necessary measures for the flora component by sections will be concerned with the following:

Section 1 KARUŠE – MEDAKOVO

SECTION 1	KARUŠE- MEDAKOVO

Location 1	Penavino hill and Matanovićevo hill
plant community	Communities of eastern hornbeam and pubescent oak
measure	All trees should be cut to standard length, cleared of all branches. All trees from which trunks or timber can be produced are considered suitable for market. A fire setting permit should be obtained in accordance with existing legal provisions. All cut trees, branches, and roots must be removed in accordance with existing legal provisions, rules and regulations. Preventing uncontrolled falling of material or intentional pushing of material down slope. Planting native species such as pubescent oak and eastern hornbeam during landscaping of the road belt (embankment slopes, channels).
Location 2	Riparian zone of the Tešanjka River along the entire route section.
plant community	Forest ecosystem communities of white willow
measure	Planting native species such as white willow, poplar, and black alder.
SECTION 2	MEDAKOVO - OZIMICA
Location 1	Penavino hill and Matanovićevo hill
plant community	Community of ecosystems of xerothermic forests of eastern hornbeam and pubescent oak
measure	All trees should be cut to standard length, cleared of all branches. All trees from which trunks or timber can be produced are considered suitable for market. A fire setting permit should be obtained in accordance with existing legal provisions. All cut trees, branches, and roots must be removed in accordance with existing legal provisions, rules and regulations. Preventing uncontrolled falling of material or intentional pushing of material down slope. Planting native species such as pubescent oak and eastern hornbeam during landscaping of the road belt (embankment slopes, channels).
Location 2	Šiljati Vrh (Sharp Peak) on the left side of the route and immediately next to it
plant community	Basophilic pine forests on serpentines
measure	Strict prohibition of excessive felling of trees. It is necessary to carefully plan, manage and perform monitoring of tourism operations in the protected area in order to ensure their long-term sustainability.
Location 3	Riparian zone of the Trebačka River The bank of Strupinska River between the villages of Čakrame and Ljubatovići
plant community	Forest ecosystem communities of white willow
measure	Planting native species such as white willow, poplar, and black alder
SECTION 3	OZIMICA - POPRIKUŠE
Location 1	Serpentine complex around Žepče
plant community	Xerophilic oak forests on serpentines forests of sessile oak with heath; Heaths; Vegetation of rocks and rocky grounds
measure	Identification and strict prohibition of destruction of protected flora, Prohibition of excessive felling of trees.
Location 2	Riparian zone of the Bosna River and its tributaries in the zone from Brezovo Polje to Golubinje Along the Bosna River and its tributaries in the zone between Brezovo Polje and Golubinje

plant community	Xerophilic oak forests on serpentines forests of sessile oak with heath, Heaths, Vegetation of rocks and rocky grounds
measure	Planting native species such as white willow, poplar, and black alder
SECTION 4	POPRIKUŠE – NEMILA
Location 1	Budakovac, Ravno hill and Golubinjska forest
plant community	The community of ecosystems of oak – hornbeam forests
measure	Planting native species such as wild cherry, Europen crab apple, European wild pear, wild service tree and common maple.
Location 2	Riparian zone of the Bosna River, between Točić Polje and Hrašće at the Ada site, site along the Bosna River, from Točić Polje to Hrašće
plant community	Forest ecosystem communities of white willow; Communities of ecosystems of hygrophilic forests and shrubs of alder
measure	Planting native species such as white willow, poplar, and black alder
SECTION 5	NEMILA – DONJA GRAČANICA
Location 1	Over the entire length of this section, on both sides of the proposed route
plant community	The community of ecosystems of oak – hornbeam forests
measure	Planting native species such as oak and hornbeam (wild cherry, European crab apple, European wild pear, wild service tree and common maple) All trees should be cut to standard length, cleared of all branches. All trees from which trunks or timber can be produced are considered suitable for market. A fire setting permit should be obtained in accordance with existing legal provisions. All cut trees, branches, and roots must be removed in accordance with existing legal provisions, rules and regulations.
Location 2	Over the entire length of this section along watercourses, on both sides of the proposed route
plant community	ecosystem of forests of white willow *Salicetum albae*; ecosystem of white and brittle willow *Salicetum albae-fragilis*; ecosystem of forests of willows and poplars *Salici – Populetum*; ecosystem of white and black poplar *Populetum nigro-albae*; ecosystem of forests of almond willow *Salicetum triandrae*; shrubs with purple willow *Salicetum purpureae*; forests of black alder and alder buckthorn *Frangulo alni- Alnetum glutinosae*; forests of black alder of continental area *Alnetum glutinosae montanum*; forests of black alder and sedges *Carici elongatae-Alnetum glutinosae*
measure	Planting native species such as white willow, poplar, and black alder.
SECTION 6	DONJA GRAČANICA - DRIVUŠA
Location 1	From the settlement of D. Gračanica, over Ričice, Kopila, Klopče, to Perin Han
Plant community	Ecosystem of xerothermic forests of eastern hornbeam and pubescent oak
Measure	Planting native species such as oak and hornbeam (wild cherry, European crab apple, European wild pear, wild service tree and common maple). All trees should be cut to standard length, cleared of all branches. All trees from which trunks or timber can be produced are considered suitable for market. A fire setting permit should be obtained in accordance with existing legal provisions. All cut trees,

	branches, and roots must be removed in accordance with existing legal provisions, rules and regulations.
Location 2	Riparian zone of the Bosna River and its tributaries
Plant community	Ecosystem of forests of white willow
Measure	Planting native species such as white willow, poplar, and black alder

- In the construction site building phase, establish the vegetation cover baseline and presence of individual flora elements.
- Monitoring of the condition and impact on the surrounding vegetation with special protection measures shall be specified as part the Construction Site Organization Plan (CSOP).
- Follow up the plans and progress of rehabilitation and reclamation of disrupted areas (work areas where machines, manpower, supporting facilities, access roads, cuts, viaducts, riverbeds, etc. are located).
- In part of construction work and construction site organization itself, integrate structures into the surrounding area, respecting and using autochthonous species.
- When forming the construction site and the area, observe floral characteristics (single trees or tree groups) that will not affect execution or organization of works.
- On outer slopes of hills, wherever possible, design cuts instead of side cuts and embankments. Design side cuts and cuts at the steepest possible gradient, in order to minimize the width of encroachment into the existing terrain.
- When performing works along river courses, keep existing vegetation where possible and leave trees where nests are built.

In operation stage

- Follow the implementation plan for reclamation of the areas disrupted by the works on the Corridor Vc route (construction sites, borrow pits, material stockpiling sites and other sites that have undergone significant changes in relation to the previous state).
- Monitor the rate of growth/ succession of vegetation cover on reclaimed areas.

5.2.1. Fauna

In construction stage

The planned activities in the construction stage of the motorway route on the Corridor Vc - Lot 2 should be carried out by observing the following measures:

- Felling of riparian forest vegetation should be carried out in the winter season to somehow reduce the additional negative impact on land and water fauna.
- Measures for protection of hunting game on many sections rich in hunting animals (Medakovo-Ozimica, Poprikuše-Nemila, Nemila - D.Gračanica, D.Gračanica-Drivuša) are facilitated by Investor's solution with numerous tunnels, viaducts, and bridges. For sections 2 and 3, or Medakovo - Ozimica and Ozimica - Poprikuše, crossings for animals have been made, ensuring undisturbed movement and migration of game from both old routes:
    - Section 2. Medakovo - Ozimica (km 4+000 to 24+901.587)
        - In 6+072.546 – 7+166.544 construction of a passage for animals, underpass or "green bridge";

        - In 17+465.017 – 18+304.836 km construction of a passage for animals
    - Section 3. Ozimica – Poprikuše (km 24+901.587 to 38+617.434)
        - In 25+240.114-26+000.00 km fence to prevent small game from entering the route.
- Establish monitoring with video cameras at animal crossing sites.
- It is necessary to build bird nesting boxes in the floodplain forest area and to monitor the daily, monthly and annual bird migration, as well as their distribution in the space.
- Part of the river bank of the Bosna River - backwaters, shall be arranged to be suitable for birds, amphibians and reptiles to stay.
- Leave fish migration passes when carrying out work on river banks and river beds.
- Continuously inform the local population and interested public (hunting, fishing clubs and nature conservation NGOs) about the motorway route to make it possible for them to consider all dimensions of the potential impact on fauna with high-quality participation in the decision-making process.
- Establish cooperation with hunting, fishing clubs and nature conservation NGOs in all areas through which the route will pass in order to timely indicate and take measures for protection of migratory corridors, animal crossings and passages, and spawning and game breeding sites.
- Inspection and review of ten-year and annual plans for the use of game and fish stocks shall be carried out by hunting and fishing clubs, and measures for protection, improvement and mitigation taken and planned accordingly (establishing prohibition of hunting and fishing of individual species, establish feeding sites for endangered birds and game species, construction of small bays, and fishing spots for sport fishermen).
- When carrying out works on or in the immediate vicinity of river courses, to a maximum extent consider reducing pollution of watercourses by solid waste, oily water, suspended particles from soil erosion, which can adversely affect the state of fish populations.
- Establish monitoring of river ecosystems and aquatic organisms.
- Establish monitoring of amphibians, reptiles and insects along sensitive ecosystems (forest ecosystems, cultivated areas, pastures, meadows, river banks and riverbeds). The monitoring would apply to the watercourses located on the route of planned motorway.
- Develop appropriate operational plans for monitoring and emergency response to possible accidents, and obtain the necessary equipment (cameras for monitoring game movements) and install it at the planned chainages.

In operation stage

- During operation, carry out video monitoring at the chainages where crossings for animals are left.
- Monitor the presence, return, and stay of game in the area - adaptation to noise of game affected by the route/ corridor.
- In accordance with annual obligations of hunting organizations, fishing clubs and non-governmental organizations, establish permanent monitoring of game (spring counts for hunting clubs, autumn and winter bird migrations along the corridor Vc route).
- Ensure the establishment of feeding sites that will keep or direct game to natural crossings.
- Identify potential nesting and feeding sites visited and inhabited by wetland birds.
- Monitor bird deaths during the route operation, and take appropriate mitigation measures in accordance with the results and in cooperation with the Motorway Administration.
- Visually mark glass wind protection.
- Monitor the condition of water quality, together with the state of fish populations, while providing safety for the corridor.

- According to fishing data, perform restocking of the Bosna river flow and of other river flows where the impact on fish species is registered.

5.2.2. Landscape

Major and significant environmental impacts can be avoided during the motorway planning and design stage, therefore at this stage it is necessary to take maximum care of the design of the route and supporting facilities.

When carrying out construction works, the basic measure for the protection of landscape features is to keep the works exclusively in the space specified by project documentation and to completely rehabilitate the terrain upon completion of the works in accordance with the reclamation and landscaping projects.

In construction stage

- Workplaces and structures should be planned and constructed so as to minimize disruption of the existing landscape features, and therefore the obligation of preserving the existing value of the landscape should be taken into account when planning stockpiles, borrow pits, temporary parking areas, etc.
- After completing construction works, the existing landscape should be reinstated as soon as possible.
- During construction, plan access roads to pass through the areas that do not require excavations and embankments so that it will be easier to rehabilitate them. If possible, plan to keep access roads that cannot be rehabilitated in operation after construction for the local population.
- When carrying out works on river banks and in riverbeds, work so as to leave migration passes for fish, and part of the work area along the riverbank should be arranged and reduced to a temporary separator/ catch basin to prevent pollution of the watercourses. In operation stage

In operation stage

- During operation, success of the self-vegetation process should be assessed and, where necessary, planned planting should be carried out.
- Establish a programme for monitoring reclaimed areas, and take mitigation / seedling replacement, replenishment, mowing, etc. measures accordingly.

5.2.3. Protected parts of nature

In construction stage

The measures to be taken in the construction stage would be related to systematic implementation of prescribed measures and monitoring of all environmental components.

In addition, existing vegetation, characterized by a high degree of biological diversity, should be preserved to the greatest extent possible. Construction site and construction activities as a whole must be organized in conformity with this fact.

In operation stage

They are implemented through the earlier described measures for mitigation of negative impacts on water, soil, air, landscape and plant and animal life. It is also necessary to monitor changes relative to baseline and to monitor the natural self-vegetation processes.

