APPLICATION FOR ISSUANCE (EXTENSION) OF THE ENVIRONMENTAL PERMIT FOR THE PROJECT “MOTORWAY ON CORRIDOR VC” LOT 1 SECTION SVILAJ – DOBOJ SOUTH (KARUŠE)

Sarajevo, February 2021

GENERAL PROJECT INFORMATION

Document	**Application for Issuance (Extension) of the Environmental Permit for the Project "Motorway on Corridor Vc" Lot 1 Section Svilaj – Doboj South (Karuše)**
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1. INTRODUCTION

JP Autoceste Federacije Bosne i Hercegovine (JPAC FBiH), hereinafter referred to as the Investor, is in the phase of preparing the application for approval of the construction of the Subsection Putnikovo brdo - Doboj South (Karuše) of the Motorway on Corridor Vc (within LOT 1: Section Svilaj (border with the Republic of Croatia) – Doboj South (Karuše), as per prior division). The Section Svilaj – Odžak in the length of approximately 11 km has been constructed, and the approval for its operation is in the preparation phase.

IPSA Institut d.o.o. Sarajevo developed the Main Design for this Section in 2010.

As part of these project activities and for the purpose of providing the necessary documentation (Environmental Impact Assessment and Waste Management Plan) for obtaining the Environmental Permit, the company IPSA d.o.o. Sarajevo prepared the Environmental Impact Assessment for the LOT 1 Section Svilaj – Doboj South (Karuše) of the Motorway on Corridor Vc.

Pursuant to Article 72 of the Law on Environmental Protection ("Official Gazette of the FBiH". nos. 33/03 and 38/09), Articles 9 and 11 of the Rulebook on plants and facilities for which the environmental impact assessment is mandatory and plants and facilities which can be constructed and commissioned only if they have the environmental permit (Off. Gazette of the FBiH, no. 19/05), and Article 200 of the Law on Administrative Procedure (Off. Gazette of the FBiH, no. 2/98), The Federal Ministry of Environment and Tourism issued the Decision on renewed Environmental Permit UPI 05/2-23-11-75/16 of 6 June 2016, and the Conclusion on correction of spelling mistakes of 19 August 2019.

The Decision was issued for the entire LOT 1 Section of the Vc Motorway: Svilaj (including the part of the bridge belonging to BiH) – Doboj South (Karuše), which consisted of two subsections in the territory of the Federation of BiH:

- Subsection 1: Svilaj – Odžak (0+10.750)
- Subsection 2: Putnikovo brdo – Doboj South (Karuše) (0+4.750)

The subject of this Application for issuance (extension) of the environmental permit is the Section Svilaj (border with the Republic of Croatia) – Doboj South (Karuše).

Considering that the Federal Ministry of Environment and Tourism, according to Article 68 of the Law on Environmental Protection (Off. Gazette of the FBiH, nos. 33/03, 38/09) issues a 5-year term environmental permit, the JPAC FBiH is determined to extend the existing environmental permit for Lot 1 since it expires on 9 June 2021.

With a view to extend or renew the existing environmental permit, the JPAC FBiH submits the **Application for issuance (extension) of the environmental permit** to the Federal Ministry of Environment and Tourism, the content of which is defined in Article 54a of the Law on Environmental Protection (Off. Gazette of the FBiH, nos. 33/03, 38/09), and is in accordance with the provisions of the Rulebook on plants and facilities for which the environmental impact assessment is mandatory and plants and facilities which can be constructed and commissioned only if they have the environmental permit (Off. Gazette of the FBiH, no. 19/04), the Rulebook on conditions for submission of applications for issuance of the environmental permit for plants and facilities with permits issued before the entry into force of the Law on Environmental Protection (Off. Gazette of the FBiH, no. 45/09), and the provisions of the Law on Waste Management (Off. Gazette of the FBiH, nos. 33/03, 72/09).

2. NAME AND ADDRESS OF OPERATOR/INVESTOR

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3. EXCERPT FROM THE PLANNING ACT

3.1. Spatial planning documentation of impact area

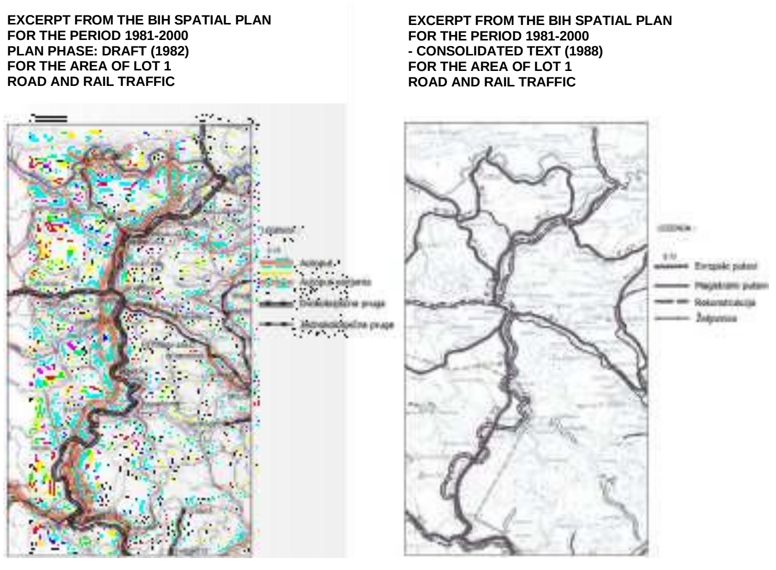
The route of the motorway on Corridor Vc, on the stretch of LOT 1, passes through the municipalities of Odžak, Vukosavlje, Modriča, Doboj, Usora and Doboj South. The spatial coverage of the wider impact area includes the region of Doboj, which comprises eight municipalities. The more limited impact area includes six municipalities, three of which are in the territory of Republika Srpska (Vukosavlje, Modriča and Doboj), while the other three are in the territory of the Federation of Bosnia and Herzegovina (Odžak, Usora and Doboj South). Until 1992, this area was part of the municipalities of Odžak, Modriča and Doboj. In the past ten years or so, significant changes occurred in this area, as well as in BiH and the region as a whole; war events, formation of new territorial–political borders, changes in the geopolitical environment, etc. The newly formed municipalities are Vukosavlje (from parts of the municipalities of Odžak and Modriča), Doboj South (separation of settlements from the municipality of Doboj), and Usora (separation from the municipalities of Doboj and Tešanj).

The Federation of Bosnia and Herzegovina is also organized at the cantonal level, unlike Republika Srpska, so that the municipalities of Doboj South and Usora are located within the Zenica-Doboj Canton, while the municipality of Odžak is in the Posavina Canton.

3.1.1. Data and spatial planning documentation of the specific area through which the Motorway on Corridor Vc will pass

Excerpt from the Spatial Plan of BIH for the period 1981–2000, consolidated text (1988)

The Spatial Plan of BiH identifies the routes of European roads (E 73, E 661, E761 and E 762) with special emphasis that on the course of the "North-South" trans-European motorway, overlapping with the road E 73 and passing along the valleys of the Bosna and Neretva rivers, the protection of municipality and town areas where the route of European road E 73 is planned should be included in the preparation of their spatial and urban plans.

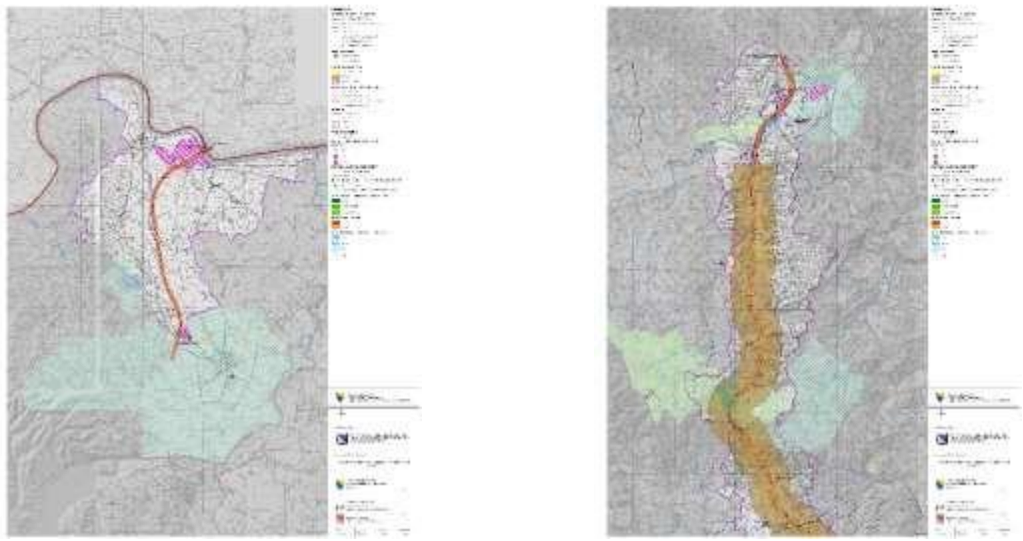


Excerpt from the Spatial Plan of BiH for the area of LOT1

The Spatial Plan of Bosnia and Herzegovina for the period 1981-2000 – Consolidated text (Off. Gazette of SRBiH, no. 33/88), adopted a certain difference in terms of the position of the motorway route determined in the Draft of that same Plan (from 1982).

The Draft Plan from 1982 determined the motorway route passing from Modriča to the north towards Odžak and the border with the Republic of Croatia. The contact point was on the Sava River near Svilaj. In the Spatial Plan of BiH for the period 1981-2000 – Consolidated text, the motorway route passed from Modriča along the valley of the Bosna river to Bosanski Šamac.

Given that Corridor Vc has had the adopted Spatial Plan for areas with special features of importance to the Federation of Bosnia and Herzegovina since 2017, "Motorway on Corridor Vc", municipalities through which the Corridor passes have adapted to that.



Combined overview of the land-use in the planning period

4. DESCRIPTION OF THE PROJECT

4.1. Section Svilaj – Odžak

The Svilaj – Odžak Section of the motorway, over 10 km long, represents the northernmost part of the Corridor Vc in Bosnia and Herzegovina.

The Section starts directly after the future interstate "Svilaj" bridge that will bridge the Sava river, and ends at the "Odžak" interchange, located to the north of the town of Odžak. The bridge over the Sava River is also a junction of the motorway that passes through Bosnia and Herzegovina and Croatia.

The beginning of the route is at the elevation of 86.74 masl, and the end at the elevation of 108.21 masl. As the motorway passes through the lowland terrain, the requirement for it was to have slight elements of vertical and horizontal curves so as to better adapt to the terrain. The design speed of the route is 120 km/h.

Important facilities on this Section include the border crossing, two interchanges, rest area, frontal toll station, 2 bridges, 3 wildlife crossings, 4 overpasses, 3 underpasses, and 2 culverts for irrigation canals.

Since the route lies on terrain that has the pronounced long-term subsidence, technical solutions of subsidence acceleration were applied using vertical drains that were previously built into the ground.

As part of the motorway construction, an access road of approximately 4 km in length will be built, which will connect the motorway with the primary road M14.1. The access road shall include the future southern arm of the Odžak bypass.

4.1.1. Description of the route with the main facilities

4.1.1.1. Route

The start point of the Section Svilaj-Odžak also represents the end point of the future interstate bridge "Svilaj" over the Sava river. The bridge is located at the inflection point of two vertical curves and designed in alignment that extends up to km 1+582.61. Since the construction of the bridge ends at chainage km 0+328.05 as measured from the middle of the bridge, the motorway section begins at that very chainage.

At this point, the construction of the Border Crossing of 550x200 m has been planned, as well as the "Svilaj" interchange, km 1 + 406.00. From the said alignment, the route goes into the right curve T1, R=2200 m. A frontal toll station "CP" has been designed for this point. The route then continues in a long alignment, L=2402.07, up to km 7+ 073.36, and goes into curve T2 with R=3500 m.

At km 7+000.00, a Type C rest area has been designed, on both sides. The Section end is at km 10+762.5, which is also the Entity border. At the Section end, construction of the Odžak interchange has been planned, and access road to connect the motorway with the primary road M14.1. The length of the access road that has elements of the primary road is approx. 4 km.

The following are the applied Technical elements of the route (both Sections):

- Length of the route: 10.434.45 m

- Minimum length of transition curve, L=350 m, applied once
- Minimum radius of horizontal curve: 1750 mm
- Maximum gradient of level line: 0.5% / 944.00 m, excluding the bridge over the Sava River where it is 2%
- Minimum gradient of level line: 0.3 % / 7.609.00 m
- Minimum radius of vertical curve, concave: 14.000 m
- Minimum radius of vertical curve, convex: 40.000 m

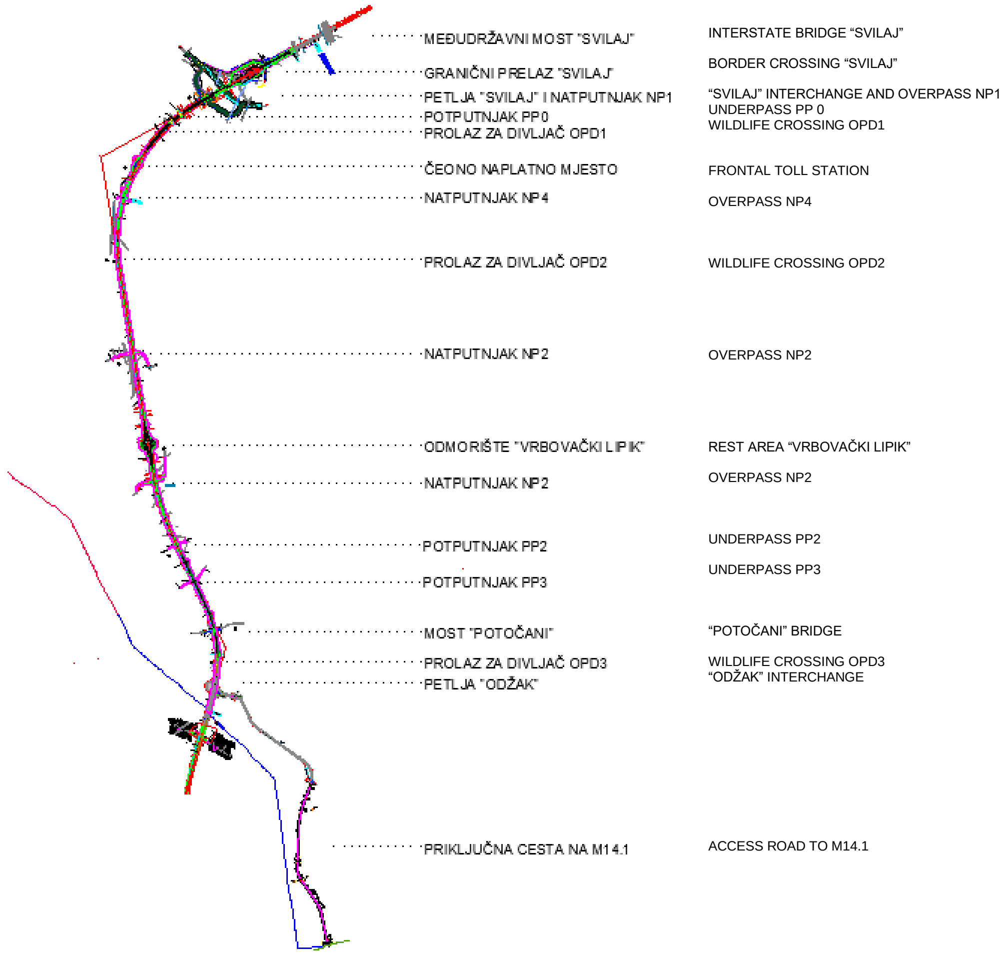


Diagram of the route with positions of the most important facilities

4.1.1.2. Facilities

4.1.1.2.1. Animal crossings

Three wildlife crossings and several minor culverts for smaller animals have been designed along the motorway, thus complying with the requirements of the Environmental Permit. The following is a layout solution with a graphical representation of the characteristic wildlife crossing.