In protected areas it is necessary to monitor the condition of visitor loads, and in the protection segment it is necessary to plan, manage and monitor tourism operations very carefully to ensure their long-term sustainability. Tourism in a protected area depends on the preservation of ecosystem qualities. Otherwise, there will be negative impacts so that, instead of contributing to its preservation, tourism will impair the quality of the protected area.

Establish permanent environmental monitoring.

5.2.4. Cultural and historical heritage

In construction stage

- Develop a study on preliminary archaeological field reconnaissance and train workers on how to identify possible finds and how to handle archaeological remains, if found;
- Mandatory and continuous supervision of archaeologists and conservators in areas where preliminary surveys establish presence of cultural heritage sites and their constant consultative participation during the execution of the section;
- In case archaeological sites are encountered during construction, it is necessary immediately to stop the works and inform the competent cultural and historical heritage protection institutions or services, depending on the municipality where the site is located.
- In organization of construction site (access roads, borrow pit and storage of materials, storage of machinery, stockpile of materials) it is necessary to make sure to avoid cultural and historical heritage sites;
- Location of access roads, disposal of waste and deployment of heavy machinery shall be forbidden in areas in close proximity to known sites of cultural and historical heritage structures, as well as in areas where the possibility of physical damage or damage to archaeological finds is identified;
- Implementation of measures relating to noise and vibration protection and environmental protection.

In operation stage

- Implementation of other measures relating to noise and vibration protection and environmental protection.

5.2.5. Noise and vibrations

In the stage of construction works

- In the further stage of design, it is necessary to specify the locations and lengths of physical barriers that will protect population from noise in parts where the route passes through populated places or in their close proximity;
- Plan construction activities so as to avoid parallel activities of multiple equipment in the vicinity of receiver.
- On all construction machines and vehicles that are used in construction, it is mandatory to install sound protection (insulation) of engine and other assemblies that produce or contribute to development of noise;

- During execution of the works, keep the machinery (construction machines and vehicles) in proper operating order and use the same only when necessary. Equipment that is not being used at that time shall be shut off.
- Restrict the activities that potentially produce high noise (e.g. driving piles, blasting, and other activities) only to working hours during the day (7:00 to 19:00, Monday to Friday, and 7:00 to 13:00 on Saturdays) and avoid Sundays. Exceptions may be applied for e.g. individual structures such as tunnels;
- If blasting is used for excavations in rock massif, choose the type of explosive that has the least harmful environmental impact, use the technique of millisecond activation of explosive charges with directed action of explosion, in order to reduce the effect of superposition of dynamic impacts (vibration), noise and dust emission. Alternatively use an excavation technique using hydraulic hammers or mechanical excavation with milling machines, "moles" and the like;
- In case of exceeding the permitted values, provide workers with safety equipment at work and apply occupational safety regulations.

In operation stage

The purpose of noise protection is to reduce noise levels to an acceptable level prescribed by legal provisions, or to a level suitable for the use of the room, rather than to completely remove noise. Therefore, during road operation, it is necessary continuously to conduct noise measurements in accordance with control measurements specified in the monitoring programme, or based on complaints from population. Such monitoring will establish whether the measures taken are adequate (in case of built barriers), and in case of exceeding the noise levels, additional noise protection measures shall be provided in the form of additional noise protection barriers, traffic noise absorbing curtain, etc.

5.2.6. Infrastructure

In construction stage

- In places of conflict with the existing power facilities (power transmission lines), through preliminary works relocate the lines; or separate/ protect/ insulate the lines by technical measures;
- In places of conflict with existing high-category traffic facilities, main roads and railway lines (double-track, electrified), it is mandatory to carry out the necessary temporary protection structures that will separate the facilities from the construction work area; apply all prescribed traffic signs and markings and, where necessary, provide traffic police patrols;
- In the stage of preparation and construction of the road, carry out measures for protection of infrastructure facilities in places where the route is intersected, run in parallel, or only approached in some places, in accordance with special regulations and conditions;
- Develop a project of temporary traffic regulation during construction of the planned project. Through it, regulate access points to the existing traffic system and ensure that there are no potential conflict points with existing traffic system during construction of the planned project;
- Plan grade-separated crossing of existing roads at places where the construction area is intersected;
- At places where field and forest roads are intersected, provide a network of alternative roads that will provide access to all the plots that had access before construction of the planned project, the locations of which will be defined in the project development stage.

All crossings of field and forest roads over the route of the planned project must be grade-separated;
- Reinstate all existing roads and roads that are damaged due to the use of machinery and vehicles on construction of the planned road;
- In the next design stage, establish the exact position of water supply facilities (pipelines, tunnels, tanks etc.) which come into conflict with the adopted motorway route, and as part of the technical documentation solve the conflicts with this infrastructure;
- In the main design development stage, analyse the methods of water supply to the population in the periods when construction works on bridging this infrastructure are performed, with mandatory cooperation with the utility companies managing this infrastructure;
- The measures for protection of existing power network are contained in special regulations for construction of power networks, and they also contain measures for protection of cable lines at intersections with the motorway and connections to it.
- In the stage of construction, apply all prescribed/stipulated construction measures in order to protect the infrastructure lines.

In operation stage

- The measures for protection of infrastructure facilities during the motorway operation are reduced to regular control of its proper technical condition and regular maintenance so that a potential malfunction would not have adverse effects on the environment, human health and property.

5.3. TECHNICAL MEASURES TO MITIGATE ADVERSE ENVIRONMENTAL IMPACTS

In the case of motorways, technical measures apply to the tunnel ventilation design, overpass and underpass designs, designs of protection walls (protection of the motorway from snow or wind, or protection of the structures outside the motorway from occurrences on the motorway (noise, headlights, air pollution)).

Planning a set of measures of environmental integration into the landscape, related to the implementation of the motorway project, is considered to be a fundamental stage in continuing to rehabilitate environmental landscape features in the context of evaluating interventions and improving uncommon elements. Landscaping is based on closer identification of the restoration works that facilitate rehabilitation of the areas covered by the project implementation and improvement of the elements caused by them. The purpose is to re-establish the continuity of existing symbols and views in the realization of works and to give landscape values to project elements.

The use of vegetation is not only aimed at offering aesthetic improvement, but it should also achieve reconstruction of natural elements, which, as noted earlier, represent sporadic phenomena. This type of intervention is part of the environmental restoration system that covers all interventions made for the purpose of spontaneous restoration of native vegetation. The purpose is to help start the development process in order to improve the capability of the natural system through interventions with existing vegetation. This is aimed at reassembling the landscape and perceptual entities, and especially the structure of the natural system. Actually, vegetation plays a fundamental role in removing landscape inconsistencies in the area of intervention.

The first phase of planning environmental and landscape interventions involves a preliminary analysis aimed at studying the existing characteristics of elements that are natural and not created by human activity, and the general potentials for transforming and developing the studied territory. To achieve this goal, it is necessary to analyse the bioclimatic and geomorphological characteristics of the area.

The technical mitigation measures are solved through main designs for the sections for which the main project is made, all according to the technical specifications for motorway design, which represent a legal document.

6. DESCRIPTION OF MEASURES FOR MONITORING EMISSIONS

In spite of detailed analysis, often calculation too, some environmental impact assessments, based on which project solutions were sought, may not be sufficiently reliable. Furthermore, environmental conditions change over time, and so do environmental regulations themselves. After the motorway is constructed it is therefore possible that some of the provided measures for mitigating environmental impacts are not sufficient, or even that the planned activities are not fully implemented. For this reason, the task of competent state organizations is to establish environmental monitoring. In a narrower sense, the task of monitoring is to monitor emissions (into the air, into waters), and to change environmental parameters (air quality, noise level, quality of water in rivers, changes in soil quality). In a wider sense, it is also monitoring of socioeconomic parameters. The monitoring system is also aimed at checking all systems on which the quality of the environment depends (treatment of wastewater collected on the motorway, maintenance of these facilities, correctness of action in case of accidents such as spills of chemicals on the motorway, etc.). Based on the results of monitoring, additional organizational or investment measures are taken.

Monitoring is performed by an environmental team and the Federal Ministry of Environment and Tourism. Monitoring involves maximum use of information collected through existing regular channels for the purpose of resource efficiency and in order to avoid additional burden on the organization collecting information.

6.1. MEASURES FOR ENVIRONMENTAL IMPLEMENTATION

The monitoring measures for environmental protection during the construction period are mainly concerned with mitigating and improving the impacts of construction activities expected from the contractor. These include rehabilitation or protection of material borrow pits, reclamation of bare areas, clearing of shrubs while minimizing damage to the landscape, proper waste management, as well as other obligations. The goal of the environmental team is to help contractors maintain sensitivity regarding environmental protection issues, meet contractual obligations, and have flexibility in responding environmental issues.

Monitoring involves monitoring of emissions (into the air, waters, soil) and changes of environmental parameters - air quality, noise levels, quality of water in the river, soil quality, etc. The monitoring system also aims at checking all systems on which the quality of the environment depends, such as treatment of wastewater collected on the road, maintenance of these devices, regularity of action in case of accidents (spills of chemicals on the road, etc.).

Additional organizational or investment (technical) measures are taken on the basis of the monitoring results. In addition, monitoring verifies the effectiveness of the prescribed protection measures and design solutions. Namely, environmental conditions and the environmental regulations themselves change over time, so it is possible, after the motorway is constructed, that some of the planned environmental impact mitigation measures are not sufficient or even that the planned activities are not fully implemented. Therefore, the task of the competent state organizations is to establish environmental monitoring.

Monitoring should be carried out in all stages of the project:

- Before the works begin - environmental baseline
- During construction of the facility
- In the period of operation of the facility
- After removing the facility.

Since the motorway is built for a longer period of time and it is not planned to be removed or ceased to be used, it is necessary to establish monitoring for the first three stages.

Baseline monitoring should be carried out before starting the works, in order to define the baseline data that will be used as reference for future project implementation stages.

The main components of the monitoring plan are:

- Parameters to be monitored,
- Parameters monitoring location,
- How the monitoring will be performed,
- When the monitoring will be conducted,
- Costs of monitoring activities,
- Responsibility for monitoring activities.

The Contractor shall develop Environmental Monitoring Programmes in accordance with requirements of this document, which will at minimum include the monitoring requirements described in the table below but will not be limited to these requirements. PC Motorways FBH will be responsible for reviewing the Environmental Monitoring Plans prepared by the Contractor and for ensuring that these monitoring programmes comply with this document. PC Motorways FBiH will be responsible for monitoring and reporting on compliance.

The following chapter provides a monitoring plan for construction of the sections that are the subject to this Application.

6.2. PHYSICAL AND BIOLOGICAL ENVIRONMENT MONITORING PLAN

The monitoring system ensures monitoring of all environmental components: emissions (into the air, into waters), and changes of environmental parameters (air quality, noise level, quality of water in rivers, changes in soil quality, changes in the structure of landscape and biological diversity). The monitoring has multiple purposes: (i) for management of the phenomena, (ii) for information, including for planning purposes, and (iii) for scientific purposes. The monitoring can be in real time, when information is to be sent and used promptly (accident), or reports can be provided for the past year. The system itself can be divided into three stages: baseline monitoring, monitoring during construction and monitoring during the operation stage. The baseline ("zero state") monitoring should be carried out before the construction begins. Based on the environmental/ biodiversity baseline data, appropriate mitigation measures are adopted for each of the biodiversity components (flora, fauna, landscape, game, hunting, protected areas). The monitoring in the construction stage covers the period from the planning and preparation of the construction site to the completion of construction. Implementation of measures for each component is monitored in this stage. The monitoring during operation covers a period of two years, in which process the defined environmental/ biodiversity parameters are monitored by being correlated with changes resulting from operation.

Based on relevant data obtained from monitoring, mitigation or compensation measures can be planned and implemented.

Water resources

Monitoring of waters is one of the components of overall environmental monitoring. For the planned motorway facility, considering the complexity of construction and the dynamics of construction works, monitoring of waters should be defined as part of the Construction Site Organization Plan for each subsection of the route. In this way, the locations and methods of monitoring will be specified in more detail through the Environmental Monitoring Programmes to be developed by the Contractor prior to commencement of the works. A specific Monitoring Plan will be established for each section to monitor and assess the quality of surface water and groundwater, including the water quality baseline for surface water and existing water sources that may be affected by the motorway construction.

During the operation period, in addition to these measurements, it is also necessary to conduct monitoring of wastewater from traffic surfaces, or its impact on the quality of surface water. The quality control of wastewater from traffic surfaces should be carried out at places where water is discharged from grease traps and at places of additional wastewater treatment. The conditions for discharge of wastewater into natural recipients and limit values of harmful substances in wastewater are defined by the Decree on conditions for discharge of wastewater into natural recipients and public sewerage system ("Official Gazette of FBiH", nos. 101/15 and 1/16).

The report on the conducted monitoring of surface water and groundwater quality should be submitted by the Investor or contractor to the relevant bodies and institutions in the area of water and environment in FBiH.

Biodiversity monitoring plan

The monitoring of fauna will provide an insight into the state of game in the area, its abundance and presence along with temporal and spatial distribution of species on certain polygons or along the subject corridor Vc route.

The biodiversity monitoring system ensures long-term recovery of favourable status of species and recovery of habitat types that have been disturbed during construction and operation of the facility.

In order to obtain qualitative and quantitative data on the state of biodiversity, the contractor will develop a biodiversity monitoring plan that will include all three stages: planning stage, construction stage and operation stage:

- Monitoring observation location - a precisely defined location with the definition of coordinates for each section separately
- Monitoring implementation times;
- The parameters to be monitored - presence of the species, its abundance and representation in space, temporal and spatial distribution of the species;
- Selecting a working methodology: the monitoring implementation method - the methodology to obtain credible data that will later be used to make comparisons:
    - o phytocoenological recordings for floral elements;
    - o line transects, polygons, observation from a point/ site for bird species,
    - o sampling through aggregates and nets for fish species,
    - o technical equipment - binoculars, spyglasses, cameras, determination keys, detection apparatus and other relevant monitoring tools;
- Costs of monitoring activities - costs of professional associates for each field separately;
- Responsibility for conducted monitoring - Investor and Client.

National authorities will be responsible for reviewing the environmental monitoring plans prepared by the contractor. Ensuring that these programmes are valid and comply with these national and international criteria will be the responsibility of the competent national authorities.

Agriculture

The decision on issuance of the Environmental Permit to the Investor from 2014 specifies all the important details concerning the monitoring of land during construction and operation of the motorway. Everything that is written there should be also stated in the new document in full. The content of the 2014 decision is not stated because of unnecessary repetition, it is necessary to keep in mind only a few elements very important for efficient implementation of the monitoring of soil and plants growing on it:

The kind of monitoring that is conducted is often not sufficient to obtain operational information for rapid response. This involves raising this activity to a higher level in terms of connecting participants in this process and rapid exchange of information in real time. This means that information on the conducted monitoring should be made available to the inspection bodies, as well as to the experts of the Food Safety Agency, immediately after its processing. In this way, important stakeholders that can contribute to much more efficient risk and incident management get involved in this very important activity, all for the purpose of protecting human and animal health, as well as timely response in case of damage to other elements of the ecosystem.

New scientific knowledge also leads to a different understanding of what is known at the moment, which is why it is important to periodically review the number of samples and their sampling periods as indicated in the 2014 decision. It is also important to review the limit values of the analysed parameters in accordance with changes in this field. It is important to state in the new decision that the competent institutions are obliged, in accordance with new scientific knowledge, to make a binding recommendation to the monitoring contractor to adjust in this regard, as well as to the inspection bodies to follow and respond to changes in these activities appropriately, taking into account the recommendations of the Food Safety Agency, which should expand its activity to a more detailed involvement in this field, considering its exceptional importance. Engaging this institution in this way is important because along the road there are some of the highest-quality soils that people are unlikely to stop using for production of food, which will end up in the food chain very quickly although it is not safe due to continuous pollution by road traffic, with bad consequences for human and animal health.

By implementing what is stated here, the whole monitoring thing is returned to the Investor, or the road manager, who will be more prepared to respond efficiently to any challenge that may arise given the binding and executive orders of the competent services.

6.3. THE POSSIBILITY OF LARGE-SCALE ACCIDENTS

During the execution of works, no accidents of the defined characteristic are expected, but minor accidents are possible. The probability of their occurrence primarily depends on implementation of the prescribed environmental and occupational safety measures, qualifications of employees and the real level of organization. Emergencies can occur when maneuvering construction machinery, in case of a traffic accident and improper handling of machinery. All the potential conditions for the occurrence of an accident are reduced mainly to the human factor.

Accidents are possible during construction works, but also during the motorway operation stage. Accidental spills of petroleum products and other hazardous substances into water and soil may occur during the operation of construction machinery and other machinery. The most common causes are worker negligence or machine failure. In case of spillage of hazardous substances, the contamination site must be remediated using an absorbent. Remediation of the contamination site will prevent or reduce the negative impact on water and soil.

Drainage pipes may break during operation. In case of a pipe break, the pipe must be repaired in order to prevent water and soil contamination. Possible pipe breaks may be detected and repaired through regular drainage system inspections.

The highest risk of an environmental accident comes from the possible discharge of harmful/ toxic substances into watercourses (and then into soil). A concrete example is the uncontrolled spillage of fuels and oils used in the operation of construction machinery and vehicles.

There is no efficient (reliable) measure to reduce this impact, but there is a general technological discipline, strict control of the implementation of safety measures by the contractor itself (its management staff). However, mitigation can be achieved by timely informing all stakeholders downstream of the accident site to take preventative measures before the polluting spillage reaches them - and then by curative measures (filtering, etc.).

The construction organization project should provide a system of response in case of accidents, and should provide the necessary resources: communication facilities, first aid, efficient means of transport and appropriate routes/ modes of emergency transport for intervention teams or the injured.

The primary activity in preventive action and accident prevention is adequate training of all workers and all staff involved in the motorway construction and operation processes. Prior to being assigned to various tasks, employees must receive operation-specific or field-specific training in accordance with the emergency response plan, during which they are instructed about measures to be taken in case of an accident and informed about escape routes and evacuation assembly points. Retraining is required as soon as there are changes to the site operating plan that could jeopardize personnel safety in case of an emergency.

In case of an increase in the amount of gas emissions, construction waste and other waste, the mitigation measures and possibly monitoring should be corrected in accordance with the increase, all in accordance with the applicable laws.

7. CONSIDERED ALTERNATIVES AND ENVIRONMENTAL REASONS FOR SELECTING THE GIVEN SOLUTION

The first studies and conceptual design of the motorway route on the corridor through Bosnia and Herzegovina in the direction north-south began about 40 years ago. The valleys of the Bosna and Neretva rivers were declared as the most attractive corridor of the future motorway through Bosnia and Herzegovina.

Since then, numerous studies and conceptual designs have been developed, making it possible to start designing and constructing the full-profile motorway facility. 102 kilometres have been built so far, and eight sections will be under construction by the end of the year for 40 kilometres of the new motorway.

The corridor route has been the subject of many studies and analyses over the past 40 years. The corridor drawn in the Spatial Plan of Bosnia and Herzegovina (1981 - 2000) was integrated in the trans-European motorway "North - South", which coincides with the road E 73, and defined the municipalities through which it passes.

An intensive phase in preparation of technical documentation along the entire corridor Vc began with signing of the contract for development of the planning and study documentation in 2004. Several alternatives, which were drawn and technically justified on maps at the scale of 1:5000, were considered during the development of the preliminary design. The most favourable route was approved by the legislative authorities, based on multi-criteria analysis, which considered four criteria: spatial, environmental, traffic and economic.

Traffic study and feasibility study were developed for the selected motorway route, proving the socioeconomic feasibility of the project along the entire route and financial and market feasibility for most sections.

The first drafts conceptual designs were made in May 2006, and the Environmental Impact Study from 2007 was prepared based on them. Subsequently the route underwent several modifications, the first of which was in 2014 through conceptual designs, and they were related to technical improvements of individual sections for the purpose of bringing the motorway project into compliance with the technical specifications prescribed by laws. Further changes followed during the preparation of main designs for individual sections in 2017 and the changes were concerned with resolving grievances of the local population on individual sections and subsections.

Section 1 (Karuše – Medakovo) and Section 2 (Medakovo – Ozimica)

IPSA INSTITUT developed the Preliminary Design for these two sections in 2014. The preliminary design was made for the route that was the subject of multi-criteria analysis of three variant solutions, of which one was the route from the 2006 preliminary design. The route mainly follows the corridor and route that were considered in the 2007 Study except in the part of the Crni Vrh tunnel, where it went out of the corridor and at the Ozimica interchange site, where it also went out of the observed corridor in one part.

Due to different limitations (populated areas, structures, rivers, power transmission lines, existing roads) in some places from the Crni Vrh tunnel the route deviates from the route from the adopted 2005/2006 preliminary design.

Section 3 (Ozimica – Poprikuše)

The motorway section Ozimica - Poprikuše was previously considered in the Preliminary Design developed in 2005/2006, which was given approval by the Žepče municipality. Before development of the Preliminary Design for this section, Conceptual Designs were made where, in addition to the route from the Preliminary Design 2006, optimized route was also treated. At this stage, variants were considered in terms of costs, and it was concluded that the optimized route was more favourable from the aspect of construction as compared to the route that was previously adopted.

On the adopted section there is a big difference in tunnel lengths on the route, the tunnels are much shorter, which makes the construction more economically feasible.

Section 4 (Poprikuše – Nemila) and Section 5 (Nemila – Donja Gračanica)

As already said, the beginning of the motorway section on the Corridor Vc Poprikuše – Nemila was defined through the analysis of the preliminary design from 2005 in the area of the Golubinja settlement with the Poprikuše interchange. Since the Žepče municipality did not give consent for the route in this part of the section, the route was moved to the right bank of the Bosna River and then also to a tunnel in order to avoid passage of the route along the Golubinja settlement, while the Poprikuša interchange is mainly kept at the same location, adjusted to the new route.

PC Motorways FBiH conducted a cost/benefit analysis of the motorway route from the 2006 preliminary design, which showed that motorway construction costs were too high for that variant.

For the purpose of optimizing construction costs of the motorway section in question, in 2014 PC Motorways FBiH commissioned preparation of the "Analysis of the Preliminary Design on the Corridor Vc" which was developed by "IPSA Institut d.o.o. Sarajevo", and the same documentation is specified by the Terms of Reference as the basis for further elaboration within the framework of the project.

However, a detailed analysis of the technical solution for route from the "Analysis of the Preliminary Design on the Corridor Vc" from 2014 determined a number of drawbacks that called into question the appropriateness of further elaboration of project documentation in accordance with the proposed solution, and the Designer found a technical solution that would satisfy all the parties involved, and at the same time reduce the motorway construction and maintenance costs. Seven design variants aimed at optimizing construction costs were made for the subject motorway section in the optimization study. The beginning of the corridor containing all the motorway variants is on the northern administrative borderline of the Zenica municipality, at the Topčić Polje site on the right side of the Bosna River bank. The corridor along which all variant routes run goes further over the northern slope of the Gusta Jabuka area, western slope of Nemilsko Brdo to the settlement of Nemila. Then the corridor passes near the Stara Stanica (Old Station) settlement and over the western slope of the Stranata Vlasača area to the Vranduk area. In the area from Vranduk to the Ponirak settlement, route variants are mapped on the east and west side of the slope of the Medvednica area and above the settlement of Koprivna. From the settlement of Ponirak, the corridor route continues through Srednje Brdo to above the settlement of D. Vraca and goes further over the west slope of the Gaja area to D. Gračanica where the route for the subject motorway section ends. In the zone of D. Gračanica, a motorway junction of the same name is planned outside the coverage of the subject section.