The crossings are planned as an integral reinforced-concrete structure of a total length of 20.00 m. The normal cross-section consists of beams the height of which varies from 1.0 m in the middle to 1.6 m at the abutment junction. Abutments consist of a 1.60 m thick body, with the average height of 6.5 m, and are firmly connected to eleven piles arranged in a single row, of 1200 mm in diameter. Wing walls, 8.00 m long, are placed on abutments and are connected to one pile of 1200 m in diameter. Transition slabs are placed behind the abutments; they consist of a single 3.7 m part and rest on the intended projection.

4.1.1.2.2. Overpasses

A total of 4 overpasses are designed on the Section. The overpass NP1 is designed as part of the primary road M14.1, while the remaining overpasses enable transverse communication on local roads.

Although overpasses differ in the number of spans that bridge the obstacle, which is caused by the geometric elements the overpasses must fit into, they are all designed with a similar static system and geometric elements to streamline the construction thereof.

The overpasses are designed as a semi-integral structure of prestressed concrete, except for the overpass NP4 which is of reinforced concrete. There is no median pier in the central reservation, the right and left carriageways are bridged with only one span. The normal cross-section consists of plates, with cantilever arms on both sides.

The overpass prestressing requires 11 strands of 19Ø15.7mm (150mm²) made of ST 1570/1770 steel.

The abutments are done as massive capping beams, dimensions __. The capping beams rest on piles of Ø1200mm in diameter which are arranged in a single row. Short hanging wings of ___ in length are placed on the abutments. The span structure is firmly connected to the median piers. Median piers over the foundation pad rest on the 1200mm diameter piles. Pile lengths are adjusted to geotechnical characteristics of the formation soil.

At the ends, the span structure has overhangs for anchorage and protection of the prestressing strands.

The front of the inclined embankments is lined with stones in cement mortar.

4.1.1.2.3. Border crossing "Svilaj"

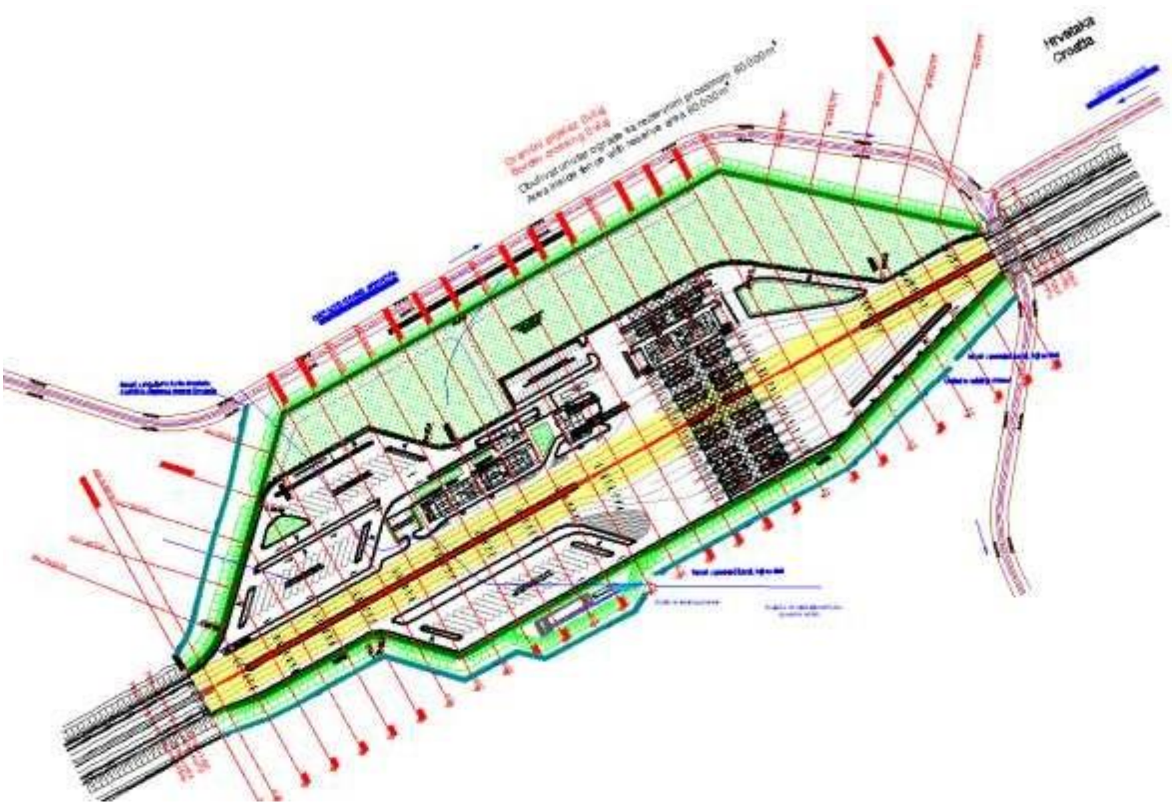
The "Svilaj" border crossing is located in the northernmost part of Bosnia and Herzegovina where the Sava River forms the natural border between BiH and the Republic of Croatia. The total length of the border crossing is 550.0 m from km 0+760.00 to km 1+310.00. With its size and amenities, it shall accommodate the future passenger and freight traffic.

The entire plateau of the border crossing is situated on the lowland terrain and surrounded by a 5-6 m high embankment. It partly crosses the existing primary road M14.1 Bosanski Brod – Odžak and the Srnotača river, which is why the existing design documentation provides for their relocation and regulation.

The total surface area of the border crossing within the confines of protective guarding is 80.000 m^2, with the reserved area of 20.300 m^2 for possible extensions.

In terms of layout, the entire plateau of the border crossing is in the alignment. Its width varies from the basic width of the motorway route at its beginning to the width of approx. 180 m at the canopy position. In vertical sense, one concave curve R=35.000 m has been planned for the plateau, with a slight downward or upward slope of 0.3%. Such elements are taken from the Main Design of the route of this part of the motorway.

The border crossing plateau contains all necessary facilities and infrastructure. In addition to lanes as the main traffic part of the crossing, the parking areas for trucks, buses, emergency vehicles, and staff vehicles are also planned on the plateau.

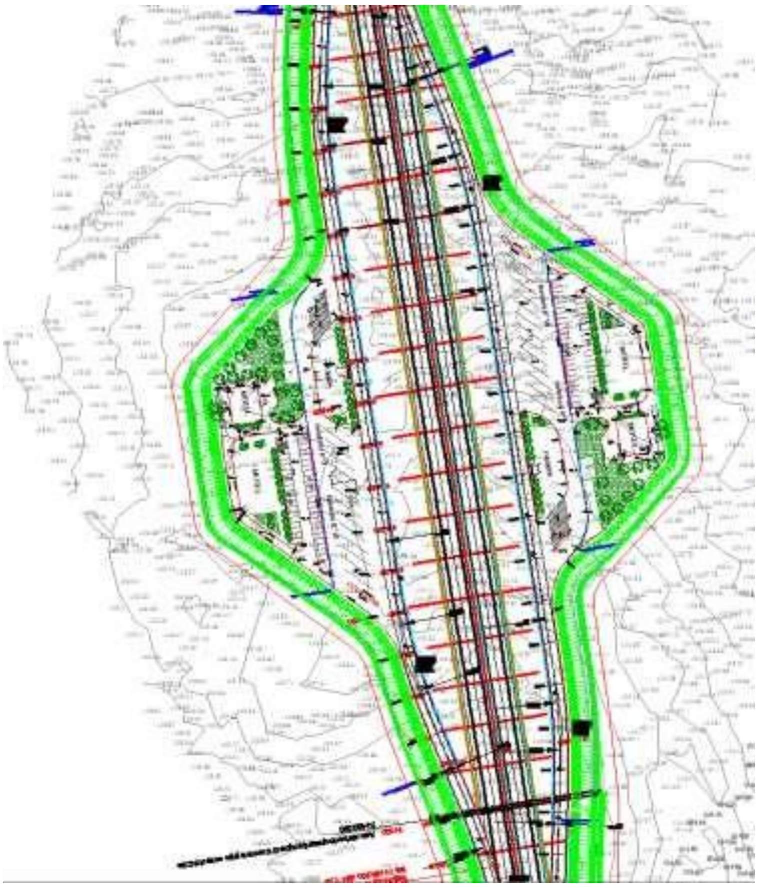


Layout plan of the Border crossing

4.1.1.2.4. Rest area "Vrbovački Lipik"

The ancillary service facility PUO "VRBOVAČKI LIPIK" is located at km 6+920.00 of the motorway, on both sides.

Both PUOs (Eng. ASFs) are located on the alignment in both the horizontal and the vertical sense. Due to the construction needs and other requirements, road widening was carried out on both sides. The level of construction of the rest area is next to the level of the facilities, including drainage.

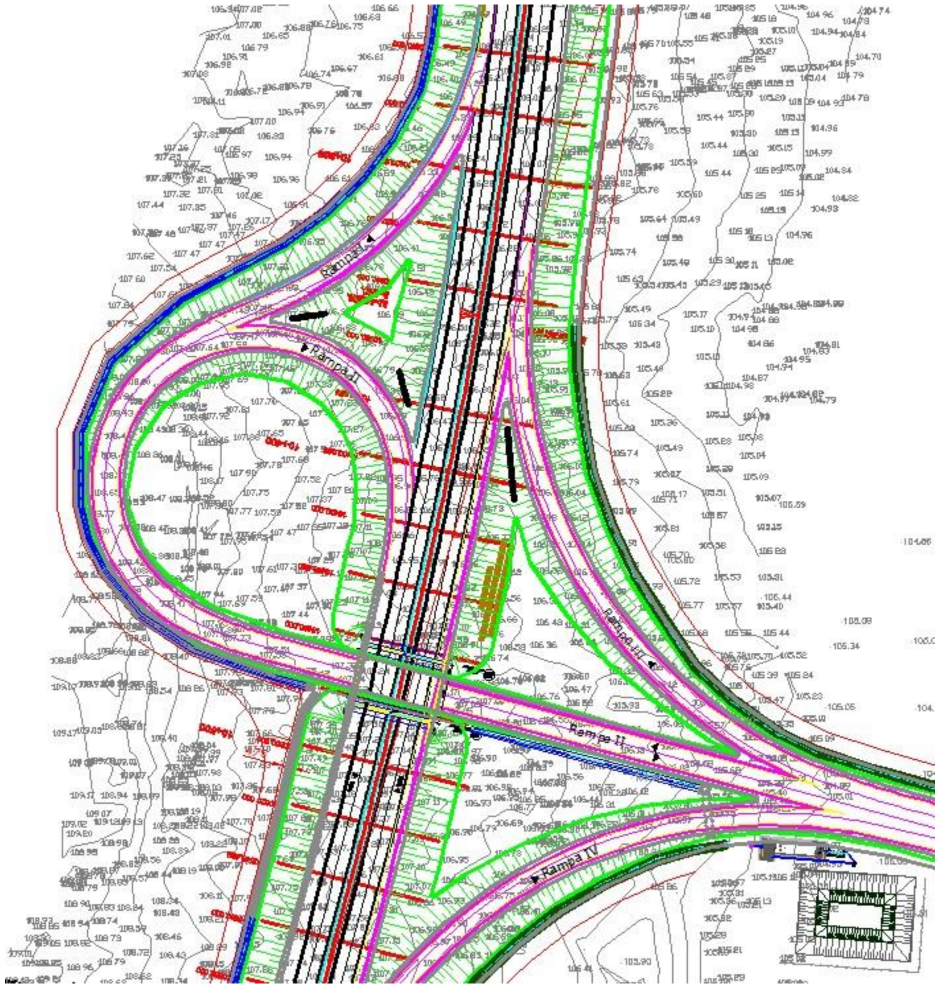


Layout plan of the "Vrbovački Lipik" rest area

4.1.1.2.5. "Odžak" interchange

The position of the interchange is defined by the Spatial Plan for areas with special features of importance to the Federation of BiH – "Motorway on Corridor Vc", 2008-2028, at km 10+471.63 on the main route of the motorway. The location of the interchange is partly in the circular curve (R=1750m) and partly in the transition curve.

The connection is achieved by the "trumpet" type interchange as the most suitable type of three-leg connections in terms of taking up space and investment costs. The trumpet-type interchange belongs to the Category 1 junctions where only merging and diverging traffic flows are present on the main carriageways. It consists of two direct ramps, one semi-direct ramp, and one indirect ramp. Based on that, the right-hand trumpet interchange has been planned. The interchange itself consists of four ramps, two for each – merging and diverging, and of acceleration/deceleration lanes (speed-change lanes).



Layout plan of the Odžak interchange

4.2. Section Putnikovo brdo – Doboj South (Karuše)

Upon exiting the Putnikovo brdo 2 tunnel, located in the Municipality of Usora, the route descends down the slope where it intersects the existing local road and comes to the Usora interchange on the left bank of the river, and it then crosses the Usora riverbed. The first bridge over the Usora River (Usora 1) is planned in this part. On the other side of the Usora River (right bank), the route enters the territory of the Municipality of Doboj South, and afterwards the territory of the Municipality of Tešanj, thus approaching the existing primary road M4, and running in parallel with the primary road, and then crosses the Usora riverbed for the second time (Tešanjka 1 bridge), thus getting back to the left bank, and enters the territory of the Municipality of Usora, then again intersects the Usora riverbed for the third time (Tešanjka 2 Bridge). Lot 1 ends at the intersection with the road M4 Doboj-Teslić.

The following facilities are planned for this Section:

- 4 bridges on the motorway,
- 1 smaller bridge on the Usora river regulation,
- 1 underpass,
- Usora interchange,
- Frontal toll station Doboj South.

A part of the Project is also the regulation of the Usora river in the length required for the construction of this Section on the motorway on Corridor Vc, as well as the relocation of the existing primary road M4.

The total length of the motorway route on this Section is approximately 5 km.

Section: Putnikovo brdo - Doboj South (Karuše)

4.2.1. Description of the route with the main facilities

In terms of layout, the route of the motorway is harmonized with the Spatial Plan and, for the most part, with the previously prepared documentation at the level of the Main Design Putnikovo Brdo – Karuše and the Preliminary Design Karuše – Medakovo.

The beginning of the route has been agreed upon with the designer of the previous Section (Section: Johovac – Putnikovo Brdo) at chainage km 10+920 of the previously done Main Design Johovac – Doboj South from 2010, with the same horizontal and vertical elements taken from the mentioned project and, at the request of Investor, the said chainage was marked as zero chainage, so that it corresponds to km 0+000.00 (LOT1 2020) = km 4+750.00 (LOT2 2010).

4.2.1.1. Route

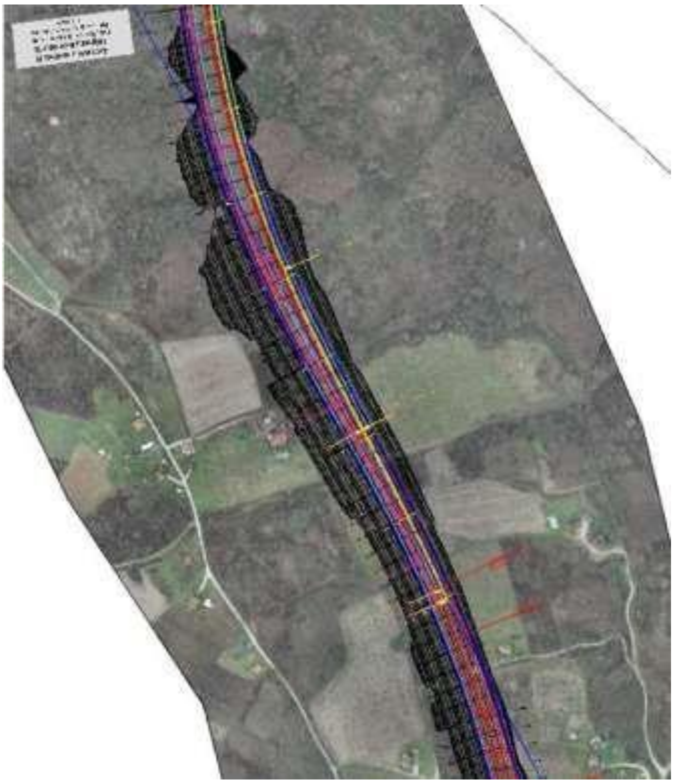
The beginning of the LOT 1 Section Putnikovo Brdo – Doboj South (Karuše) is located in a curve with the radius R=1200m, after which the route, in a wide "S" curve with R=1450m, descends towards the settlements of Ularice and Makljenovac passing between them.

At the initial part of the route (km 0+000.00 - 1+120.00), the level line is in the larger cutting (consisting mainly of claystone, marlstone and sandstone).

After that stretches a part of the route which is positionally conditioned by the Usora interchange, since there are water wells near the route from which the mentioned settlements are supplied with the drinking water (highest level of water protection) and there is limited space where interchange legs can be connected to the motorway route.

4.2.1.1.2. Technical elements of the route

- Type of road: motorway
- Terrain category: Lowland, hill and mountain categories alternate
- Design speed: 120km/h
- Maximum gradient: 4%
- Minimum radius of horizontal curve: 700m
- Minimum transition curve: 90m
- Traffic lane: 3.75m
- Breakdown lane: 2.50m
- Marginal strip along the central reservation: 0.50m (included in central reservation) Marginal strip along the breakdown lane: 0.25m (on the outer side of the breakdown lane and included in its width)
- Central reservation: 4.0m, including the gutter, curb and marginal strip
- Flank: min. 1.50 m + gutter or segmental ditch needed
- Berm: min. 2.50 m (conditioned by the drainage regime and geomechanical properties of the material)
- Full road cross-section: 4.70m



Beginning of the motorway LOT1 Section Putnikovo Brdo – Doboj South (Karuše) (after exiting the "Putnikovo Brdo 2" tunnel)

4.2.1.2. Facilities

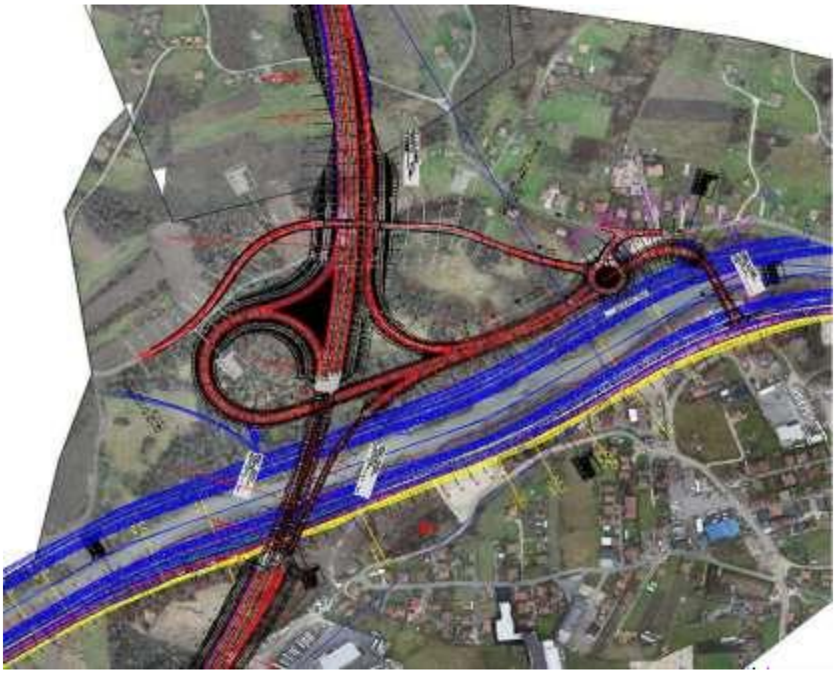
In a relatively small area, several projects have been planned, namely:

- Usora interchange with the connection (roundabout) to the relocated primary road M4 and local road through the Municipality of Usora
- Regulation of the Usora River
- Usora 1, Usora 2 and Usora 3 bridges

- As well as the relocation of the local road that connects Ularice and Makljenovac.

4.2.1.2.1. Usora interchange

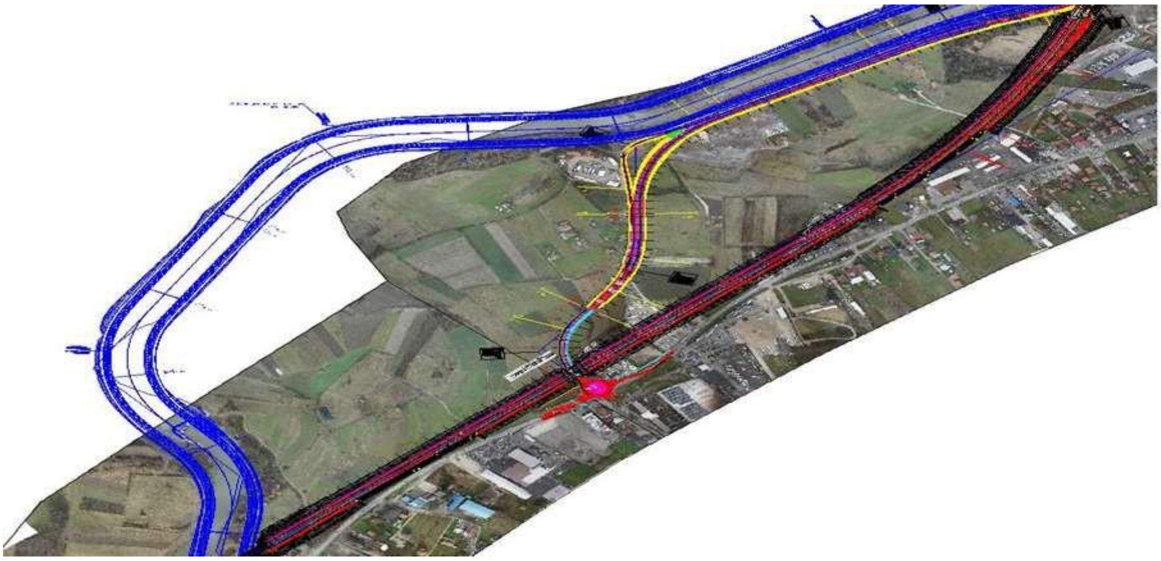
The crossing over the regulated riverbed of the Usora River and the relocated primary road M4 is achieved by the "Usora 1" bridge of L=276.00 m in length, and the "Usora 2" bridge on the interchange leg which spans these obstacles is also planned.



Usora interchange area, regulation of the Usora River and relocation of the primary road M4

4.2.1.2.2. Regulation of the Usora River and relocation of the primary road M4

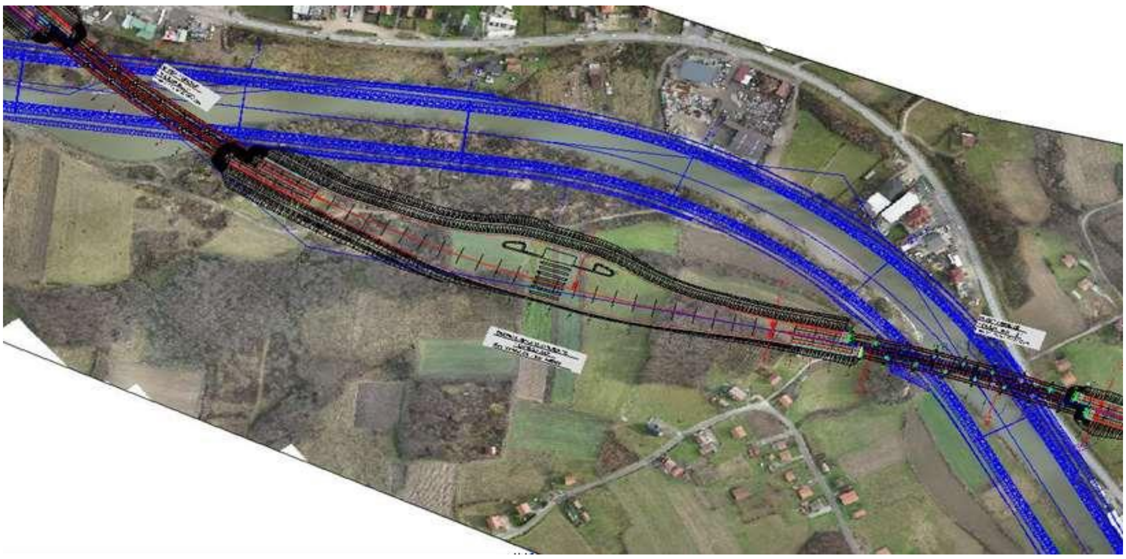
From km 2+000.00 to km 3+650.00 the route passes along the settlement at the beginning, and along the industrial zone parallel to the existing primary road M4. The existing primary road and commercial facility are protected by support structures of reinforced soil. The route is in the embankment of an average height of 7-9 m. At km 3+020.00, the route of the motorway crosses the relocated primary road over the 28m long "Kraševo" bridge.



Parallel stretch of the motorway route to the existing primary road, regulation of the Usora River and relocation of the primary road M4

From km 3+650.00 to km 4+750.00, the route crosses the regulated riverbed of the Usora River twice over the bridges "Tešanjka 1" of L=228m and "Tešanjka 2" of L=228m between which lies the frontal toll station "Doboj South" of l=500m (km 3+980.00 - km 4+480.00) in length).

4.2.1.2.3. Toll station



Frontal toll station "Doboj South"

5. NON-TECHNICAL SUMMARY

Purpose and objective of the Project

Corridor Vc is included in the TEM transport infrastructure network of Southeastern Europe, and runs from Budapest (Hungary) via Osijek (Croatia) and Sarajevo (BiH) to the port of Ploče (Croatia). The route of Corridor Vc in BiH is approx. 330 km long and runs in the north-south direction, through the central part of the country, utilizing the most favorable natural conditions, along the valleys of the Bosna and Neretva Rivers.

The transport Corridor Vc stretch through BiH includes:

- E-road E-73 Šamac - Doboj - Sarajevo - Mostar - Čapljina - Doljani, which reaches the Adriatic Sea via the port of Ploče, while Budapest is its connection point in the north,
- Railway Šamac - Doboj - Sarajevo - Mostar - Čapljina - Metković,
- Sarajevo and Mostar airports,
- Waterways and ports on the Sava, Bosna and Neretva rivers.

In the 1970s, the UNDP Geneva proposed the initiative and the plan to improve the motorway network in Europe. The project also included the Baltic Sea-Adriatic Sea (Baltic-Adriatic) motorway, called the TEM.

At the Third Pan-European Transport Conference, which gathered the European Union member states and international organizations involved in the development of infrastructure in Europe and was held in Helsinki in 1997, the "Helsinki Declaration" was adopted, laying the framework to construct additional 10 Pan-European corridors, including the motorways.

That Declaration also defined the routes of these 10 Trans-European corridors and their branches. The choice of the route direction through BiH was defined under item Vc of the Pan-European Corridor (Budapest-Osijek-Sarajevo-Ploče).

As already mentioned, Corridor Vc belongs to the Pan-European network of corridors connecting the central part of the Adriatic coast, which has great tourism potential, but more importantly the port of Ploče, with Corridor X between Zagreb and Belgrade, ending at the Budapest junction. With the planned increase in the capacity of the port of Ploče, the Corridor has the potential to enhance trade relations for the countries in the region, and for Bosnia and Herzegovina, the Corridor has the potential to improve trade with neighboring countries and Central Europe.

All study and design documents for the motorway aim to provide a comprehensive analysis of the need to improve the quality of transport, capacity and traffic safety in the corridor by constructing a full-profile motorway. Study sponsors and financial institutions will use the study output as a basis for making investment decisions. This should particularly be kept in mind while preparing the Prefeasibility Study and the Environmental Protection Study.

Pursuant to the Pan-European Transport Initiatives and Helsinki Declaration, which have been embraced as a great opportunity for Europe and particularly BiH, increased activity in BiH has recently been observed in preparations for the construction of high-order roads, i.e. motorways and expressways, in order to meet the needs of the population and economy, and to influence the overall development. Along with other roads (Banja Luka-Gradiška, Tuzla-Orašje and Adriatic-Ionian motorway), preparatory activities have also started for the motorway on Corridor Vc. Hence the Ministry of Communications and Transport of BiH:

- issued the Decision on existence of public interest in constructing the motorway on Corridor Vc through Bosnia and Herzegovina on the basis of a concession granted on the section and route to be defined by contract (Off. Gazette of BiH, no. 23 of 7 August 2003),
- signed the agreement and agreed on the border crossing point between the Republic of Croatia and BiH on the Sava River (Svilaj-Odžak) as part of the motorway route along with the route coordinates (3 September 2003),
- deliberated on the proposal of the Republic of Croatia to determine the southern junction point of the motorway on Corridor Vc, and concluded that, due to the insufficiently elaborated design documentation and complexity of connection to the Adriatic-Ionian motorway, determining the position of this point requires a more detailed design documentation,
- continuously exchanged information and views with representatives of the Republic of Croatia and the Republic of Hungary regarding the preparations for the construction of the motorway on Corridor Vc,
- provided the necessary funds for the preparation of planning and study documentation and other preparatory activities for the motorway on Corridor Vc.

Taking into account the country's indebtedness, the status with the World Bank and International Monetary Fund as well as the impossibility of significant borrowing or allocation of funds from the budget, the Council of Ministers of BiH decided that one suitable way to finance the construction of this motorway would be through concessions. Thus the Council of Ministers of BiH made a decision to proceed with the preparation of the study and design documentation as the basis for defining solutions and creating conditions to find the way of financing the construction of the motorway.

Besides BiH, both Hungary and Croatia have also expressed great interest in the construction, intending to construct parts of this corridor, at the motorway level, on their territories by 2010. Thus, the motorway on Corridor Vc Budapest-Osijek-Sarajevo-Ploče through BiH is one of the most important and top-priority projects for BiH.

The objective of the study and design documentation is to determine the economic rationale for the construction of parts of the motorway and the motorway as a whole, as well as the conditions for the project's cost-effectiveness, and that, based on the prefeasibility study, the interest in getting a concession for the entire motorway route through BiH be examined by announcing the International Invitation to Tender. The secondary objective is to attract foreign investments, kick-start the investment cycle by launching the construction works at several points, and enable the development of follow-up activities along the route of the constructed motorway.

Complete planning and design documents in their final form will serve as a basis for submitting the request to obtain the urban planning consent for individual sections of the motorway. There is political willingness to support the development of the country by approving the project, construction and operation of the motorway in a cost-effective manner, and as soon as possible.

Following the political decisions to accelerate the preparations for the construction of the motorway, the study and design documentation for the entire length of the route got underway in line with the contemporary standards of research and design, and in accordance with the standards of the World Bank and other international financial institutions.

Upon its completion, the motorway is expected to be a key driver of economic activity and to enable BiH's inclusion in the main European transport communications network, and the global European economic system. The motorway will achieve a rational connection between Bosnia and Herzegovina and its neighboring countries and regions, and have stabilizing and developmental effects on the country. Improved transport conditions will enhance quality of life, which will be manifested through:

- reduction of travel distance and travel time for goods and passengers,
- cost reduction in transporting goods and passengers,
- increased employment,
- valorization of geo-traffic position of BiH,
- increased economic competitiveness in the corridor catchment area,
- launching new projects and increasing private investments in the regional economy.

The commissioned study and design documentation aims to provide a comprehensive analysis of the need to improve the quality of transport, capacity and traffic safety in the corridor by constructing a full-profile motorway. Study sponsors and financial institutions will use the study output as a basis for making investment decisions.