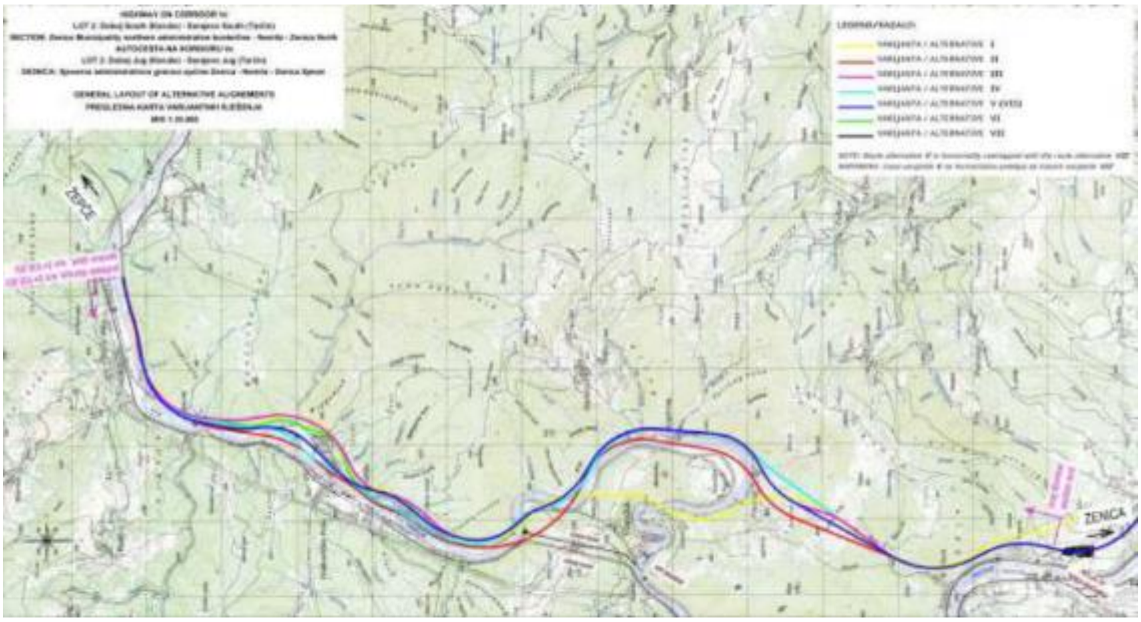


Figure 68: View of route positions of 7 optimization study solution variants for section 4 and section 562

Section 5 (Nemila – Donja Gračanica) and section 6 (Donja Gračanica – Drivuša)

Section 5 is bypass of the regional centre Zenica (which is also administrative centre of Zenica-Doboj Canton), so there a relatively large number of individual residential buildings located near the adopted motorway route.

Due to the conceptual change of the design solution for connecting the motorway route to the existing main road (proposed relocation of the conflict section) in the area of Drivuša, there was a justifiable questioning of the need for construction of the sub-junction Lašva - leg 2 in the settlement of Janjići.

8. A COPY OF THE APPLICATION FOR OTHER PERMITS THAT WILL BE OBTAINED TOGETHER WITH THE ENVIRONMENTAL PERMIT

Copies of applications for other permits that will be obtained together with the environmental permit are enclosed as a standalone document.

9. NON-TECHNICAL SUMMARY

PC Motorways FBiH is responsible for construction, management and maintenance of motorways in FBiH. One of the key projects is the development and construction of a motorway that is part of the trans-European network of Corridor Vc, which connects Budapest (Hungary) and the Ploce port (Croatia). The total length of Corridor Vc is 321 km, of which 285 km passes through FBiH. About 100 km of the motorway has already been constructed and is in operation

For construction of the subject sections on the Corridor Vc, PC Motorways FBiH have developed the Environmental Impact Study for LOT 2 - Section DOBOJ SOUTH (KARUŠE) - SARAJEVO SOUTH (TARČIN) in 2007

Pursuant to Articles 68 and 71 of the Law on Environmental Protection (Official Gazette of FBiH, no. 33/03), Article 18 of the Law Amending the Law on Environmental Protection (Official Gazette of FBiH, no. 38/09), and Article 200 of the Law on Administrative Procedure (Official Gazette of FBiH, no. 2/98), the Federal Ministry of Environment and Tourism issued the Decision on Environmental Permit UP-I/05/2-23-11-4/14 SS of 18 February 2014.

The Decision was issued for the entire LOT 2 in a total length of 145 km, which consisted of four sectors:

- Karuše - Donja Gračanica
- Donja Gračanica - Kakanj
- Kakanj - Vlakovo
- Vlakovo - Tarčin

The sectors are divided into a total of eight sections:

- Section 1 Karuše - Medakovo
- Section 2 Medakovo - Ozimica
- Section 3 Ozimica - Poprikuše
- Section 4 Poprikuše - Nemila
- Section 5 Nemila - Donja Gračanica
- Section 6 Donja Gračanica - Drivuša
- Section 7 Drivuša - Kakanj
- Section 8 Kakanj - Tarčin

In the previous period since the above-mentioned integral Environmental Permit was obtained until today, individual sections were constructed and completed in stages and Operating Permit was obtained for them.

Essentially, this Application for Extension of the Environmental Permit for Lot 2 applies to the unconstructed sections and sections in the construction stage (Section 1 Karuše-Medakovo, Section 2 Medakovo-Ozimica, Section 3 Ozimica-Poprikuše, Section 4 Poprikuše -Nemila, Section 5 Nemila-Donja Gračanica and Section 6 Donja Gračanica-Drivuša) in a total length of approximately 70 km.

Lot 2 sections (Section 7 Drivuša-Kakanj and Section 8 Kakanj-Tarčin) in a total length of approximately 75 km, which have already been constructed and with obtained Operating Permits, are not subject of this application.

Activities on preparation of the Spatial plan of the area of special features of significance for the Federation of Bosnia and Herzegovina "Motorway on the Corridor Vc" for a period of 20 years are initiated by adopting the Decision of establishing the area "Motorway on the Corridor Vc" as an area of special features of significance for the Federation of BiH (Official Gazette of FBiH no. 56/08) and by the Decision to start developing the Spatial plan of the area of special features of significance for the Federation of BiH "Motorway on the Corridor Vc" for the period from 2008 to 2028 (Official Gazette of FBiH, no. 48/08), and the Plan was adopted on 9 February 2017.

This Application for Extension of the Environmental Permit for Lot 2 has been updated in relation to the Environmental Impact Study for LOT 2: SECTION DOBOJ SOUTH (KARUŠE) - SARAJEVO SOUTH (TARČIN) only in the part concerning: change of legislature and obligations of the Investor, population and change in relation to the Preliminary Design. The environmental condition data that were available from the approved LOT 2 Environmental Impact Study (hereinafter: the 2007 Study) and other study documentation made for the needs of the spatial planning documentation in the previous period were used in this Application for Extension of the Environmental Permit. In places where the route deviates from the route in the 2007 Study, the expert team analysed the data from the study and in some places updated them with more recent data from the field.

9.1. PURPOSE AND OBJECTIVE OF THE PROJECT

The motorway on the Corridor Vc is a part of the trans-European network of inland corridors and at its end points it connects the central part of the Adriatic See coast with Budapest in Hungary. The 321 km long Corridor Vc route runs through BiH in the direction north-south, through the middle of the country with the most favourable natural conditions - the Bosna and Neretva river valleys.

In the stretch through BiH, the transport Corridor Vc includes:

- E-road E-73 Šamac-Doboj-Sarajevo-Mostar-Čapljina-Doljani, which has access to the Adriatic Sea through the Ploče port, while in the north it is connected in Budapest
- Railway Šamac-Doboj-Sarajevo-Mostar-Čapljina-Metković,
- Airports Sarajevo and Mostar,
- Waterways and ports along the Sava, Bosna and Neretva rivers.

The purpose of this project is also to enable better integration of Bosnia and Herzegovina with neighbouring countries and regions, which would at the same time enable stabilization and stimulation of the development of the country as a whole.

The improvement of traffic conditions will improve the quality of life, which will be manifested through:

- reduction of road length and travel time of goods and passengers in relation to existing sections,
- reduction of goods and passenger transport costs,
- reduction of harmful environmental impacts by directing a part of traffic from the existing relevant network to the future motorway route,
- increase in employment,
- valorisation of the BiH geo-traffic position,
- increase in competitiveness of economy in the corridor gravitation area,

launching of new projects and increase in private investments in regional economy.

9.2. SOCIOECONOMIC SIGNIFICANCE OF THE PROJECT

The overall objective of implementation of the Corridor Vc motorway project is to include BiH in the main European traffic flows and the European economic system in the context of development of the Trans-European Transport Network ("TEN-T") in the EU territory. Construction of this motorway will accomplish proper integration of Bosnian and Herzegovinian areas with neighbouring countries and regions and achieve stabilization and development effects for the entire country.

In addition to the primary development axis, the motorway in the Corridor Vc will also generate the development of transverse directions significant in terms of spatial linking and integration, whether these directions are planned as new traffic routes or as major reconstructions of the existing transport network.

9.3. DESCRIPTION OF THE ENVIRONMENT THAT COULD BE VULNERABLE TO PROJECT IMPACTS

Water resources

In the zone of motorway passage in this section, there is a densely developed network of watercourses, the most significant being the Bosna River with its smaller and larger tributaries. In addition to the dense network of surface watercourses, there are also significant groundwater resources, most of which are still insufficiently explored.

Analysis of hydrogeological characteristics of the corridor treated by the 2007 Study identified sensitive areas in the form of aquifers, which represent an important resource of high-quality drinking water for satisfying the growing needs. Besides, in terms of construction and operation, the study defined that the banks of the watercourse along which the motorway is design and which the motorway intersects, as well as surface water phenomena (water sources) in and out of the water supply system are also considered to be sensitive areas. Taking into account the specific location conditions and existing available data, the potential negative impact of the construction and operation of the motorway on surface water and groundwater phenomena was assessed, and measures for prevention and minimization thereof proposed accordingly.

Flora

Based on the collected literature data and data collected through fieldwork, it was learned that the condition of vegetation cover on the subject sections is rather diverse, which provides a high floral and landscape diversity. On individual sections, the following plant communities are represented:

On section 1 there are communities of ecosystems of xerothermic forests of eastern hornbeam and pubescent oak Querco–Ostryetum carpinifoliae (EUNIS habitat code G1.7C1), forest ecosystem communities of white willow Salicion albae (Habitat code 91A0).

On section 2 there are communities of ecosystems of xerothermic forests of eastern hornbeam and pubescent oak Querco–Ostryetum carpinifoliae (Eunis habitat code G1.7C1), forest ecosystem communities of white willow Salicion albae (Habitat code 91A0), basophilic pine forest on serpentines (Pinetum silvestris-nigrae serpentinicum).

On section 3 there are xerophilic oak forests on serpentines forests of sessile oak with heath Erico- Quercetum petraea (K. ET L.) HT; heaths, vegetation of rocks and rocky grounds, vegetation of rocks, forest ecosystem communities of white willow Salicion albae (EUNIS Habitat code 91A0), communities of ecosystems of hygrophilic forests and shrubs of alder (EUNIS Habitat code 91E08*).

On section 4 there are communities of ecosystems of oak - hornbeam forests Querco-Carpinetum betuli (EUNIS Habitat code G1.A1A), forest ecosystem communities of white willow Salicion albae (EUNIS Habitat code 91A0), communities of ecosystems of hygrophilic forests and shrubs of alder (EUNIS Habitat code 91E08*)

On section 5 there are communities of ecosystems of oak - hornbeam forests Querco-Carpinetum betuli (EUNIS habitat code G1.A1A), alder forests that are differentiated into several communities.

On section 6 there are communities of ecosystems of xerothermic forests of eastern hornbeam and pubescent oak Querco–Ostryetum carpinifoliae (EUNIS Habitat code G1.7C1), forest ecosystem communities of white willow Salicion albae (EUNIS Habitat code 91A0).

Fauna

Data on composition of fauna in the analysed area of the motorway Vc route (Lot-2) were collected on the basis of interviews and consultations with the local population, while hunting clubs of existing municipalities were consulted for additional data on the state of game animal populations. Considering the high population density, plant communities are still in a preserved state, which is indicative of a greater biodiversity of the fauna of this area. 26 bird species are registered, of which some fly over this area as an integral part of their migratory movements, while some are nesting birds. Hunting game is represented by species: wild boar, roe deer, hare, squirrel, etc. Of mammals, more than 20 species are registered on the studied part of the motorway route section. Of fish species, the species of the cyprinid and salmonid families are significant. The areas along riverbeds are inhabited by amphibians, reptiles, butterflies and other insects that need to be registered through additional monitoring.