General description of the Project

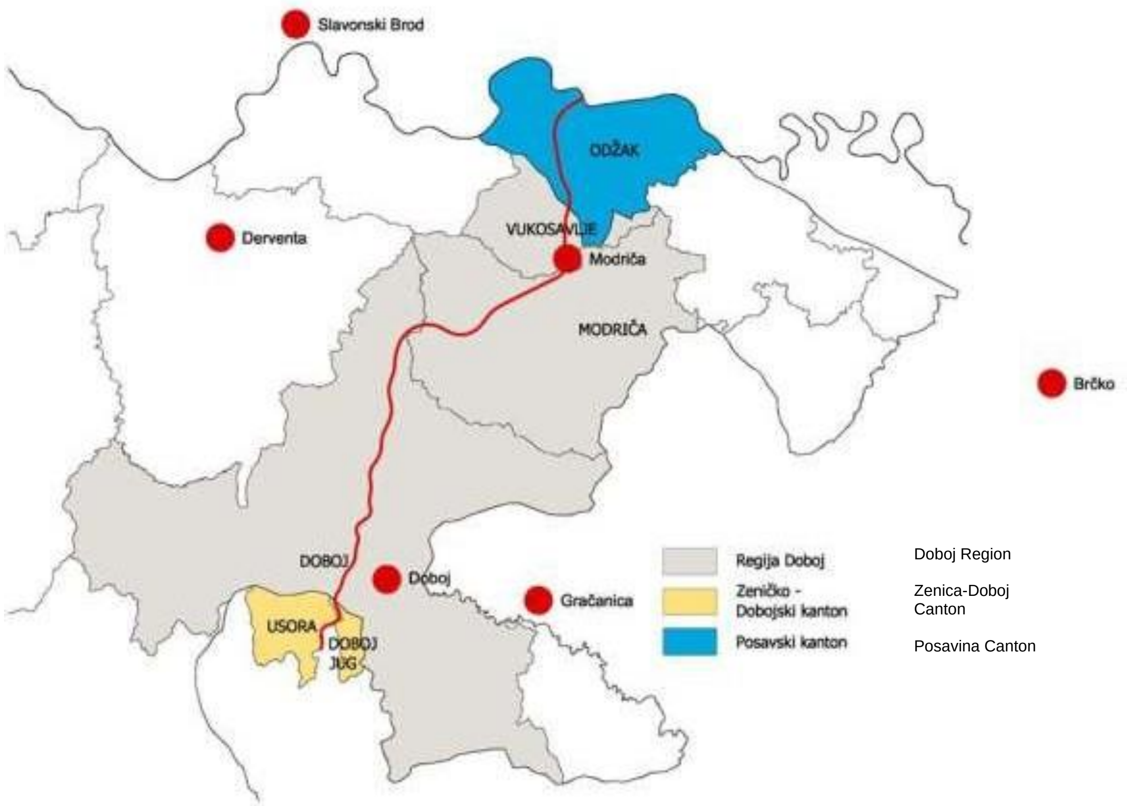
Individual sections of the motorway have so far been considered in the form of studies, conceptual designs and preliminary designs. The motorway route may be found in both previous and current spatial plans. Since a prefeasibility study is required for the entire route through BiH, the subjects of two separate Contracts (Lots) are anticipated to be the Traffic Study and Prefeasibility Study for the Sections Svilaj - Sarajevo South and Sarajevo South - Border South. Each of these two sections represents a special, distinctive whole. Thus the study and design documents for the motorway through BiH shall be observed in six functional units through six Contracts (six Lots), while the study and design documents for the entire route length ought to be approached bearing in mind contemporary research and design standards, TEM standards and guidelines, as well as the standards of the World Bank and other international financial institutions.

The future motorway route is divided into four design sections, i.e. LOTs, of which LOT 1 includes the Section Svilaj – Doboj South (Karuše) – approx. length of 63 km. The Lot Svilaj – Doboj South (Karuše), to be more efficient and operational, is divided into six sections, two of which pass through the Federation of BiH:

- **Section 1: Svilaj – Odžak..approx. length of 11 km**
- **Section 2: Putnikovo brdo (RS Entity border) – Doboj South (Karuše)......approx. length of 5 km**

In addition to the motorway on Corridor Vc, the studies also include the necessary access roads to all cities and settlements close to the route, as well as the Doboj bypass.
LOT1 begins with the bridge over the Sava River (the bridge is a joint investment with the Republic of Croatia) and, in its initial part, runs along the valley of the Bosna River passing by the settlement of Vukosavlje, through the town of Modriča, to the village of Podnovlje. The route is laid along the western rim of Posavina region, and then on the terraces along both banks of the Bosna River. In this part of the route the terrain is flat and suitable; the road lies mainly in the embankment. The soil is made of layers of alluvial sediments found in Posavina and the Bosna River valley, which means it is stable. The highest altitude of the route is 130 masl.

There shall be five larger bridges in this part with a total length of approx. 1700 m, two locations with ancillary service facilities. At the approx. chainage km 7+100, the ancillary service facilities "Potočani" (Type C) are built, opposite each other, one for each direction, and at chainage km 30+410 the ancillary service facilities "Podnovlje" as well as three interchanges – "Odžak" at chainage km 9+410, "Vukosavlje" at chainage km 16+340, and "Podnovlje" at chainage km 32+590. The longest facility is the interstate bridge on the Sava River, about 600 m long, for which the Republic of Croatia has prepared the Conceptual Design that should be reviewed, and the follow-up activities proposed. Besides this facility, bridges are planned at chainage km 16+630 (town of Modriča) – 512m long, at chainage km 23+940 – __ long, at chainage km 27+220 – 245m long, and at chainage km 27+860 – 350m long, each over the Bosna River, since the route intersects the river on several occasions in the zone of Donje Polje. The route also intersects a number of smaller waterways and local roads. The total length of larger bridges in this part is 1650m (excluding the bridge over the Sava).



The motorway has been designed with two carriageways, divided by central reservation, each with two traffic lanes and one breakdown lane. All technical elements of the motorway have been defined according to the Terms of Reference and Rulebooks for the category and importance of the subject motorway for the design speed Vp=120km/h.

Spatial boundaries of research within EIA

The widest spatial boundaries of the area of interest for researching the impact of the planned motorway on Corridor Vc, LOT 1, include a wider spatial unit in the valley of the Bosna River between Svilaj and Doboj, that is, from the border with the Republic of Croatia to Doboj (Karuše). On the west side, the research boundary is set along the existing road from Svilaj to Doboj, and on the east side, along the existing railway.

The research area in terms of water resources includes a one-kilometer belt both to the left and the right side of the outermost contour lines of the motorway, including the route itself. In cases where justified from the hydrogeological or from the aspect of groundwater protection, when defining the spatial limitations, the natural boundary between aquifers and aquifuges was adopted as a contour boundary, given that such environment frequently yields sources, springs or wellfields for water supply.

The roadway width considered in terms of the motorway impact and protective measures is 500m (250 m on each side from the motorway centerline). However, the map also shows a wider belt of 1000 m (500 m from the motorway centerline) the wider state of distribution of certain types of soil and corresponding categories of protection, which is closely related to the use value thereof. This is because the route mainly passes through the lowland terrain and claims the arable land. Besides, it is still unknown where the sites of ancillary facilities and supporting infrastructure will be constructed (gas stations, restaurants, motels, parking lots, changeovers, motorway entrances and exits, etc.), which will certainly put additional pressure on the environment, including the ground. Because of all the above, insight into the wider area is also important.

The research by the majority of authors who have dealt with the issue of defining the potential for the purpose of determining the possible risk due to the construction of roads shows that all direct impacts occur within certain boundaries in relation to the spatial position of the road. These boundaries primarily depend on the traffic volume, morphological characteristics of the terrain as well as individual potentials. The impact zone is generally the narrowest in terms of soil potentials and the widest in terms of potentials related to areas reserved for rest and recreation. The area of indirect impacts is wider and it is difficult to define it within certain boundaries.

Methodology of EIA preparation

Regardless of the already stated fundamental views related to environmental protection issues and certain characteristics of the methods used in the process of impact assessment for the needs of this study, a number of facts require a more detailed analysis of the research methodology applied, where special attention should be paid to the steps taken respecting hierarchy, their objectives and relation to the very planning and design process. This analysis is required in order to make the necessary comparisons with the applied methodology used for the purpose of this study and the methodological bases that are valid within the general legislation regulating this issue (Rulebook on plants and facilities for which the environmental impact assessment is mandatory and plants and facilities which can be constructed and commissioned only if they have the environmental permit (Off. Gazette of the Federation of BiH, no. 19/04)). The main goal consists primarily in trying to adapt the general methodology to the specifics of the subject road and methodological steps in the preparation of the planning and design documentation.

As part of preliminary activities and in line with the legislation requirements of Bosnia and Herzegovina, the analysis of environmental impact in such projects is conducted in two stages: the relevant Ministry prepares the Preliminary Environmental Impact Assessment based on the preliminary assessment documentation, and the relevant Ministry issues the Environmental Permit based on the Terms of Reference of the Ministry and the Environmental Impact Study done on the basis of the Terms of Reference.

The Preliminary Environmental Impact Assessment was completed in 2005 by the following consultants: IPSA - Sarajevo, the Institute for Urbanism of the Republic of Srpska - Banja Luka, Institute for Hydrotechnics - Sarajevo, and Dvokut – Ecro, Zagreb. As part of the assessment procedure, the preliminary environmental impact assessment documentation was available to all interested parties on the website of the Federal Ministry of Physical Planning and Environment, and submitted for opinion to all relevant entities. The documentation of the previous environmental impact assessment examined the area of research that covers the entire route of the LOT1 section. The environmental impact study treated the route selected on the basis of multi-criteria analysis.

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General methodology

In order to accomplish the preliminary objectives, the processes of road design and environmental impact assessment will have to be comparable and harmonized on all levels, with a clear hierarchy structure and an established order of mutual data exchange. Based on the presented facts, it is unequivocally clear that there must exist a unique methodological basis with clearly defined steps for the analysis of environmental issues. The need for unique methodological steps in researching environmental issues stems from the necessity to meet the basic principles of compatibility, harmonization of analysis levels, hierarchical order and successive exchange of information.

The principle of compatibility of the processes of road design and environmental impact assessment is important since it serves to ensure that, first, the results obtained by one process can be used by the other, and secondly, as information, they can be used more broadly and have greater application within both areas.

The need to harmonize levels of analysis is equally important given the scope of approach, the level of detail in the existing and obtained information as well as the elements of any analytical apparatus used. All analyses and conclusions must be at the equal level of detail as only like that will they be relevant for making the right decisions and may be the starting base for further steps.

The hierarchical structure of methodological steps is the prerequisite for the correct methodological approach, enabling primarily the compliance with the established order of actions and the creation of a basis for decision-making. All conclusions drawn from the previous phase are the obligation and the starting base for each subsequent step.

The need for a uniform order of data exchange between these processes is conditioned by the fact that the results of one process represent the input data for the other, and vice versa. It is important to emphasize that this order is not arbitrary but strictly follows the logic of both groups of analyses and their interrelatedness. Another important fact refers to the multidimensional harmonization of these data, both for the needs of the processes and for the needs of creating unique information bases of greater significance.

Having in mind the global character of the environmental protection issue, the basic methodological steps are defined in a broader context. This context implies the process of spatial planning that integrates the specific planning procedures characteristic for the road, given its functional requirements and distinctive consequences. The design process itself must be defined through the common methodological steps compounded with the steps of the preparation of investment documentation.

In terms of these facts, the Environmental Impact Study is a key step in the positive approach to environmental issues. With the selection of optimal design solutions as the essence of the appropriate design phase, it is clear that this level may provide the only real opportunity for environmental protection. The preparation dynamics must be in balance with the preparation dynamics of other design documentation. Part of the most extensive spatial analysis done in the preliminary phase must precede the actual design work. Since this is about the spatial distribution of potential pollutants, it is very important to systematically define all impact criteria and quantify them through appropriate indicators. The informative basis of this study is a 1:25000 scale base map. The purpose of this documentation is to serve as a means of wider communication between all interested parties.

Bases for environmental impact assessment

All types of transport systems, with their current characteristics, represent sources of significant environmental pollution. In this sense, the planning, design, construction and ope-ration of motorways is a very important issue in preserving and protecting the environment.

In view of the stated, it can be argued with certainty that the planning and, consequently, the construction of high-capacity communications, which by its nature the Svilaj – Doboj motorway certainly is, always brings about a series of conflicts between the motorway and the environment.

The global analysis of the motorway impact on the environment shows that all effects manifest themselves within three basic types of impact. The first type is represented by impacts resulting from the construction of the facility and being mostly temporary by nature. They are a consequence of human and machine presence, as well as the technology and organization of construction works. As a rule, negative consequences occur as a result of excavation/dumping, transport and building in large quantities of construction materials, as well as permanent or temporary occupation of the area and all related activities.

Environmental impacts that occur as a result of the existence of the motorway in space and its exploitation over time are mainly permanent in character and, as such, surely represent the effects that are particularly interesting from the aspect of the motorway - environment relationship. These impacts in most cases possess the character of spatial and temporal growth, which warns us of the need to pay attention to their nature in a timely manner.

All processes within the complex motorway - environment relationship take place on the basis of the interdependence of a multitude of relations, and as a result thereof, many changes happen. These changes range from quite insignificant ones to ones so radical that certain elements completely lose their basic characteristics. A systematic approach to these relations by means of analysis of individual criteria produces satisfactory results in the majority of cases, only through their objective quantification and consistent adherence to the hierarchy of methodological steps.

Each of the criteria may become dominant in certain conditions, but the practice to date has outlined the basic relation matrices, which does not mean that in the future, with the development of certain knowledge and sharpening of environmental awareness such matrices will not undergo changes, on the basis of which we define the majority of potential impacts.

Within this research, respecting all the specifics that characterize the route of the planned motorway, and local spatial relations, consideration was given to the basic criteria that turned into indicators through quantification procedures with the basic intention to quantify future relations in detail and define the true nature thereof. Based on the prescribed limit values of certain impacts and their projected values in the context of future relations, adequate environmental protection measures have been proposed.

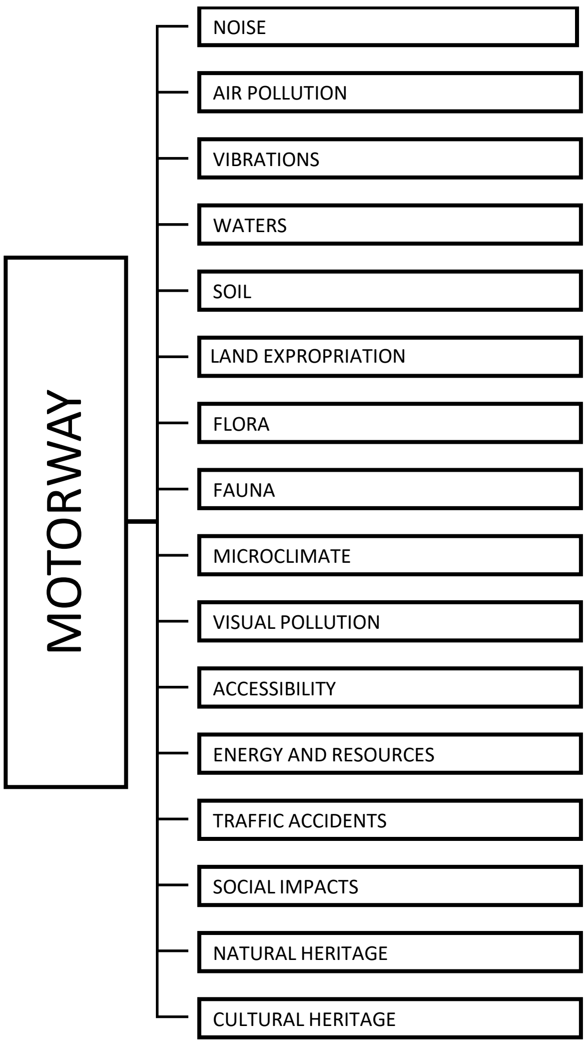
The analysis and assessment of the current state of the environment, as well as the assessment of possible impacts resulting from the construction of the planned motorway show that unambiguous quantified data may be obtained only on the basis of a comprehensive analysis.

All previous experiences in this issue show that today we can speak with sufficient reliability about the known impact matrix, always bearing in mind that such matrix is a spatially and temporally variable category, and that both the relative importance of individual impacts and their absolute boundaries must always be observed in real spatial relations. These facts primarily mean that each impact must be quantified through verified procedures and that its true significance must be determined depending on the specific local relations.

In order to adequately quantify the significance of each impact, it is necessary for specific conditions to associate each impact with a series of indicators which, by the nature of things, should be exact values, then simply used in the process of defining the necessary measures of protection. Part of the problem in the relationship between the motorway and the environment lies in the fact that for certain impacts, which we know to exist, the exact indicators cannot be determined and that part or all of the impact takes place in the sphere of a subjective relationship.

Defining individual impacts (criteria) and their indicators in detail is essentially related to the phase of the project for which the analyses are performed. As each phase of the project or planning documentation is related to the characteristics of the information base, which entails all important facts regarding the scope and accuracy of available information, the possibility of quantification and the accuracy of exact indicators are limited by these facts.

The basic impacts (criteria) have been defined in this research based on the previously defined facts and concrete location conditions.



Matrix of analyzed criteria

The matrix of analyzed criteria is the result of previous knowledge about issues in the relationship between the motorway and the environment. What is clear at first glance is the fact that not all criteria are equally important, especially if we take into account the specific spatial relations within the analyzed area.

The issue of air pollution is a factor that requires quantification given the potential impacts along the planned section of the motorway, primarily in relation to the flora, and also to a limited extend the human population and facilities.

The issue of noise in the analyzed area is present primarily as a parameter of current and future relations along the planned motorway in relation to the population inhabiting the analyzed area.

The issue of water pollution is a criterion of significance primarily in the context of pollution of the Bosna River and its tributaries.

Soil pollution, land expropriation and accessibility issues are important criteria in these circumstances, given the fact that the analyzed corridors intersect the land in the valley of the Bosna River, which land is the characteristically reproductive soil.

The specifics of spatial relations in the zone of the analyzed corridors determine the importance of the impact on the flora and fauna, since the existence of certain potentials in this domain has been confirmed within the analysis of the current state.

The existing relations within the analyzed area condition the lesser importance of other criteria. Lesser importance is reflected primarily in two basic phenomena that can be defined as: local spatial distribution of impact or low intensity along the analyzed corridors. Microclimatic impacts and impacts related to resources and energy are local in character.

Impacts in social sphere shall have certain significance, primarily in the context of the current situation along the valley of the Bosna River. The construction of the new motorway in this area will bring significant economic changes.

All these facts show that the clarification of relations in the field of environmental issues can be expected only if each of the mentioned criteria is analyzed within specific spatial relations and through quantification procedures turned into a representative indicator.

Taking into account specific location conditions, characteristics of traffic flows, the intended use of areas inside the corridor, as well as the fundamental laws of relevant relations within most criteria that define the motorway – environment relationship, based on quantified indicators, the requirements for necessary protective measures shall be specified.

Population

The Posavina Canton, with the area of 324.6km^2, makes 1.2% of the territory of the Federation of Bosnia and Herzegovina, and has 1.9% of the total population of the FBiH. The average population density of 137.5/km^2 is above the average density of the Federation of BiH (89.1/km^2). The growth rate in the Posavina Canton is 2.4% and the population density is rather high in comparison with the Doboj Region.

As regards the Zenica-Doboj Canton, there are two municipalities in the scope, Usora and Doboj-South. The area of this Canton is 3343.3 km^2 with a population of 401.667, and the average population density of 120/km^2.

The impact this road will have on the social environment may be observed only if specific social groups are clearly determined, as users of the space and facilities thereon in relation to which this phenomenon may be studied. In terms of the above, in the specific conditions related to the planned motorway, two basic groups of population of interest can be clearly distinguished. One group consists of road users, while the other consists of residents along the road and property owners who will be affected due to the planned construction.

The first social group consisting of road users shall benefit from the fact that the construction of the planned road shall significantly improve traffic safety, reduce fuel consumption (which will have a positive impact on a number of related global issues), shorten the travel time, enhance transport connectivity in the wider area (with all the positive characteristics that result from it), and create more favorable conditions for the development in a wider area.

In situations where the route is located in sparsely populated areas, part of the problem is minimized, but impacts may occur due to exposure to social contacts on a significantly higher level (of practically international importance), which may result in significant problems in communities that have lived in the traditional environment.

Some of these problems will have to be resolved prior to the actual motorway construction, primarily through communication with these communities and clarification of the basic problems that will affect them during and after the construction of the planned motorway.

Part of the problems in the social sphere will be present during the execution of works, whereby efforts should be made to place temporary construction facilities in such a manner as to avoid possible problems between construction workers and local population.

The issue of expropriation of land needed for the construction of the motorway and additional facilities that are important for the complete construction program implementation is one of the important parameters relevant for defining the relationship between the road and the environment. The study of this issue became topical at the moment of realization that the areas occupied by roads shall represent a permanently lost resource, practically without the possibility to use them for any other purpose ever again.

The stated fact as well as the fact that especially arable land is limited in terms of available quantities, has led to the need to consider this indicator. In the process of defining potential impacts, the need to occupy these areas must be considered from the ecological standpoint and appropriate measures must be taken for the best possible minimization of impacts. In order to minimize the undesired effects in the earliest design phases, it is necessary to determine the approximate number of properties, houses, shops and businesses along the route which could be affected by expropriation. Such procedure shall provide the first indications of the extent of potential problems related to land expropriation and population displacement.

Soil and agricultural land

This entire area is characterized by the semi-humid climate with a tendency of the brown soils development. In the wider area of the Corridor Vc – LOT 1 route, predominant are the lithological substrates on which the current soils had formed, namely: alluvial-diluvial deposits, tertiary clays, claystones and loams, sands, shales, sandstones, gravels, marls and solid limestones. Such structure of the parent substrate on which these soils had formed indicates its erodibility and potential mobility through erosion.

In the wider area of the corridor route, 24 pedosystemic units were identified, of which 7 belong to the Order of Automorphic soils and 17 to the Order of Hydromorphic soils. In the Order of Automorphic soils, the predominant types belong to the class of Cambic and Humus-accumulative soils, while in the Order of Hydromorphic, to the class of Fluvial and Fluvial gley soils, and the class of Hypogley soils. All stated pedosystemic units are divided into four categories of use value. The highest use value category is II (two), and the lowest is V (five). This indicates that the motorway route mainly goes across the agricultural land which is, given the terrain conditions, more or less extensively used. The physical, mechanical and chemical properties of these pedosystemic units are also presented. The highest use value category is II (two), and the lowest is V (five). The section has no land of the use value category I (one). This indicates that the motorway route mainly goes across the agricultural land which is, given the terrain conditions, more or less extensively used.

Based on the permanent soil properties, such as: inclination, depth, mechanical composition, soil drainage, and other physical and chemical properties, the following soil use-value categories were identified in the area of research:

Use value Category II

Use-value Category II includes soils from the alluvial class, which are mainly carbonate, of a divergent mechanical composition from clayey to loamy and sandy. They had developed mainly on sands, gravels or both sands and gravels, depending on conditions during the sedimentation process of the material on which the alluvial soil was formed. These are very good agricultural soils, with moderate limitations, suitable for growing a wide range of agricultural crops, especially at lower altitudes, and the reclamation measures of these soils are relatively simple. These include the pedosystemic units marked in the table and map under the ordinal numbers: 8, 9, 10, 11, 12, 13, 14, and 16.

Use value Category III

Use-value Category III includes soils from the alluvial–diluvial class and the class of semi-gley soils. These are moderately good agricultural soils with certain limitations in terms of the soil properties, topography or drainage. In the selected pedosystemic units shown in Table 2, the most significant limitations pertain to the hydrological regime, i.e. drainage. This category contains the pedosystemic units marked in the table and map under the ordinal numbers: 15, 17, 18, 19, 20, and 21.

Use value Category IV

Use-value Category IV includes soils from the class of cambic soils, where dystric cambisol or acid brown soil is predominant. The gray-brown meadow degraded soil from the class of semigley soils also belongs to this category, as well as the mineral-hydromorphic gleyed acid soil and mineral-hydromorphic non-carbonate soil. These soils are considered to be quite good in agriculture, with certain strong limitations. The choice of crops is significantly reduced to just a few compared to the previous use category. This category contains the pedosystemic units marked in the table and map under the ordinal numbers: 3, 4, 5, 6, 22, 23, and 24.

Use value Category V

Use-value Category V includes mainly the forest soils from the class of cambic, dystric or eutric type, with natural meadows and pastures appearing within the forest. These soils had generally developed on shale rocks on the slopes. They can be very good forest soils, but they don't have to be prone to erosion, as they are covered in vegetation. This category contains the pedosystemic units marked in the table and map under the ordinal numbers: 1, 2, and 7.

Agricultural land is mainly located in the area of use-value Categories II and III, which is around 70% of the total area, while the rest are areas under degraded forest, sloping agricultural land, or land where agricultural limitations are conditioned by high groundwater levels.

The shorter the route and the larger the route section with viaducts and tunnels, the lesser the loss of soil through the change of use. From the agricultural standpoint, it is logical to request that deep fertile soils of this area be avoided as much as possible, if at all possible.

Efficient traffic flow is often in conflict with the requirement to reduce fragmentation of production lots. This is feasible in the part of the sector at the foot of the slope, by orienting the route along the margin, thus avoiding the intersection of major production lots. In this way, three effects could be achieved: more valuable soils are preserved from change of use, fragmentation of land lots is prevented, and the route is elevated relative to the soils in the valleys and fields where air currents are more frequent, having less haze and foggy days on the motorway itself.

Any introduction of harmful substances into agricultural soil jeopardizes its function. As regards the basic meaning of harmful emissions from traffic, they can be divided into four groups: emission of particulate matter – dust, emission of liquids, emission of gases, road salt emission. As an example, the average concentration of heavy metals (Pb, Cd and Zn) was calculated for the 3 m belt off the road edge (flank or embankment belt), and the traffic intensity was taken from the "Final Report on Pre-feasibility Study" for 2015. The accumulation of three major heavy metals was assessed in the 3 m wide belt on each side off the road surface, by sections and for the entire length of the route. The total quantity of Pb, Cd and Zn in the targeted zone along the entire route was 9.27, 5.59 and 9.27 tons. This is certainly a rough estimate but it indicates the potential danger of contamination of the belt along the motorway. Access of heavy metals to the plant depends on the soil condition, and especially on pH reaction, so the intervention of changing the pH reaction of the soil may prevent introduction of heavy metals into the food chain.

The predictable impacts of the Svilaja – Karuše section of the motorway on Corridor Vc near Doboj on agricultural soils and agroecosystems were analyzed, especially in view of the land use change, fragmentation of production lots, and emissions of harmful substances into soil.

Measures to mitigate negative effects on the soil – given the geomorphological conditions, type determination, depth, (skeletality), physical and chemical properties of impact on soil fertility, all soils along the section within 500 m of the road axis, in view of necessary measures and level of protection are grouped in four categories (levels), as per following general criteria:

Category I – full protection, includes fertile, deep, most valuable soils on the route, with favorable physical and chemical properties. These soils need to be fully, that is, completely protected. In the area where the route intersects these soils, it is necessary to apply a closed system of drainage off the road surface, span surfaces with overpasses, and certainly put windbreaks by careful selection of species, all with the aim of collecting emitted pollutants in a narrow zone along the road, that is, within the enclosure.

Category II – high protection, includes soils with favorable physical and chemical properties of high fertility, but soils on limited, smaller areas. Agricultural lots are rather dispersed, so it is necessary to plan windbreaks and vegetation belts along the edge of the motorway to prevent the spread of waste materials to wider agricultural areas that will be located along the motorway.

Category III – selective protection, primarily soils with sparser or thicker maquis shrubland, where deeper soils appear in sinkholes, dells or cuts that are used for extensive cultivation of mainly fruits and vegetables. This also includes protected forest lands. Should the route intersect such areas, care must be taken to ensure that soil damage by road construction is carried out with extreme caution, so as to avoid pockets of erosion by water.

Category IV – protected (forest) soils, includes soils under coherent forest cover. Should the route intersect such areas, care must be taken to ensure that soil damage by road construction is carried out with extreme caution, so as to avoid pockets of erosion by wind and water.

For the section that is the subject of this study, we propose the concept of protection of agricultural production area – soil, or agricultural ecosystem, based on several basic principles:

Effective protection of all more valuable agricultural soils against coarse dust

Dispersing the fine dust and aerosols on as narrow a space as possible, and in doing so avoiding contamination of more valuable agro-biotopes

In addition, it is very important to have the optimal design of the level of the route in relation to the terrain through which the motorway passes, the application of biological measures and the cultivation of protective plantations, the choice of species for windbreak belts.

The above listed approaches should be applied in the preparation of detailed design documentation in each specific situation on the ground, with regard to the constellation of factors and the environment through which the route passes. Since the corridor route passes mostly through the areas that require the application of Category I – full protection, it will be necessary to apply a combination of biological protective measures with the construction of facilities for collection (drainage) and wastewater treatment, construction of sedimentation tanks, ponds, etc. It is also imperative to know the dominance of wind movements in order to reduce the space of pollutant dispersion to the narrowest belt possible.

Technical measures for the mitigation of negative effects on the environment, especially in the Categories I and II protection, include the construction of an efficient drainage system consisting of drainage channels along the cross-section of the catchment section, properly positioned to collect all wastewaters and carry them to the collection pool located at the lowest possible level, and as far away as possible from the settlements or agricultural land used in crop production. These wastewaters coming off the motorway must not flow directly into the rivers and small watercourses, but into the built collection pools or natural wetlands in which the pollutants present will settle and thus remain in a limited space.

Measures during construction – on surfaces that will be permanently covered with asphalt or some infrastructure facilities, the fertile humus soil from the surface should be selectively removed, deposited and preserved for the purpose of filling and landscaping the surrounding damaged area. This primarily refers to the soils in the use-value Category II, which are both the best and the most fertile soils. The depth of removed soil should range from 25 to 35 cm, depending on the quality of the surface layer. By doing this, the permanent loss of soil due to road construction would be at least partly compensated. In this way, over m3 of soil could be preserved (stockpiled) for reclamation and re-spreading over the barren surfaces, damaged and shallow soils. Thus through this program, economic benefits can be achieved by establishing new agricultural areas or improving the landscape appearance.

Measures during operation – taking into account that the Project will significantly change the landscape since it will not be at the level of the surrounding terrain. Areas on which plants will be planted or sown require proper preparation and selection of adequate, indigenous seeds of grasses, shrubs and trees for sowing and planting, and this above all means:

When sowing grass, care should first be taken about the preparation, depth of re-spreading, introduction of organic and mineral (NPK) fertilizers, treatment depending on the relief, inclination and other factors.

When planting shrubs, bushes and other undergrowth, attention should be paid to whether there is the actual need and reason to plant such type of vegetation in a particular location, as well as to natural characteristics of the environment and other characteristics and effects achieved by this measure.

Afforestation is carried out on the most exposed slopes, steep inclinations, potential landslides and cuts, near the tunnels, etc.

Soil monitoring primarily involves determining the zero state and monitoring the soil condition on the observed section of the Corridor Vc. This is one of the major preconditions in creating special precautions and soil protection measures on the endangered parts of the route.

The responsibilities of the program proponent should be to form a competent research team that will execute the field work, sampling, laboratory soil analyses and data processing, as well as develop the study on the current status and the monitoring program of the zero-status soil monitoring before the commencement of works, which would require:

- Field research
- Laboratory analyses
- Processing of results

Only after this the implementation of the following could continue:

- Monitoring during the construction phase
- Monitoring during the operation of the facility

Water resources

The research area in terms of water resources includes a one-kilometer belt both to the left and the right side of the outermost contour lines of the motorway, including the route itself. In cases where justified from the hydrogeological or from the aspect of groundwater protection, when defining the spatial limitations, the natural boundary between aquifers and aquifuges was adopted as a contour boundary, given that such environment frequently yields sources, springs or wellfields for water supply. Surface watercourses and their banks, which the motorway has been routed along or intersects them, are also treated as sensitive areas.

In the zone of motorway passage on this section, there is a densely developed network of watercourses, among which the most important is the Bosna River with its smaller and bigger tributaries, as well as the Usora River with its tributaries. Besides the dense network of surface watercourses, there are also significant groundwater resources, most of which are still insufficiently explored. Significant information regarding water supply sources, as well as assistance in the planning of water resources monitoring along LOT 1 for the construction and operation phases of the motorway, was obtained from the Public Company for the Sava River Basin in Sarajevo and the Republika Srpska Water Directorate in Bijeljina.