Protected parts of nature

From the aspect of protection of natural values, the most significant on the section of the planned motorway is the serpentine complex that is particularly developed in the area of Papratnica, immediately next to the proposed route and on its left side from the starting point of this section between 7.0 and 8.0 km of the route. This area is protected by decision of the competent municipal bodies of the Žepče Municipality. Serpentines are susceptible to erosion and falling and therefore need to be protected. The Spatial plan of the area of special features of significance for the Federation of BiH "Motorway on the Corridor Vc" also defines two zones that are in conflict with the motorway route: part of the Regional Nature Park Crni Vrh, with which the route is in conflict in the chainage from km 13+150.00 to km 14+800.00 Section I Karuše - Ozimica; and Kraljevo Brdo - the protected zone of pine forest with serpentines, which is not in direct conflict with the motorway, because the closest point is located at a distance of more than 400 m from the motorway axis.

Landscape

Along the motorway, there are very valuable forest and plant communities such as: the community Erica and black pine (Erico Pineetum) with a large number of endemic plants located in the area of the municipality of Žepče. Valuable communities of flood forests of black alder, communities of white and brittle willow and communities of poplar can be found in close proximity of river courses (Lepenica, Zujevina and Bosna) that follow the motorway. The presence of these valuable specimens of plant communities indicates the necessity of their preservation and protection. In order to achieve natural balance, it is necessary to compensate or to balance the changed areas through the landscape architecture design in terms of preserving valuable and functional landscape elements.

Game

The Law on Hunting defines game as animal species living freely in nature. Within the scope of hunting legislation, game is divided into big and small game (hairy and feathered game). Big game includes wild boar, roe deer, hare, etc. Hunting game has its economic value and as such is subject to hunting.

Feathered game (pheasants, ducks, quail, partridge, etc.) are also subject to hunting and are of interest to hunters. Song birds and wetland birds form a group that requires systematic protection through protection of habitats and protection of each species separately.

Hunting

During preparation of the Environmental Impact Study for LOT 2 (2006), those who elaborated the fauna and hunting aspect contacted the representatives for hunting in the Public Company ŠPD of Ze-Do Canton and the hunting clubs: "Borja" Teslić, "Jeleč" Žepče, "Klek" Zavidovići, "Zmajevac" Zenica. Overviews of the state and abundance of game and quotas for use are given consistently with their hunting and economic programmes and annual plans.

Through the utilization plan, hunting clubs control the abundance of game in the area and, in accordance with the spring count, undertake measures of use and improvement.

As a result of the planned interventions in space, construction of the Corridor Vc route on Lot 2 will significantly affect the state of wildlife and hunting.

Agriculture

Construction of the motorway is undoubtedly of strategic importance for the entire country and its economic prosperity and benefits derived by the society from it are indisputable.

Roads are physical objects that must be located in space, with the important skill being the avoidance or minimization of damage that may result from the needs of existing users of the space.

Agricultural land is often ruined by construction of roads, and it often happens that these are the best plots or complexes found in the particular area. Sometimes this is inevitable, often it can be avoided or minimized.

However, it should be borne in mind that agricultural land is the basic medium for food production and it will be so for a very long time yet. At the same time, it is a medium whose natural formation cannot be seen in the course of a single human life. This is why soil is said to be a non-renewable resource that will no longer exist when it physically disappears.

Food production is a proven condition for the survival of humans and maintenance of political and economic sovereignty of society. This is often disregarded or deliberately overlooked, so people build without thinking what will be tomorrow or 50 years from now.

When constructing a road, if it is ignored that soil should be preserved to a maximum extent possible, or that damage to it should be minimized, then the roads will be used for departures of people and for transport to supermarkets of food produced on resources that other countries from which the food comes have protected and preserved so they can sell to others who have not done so.

This should be borne in mind when carrying out this major project, it is necessary to strictly adhere to the Law on Agricultural Land and to respect other regulations in construction and operation of the road, primarily in the sphere of quality monitoring.

All that was said in the part concerning land in the 2007 Study is also valid for issuance of environmental permits for sections that have not been constructed. This overview is a supplement to that document, noting that it is very important for all services to do their job, especially inspection bodies, in monitoring strict compliance with the Law and with the provisions defined in the Environmental Permit once it is made.

9.4. THE MAIN POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

Motorway construction impacts and measures for their mitigation are presented in the table below.

Impact	Mitigation measures
▪ *BEFORE CONSTRUCTION*	
Risks for all environmental components, and: ▪ cutting of all existing and established communications, ▪ demolition of structures and/or relocation of population; ▪ disruption of habitats and ecosystems, cutting of animal migration routes ▪ disrupting the harmony and integrity of the landscape	▪ Develop the project documentation in accordance legal regulations, environmental permit, and with observance of all specific features of the area. ▪ Develop appropriate operational emergency response plans for any accident situations and procure the necessary equipment.
	▪ Planning and establishing new communications structures for settlements where traditional ways of communication are disrupted by the motorway construction. ▪ Provide systematic and detailed information to the local population and interested public about the motorway route to make it possible for them to consider all dimensions of potential impacts and to participate in the decision-making process in a high-quality manner. Publicly announce daily traffic situation and provide information to the public on the scope and schedule of construction activities, expected difficulties and access restrictions. ▪ Prepare project documentation that will be the basis for implementing the expropriation process in accordance with the applicable legislation, and make timely payments of compensations in accordance with the national law; ▪ At a minimum, the drainage design shall provide a closed drainage system, with oil and grease separator, and, where necessary, further treatment of water to achieve the water quality in accordance with the regulations; ▪ On all locations where the route crosses watercourses, or is located near stream banks, as well as near water sanitary protection zones, thermal water sources or aquifers, it is mandatory to design traffic barriers or concrete blocks (New Jersey) to physically prevent vehicles from rolling off the motorway. ▪ As part of the Construction Site Organization Plan (CSOP), completely plan the construction site, places for disposal of construction and waste materials, parking places, fuel filling points, etc.; ▪ Finding a solution that will provide local population with access to plots and other areas located immediately next to the construction during construction of the motorway and support structures; ▪ The watercourse training project, which includes environmentally acceptable structures, that is, the criterion should be to avoid relocating the natural bed, or to design culverts through the motorway structures wherever conditions permit. Apply the principles of environmentally friendly practices when designing relocation of beds.

	▪ When designing bridges, take maximum care of the bridge design in order to integrate it into the landscape in the best possible way. When designing bridge structure, to a maximum extent avoid solutions requiring high and massive elements, on the bridge itself and on the banks alike, and to a maximum extent possible avoid encroaching upon the riverbed itself or canyon sides. From the conceptual design stage onwards, include both an architect and a landscape architect as part of the design team; ▪ In addition to bridges, a design solution with an included system of measures for integration of the facilities in the environment, should also be developed for the areas of junctions, roadside service facilities, border crossing, toll gates, and TMCCs; ▪ Tunnel portals shall be designed not to protrude beyond the rock on any part, but to be a part of the rock both structurally and perceptively, and with stone lining of a similar colour as the rock; ▪ The design solution of roadside service facilities shall respect the surrounding natural space, both in architecture of the structure itself (minimum height of the structure, type of construction materials - use natural stone, colours and textures as much as possible), and in the open space next to the structures (use plant species from the composition of the local flora); ▪ On outer slopes of hills, wherever possible, design cuts instead of side cuts and embankments. Design side cuts and cuts at the steepest possible gradient, in order to minimize the width of encroachment into the existing terrain; ▪ Establish water and air quality baseline in the area affected by the project before construction commences in order to conduct monitoring in the further stages of project implementation; ▪ In parts where the motorway passes near residential buildings and populated areas, provide physical barriers that will protect the population from noise; ▪ Prior to construction, it is necessary to perform a survey and record any rare and endangered plant and animal communities (especially in the vicinity of river courses), and provide precautionary measures in accordance with expert guidance, in order to preserve these communities if any are registered; ▪ Prior to proceeding with construction of the motorway, carry out detailed archaeological surveys and develop a study on preliminary archaeological reconnaissance of the terrain, which will establish positions of registered sites and possible new sites that have not been registered so far, given that the route also partly passes through so far unexplored and inaccessible terrain, and establish their relationship with the planned motorway route.
Conflict points of the motorway with existing and planned infrastructure	▪ As part of the main projects for individual sections, develop separate documents that will specify all points of conflict of the road with the existing infrastructure system: local roads and parts of the water and power supply networks, as well as solving of these points of conflict.

Compliance with legal regulations relating to construction site.	▪ Obtaining all necessary permits for execution of the planned works, and certificates for equipment and machinery. ▪ Preparation of the Construction Site Organization Plan (SCOP) (for all subsections according to the construction plan), technological diagrams, Study on safety at work and fire protection and the Environmental Management Plan pursuant to the Regulation on construction site organization, obligatory documentation on construction site and participants in construction (Official Gazette of FBiH, nos. 48/09, 75/09 and 93/12) and the Waste Management Plan pursuant to the Law on Waste Management (Official Gazette of FBiH nos. 33/03 and 32/09).
▪ *CONSTRUCTION*	
Impact on population: ▪ Increased levels of noise and vibration in the immediate vicinity of the construction site; ▪ Partial or complete change of traditional movement routes of local population; ▪ Proximity or overlap of traditional roads with construction roads, which can create disruptions in traffic and increased possibility of accidents; ▪ Increase in length of travel from place of residence to places of work, schools, shops, etc.	▪ Minimize any negative impacts such as difficult access, increased levels of noise, vibration and dust, and presence of heavy machinery by adhering to specified measures; ▪ Publicly announce daily traffic situation and provide information to the public on the scope and schedule of construction activities, expected difficulties and access restrictions. ▪ Restrict movement of heavy machinery during the motorway construction, in order to minimize the area of agricultural soil devastated by the works. To the maximum extent, use the existing network of roads, which should to be repaired upon completion of construction works; ▪ Use modern machines and vehicles with insulated noise sources (engines; exhaust system), which involves purchase of new machines or measures of installing additional sound insulation, as well as constantly maintaining the proper condition of the sound insulation. In addition, it is recommended to operate machinery only in the period from 7:00 to 18:00 (in all parts of the route which are less than 60 m away from the settlements).
Impact on microclimate: ▪ with respect to increased air warming and emissions of pollutants into the air, which leads to the effect of a 'cloudy' atmosphere and consequences in the form of higher air temperatures.	▪ As soon as possible introduce automatic monitoring of meteorological parameters and parameters of air pollution along the entire motorway route. On the stretch from Doboj to Tarčin, automatic meteorological stations should be installed at least 20 points on the route, of which at least 5 should be with measurements of all relevant meteorological parameters. ▪ The above-mentioned negative impacts on microclimate can be considerably mitigated by planting green belt in the immediate motorway area.
Impact on waters: ▪ Silting of the bed, water contamination, increase in water level in the upstream part or even complete filling of the bed with construction material. ▪ Execution of construction works like blasting in rock massif, excavation, destruction and stripping of	▪ Special method of blasting in order not to disrupt groundwater flows on the stretches where the route passes near sensitive zones, or zones of unacceptable and high risk to groundwater; ▪ Tunnelling shall be carried out so as to avoid affecting the direction of groundwater flow and to prevent inflow into surface water; ▪ All excavation material that will not be immediately used in construction activities must be stockpiled in the designated locations in accordance with the construction site organization project (excess material stockpiles)