Bearing in mind that the motorway causes numerous changes in the water phenomena along the route, which largely depend on the method of construction and operation, and taking into account the best environmental practices, the measures of prevention or minimization of adverse impacts have been proposed. Certain impacts on waters can be avoided in the design phase, and in that sense prevention measures recommend the development of appropriate design solutions for external and internal drainage, watercourse regulation, horticultural landscaping of the protection belt, and design of vertical barriers (fences) along the motorway in the locations marked as vulnerable and sensitive from the aspect of water resources. The negative impacts on the quality of groundwater and surfaces waters can be avoided by the appropriate organization of construction sites, the application of proposed prevention measures during construction and in the operation phase, and by the maintenance of constructed facilities for the off-road wastewater treatment.

Flora and fauna

The project area is characterized by a variety of hydrological, hydrogeological, pedological, and geological units, as well as landscape diversity, while on the other hand it is characterized by homogeneity of climatic conditions (characteristics of moderately warm rainy climate), where minor deviations occur due to relief features.

Natural conditions, relief and climate, directly affected the appearance and condition of the vegetation of the project area. Anthropogenic factors have considerably altered the original appearance of its vegetation, but the area still abounds in diverse ecosystems and habitats.

As per their origin, the ecosystems are grouped into primary and secondary. Of the primary ecosystems in the project area, there are forests, and of the secondary (anthropogenic) ecosystems, there are agricultural (grasslands, arable fields), urban (settlements, cities), artificial aquatic ecosystems (reservoirs, fishponds), afforested areas and other. Thus, the project area is characterized by the following ecosystems: forests, grasslands and arable fields.

According to the phytogeographical analysis, the wider part of the project area belongs to the Euro-Siberian/North American region, and as regards forest communities, it can be divided into the lower and higher parts. Mountain ranges belong to the Illyrian plant-geographical province of Illyrian beech forests, and the lower part to the Central European plant-geographical province of Illyrian hornbeam forests.

Grasslands, despite the fact that they are not of natural origin, represent habitats that greatly enrich the biological and landscape diversity of the project area. They are populated with plant species that originate in forests, and partly in other, especially steppe areas of Eastern Europe and Asia, while some cognates of polymorphic species have developed precisely due to anthropogenic influences on grasslands.

In the project area, an extensive way has traditionally been applied in using grasslands, which are mostly endangered because they have been turned into arable fields. They are now used very extensively and only occasionally for grazing and haying. Grasslands are characterized by various species from the family of grasses (Poaceae), daisies (Asteraceae), then rushes (Juncus) and mints (Mentha), which populate the humid habitats.

Arable fields as the artificial ecosystems are intended exclusively for agricultural production, and are cultivated in a way that that insufficiently respects the protection of biological diversity, because they are used intensively with the application of artificial fertilizers and chemical plant protection products.

These are nitrophilous ecosystems, which include the orchards, vineyards, gardens, and field-edge areas, channels and houses, trampled areas of roads and yards, and landfills. Their common feature is the increased amount of nitrogen, which leads to floristic affinity reflected in the multitude of common nitrophilous plants (the so-called Ruderal communities). The work carried out here is a strict selection of plants by various agricultural measures (plowing, digging, fertilizing, using pesticides).

Today's prevalence of animals is the current state of the historical product of all depending factors, and it is not fixed and permanent, because they are all together with animals subject to constant change. Thus, the composition of the fauna in the area of Corridor Vc has probably changed in relation to the latest data available to us with regard to the war events at the end of the last century in Croatia and Bosnia and Herzegovina. The anthropogenic impact in the area after the war should also be taken into account, especially in areas with the increased settlement.

The beginning of Corridor Vc, the lowland part of Posavina, zoogeographically belongs to the so-called European Sub-Area Pannonian Subprovince, or the Subalpine Slavonian-Syrmian Region, while the remaining part belongs to the Central European Alpine Region.

The motorway route mostly passes through the area with the habitats of small (low) game, and partly of large (high) game. Species that inhabit the area included in the adopted option, and which are important for the hunting economy are primarily the European hare (Lepus europaeusPallas), grey partridge (Perdix perdix L.), pheasant (Phasianus colchicus L.), quail (Coturnix coturnix L.), and various waterfowl (wild ducks and geese, Eurasian coots, etc.), mainly along watercourses, and the large game ones are the roe deer (Capreolus capreolus L.) and wild boar (Sus scrofa L).

No data exist on the routine paths of animals for the subject area that could be the basis for the formation of special structures for their movement. It is the Investors' obligation, upon the registered data on migratory movements of animals in the subject area, to build special structures for the movement of animals in the form of passages, i.e. crossings, which should be developed through Designs of special structures for the crossing of animals.

The planned road impact on the river fauna during operation should be seen as the one with no distinct negative effects given the quality characteristics of the Bosna River watercourse.

Analysis of the current state determined that no habitats of rare and protected species exist in the wider area and that, in this regard, no negative impacts should be expected during operation. Considering the spatial positions of the existing habitats and the route in question, it can be concluded that particularly negative impacts should not be expected.

Minimization during the construction phase

To avoid unnecessary biotope loss, the construction site must be limited to the minimum possible needed area, especially at the sections of high importance for plants and animals. Disposal of materials must be done on the construction site only. The areas of great ecological importance must be fenced off and protected during the construction phase. Construction machinery should not move outside the construction site due to danger of soil compaction. Removed biotope structures on the construction site should be restored after the completion of works.

Attention must be paid in the vicinity of streams in order to avoid disruption or disturbance of surface waters or groundwater. This achieves the preservation of the existing wetland and aquatic vegetation and ornithological population.

Removal of trees and thicket must be done in wintertime in order not to interfere with the brooding period, which is from 1 March to 30 September 30. Upon the completion of works, the previously removed biotopes must be restored.

During the construction phase of the road, care must be taken not to disturb the landscape values, especially in the lake zones. In other words, degradation of space during excavation and embankment works must be minimized, and it must be easily corrigible.

The contractor must undertake to collect and take to the nearest landfill the excess solid waste of any kind, immediately after the completion of works on that section. Solid waste produced in temporary worker housing zones, on parking lots and vehicle maintenance grounds must be collected and disposed of.

Minimization of impacts caused by presence of road base

Most impacts caused by the road base are inevitable. (places are quoted in the study, where major conflicts occur due to: bridges designed with detrimental effects to the environment, intersections in river valleys, proximity of road and river, et al). Care must be taken when designing to avoid the felling of wild (autochthonous) trees such as poplar, cottonwood and willow.

Analysis by sections to identify and preserve endangered species. If these species grow in road construction zones, they should be transplanted into zones with similar conditions.

Measures for the minimization of impact caused by traffic

Constant monitoring of the number and species of birds killed along the road, consultations and adequate protection measures to diminish risks should be undertaken on the motorway sections where wildlife is endangered.

In cases of a large number of amphibians killed on certain sections of the road, it is necessary to consult with relevant experts in order to find adequate solutions.

Bridges should have high fences to prevent birds (flocks or individuals) from colliding with vehicles, especially during migration periods.

High-value biotopes should not be planted near the road as it is a congested zone that will have a negative impact on the fauna. Birds will be attracted by hedges and use these biotope structures along the road as new habitats. Thus planting the trees and shrubs should be reduced to a minimum, sufficient for the landscape and prevention of erosion, but not for the creation of new biotopes. Planting at cuts is somewhat less problematic since the trees and shrubs are located above the road and, as a result, vehicles and birds will not collide.

Landscape

Framework analysis of the landscape of this area and its features, associated habitation type, its location and relation to the surroundings, manner of agricultural cultivation of the area surrounding the habitation, spatial organization – habitation matrix, characteristics and manner of utilizing the typical lot, structural, morphological and functional characteristics of residential and economic architecture, leads to the following conclusions:

The wider area of the project belongs to the Northern Peri-Pannonian region characterized by hilly terrain that gradually descends to the lowland.

Wider area of the project is characterized by a valley type landscape bordering on a hilly one. This area is also characterized by the zone of contact of these two types of landscape with the lines of sight containing elements of both. The landscape of lowland areas is determined mainly by forested and agricultural areas that alternate in the landscape image. The valley landscape is longitudinally cut by the Bosna River course, almost through the middle. The elevations of the hilly landscape are covered in forests and pastures. This hilly area is filled with suburban-type family housing, with the developed garden agriculture.

The landscape of a wider spatial unit is characterized by four basic categories of landscape:

- Natural landscape
- Cultivated landscape
- Built landscape
- Cultural–historical landscape.

The zone of altered landscape characteristics can be defined on the basis of the medical threshold of visibility, applying the standard measuring viewing angle of 10° as a measure for perceiving the maximum height difference in the alignment profile to the terrain line.

In the light of defined potentials, appropriate measures for protection, minimization of impact or compensation should be sought, and one should always keep in mind that it is not possible to construct a road without impacts in the field of landscape.

Efforts in the design process must be made to minimize the measures present, while taking into account the following:

- Elements of design geometry must meet the principles of homogeneity and must conform with the local morphological characteristics.
- Cut and fill gradients should be variable and in line with the local morphological characteristics.
- Bridges, viaducts and tunnels may be used when the road runs across steep slopes rather than using cuts and fills. This will help preserve the visual and physical continuity of the landscape.
- The view from the road can be especially enhanced by purposefully shaping the elements of the situation and leveling plans.

Particularly significant effects can be achieved if special attention is paid to the soft landscaping of the areas through which the road passes, while taking care that:

- The road fits in the local vegetation (trees, shrubs, lines of trees, hedges)
- Plants should be transplanted to harmoniously fit into the existing landscape,
- The selected species match the road category and its function,

- Planted vegetation does not restrict views and that the plants are not to be planted just to fill the space,
- Planted vegetation borders on and underlines various landscape units alternating along the motorway route,
- Vegetation accentuates various conditions of traffic flows (changes in the Layout Plan).
- Care should be taken to use local materials to construct the facilities on the route.

The constructed road maintenance procedures can greatly affect the landscape and visual features of the road. Visual pollution can be reduced if special attention is paid to the shaping of various protective and supporting structures (various structures for noise protection), special penalties introduced, the advertisement system along the road regulated, etc.

Negative impacts on the landscape can be compensated to some extent by afforestation of the landscape to replace those trees that had to be felled during the road construction and rehabilitation of problematic areas. Hence, as part of the documentation, the Landscape Planning Project was prepared, which treats this issue in detail and defines the necessary measures to minimize the impacts.

Protected areas of nature

Determining the impact the planned road will have on the natural heritage requires the analysis of natural complexes that are usually defined as national parks, strict nature reserves, nature reserves for scientific research, areas with special natural features, characteristic landscapes, special nature reserves and natural monuments.

Spatial complexes indicated as such imply a certain level of public care and are usually introduced into a certain system of protection under legislation. As such spatial complexes, by definition, represent nature rarities, the main principle that should be respected is to keep the road at a sufficient distance from these complexes in order to prevent any negative impact.

As per data from the Basis for planning documentation which examined the wider area of the motorway, there are no protected areas of nature in the zone of the analyzed section, that is, there is no need for additional protection measures so this issue is not under consideration.

Cultural-historical heritage

The analysis of the current state and possible impacts established that there are archaeological sites at the analyzed location, as well as that their exact spatial position was not precisely determined, which might give rise to certain conflicts.

Given the potential zone of indirect impacts, due to changes in the groundwater regime, air pollution and vibrations, the occurrence of negative impacts is possible on monuments that are located in the wider environment.

As these sites require special treatment, during the creation of the Main Design it is necessary to carry out sounding and protective research according to special programs of archaeological excavations. In terms of these facts, the protection of potential sites would be carried out in three phases, which would follow each other according to the development of the specific situation.

Phase One – represents archaeological research by sounding on recorded sites, which would identify the exact cultural affiliation of the very sites, stratigraphy of archaeological layers, chronological determination, and preservation of cultural layers and architectural remains, if any. Research in this phase would have to be conducted before the commencement of works on the route.

Phase Two – based on the findings of archaeological research conducted in Phase One, protective archaeological excavations would be planned for certain parts of sites that might be endangered by construction. If during the research in Phase One it is determined that the cultural layer has not been preserved on the sites or that the route of the road in question bypasses them, the research planned in Phase Two will not be conducted.

Phase Three – represents the expert service supervision, that is, inspection during earthworks on the route, with the mandatory performance of protective archaeological excavations if during the works the previously unknown archaeological sites are uncovered. Given the possibility of new sites in the rest of the area, it is necessary to have archaeological and conservation supervision during the execution of works along the entire section of the subject motorway.

Noise

One of the main objectives of noise assessment is to examine the effect of mitigation measures so as to avoid the negative impacts of noise on the facilities surrounding the motorway. Noise reduction can be achieved by various approaches:

- Reduction of noise transmission by installing sound barriers (obstacles).
- Reduction of noise emission at its sources (vehicles, motorway surface).
- Reduction of noise impact in residential areas by installing noise protection windows in each individual building.

Implementation order of these measures starts with the installation of sound barriers; the second is elimination at source; and the third, elimination at the receiver's end. One of the most important mitigation measures is the installation of sound barriers. Since the motorway on Lot 1 is mostly laid on the embankment, using thin walls for noise prevention (e.g. panels) is considered more reasonable than using broad structures in the form of steep fills, known for the quality of preventing sound diffusion.

To compare the protection effects of the noise protection walls of various heights to be used in residential areas along the new motorway, the isophone of the relevant noise was calculated. Based on this, the dimensions of the noise protection walls were determined depending on the location (height and length) in order to meet the standard of 50 dB(A) at night. A summary of certain mitigation measures is given in the table... The average wall height of 3 m was adopted for the calculation of the noise levels. The study used the bases of revised route solutions from the Conceptual Design completed in 2D. The calculated wall height is satisfactory in most cases, given that the motorway is mainly laid on the embankment. For residential buildings located higher on the slopes of the hill above the effective height of the noise protection wall, especially those located directly next to the route, higher noise protection walls (5 to 10 m) would be required, which would be cost-ineffective and unacceptable, and would hinder the residents' view. Efficient noise protection windows (passive measures) should be installed in such building. All these measures were elaborated in the Noise Protection Preliminary Design, as part of the Preliminary Design documentation.

Air pollution

At the level of Bosnia and Herzegovina, data on air quality are very scarce. A survey conducted in the observed area shows that the pollution problem does exist, since the answer to the question on the problem related to environmental pollution that particularly affects the population was – air pollution. In terms of the impact that various air pollutants have on plants, this phenomenon is significant due to the characteristics of the surfaces in the immediate vicinity of the motorway. Negative consequences should be expected only in the immediate vicinity of the motorway, and the obtained values can be reduced by planting the adequate vegetation. The general conclusion that can be made on the basis of all analyses is that the problem of air pollution is not particularly pronounced in the area of the planned motorway and that, given the modernization of vehicles in the future and significant restrictions with regard to the exhaust gas quality, the reduction in pollutant concentrations should be expected, regardless of the volume increase.

Danger of landmines

As per data from the Basis for planning documentation, the presence of landmines was noticed on the part of the section Svilaj - Odžak and on the section Putnikovo brdo - Karuše. It is important to emphasize that due to external impacts, primarily precipitation, precise data on landmines are not known, and for this issue, i.e. for disclosure of information in the territory of BiH, the Mine Action Center - MAC is exclusively responsible, whose cooperation is necessary in further project implementation process. A special study is required for more detailed data on landmines in the subject area. It is quite understandable that it is necessary to clear the area of mines, that is, to demine all the minefields. It should be emphasized in particular that attention must be paid to this issue in the construction phase, as well as to the possibility of finding mines even in places that are not marked as such in the plans and maps.

Infrastructure

As part of the analysis of impacts that will reflect on the existing and planned infrastructure, all relevant data were collected on the settlements and road network, water management systems, electric power and telecommunications system, planned gas transportation system, and other. Pursuant to these data, measures for the protection of individual facilities during construction have been proposed, thus avoiding collision points and negative impacts that may occur.

Monitoring system

The Environmental Action Plan is an indispensable part of this documentation and its purpose is to ensure adequate implementation of the proposed protection measures. The EAP also facilitates insight into the effects of protection measures and introduction of the necessary improvements and corrections.

Design phase

A checklist in the design phase is necessary for the adequate consideration and examination of all environmental aspects and issues, i.e. to properly prepare the protection measure design. Special protection zones specified in the design must be respected and special protection measures adopted with regards to them. The same applies to the construction phase and must be emphasized in the tender documentation.

Construction phase

In order to meet all environmental requirements of the project, it is necessary to hire an environmental engineer (expert in ecology) who would oversee the manner of execution of works by conducting frequent inspections, thus protecting the interests of Investor.

The Contractor is also required to have a person or persons responsible for monitoring the implementation of environmental requirements as per tender documentation. This condition should be emphasized to the Contractor during negotiations, and prior to signing the contract.

The parameters monitored during the execution of works include the implementation of the adopted protection measures, and all these parameters will be frequently inspected by environmental engineers, and under the responsibility of the Contractor.

Maintenance phase

The environmental engineer is responsible for the provision of detailed procedures, technical manual/instructions on regular maintenance of drainage system, safety and light signaling systems, accident management (spill/leakage of hazardous substances) and maintenance of green areas (these documents can also be included in the tender documentation).

Conclusion

The overall issue was analyzed within several special chapters which contain the bases for research, characteristics of the planned motorway, characteristics and evaluation of the current state, complex analysis of environmental impacts, necessary protection measures, monitoring and the Environmental Protection Action Plan.

The bases for research define all relevant factors that influenced the subject study, and which primarily covered the initial program bases, legal provisions and research methodology. The chapter dealing with the characteristics of the motorway defines the characteristics defined in the Preliminary Design.

The research and evaluation of the current state have served as a detailed analysis of the existing resources (soil, water, biotopes, climate, landscape, etc.) and an assessment of their state. This analysis has shown that the subject spatial unit possesses substantial resources, and it was absolutely necessary to run all analyses of potential environmental impacts.

The Environmental Impact Study examines the issues of noise, vibrations, air, water and soil pollution, land expropriation, flora and fauna, visual pollution, natural and cultural heritage, and other relevant impacts. Each impact has been defined through indicators that characterize local conditions, taking into account all the spatial specifics and the specifics of the origin and spatial distribution of impacts.

Taking into account the permissible value of individual impacts as well as characteristic spatial relations, the analysis led to the possibility of taking certain protection measures. Based on all analyses of relevant impacts, it is possible to draw a general conclusion that the impact in the immediate riparian zone of the Bosna River and the water protection zone is particularly important.

6. INTRODUCTION

6.1. Bases for environmental impact assessment

The initiative to start preparing the planning and study documentation for the construction of the motorway on Corridor Vc resulted in a request to shed light on the investment project in terms of the relationship with the environment. The starting point for preparing the Environmental Impact Study was the contract documentation which specified the initial framework for the preparation of this study. The initial program bases defined within tender documentation had created the basic assumptions on the necessity of performing the subject research, which is done as an integral part of the Preliminary Design.

Given the potential impacts, as a consequence of construction and operation of the motorway, this facility/structure belongs to the group of those that require the preparation of such research. In view of the mentioned facts, knowledge of specific spatial relations and impacts, and the role of the planned route in the road network, all the conditions for the preparation of research at the Environmental Impact Study level have been met.

Since the Study is conducted as an integral part of the Preliminary Design, all its global frameworks are predetermined by this fact, which primarily means that the analyses of this research must find their right place in the decision-making process on the construction feasibility. Fulfillment of the previous requirement, on the one hand, represents a qualitative contribution to the issue of protection and improvement of the environment, and on the other hand, certainly, specific improvements related to the route of the planned motorway.

The bases for the preparation of the Environmental Impact Study arose from the assumptions of the documentation that preceded this phase of the design documentation, primarily the Preliminary Environmental Impact Assessment, as well as support documentation done for this level of design, i.e. for the Conceptual Design level. Within this documentation, especially valuable data that are relevant to most of the potential impacts came from dedicated research related to geotechnical surveys, surveys done for the purpose of preparing the planning documentation for urban areas within the analyzed area as well as dedicated surveys for the purposes of this analysis carried out on site. All survey activities done in the previous period for the purpose of drafting the design documentation were the basis for this research as well.

Significant assumptions that were relevant for the preparation of the Environmental Impact Study also came from the valid planning documentation for the wider survey area from Svilaj to Karuše.

All the mentioned assumptions created the basis and initial framework for research on the issue of environmental protection and improvement, and for the starting point for the preparation of the Environmental Impact Study as a part of the last year's study documentation of the motorway on Corridor Vc, Section Putnikovo brdo - Karuše.

The Environmental Impact Study represents the relevant documentation that should be used to give an insight to all relevant parties into environmental issues for the motorway on Corridor Vc, and to serve for conducting the public discussion procedure, in accordance with applicable laws, as well as for issuing decisions within competent ministries for environmental protection in the Federation of BiH and Republika Srpska.

6.2. Legislation

An important basis on which every survey on the environmental impact of facility construction is founded must be the valid legal provisions and appropriate legislation that govern these issues. For the purpose of this survey, a broader legislation was used, which created some of the legal presumptions in the wider environmental field that have certain significance for the interpretation of relations arising from the construction and operation of the planned motorway. The legislation in force in the Federation of BiH was used:

1.0 Law on Environmental Protection (Off. Gazette of the FBiH, no. 33/03);

2.0 Law on Air Protection (Off. Gazette of the FBiH, no. 33/03);

3.0 Law on Water Protection (Off. Gazette of the FBiH, no. 33/03);

4.0 Law on Waste Management (Off. Gazette of the FBiH, no. 33/03);

5.0 Law on Nature Protection (Off. Gazette of the FBiH, no. 33/03);

6.0 Law on Environmental Protection Fund (Off. Gazette of the FBiH, no. 33/03);

7.0 Law on Waters – new (Off. Gazette of the FBiH, no. 70/06);

8.0 Law on Waters – old (Off. Gazette of the FBiH, no. 18/98);

9.0 Law on Agricultural Land (Off. Gazette of the FBiH, no. 2/98);

10.0 Law on Forests (Off. Gazette of the FBiH, no. 20/02);

11.0 Law on Freshwater Fishing (Off. Gazette of the FBiH, no. 64/04);

12.0 Law on Plant Health Protection (Off. Gazette of BiH, no. 23/03);

13.0 Law on Spatial Planning and Land Use at the Level of the FBiH (Off. Gazette of the FBiH, no. 2/06);

14.0 Law on Spatial Planning (Off. Gazette of the FBiH, no. 52/02);

15.0 Law on Construction (Off. Gazette of the FBiH, no. 55/02);

16.0 Law on Communal Services (Off. Gazette of SR BiH, no. 20/90);

17.0 Correction of the Translation of the High Representative's Decree No. 147/03 on Enacting the Law on Construction Land of the Federation of BiH (Off. Gazette of the FBiH, no. 25/03);

18.0 Law on Amendments to the Law on Protection of Properties Designated as National Monuments of BiH by Decisions of the Commission for Preservation of National Monuments (Off. Gazette of the FBiH, nos. 27/02 and 8/02);

19.0 Law on Protection of Properties Designated as National Monuments of BiH by Decisions of the Commission for Preservation of National Monuments (Off. Gazette of the FBiH, no. 02/02);

20.0 Law on Amendments to the Law on Forests (Off. Gazette of the FBiH, no. 29/03);

21.0 Law on Amendments to the Law on Companies (Off. Gazette of the FBiH, no. 29/03);

22.0 Law on Amendment to the Law on Forests (Off. Gazette of the FBiH, no. 37/04);

23.0 Law on Freedom of Access to Information in the FBiH (Off. Gazette of the FBiH, no. 32/01);

24.0 Decree on classification of waters of inter-republican waterways, the inter-state waterways and the coastal waters of Yugoslavia (Off. Gazette of the SFRY, no. 6/78);

25.0 Decree on classification of waters and the coastal waters of Yugoslavia within borders of the SRBiH (Off. Gazette of the SRBiH, no. 19/80);

26.0 Decree on categorization of waterways (Off. Gazette of the SRBiH, no. 42/67);

27.0 Decree on flood defense plan; the area of the Sava and Neretva rivers (Off. Gazette of the SRBiH, no. 5/78);

28.0 Decree on reporting the facilities that can pollute air quality (Off. Gazette of the FPRY, no. 14/66);

29.0 Rulebook on hazardous substances that must not be discharged into waters (Off. Gazette of the FPRY, nos. FNRJ 3/66 and 7/66);

30.0 Rulebook on types, methods and scope of measurement and testing of used and utilized water and discharged wastewater (Off. Gazette of the SRBiH, nos. 39/85, 20/90);

31.0 Rulebook on air protection against pollution (Off. Gazette of the SRBiH, no. 18/76);

32.0 Rulebook on hazardous substances that must not be discharged into waters (Off. Gazette of the SFRY, nos. 3/66 and 7/66);

33.0 Rulebook on maximum limits of radioactive contamination of the environment and on performing decontamination (Off. Gazette of the SFRY, nos. 8/87 and 27/90);

34.0 Rulebook on manner of collection, recording, processing, storage, permanent disposal and discharge of radioactive waste material into the environment (Off. Gazette of the SFRY, no. 40/86);

35.0 Rulebook on special regime of control of activities that endanger or may endanger the environment (Off. Gazette of the SRBiH, nos. 2/76, 23/76, 23/82, 26/82);

36.0 Rulebook on amendments to the Rulebook on working conditions, organizational and other requirements for the operation of stations for technical inspection of vehicles (Off. Gazette of the FBiH, no. 16/04);

37.0 Rulebook on requirements to be met by the authorized laboratory, and the content and manner of issuing the authorization (Off. Gazette of the FBiH, no. 54/99);

38.0 Rulebook on types, methods and scope of measurement and testing of used water, discharged wastewater and material extracted from waterways (Off. Gazette of the FBiH, nos. 48/98 and 36/00; correction 35/01, 20/03 and 56/04);

39.0 Rulebook on conditions for determining sanitary protection zones and protective measures for sources of water used or planned to be used for drinking (Off. Gazette of the FBiH, no. 51/02);

40.0 Rulebook on requirements to be met by the authorized laboratories, and the content and manner of issuing the authorization (Off. Gazette of the FBiH, no. 54/99);

41.0 Rulebook on plants and facilities for which the environmental impact assessment is mandatory and plants and facilities which can be constructed and commissioned only if they have the environmental permit (Off. Gazette of the Federation of BiH, no. 19/04);

42.0 Rulebook on conditions and criteria that must be met by the developers of the Environmental Impact Study and the amount of compensation and other expenses incurred in the process of environmental impact assessment (Off. Gazette of the FBiH, no. 68/05);

43.0 Rulebook on hygienic safety of drinking water (Off. Gazette of the Republic of BiH, nos. 2/92 and 13/94; previously published in "Off. Gazette of the SFRY", nos. 33/87 and 23/91);

44.0 Decision on maximum permissible concentrations of radionuclides and hazardous substances in inter-republican waterways, the inter-state waterways and the coastal waters (Off. Gazette of the SFRY, no. 8/78);

45.0 Decision Enacting the Law on Construction Land of the Federation of BiH (Off. Gazette of the FBiH, no. 25/03);

46.0 Decisions on national monuments (Off. Gazette of BiH, no. 15/03);

47.0 Decisions on designation of the property as a national monument (Off. Gazette of BiH, no. 23/03);

48.0 Commission to Preserve National Monuments – Decisions (Off. Gazette of BiH, no. 43/03);

49.0 Decision on amendment of criteria for designation of properties as national monuments (Off. Gazette of BiH, no. 15/03);

50.0 Decision on boundaries of water basins (Off. Gazette of the FBiH, no. 37/98);

51.0 Decision on boundaries of the main catchment areas (Off. Gazette of the FBiH, no. 37/98);

52.0 Decision on maximum permissible concentrations of radionuclides and hazardous substances in inter-republican waterways, the inter-state waterways and the coastal waters of Yugoslavia (Off. Gazette of the SFRY, no. 8/78);

53.0 Instruction on determining the permitted quantities of harmful and hazardous substances in the soil and methods of their testing (Off. Gazette of the FBiH, no. 11/99);

International Treaties and Conventions BiH has acceded to:

1.0 Convention on Long-range Transboundary Air Pollution, Geneva, 1979 (entered into force on 16 March 1986) (Off. Gazette of the RBiH, no. 13/94, Off. Gazette of the SFRY IT, no. 11/86);

2.0 Protocol to the Convention on Long-range Transboundary Air Pollution from 1979, on Long-Term Financing of the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe, Geneva, 1984 (entered into force on 28 January 1988) (Off. Gazette of the RBiH, no. 13/94, Off. Gazette of the SFRY IT, 2/87);

3.0 Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985 (entered into force on 22 September 1988) (Off. Gazette of the RBiH, no. 13/94, Off. Gazette of the SFRY IT, no. 1/90);

4.0 United Nations Framework Convention on Climate Change, Rio de Janeiro, 1992 (entered into force on 21 March 1994) (Off. Gazette of BiH, no. 19/00).

5.0 Convention on the Transboundary Effects of Industrial Accidents, Helsinki, 1992 (entered into force on 19 April 2000)

6.0 International Plant Protection Convention, Rome, 1951 (entered into force on 3 April 1952);

7.0 Convention on Biological Diversity, Rio de Janeiro, 1992 (entered into force on 29 December 1993);

8.0 Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, Vienna, adopted on 26 September 1986 (entered into force on 26 February 1987) (Off.

Gazette of the RBiH, no. 13/94, Off. Gazette of the SFRY IT, no. 4/91);

9.0 Convention on Early Notification of a Nuclear Accident, Vienna, 1986 (entered into force on 27 October 1986) (Off. Gazette of the RBiH, no. 13/94, Off. Gazette of the SFRY IT, no. 15/89);

10.0 Convention on Cooperation for the Protection and Sustainable Use of the Danube River (The Danube River Protection Convention), Sofia, 1994 (Off. Gazette of BiH – International Treaties, no. 01/05);

11.0 Convention for the Protection of the Mediterranean Sea against Pollution of 16 February 1976, Barcelona, entered into force in 1978 (Off. Gazette of the SFRY – International Treaties, no. 12/77);

12.0 Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources, Athens, 1980 (entered into force on 17 June 1983). Modified in Syracuse (Italy) in 1996. (Off. Gazette of the RBiH, no. 13/94, Off. Gazette of the SFRY IT, no. 1/90);

13.0 Protocol concerning Specially Protected Areas and Biodiversity in the Mediterranean, Monaco, 1996 (old name Protocol on Specially Protected Areas in the Mediterranean Sea, Geneva, 1982) (entered into force on 23 March 1986) (Off. Gazette of the RBiH, no. 13/94, Off. Gazette of SFRY IT, no. 9/85);

14.0 International Convention for the Prevention of Pollution of the Sea by Oil, London, 1954 (entered into force on 26 July 1958) (Off. Gazette of the RBiH, no. 13/94, Off. Gazette of the SFRY IT, nos. 60/73 and 53/74);

15.0 International Convention for the Prevention of Pollution from Ships, London, 1973 (entered into force on 2 October 1983) (Off. Gazette of the RBiH, no. 13/94, Off. Gazette of the SFRY IT, no. 2/85).

16.0 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, Basel, 22 March 1989 (entered into force on 5 May 1992) (Off. Gazette of BiH, no. 31/00);

17.0 Amendment to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, Brussels, 1997;

18.0 Decision on ratification of the Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Off. Gazette of BiH, no. 31/00);

19.0 Decision on ratification of the United Nations Framework Convention on Climate Change (Off. Gazette of BiH, no. 19/00);

20.0 Decision on ratification of the Convention on Biological Diversity, Rio de Janeiro, 5 June 1992 (Off. Gazette of BiH, no. 13 of 31 December 2002);

21.0 Decision on giving consent to ratification of the International Plant Protection Convention (Off. Gazette of BiH, Annex International Treaties, no. 10/03, 21 July 2003);

22.0 Decision on giving consent to ratification of the Framework Agreement on the Sava River Basin (Off. Gazette of BiH, Annex International Treaties, no. 10/03, 21 July 2003);

23.0 Agreement between the Government of the Republic of Croatia and the Government of Bosnia and Herzegovina on the Regulation of Water Management Relations (Off. Gazette of the RBiH – Special issue – International Treaties, no. 6/96);

24.0 Decision on ratification of the International Plant Protection Convention (Off. Gazette of BiH, no. 8/03, 30 June 2003 – Annex).