topsoil, disposal of material, etc. can lead to disturbance or cutting of natural groundwater recharge routes. In the same way, occurrence of soil pollution is also possible, and such turbid or otherwise polluted water can easily infiltrate underground; ▪ Contamination of the surrounding soil, banks and water surfaces due to uncontrolled/accidental leakage of fuels, lubricants and oils from construction machinery or vehicles because of their faulty operation or negligence of workers, due to improper filling of fuels and improper disposal of wastewater from the construction site may lead to groundwater pollution; ▪ Dumping different waste from the technological process or construction complex (liquids, particles and solid waste) on the banks or directly into beds of rivers can lead to water pollution and propagation of pollution along the course; ▪ Discharging used water (technological and hygienic) into water courses, or into the soil can lead to diffusion of hazardous pollutants and biological agents; ▪ Changing the hydrological regime in marshes and ponds in the wider motorway area threatens the complex ecosystem.	protected from erosion, as well as outside of the defined sensitive zones, or zones of unacceptable and high risk to groundwater; ▪ Vegetation cover shall be preserved to the maximum extent possible, i.e. buffer zones made of plant cover shall be left between the road and water bodies. ▪ In the vicinity of watercourses, use only clean material for embankment, such as gravel, without earth or other impurities. ▪ Disposal should not be made in the riverbed and along watercourse banks, or in the sanitary protection zones as well as in the zones identified as aquifers. In case that these sites are found to be on a water domain and public water domain, it is necessary to request water management approval. ▪ Surfaces sensitive to erosion shall be protected by stabilizing agents and erosion-preventing plants. ▪ Conduct frequent and controlled disposal of municipal and hazardous waste in the prescribed manner, or prohibit any temporary or permanent disposal of waste material on the surrounding soil, except at the places designated for that purpose by the Construction Site Organization Project, and provide watertight waste containers. At the same time, disciplinary action shall be taken against violators of the established rules of conduct. During the construction, it may be expected that contractors will find registered or unregistered (illegal) dumps of different waste at several places. Depending on the type of waste, all these sites shall be rehabilitated according to specific projects; ▪ Used water from construction site shall be collected by safe drainage systems, collected in appropriate tanks and treated in the prescribed manner (whether on site or on a remote location) before being discharged into watercourses. On construction sites, it is mandatory to install ecological toilets to be used by workers; ▪ Machinery storage and servicing areas shall be protected by an impermeable base, outside the zones defined as the zones of unacceptable and high risk to groundwater. Oily rainwater from these areas shall be collected and treated in grit trap and oil and grease separator before being discharged into the recipient; ▪ Repair of machinery and replacement of oil shall be prohibited in the zones of high risk to groundwater; ▪ River flow shall be maintained at all times. If access to river channel is required, measures should be taken to divert the water flow past the works; ▪ Contractors should be prepared for flash floods and sudden rises in water level, and should secure all works (including embankments under construction, formwork, steel, etc.) so that the works are not disrupted by flood flows. ▪ All construction site areas and other temporary impact zones shall be rehabilitated in accordance with the Rehabilitation Plan, i.e. reinstated depending on the future land use.

	▪ Separate water management requirements shall be requested for the locations of construction site bases, services, asphalt plants, borrow pits and other facilities. ▪ In case of harmful impacts on water sources used for water supply, in the shortest possible period provide an alternative water supply for the population in the affected area.
Impact on air Disruption of air quality will result from: ▪ impact of exhaust gases from trucks and machinery that will be used in the construction of the motorway, ▪ impact of particulate matters (dust) that will be raised from the construction site, transport roads during passage of trucks and machinery, ▪ impact of particulate matters from temporary stone aggregate stockpiles	▪ Construction site, places of borrow pit of materials, temporary roads and handling areas shall be dampened during warm, dry and windy weather conditions in order to prevent dust from being raised. ▪ Transport of gravel, asphalt, stone and earth material and similar materials shall be carried out with tarpaulin covered trucks. ▪ When blasting for excavations in rock massif, choose the type of explosive that has the least harmful environmental impact. For the use of blasting boreholes use drills with dust collection in plastic bags. ▪ Install soot separating filters on exhaust pipes of all machines and vehicles with diesel engines; ▪ Use machinery in good technical order and perform regular maintenance of construction machines, turning them off when not in use; ▪ With regular (planning periodic) and extraordinary technical inspections of machines and vehicles, ensure maximum proper order and functionality of the motor fuel combustion system, and use (and regularly control) fuel with guaranteed quality standard.
Impact on soil and agricultural land ▪ Land of the best types, the highest-quality capability classes, the best use structure and the most favourable agro-zones will physically disappear by construction of the motorway. ▪ On the parts of agricultural land that are saved from physical disappearance, long-term exposure to contamination and erosion processes, as well as other adverse impacts, can be expected.	▪ Enforcement of preventive measures like: banning the use of leaded fuel, mandatory use of vehicles with catalytic converters, regulating movement speeds in zones of intensive agricultural production (agro-zone I), within the corridor prohibiting the cultivation of crops that accumulate toxic substances in edible parts of the plant. ▪ It is necessary to regulate implementation of all preventive measures by introducing appropriate legal solutions and international standards. The action of inspection services to strictly monitor compliance with appropriate measures is also very important in all this, especially when the measures are carried out on the recommendations to be given by the Food Safety Agency. ▪ Mitigation measures in the stage of road construction are carried out by removing, stockpiling and preserving the humus layer of soil, maintaining passability of roads and access to agricultural plots, remedying degraded soil, decontaminating contaminated soils and establishing vegetation protection belts. ▪ Removing and stockpiling the fertile soil layer is an important measure to take, bearing in mind that it is almost impossible to avoid destruction of the first agro-zone soils. It is important to take into account the practical aspects of the measure, since if the humus layer is only removed and stockpiled only as a matter of form and not used soon thereafter, this measure is useless as it entails the additional cost of storing and maintaining such material and the gradual loss of humus that it mineralizes or erodes over time and becomes useless.

	▪ Ensuring accessibility and passability of agricultural properties is one of the requirements that must be met in the motorway construction stage, which is accomplished by construction of bridges and appropriate passages. ▪ Carry out remediation of degraded land, thus achieving rehabilitation of erosive processes, preventing the occurrence of water pooling, rehabilitating the surfaces on which temporary structures were built, and where stockpiles for disposal of the stripped fertile soil layer and open borrow pits of filling materials were located. ▪ In places where fuel, oil and lubricant were spilled, carry out decontamination by applying sawdust or some other material, where in the case of sawdust, after decontamination it is collected and burned under controlled conditions, and then the decontaminated soil layer is removed and stored to the designated place. ▪ An important measure to be taken during construction of the road is the establishment of vegetation belts, which is especially important for protection of the remaining agricultural lands of capability classes II and III. The vegetation belt should be at least 2.5-3 m high.
Impact on flora ▪ Impacts that will be reflected on flora during construction of the motorway route will be manifested in the loss of wood mass, decrease in biological diversity, decrease in the number of flora elements, loss of habitats, as well as change of landscape characteristics of the area. ▪ Impacts on flora will occur along the entire road route in full profile with the additional impact of the route during operation. In this part, the vegetation part and all stratal elements will be completely lost. ▪ Impact on the vegetation component is expected along the entire route profile due to the formation of pavement lanes, due to construction of bridges, viaducts, tunnels, interchanges, RSF - roadside service facilities, access roads, construction and organization of construction sites, borrow pits, supporting facilities and stockpiles for disposal of excavated material. ▪ Significant impact on flora will be manifested during construction in the immediate vicinity of the route	▪ Prior to construction, it is necessary to perform a survey and record any rare and endangered plant communities (especially in the vicinity of river courses), and provide precautionary measures in accordance with expert guidance, in order to preserve these communities if any are registered; ▪ Systematically implement measures for conservation of flora elements with a previously developed plan of work and of implementation of environmental monitoring measures. ▪ All trees should be cut to standard length, cleared of all branches. All cut trees, branches, and roots must be removed in accordance with existing legal provisions, rules and regulations. ▪ Strict prohibition of excessive felling of trees in the area of serpentines near Žepče. It is necessary to carefully plan, manage and perform monitoring of tourism operations in the protected area in order to ensure their long-term sustainability. ▪ Preventing uncontrolled falling of material or intentional pushing of material down slope. Planting native species as described in more detail by sections in Chapter 5.2.6. Flora within the Application. ▪ In riparian areas carry out planting of native species as described in more detail by sections in Chapter 5.2.6. Flora within the Application. ▪ In the construction site building phase, establish the vegetation cover baseline and presence of individual flora elements. ▪ Monitoring of the condition and impact on the surrounding vegetation with special protection measures shall be specified as part the Construction Site Organization Plan (CSOP). ▪ Follow up the plans and progress of rehabilitation and reclamation of disrupted areas (work areas where machines, manpower, supporting facilities, access roads, cuts, viaducts, riverbeds, etc. are located).

where construction sites will be located, as well as in the part of access roads to the route itself, as well as by the location of other infrastructure facilities that will be constructed for the purpose of construction of the route and individual structures on it.	▪ In part of construction work and construction site organization itself, integrate structures into the surrounding area, respecting and using autochthonous species. ▪ When forming the construction site and the area, observe floral characteristics (single trees or tree groups) that will not affect execution or organization of works. ▪ On outer slopes of hills, wherever possible, design cuts instead of side cuts and embankments. Design side cuts and cuts at the steepest possible gradient, in order to minimize the width of encroachment into the existing terrain. ▪ When performing works along river courses, keep existing vegetation where possible and leave trees where nests are built.
Impact on fauna will be manifested through direct and indirect impact: ▪ Direct impact implies the physical loss of particular species in space, whether it is an immediate death caused by works related to the route or a long-term loss caused by cumulative action. ▪ Indirect impact implies the impact on organisms and species that will be manifested by population decline, migration from the affected space. These impacts are caused by the intensity and manner of the works (increased noise from the operation of machinery and trucks, vibrations, physical pollution of the environment, reduction of natural food sources, loss of habitats, loss of spawning and nesting sites, etc.). ▪ The impacts will affect all groups: birds, mammals, amphibians, reptiles, insects along the whole or part of the route.	▪ Carry out felling of riparian forest vegetation in the winter season to somehow reduce the additional negative impact on land and water fauna. ▪ Measures for protection of hunting game on many sections rich in hunting animals (Medakovo-Ozimica, Poprikuše-Nemila, Nemila - D.Gračanica, D.Gračanica-Drivuša) are facilitated by Investor's solution with numerous tunnels, viaducts, and bridges. For sections 2 and 3, or Medakovo - Ozimica and Ozimica - Poprikuše, crossings for animals have been made, ensuring undisturbed movement and migration of game from both old routes. ▪ Establish monitoring with video cameras at animal crossing sites. ▪ It is necessary to build bird nesting boxes in the floodplain forest area and to monitor the daily, monthly and annual bird migration, as well as their distribution in the space. ▪ Part of the river bank of the Bosna River - backwaters, shall be arranged to be suitable for birds, amphibians and reptiles to stay. ▪ Leave fish migration passes when carrying out work on river banks and river beds. ▪ Continuously inform the local population and interested public (hunting, fishing clubs and nature conservation NGOs) about the motorway route to make it possible for them to consider all dimensions of the potential impact on fauna with high-quality participation in the decision-making process. ▪ Establish cooperation with hunting, fishing clubs and nature conservation NGOs in all areas through which the route will pass in order to timely indicate and take measures for protection of migratory corridors, animal crossings and passages, and spawning and game breeding sites. ▪ Inspection and review of ten-year and annual plans for the use of game and fish stocks shall be carried out by hunting and fishing clubs, and measures for protection, improvement and mitigation taken and planned accordingly (establishing prohibition of hunting and fishing of individual species, establish feeding sites for endangered birds and game species, construction of small bays, and fishing spots for sport fishermen).

	▪ When carrying out works on or in the immediate vicinity of river courses, to a maximum extent consider reducing pollution of watercourses by solid waste, oily water, suspended particles from soil erosion, which can adversely affect the state of fish populations. ▪ Establish monitoring of river ecosystems and aquatic organisms. ▪ Establish monitoring of amphibians, reptiles and insects along sensitive ecosystems (forest ecosystems, cultivated areas, pastures, meadows, river banks and riverbeds). The monitoring would apply to the watercourses located on the route of planned motorway. ▪ Develop appropriate operational plans for monitoring and emergency response to possible accidents, and obtain the necessary equipment (cameras for monitoring game movements) and install it at the planned chainages.
Impact on landscape ▪ Visual and aesthetic adverse effects in terms of disruption of the harmonious landscape environment due to formation of excavations, embankments, stockpiles of excavated material, temporary construction site structures, stockpiles of stored materials and elements for installation, etc. ▪ when forming borrow pits, disruption of landscape features can assume a permanent character.	▪ Workplaces and structures should be planned and constructed so as to minimize disruption of the existing landscape features, and therefore the obligation of preserving the existing value of the landscape should be taken into account when planning stockpiles, borrow pits, temporary parking areas, etc. ▪ After completing construction works, the existing landscape should be reinstated as soon as possible. ▪ During construction, plan access roads to pass through the areas that do not require excavations and embankments so that it will be easier to rehabilitate them. If possible, plan to keep access roads that cannot be rehabilitated in operation after construction for the local population. ▪ When carrying out works on river banks and in riverbeds, work so as to leave migration passes for fish, and part of the work area along the riverbank should be arranged and reduced to a temporary separator/ catch basin to prevent pollution of the watercourses. In operation stage ▪ During operation, success of the self-vegetation process should be assessed and, where necessary, planned planting should be carried out. ▪ Establish a programme for monitoring reclaimed areas, and take mitigation / seedling replacement, replenishment, mowing, etc. measures accordingly.
Impact on protected parts of nature ▪ Serpentine complex Žepče - impacts due to falling, erosion and forest felling; ▪ Removal of vegetation and soil layer as a consequence of the motorway construction; ▪ Degradation of land due to construction works and movement of heavy machinery;	▪ The measures to be taken in the construction stage would be related to systematic implementation of prescribed measures and monitoring of all environmental components. ▪ In addition, existing vegetation, characterized by a high degree of biological diversity, should be preserved to the greatest extent possible. Construction site and construction activities as a whole must be organized in conformity with this fact.

▪ Deposition of dust that will be raised from the construction site and transport routes when trucks and machinery pass; ▪ Negative impact of exhaust gases from trucks and machinery on the physiology of plants near construction site. ▪ During construction works on bridges, development of access roads along river courses and execution of works in riverbeds, the landscape view along river banks and river courses themselves may be disrupted.	
Impact on cultural and historical heritage ▪ In the observed scope there are no formally protected monuments, but considering that the entire territory of Bosnia and Herzegovina has been inhabited since prehistoric times and there are numerous material remains from all historical periods, and since the route is being constructed on so far unexplored terrain, it is possible that chance material finds of movable or immovable heritage will occur, especially the when works are carried out in and near the riverbed of Bosna. ▪ Indirect impact on structures in the immediate vicinity of cultural and historical heritage is also possible due to noise and vibration during construction site organization, transport and storage of materials, borrow pits and stockpiling of materials.	▪ Develop a study on preliminary archaeological field reconnaissance and train workers on how to identify possible finds and how to handle archaeological remains, if found; ▪ Mandatory and continuous supervision of archaeologists and conservators in areas where preliminary surveys establish presence of cultural heritage sites and their constant consultative participation during the execution of the section; ▪ In case archaeological sites are encountered during construction, it is necessary immediately to stop the works and inform the competent cultural and historical heritage protection institutions or services, depending on the municipality where the site is located. ▪ In organization of construction site (access roads, borrow pit and storage of materials, storage of machinery, stockpile of materials) it is necessary to make sure to avoid cultural and historical heritage sites; ▪ Location of access roads, disposal of waste and deployment of heavy machinery shall be forbidden in areas in close proximity to known sites of cultural and historical heritage structures, as well as in areas where the possibility of physical damage or damage to archaeological finds is identified; ▪ Implementation of measures relating to noise and vibration protection and environmental protection.
Impact on hunting ▪ Decreasing incomes of hunting clubs from the sale of hunting licenses and hunting game shooting itself. ▪ impact on condition, presence, abundance of game in the area due to exposure to noise, vibration,	▪ Implementation of measures relating to noise and vibration protection and protection of fauna.

presence of machinery, people and other elements that will negatively affect wildlife and hunting in general. ▪ Decrease in game abundance due to migration of game inland, then fragmentation of habitats, increase in pressure of poachers and hunters on unprotected game. ▪ Impact on birds and their presence and abundance in the area will be manifested through cutting of vegetation, disruption and loss of habitats and nesting sites. ▪ Letting alone and not disturbing game and birds during nesting is one of the main ecological factors to which birds and game respond by migrating or leaving these habitats.	
Impact of noise and vibrations: ▪ Mechanization of motorway construction causes large noise and vibration in the construction work area, but also in prefabrication areas (crushing and separating plants, concrete plants, asphalt plants) and on roads where vehicles move. The sources of construction noise are the execution of construction works on construction sites (heavy construction machinery, possibly blasting at tunnel construction sites) as well as the noise caused by the traffic of construction machinery related to the execution of works. ▪ A particular problem is the application of blasting for excavation in rock material - especially in open space (on the route, in quarries-borrow pits) and to a lesser extent in tunnels, which result in intense but short vibration effects (seismic action of explosion may	▪ In the further stage of design, specify the locations and lengths of physical barriers that will protect population from noise in parts where the route passes through populated places or in their close proximity; ▪ Plan construction activities so as to avoid parallel activities of multiple equipment in the vicinity of receiver. ▪ On all construction machines and vehicles that are used in construction, it is mandatory to install sound protection (insulation) of engine and other assemblies that produce or contribute to development of noise; ▪ During execution of the works, keep the machinery (construction machines and vehicles) in proper operating order and use the same only when necessary. Equipment that is not being used at that time shall be shut off. ▪ Restrict the activities that potentially produce high noise (e.g. driving piles, blasting, and other activities) only to working hours during the day (7:00 to 19:00, Monday to Friday, and 7:00 to 13:00 on Saturdays) and avoid Sundays. Exceptions may be applied for e.g. individual structures such as tunnels; ▪ If blasting is used for excavations in rock massif, choose the type of explosive that has the least harmful environmental impact, use the technique of millisecond activation of explosive charges with directed action of explosion, in order to reduce the effect of superposition of dynamic impacts (vibration), noise and dust emission. Alternatively use an excavation technique using hydraulic hammers or mechanical excavation with milling machines, "moles" and the like;

have a particular effect by transmitting the shock wave through the ground to the environment).	▪ In case of exceeding the permitted values, provide workers with safety equipment at work and apply occupational safety regulations.
Impact on infrastructure: ▪ At places where power transmission lines intersect with the motorway, reconstructions on the power transmission lines may be needed in order to comply with prescribed safety and technical elements. ▪ In the area of Zenica Municipality (section Perin Han - Crkvica), the gas pipeline route is intertwined with the motorway route, so that the collision points between the gas pipeline and the motorway should be technically solved in this part. ▪ The conflict with existing power facilities (transmission lines) must be resolved through the main design and eliminated through preliminary works. ▪ There is a significant conflict with existing traffic routes of higher categories: main roads and railway line (double-track, electrified) which was solved already at the levels of conceptual designs, and in more detail in the stage of main design.	▪ In places of conflict with the existing power facilities (power transmission lines), through preliminary works relocate the lines; or separate/ protect/ insulate the lines by technical measures; ▪ In places of conflict with existing high-category traffic facilities, main roads and railway lines (double-track, electrified), it is mandatory to carry out the necessary temporary protection structures that will separate the facilities from the construction work area; apply all prescribed traffic signs and markings and, where necessary, provide traffic police patrols; ▪ In the stage of preparation and construction of the road, carry out measures for protection of infrastructure facilities in places where the route is intersected, run in parallel, or only approached in some places, in accordance with special regulations and conditions; ▪ Develop a project of temporary traffic regulation during construction of the planned project. Through it, regulate access points to the existing traffic system and ensure that there are no potential conflict points with existing traffic system during construction of the planned project; ▪ Plan grade-separated crossing of existing roads at places where the construction area is intersected; ▪ At places where field and forest roads are intersected, provide a network of alternative roads that will provide access to all the plots that had access before construction of the planned project, the locations of which will be defined in the project development stage. All crossings of field and forest roads over the route of the planned project must be grade-separated; ▪ Reinstate all existing roads and roads that are damaged due to the use of machinery and vehicles on construction of the planned road; ▪ In the next design stage, establish the exact position of water supply facilities (pipelines, tunnels, tanks etc.) which come into conflict with the adopted motorway route, and as part of the technical documentation solve the conflicts with this infrastructure; ▪ In the main design development stage, analyse the methods of water supply to the population in the periods when construction works on bridging this infrastructure are performed, with mandatory cooperation with the utility companies managing this infrastructure; ▪ The measures for protection of existing power network are contained in special regulations for construction of power networks, and they also contain measures for protection of cable lines at intersections with the motorway and connections to it. ▪ In the stage of construction, apply all prescribed/stipulated construction measures in order to protect the infrastructure lines.

▪ *OPERATION*	
Impact on population: ▪ Increased emissions of noise and harmful substances into the air on the structures in the immediate vicinity of the motorway, and the risks of accidents; ▪ Change of the established social patterns in the case of passing near populated places. ▪ Traditional systems and functions of settlements, as well as communication among residents in certain parts of the route will be disrupted and interrupted. ▪ Normal connections between villages and land properties can be cut off and separated in rural areas.	▪ Population protection measures are implemented through noise, water, land and air protection measures. ▪ Measures for establishing new communication structures in settlements where traditional modes of communication are disrupted by the motorway will be realized through construction of passages, bridges, viaducts, overpasses.
Impact on waters: ▪ Pollution of surface water and groundwater by discharging untreated water that flows from the road; ▪ impacts due to the occurrence of incident situations in the form of fire, explosion or damage to the wastewater collection system and discharge of polluted water to the soil/waters; ▪ impacts in the event of technical failures on contaminated water collection and drainage systems and irregular and/or inadequate maintenance of the road and stormwater drainage systems; ▪ in case of accident of a goods vehicle transporting larger quantities of environmentally harmful and hazardous substances, when there is an impact load, which spreads to much greater distances than in normal use of the road, in case of penetration underground. Due to their temporal and spatial	▪ All rainwater from the pavement in the immediate zone of watercourses and in water source protection zones shall be drained by a closed drainage system and treated in the grease and oil interceptor before being discharged into the recipient. The separator shall be designed according to the reference precipitation and characteristics of the sludge being treated. Only treated water shall be discharged into the final recipient in accordance with the applicable legal regulations; ▪ Regular maintenance of the road rainwater drainage system and facilities. Frequency of extraction and removal of sludge and oil from the grease and oil separator shall be determined during operation. Emptying of the separator shall be organized through the company in charge of road maintenance; ▪ Erosion control shall be implemented using stabilization means and erosion preventing plants; ▪ Road de-icing agents (salt, ice-melting chemicals) will be selectively applied at optimal rates and times, following weather forecast and avoiding any excessive application; ▪ Develop an Emergency Response Plan in case of accidents as defined in the Special Water Protection Measures; ▪ Within the organizations managing the motorway operation and maintenance, establish an environmental protection service that will perform the tasks of monitoring, maintenance and registering all actions in the domain of environmental protection.

unpredictability, such situations pose the greatest threat to groundwater and water sources. ▪ in case of accidents caused by human factor (driver fatigue, careless driving), which can cause the vehicle to skid off and overturn, petroleum and petroleum products and other harmful substances to spill into the environment, which may result in environmental accidents of a larger scale.	
Impact on air: ▪ deterioration of air quality along the motorway due to the continuous pollution consisting of waste gases and particulates of burnt motor fuel and raised dust of harmful substances already deposited on the pavement.	▪ In case the allowable air quality values are exceeded, act in accordance with legal regulations, or plan additional protection measures.
Impact on soil: ▪ Prolonged soil contamination and degradation effects, which is related to the occurrence of fuel combustion products, wear of tires, road surface, incident situations, and road maintenance in winter months.	▪ One of the most important measures to be continuously conducted throughout the road operation period is soil and plant monitoring, which should start by establishing baseline and be operational from the first day of road operation. Conducting monitoring does not mean that in the period after the road construction there will be no need for the measures specified for the period of its construction. ▪ Monitoring provides indication of concentrations of heavy metals, organic pollutants and salts and based on this a system of rehabilitation measures is developed. When circumstances require, rehabilitation measures are carried out in the zone 0-200 m to the right and left of the motorway, by conducting chemical, technical and phytomelioration works. ▪ Prolonged motorway use will certainly lead to documented accumulation of heavy metals in soil and plants. Pollutants accumulated along the roads enter the animal food chain, and reach other ecosystems as animals migrate due to erosive processes. Gritting salt also adversely affects soil primarily by reducing its fertility through changes in reaction, salt concentrations, peptization of soil colloids, and destruction of structure, which ultimately drastically reduce soil fertility. ▪ The impact of traffic and accompanying pollutants on land and the living world is cumulative, which is why it is important to establish baseline correctly and in a timely manner and to develop and implement monitoring of changes in space and time along the motorway route. This makes it easier to manage risk and take appropriate measures in incident situations, without improvisations and inadequate environmental management solutions.

Impact on flora: ▪ Impact on flora elements along the route (in the zone of 50-100 m on both sides) due to exhaust gases from cars. ▪ The impact on the flora component during operation will be manifested in the rate of growth of the vegetation cover on reclaimed surfaces. From the aspect of growth rate, the total biodiversity will increase on reclaimed and rehabilitated surfaces (surfaces where machinery, manpower, borrow pits, material stockpiles were located, then cuts, tunnels, strip along river courses etc.).	▪ Follow the implementation plan for reclamation of the areas disrupted by the works on the Corridor Vc route (construction sites, borrow pits, material stockpiling sites and other sites that have undergone significant changes in relation to the previous state). ▪ Monitor the rate of growth/ succession of vegetation cover on reclaimed areas.
Impact on fauna: ▪ Increased deaths on the route itself, of small or of large game animals, and of birds that are in constant or periodical migration along the corridor route. ▪ Impacts on fish species, amphibians and reptiles are possible through pollution from storm and oily water from road surface and in case of accident situations.	▪ During operation, carry out video monitoring at the chainages where crossings for animals are left. ▪ Monitor the presence, return, and stay of game in the area - adaptation to noise of game affected by the route/ corridor. ▪ In accordance with annual obligations of hunting organizations, fishing clubs and non-governmental organizations, establish permanent monitoring of game (spring counts for hunting clubs, autumn and winter bird migrations along the corridor Vc route). ▪ Ensure the establishment of feeding sites that will keep or direct game to natural crossings. ▪ Identify potential nesting and feeding sites visited and inhabited by wetland birds. ▪ Monitor bird deaths during the route operation, and take appropriate mitigation measures in accordance with the results and in cooperation with the Motorway Administration. ▪ Visually mark glass wind protection. ▪ Monitor the condition of water quality, together with the state of fish populations, while providing safety for the corridor. ▪ According to fishing data, perform restocking of the Bosna river flow and of other river flows where the impact on fish species is registered.
Impact on landscape: ▪ reduction of existing green areas (landscapes) ▪ green areas cutting ▪ environmental pollutant load	▪ During operation, success of the self-vegetation process should be assessed and, where necessary, planned planting should be carried out.

▪ degradation of flora and fauna ▪ change of the visual image of the area	▪ Establish a programme for monitoring reclaimed areas, and take mitigation / seedling replacement, replenishment, mowing, etc. measures accordingly.
Impact on protected parts of nature: ▪ Disruption of basic elements due to which the particular natural asset is placed under protection Therefore, it can be considered that the originality, representativeness, diversity, integrity and aesthetics of the area due to which it was declared a natural asset will be lost to some extent by construction of the motorway and its further operation	▪ They are implemented through the earlier described measures for mitigation of negative impacts on water, soil, air, landscape and plant and animal life. It is also necessary to monitor changes relative to baseline and to monitor the natural self-vegetation processes. ▪ In protected areas it is necessary to monitor the condition of visitor loads, and in the protection segment it is necessary to plan, manage and monitor tourism operations very carefully to ensure their long-term sustainability. Tourism in a protected area depends on the preservation of ecosystem qualities. Otherwise, there will be negative impacts so that, instead of contributing to its preservation, tourism will impair the quality of the protected area.
Impact on cultural and historical heritage: ▪ Impact on cultural and historical heritage structures during road operation is considered insignificant if the specified measures related to noise protection and environmental protection against pollution are adhered to.	▪ Implementation of other measures relating to noise and vibration protection and environmental protection.
Impact of noise and vibrations: ▪ Vibrations generated by traffic resonance can have harmful effects on structures near the road, especially on structures of cultural and historical heritage. ▪ Wildlife disturbance is caused by frightening of animals from crossing the road used by traffic.	▪ Continuously conduct noise measurements in accordance with control measurements specified in the monitoring programme, or based on complaints from population. Such monitoring will establish whether the measures taken are adequate (in case of built barriers), and in case of exceeding the noise levels, additional noise protection measures shall be provided in the form of additional noise protection barriers, traffic noise absorbing curtain, etc.
Impact on infrastructure: ▪ Not expected.	▪ The measures for protection of infrastructure facilities during the motorway operation are reduced to regular control of its proper technical condition and regular maintenance so that a potential malfunction would not have adverse effects on the environment, human health and property.

9.5. MONITORING SYSTEM

A plan for monitoring surface water and groundwater phenomena both during motorway construction and operation stages is proposed for the purpose of addressing and assessing the environmental changes occurred during the construction and exploitation stages, and/or effects of the proposed prevention/ minimization measures, and introduction of the necessary improvements and corrections

Establish continuous monitoring by the contractor of all environmental components: flora, fauna, hunting, wildlife, landscape diversity, protected areas in all stages: planning stage, construction stage, operation stage.

9.6. CONCLUSION

Construction of new motorway sections will improve regional traffic and help reduce local traffic congestion. The proposed changes in the project will improve road safety. PC Motorways has adequate capacity and resources to manage environmental and occupational health and safety risks if it fully implements the mitigation measures provided in this application and accompanying permits.

10. LIST OF LAWS

- Law on Environmental Protection (Official Gazette of FBiH, nos. 33/03 and 38/09)
- Law on Air Protection (Official Gazette of FBiH, nos. 33/03 and 39/09)
- Law on Waste Management (Official Gazette of FBiH, nos. 33/03 and 72/09)
- Law on Waters (Official Gazette of FBiH, no. 70/06)
- Law on Noise Protection (Official Gazette of FBiH, no. 110/12)
- Law on Physical Planning and Land Use at the level of the Federation of Bosnia and Herzegovina (Official Gazette of FBiH nos. 2/06; 72/07; 32/08; 4/10; 13/10 and 45/10) and bylaws adopted thereunder
- Law on Construction Products (Official Gazette of FBiH no. 78/09) and bylaws adopted thereunder
- Law on Nature Protection (Official Gazette of FBiH, no. 66/13)
- Law on Municipal Services (Official Gazette of SR BiH, 20/90);
- Law on the Protection of Cultural, Historical and Natural Heritage (Official Gazette of SR BiH, 20/85);
- Law on Protection of Assets Declared National Monuments of Bosnia and Herzegovina under Decisions of the Commission for Preservation of National Monuments (Official Gazette of FBiH, 2/02 8/02, 27/02);
- Decision to amend the criteria for designating assets as national monuments (Official Gazette of BiH, no. 15/03)
- Law on Forests (Official Gazette of FBiH, nos. 20/02, 29/03, 37/04)
- Law on Agricultural Land (Official Gazette of FBiH, no. 2/98)
- Law on Motorway on the Corridor Vc (Official Gazette of FBiH, no. 8/13)
- Law on Roads of FBiH (Official Gazette of FBiH, no. 12/10)

Implementing regulations relating to the set of environmental laws

Law on Environmental Protection

- Rules on plants and facilities for which environmental impact assessment is required and plants and facilities which can be constructed and commissioned only if they have an environmental permit (Official Gazette of FBiH, 19/04);
- Rules on the conditions and criteria to be met by Environmental Impact Study developers, amount of fees and other expenses incurred in the process of environmental impact assessment (Official Gazette of FBiH, 68/05);
- Rules on deadlines for submission of applications for issuance of the environmental permit for plants and facilities which have permits issued before the entry into force of the Law on Environmental Protection (Official Gazette of FBiH, 68/05);
- Rules on conditions for submission of applications for issuance of the environmental permit for plants and facilities which have permits issued before the entry into force of the Law on Environmental Protection (Official Gazette of FBiH, 68/05);
- Rules on the preparation of annual/semiannual programmes of environmental protection inspections (Official Gazette of FBiH, 68/05);
- Rules on the content of reports on the state of safety, content of information on safety measures and content of internal and external intervention plans (Official Gazette of FBiH, 68/05).

Law on Waste Management

- Rules on the conditions for transfer of obligations from manufacturers and sellers to the operator of the waste collection system (Official Gazette of FBiH, 9/05)
- Rules on waste categories with lists (Official Gazette of FBiH, number 09/05);

- Rules on the content of the waste management adjustment plan for existing waste treatment and disposal plants and activities undertaken by the competent body (Official Gazette of FBiH, 9/05);

Law on Air Protection

- Rules on air quality monitoring (Official Gazette of FBiH, 12/05);
- Rules on monitoring emissions of pollutants into the air (Official Gazette of FBiH, 12/05);
- Rules on limit air quality values (Official Gazette of FBiH, 12/05);
- Rules on the emission of vaporizing organic compounds (Official Gazette of FBiH, 12/05);
- Rules on limit values for emissions of pollutants into the air (Official Gazette of FBiH 12/05);
- Rules on gradual exclusion of ozone-depleting substances (Official Gazette of FBiH, 39/05)

Others

- Rules on establishing and managing an information system for nature protection and monitoring (Official Gazette of FBiH, no. 46/05).
- Regulation on wastewater discharge into the environment and public sewerage systems (Official Gazette of FBiH, nos. 101/15 and 01/16)
- Rules on allowable limits of sound and noise intensity (Official Gazette of SR BiH, no. 46/89)
- Rules on the method of monitoring air quality and defining the types of pollutants, limit values and other air quality standards (Official Gazette of FBiH, no. 01/12)
- Regulation on construction site organization, mandatory documentation on construction site and construction work participants (Official Gazette of FBiH, nos. 48/09, 75/09.)
- Regulation on type, content, marking, keeping, control and validation of investment and technical documentation (Official Gazette of FBiH, no. 33/10)
- Regulation on spatial standards, urban and technical conditions and standards for preventing creation of all barriers for persons with reduced physical abilities (Official Gazette of FBiH, no. 48/09)
- Regulation on technical properties that structures must meet in terms of safety and method of use and maintenance of structures (Official Gazette of FBiH, nos. 29/07 and 51/08)
- Decision on ratification of the Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Official Gazette of BiH, no. 31/00)
- Decision on ratification of the United Nations Framework Convention on Climate Change (Official Gazette of BiH, no. 19/00)
- Decision on ratification of the Convention on Biological Diversity, Rio de Janeiro, 5 June 1992 (Official Gazette of BiH, no. 13/02)
- Decision on giving consent for ratification of the International Plant Protection Convention (Official Gazette of BiH, annex International Agreements, no. 10/03)
- Decision on giving consent for ratification of the Framework Agreement on the Sava River Basin (Official Gazette of BiH, annex International Agreements, no. 10/03)
- Decision on ratification of the International Plant Protection Convention (Official Gazette of BiH, no. 8/03)
- Instruction on determination of permissible quantities of harmful and hazardous substances in soil and methods of their testing (Official Gazette of FBiH, 11/99)

- Guidelines for design, construction, maintenance and supervision on roads, 2005 (PC Roads Directorate of FBiH and PC Roads of RS, hereinafter referred to as the "Guidelines"), adopted by entity governments.

Adopted BAS standards in the field of roads, which are specifically related to construction products.

As well as all other laws, regulations and standards in subject fields for which technical documentation is made.

The most important EU directives in the field of environmental protection are:

- Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC on assessment of environmental impact of certain public and private projects;
- Council Directive 96/61/EC of 24 September 1996 relating to integrated pollution prevention and control (IPPC Directive);
- Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances - Seveso II Directive
- Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment
- Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information and repealing Council Directive 90/313/EEC,
- Directive 2003/35/EC of the European Parliament and of the Council of 26 May 2003 providing for public participation in respect of the drawing up of certain plans and programmes relating to the environment
- and amending with regard to public participation and access to justice Council Directives 85/337/EEC and 96/61/EC - Statement by the Commission

International conventions and protocols relating to the environment, acceded to by Bosnia and Herzegovina:

- Framework Convention of the United Nations on Climate Changes, Rio de Janeiro, 1992. (Became effective on: 21 March 1994) (Official Gazette of BiH, 19/00)
- Convention on Long-Range Transboundary Air Pollution, Geneva 1979. (Became effective on: 16 March 1986) (Official Gazette of R BiH 13/94)
- The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, Basel, 1989. (Entered into force on: 05 May 1992) (Official Gazette of BiH, 31/00)
- Convention on Biological Diversity, Rio de Janeiro, 1992. (Entered into force on: 29 December 1993) (BiH joined on 26 August 2002, ratified on 4 October 2002)
- Convention Concerning the Protection of the World Cultural and Natural Heritage (Entered in force on: 17 December 1975)
- UNECE Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, Aarhus, 1998,
- Kyoto Protocol, Kyoto, 1997.

11. APPENDICES