Standards

- Standards in the field of environmental protection management,
- Standards for air
- Standards for water
- Standards for soil

EU Directives

- EU Habitats Directive 92/43/EEC
- The Urban waste water treatment Directive 91/271/EEC of 21 May 1991 concerning discharges of municipal and some industrial waste waters
- Directive on the water intended for human consumption
- (The Drinking water directive 98/83/EC of 3 November 1998 concerning potable water quality)
- Water Framework Directive 2000/60/EC of 23 October 2000 concerning water resource management)
- Freshwater Fish Directive 78/659/EEC
- Revised Bathing Water Directive 2006/7/EC

Recognizing the fact that a large part of the specific relations in the environmental field, which characterize the construction of a motorway, is not covered within the existing legislation, the regulations and guidelines of other countries, widely verified in the international community, have been used for the purpose of producing this document.

Guidelines covering the general issue were specifically used, such as Mjerkblatt zur Umnjeltverträglichkeitsstudie in der Strassenplanung, and in particular the issue of noise, Richtlinien für den Lärmschutz an Strassen (RLS-90), the issue of air pollution, Mjerkblattüber Luftverunrei-nigungen an Strassen (MLus-92), and the issue of water pollution, Richtlinien für Bautechnische Massnamjen an Strassen in Wassergenjinnungsgebieten.

Also, the technical documents of the World Bank were used, more precisely: "The World Bank technical paper No.376: Roads and the Enviroment, A Handbook", The World Bank Washington, D.C.

6.3. Methodology of EIA preparation

Regardless of the already stated fundamental views related to environmental protection issues and certain characteristics of the methods used in the process of impact assessment for the needs of this study, a number of facts require a more detailed analysis of the research methodology applied, where special attention should be paid to the steps taken respecting hierarchy, their objectives and relation to the very planning and design process. This analysis is required in order to make the necessary comparisons with the applied methodology used for the purpose of this study and the methodological bases that are valid within the general legislation regulating this issue (Rulebook on plants and facilities for which the environmental impact assessment is mandatory and plants and facilities which can be constructed and commissioned only if they have the environmental permit (Off. Gazette of the Federation of BiH, no. 19/04)). The main goal consists primarily in trying to adapt the general methodology to the specifics of the subject road and methodological steps in the preparation of the planning and design documentation.

As part of preliminary activities and in line with the legislation requirements of Bosnia and

Herzegovina, the analysis of environmental impact in such projects is conducted in two stages: the relevant Ministry prepares the Preliminary Environmental Impact Assessment based on the preliminary assessment documentation, and the relevant Ministry issues the Environmental Permit based on the Terms of Reference of the Ministry and the Environmental Impact Study done on the basis of the Terms of Reference.

6.3.1. General methodology

In order to accomplish the preliminary objectives, the processes of road design and environmental impact assessment will have to be comparable and harmonized on all levels, with a clear hierarchy structure and an established order of mutual data exchange. Based on the presented facts, it is unequivocally clear that there must exist a unique methodological basis with clearly defined steps for the analysis of environmental issues.

The need for unique methodological steps in researching environmental issues stems from the necessity to meet the basic principles of compatibility, harmonization of analysis levels, hierarchical order and successive exchange of information.

The principle of compatibility of the processes of road design and environmental impact assessment is important since it serves to ensure that, first, the results obtained by one process can be used by the other, and secondly, as information, they can be used more broadly and have greater application within both areas.

The need to harmonize levels of analysis is equally important given the scope of approach, the level of detail in the existing and obtained information as well as the elements of any analytical apparatus used. All analyses and conclusions must be at the equal level of detail as only like that will they be relevant for making the right decisions and may be the starting base for further steps.

The hierarchical structure of methodological steps is the prerequisite for the correct methodological approach, enabling primarily the compliance with the established order of actions and the creation of a basis for decision-making. All conclusions drawn from the previous phase are the obligation and the starting base for each subsequent step.

The need for a uniform order of data exchange between these processes is conditioned by the fact that the results of one process represent the input data for the other, and vice versa. It is important to emphasize that this order is not arbitrary but strictly follows the logic of both groups of analyses and their interrelatedness. Another important fact refers to the multidimensional harmonization of these data, both for the needs of the processes and for the needs of creating unique information bases of greater significance.

Having in mind the global character of the environmental protection issue, the basic methodological steps are defined in a broader context. This context implies the process of spatial planning that integrates the specific planning procedures characteristic for the road, given its functional requirements and distinctive consequences. The design process itself must be defined through the common methodological steps compounded with the steps of the preparation of investment documentation. In terms of these facts, the Environmental Impact Study is a key step in the positive approach to environmental issues. With the selection of optimal design solutions as the essence of the appropriate design phase, it is clear that this level may provide the only real opportunity for environmental protection. The preparation dynamics must be in balance with the preparation dynamics of other design documentation. Part of the most extensive spatial analysis done in the preliminary phase muse precede the actual design work. Since this is about the spatial distribution of potential pollutants, it is very important to systematically define all impact criteria and quantify them through appropriate indicators. The informative basis of this study is a 1:25000 scale base map. The purpose of this documentation is to serve as a means of wider communication between all interested parties.

6.3.2. Applied methodology

The specifics of the concrete conditions related to this research are reflected in the fact that the research is done in the design development phase, so, given the above facts, the study on the impacts of road construction on the environment could be done as a detailed analytical quantification since the basis of the impact assessment is a completely spatially defined position of the motorway on Corridor Vc with all its characteristics.

As far as global requirements are concerned, it is clear that the defined and acceptable limit values are only a reflection of current knowledge, which needs special attention. Special attention within this procedure must be paid to the analytical apparatus, given that the values of the obtained indicators usually serve as input data for defining the necessary protection measures.

In terms of general methodological principles, the bases for research are defined primarily through the initial program elements, valid legal provisions, planning documents, characteristics of the facility itself, design bases and information basis.

An important part of the research, according to the adopted methodology, is the quantification and evaluation of the existing situation, which primarily includes the analysis of basic ecological potentials as well as defining the degree of their protection. The necessity of this research stemmed from the fact that for the area that is the subject of this study, there were no detailed analyses done for the purpose of designing the basic network. The result of this research must be a confirmation of the existence or non-existence of any ecological risk during the construction and operation of the planned road.

In the Impact Study preparation phase, the indicated methodological steps in researching environmental issues, according to their hierarchical structure and content, represent a verified manner of obtaining documented data and creating a basis for the definition of optimal solutions. The specifics of the concrete project and the specifics of the current state of the environment along the subject corridor have conditioned that the applied methodology in all its essential characteristics corresponds to all previously-defined general methodological principles.

The specifics of the concrete project and the specifics of the current state of the environment at the very location have conditioned that the applied methodology be modified to a certain extent while preserving the hierarchical consistency of individual steps as much as possible.

Since the current state analysis revealed certain problems related to potential impacts, the second part of the research was conducted as their detailed quantification. From the basic matrix of impacts, those that had been proven to determine the relationship between the subject road and the environment in specific spatial conditions were analyzed in detail.

Based on the verified indicators of individual criteria, the possibilities of environmental protection were examined and adequate measures were proposed for which there is justification in terms of reasonable reduction of negative impacts. On the basis on all defined criteria and their indicators, the impact assessment and proposed environmental protection measures were eventually completed.

According to all preceding paragraphs, it is evident that this study includes all assumptions implied by legislation, which have been prescribed through the content of acts dealing with issues of environmental protection, and that certain methodological steps have been especially analytically enriched, taking into account primarily the specifics of the facility as well as the latest knowledge thereof in the field of highway engineering.

6.3.3. Terms of Reference

The preparation of the Environmental Impact Study has originally been defined by the legislation in the field of environmental protection, and for this specific section of the motorway on Corridor Vc, subsection LOT 1 from Putnikovo brdo to Karuše, by the elements of the Decision issued by the competent Ministry. Therefore, the complete Decision is being quoted as the basis for the preparation of documentation.

7. DESCRIPTION OF THE PROPOSED PROJECT

7.1. Purpose and objective of the Project

Corridor Vc is included in the TEM transport infrastructure network of Southeastern Europe, and runs from Budapest (Hungary) via Osijek (Croatia) and Sarajevo (BiH) to the port of Ploče (Croatia). The route of Corridor Vc in BiH is approx. 330 km long and runs in the north-south direction, through the central part of the country, utilizing the most favorable natural conditions, along the valleys of the Bosna and Neretva Rivers.

The transport Corridor Vc stretch through BiH includes:

- E-road E-73 Šamac - Doboj - Sarajevo - Mostar - Čapljina - Doljani, reaching the Adriatic Sea via the port of Ploče, while Budapest is its connecting point in the north,
- Railway Šamac - Doboj - Sarajevo - Mostar - Čapljina - Metković,
- Sarajevo and Mostar airports,
- Waterways and ports on the Sava, Bosna and Neretva rivers.

In the 1970s, the UNDP Geneva proposed the initiative and the plan to improve the motorway network in Europe. The project also included the Baltic Sea-Adriatic Sea (Baltic-Adriatic) motorway, called the TEM.

At the Third Pan-European Transport Conference, which gathered the European Union member states and international organizations involved in the development of infrastructure in Europe and was held in Helsinki in 1997, the "Helsinki Declaration" was adopted, laying the framework to construct additional 10 Pan-European corridors, including the motorways.

That Declaration also defined the routes of these 10 Trans-European corridors and their branches. The choice of the route direction through BiH was defined under item Vc of the Pan-European Corridor (Budapest-Osijek-Sarajevo-Ploče).

As already mentioned, Corridor Vc belongs to the Pan-European network of corridors connecting the central part of the Adriatic coast, which has great tourism potential, but more importantly the port of Ploče, with Corridor X between Zagreb and Belgrade, ending at the Budapest junction. With the planned increase in the capacity of the port of Ploče, the Corridor has the potential to enhance trade relations for the countries in the region, and for Bosnia and Herzegovina, the Corridor has the potential to improve trade with neighboring countries and Central Europe.

All study and design documents for the motorway aim to provide a comprehensive analysis of the need to improve the quality of transport, capacity and traffic safety in the corridor by constructing a full-profile motorway. Study sponsors and financial institutions will use the study output as a basis for making investment decisions. This should particularly be kept in mind while preparing the Prefeasibility Study and the Environmental Protection Study.

Pursuant to the Pan-European Transport Initiatives and Helsinki Declaration, which have been embraced as a great opportunity for Europe and particularly BiH, increased activity in BiH has recently been observed in preparations for the construction of high-order roads, i.e. motorways and expressways, in order to meet the needs of the population and economy, and to influence the overall development. Along with other roads (Banja Luka-Gradiška, Tuzla-Orašje and Adriatic-Ionian motorway), preparatory activities have also started for the motorway on Corridor Vc. Hence the Ministry of Transport and Communications of BiH:

- issued the Decision on existence of public interest in constructing the motorway on Corridor Vc through Bosnia and Herzegovina on the basis of a concession granted on the section and route to be defined by contract (Off. Gazette of BiH, no. 23 of 7 August 2003),
- signed the agreement and agreed on the border crossing point between the Republic of Croatia and BiH on the Sava River (Svilaj-Odžak) as part of the motorway route along with the route coordinates (3 September 2003),
- deliberated on the proposal of the Republic of Croatia to determine the southern junction point of the motorway on Corridor Vc, and concluded that, due to the insufficiently elaborated design documentation and complexity of connection to the Adriatic-Ionian motorway, determining the position of this point requires a more detailed design documentation,
- continuously exchanged information and views with representatives of the Republic of Croatia and the Republic of Hungary regarding the preparations for the construction of the motorway on Corridor Vc,
- provided the necessary funds for the preparation of planning and study documentation and other preparatory activities for the motorway on Corridor Vc.

Taking into account the country's indebtedness, the status with the World Bank and International Monetary Fund as well as the impossibility of significant borrowing or allocation of funds from the budget, the Council of Ministers of BiH decided that one suitable way to finance the construction of this motorway would be through concessions. Thus the Council of Ministers of BiH made a decision to proceed with the preparation of the study and design documentation as the basis for defining solutions and creating conditions to find the way of financing the construction of the motorway.

The objective of preparing the entire set of study and design documentation, with the environmental impact study as an important segment, is to determine the economic rationale for the construction of parts of the motorway and the motorway as a whole, as well as the conditions for the project's cost-effectiveness, and that, based on the prefeasibility study, the interest in getting a concession for the entire motorway route through BiH be examined by announcing the International Invitation to Tender. The secondary objective is to attract foreign investments, kick-start the investment cycle by launching the construction works at several points, and enable the development of follow-up activities along the route of the constructed motorway.

Complete planning and design documents in their final form will serve as a basis for submitting the request to obtain the urban planning consent for individual sections of the motorway. There is political willingness to support the development of the country by approving the project, construction and operation of the motorway in a cost-effective manner, and as soon as possible.

Following the political decisions to accelerate the preparations for the construction of the motorway, the study and design documentation for the entire length of the route got underway in line with the contemporary standards of research and design, and in accordance with the standards of the World Bank and other international financial institutions.

Upon its completion, the motorway is expected to be a key driver of economic activity and to enable BiH's inclusion in the main European transport communications network, and the global European economic system. The motorway will achieve a rational connection between Bosnia and Herzegovina and its neighboring countries and regions, and have stabilizing and developmental effects on the country. Improved transport conditions will enhance quality of life, which will be manifested through:

- reduction of travel distance and travel time for goods and passengers,
- cost reduction in transporting goods and passengers,
- increased employment,
- valorization of geo-traffic position of BiH,
- increased economic competitiveness in the corridor catchment area,
- launching new projects and increasing private investments in the regional economy.

The commissioned study and design documentation aims to provide a comprehensive analysis of the need to improve the quality of transport, capacity and traffic safety in the corridor by constructing a full-profile motorway. Study sponsors and financial institutions will use the study output as a basis for making investment decisions.

7.2. General description of the Project

For the study documentation purpose, the motorway route has been divided into four LOTs:

- LOT 1: SECTION SVILAJ – DOBOJ SOUTH (KARUŠE)
- LOT 2: SECTION DOBOJ SOUTH (KARUŠE) – SARAJEVO SOUTH (TARČIN), no subsection
- Kakanj – Blažuj (Vlakovo),
- LOT 3: SECTION SARAJEVO SOUTH (Tarčin) – MOSTAR NORTH, and
- LOT 4: MOSTAR NORTH – BORDER SOUTH.

The future motorway route is divided into four design sections, i.e. LOTs, of which LOT 1 includes the Section Svilaj – Doboj South (Karuše) – approx. 63 km long. The LOT Svilaj – Doboj South (Karuše) is divided into six sections so as to be more efficient and operational:

Section 1: **Svilaj – Odžak................................. approx. length of 11 km - completed**

Section 2: Odžak – Vukosavlje.........................approx. length of 6 km

Section 3: Vukosavlje – Podnovlje...................approx. length of 16 km

Section 4: Podnovlje – Johovac.......................approx. length of 13 km

Section 4: Johovac – Rudanka.........................approx. length of 6 km

Section 5: Rudanka – Doboj South (Karuše)...approx length of 10 km of which approximately **5 km on the stretch Putnikovo brdo – Karuše belong to the Federation of BiH**

LOT1 begins with the bridge over the Sava River (the bridge is a joint investment with the Republic of Croatia) and, in its initial part, runs along the valley of the Bosna River passing by the settlement of Vukosavlje, through the town of Modriča, to the village of Podnovlje. The route is laid along the western rim of Posavina region, and then on the terraces along both banks of the Bosna River. In this part of the route the terrain is flat and suitable; the road lies mainly in the embankment. The soil is made of layers of alluvial sediments found in Posavina and the Bosna River valley, which means it is stable. The highest altitude of the route is 130 masl. There are 5 larger bridges in this part with a total length of approx. 1700m, two locations with ancillary service facilities and three interchanges. The longest facility shall be the interstate bridge over the Sava river, about 600 m long. The bridge is currently under construction and should be completed soon.

The second part of the route begins in the valley of the Bosna River in Podnovlje and ends with a bridge in the vicinity of Karuše (km 62+600). The route is laid along the left bank of the Bosna River to the village of Rudanka. After Rudanka, the route reaches a hilly terrain and then gets into the valley of the Usora River, thus avoiding a collision with the existing urban infrastructure of the town of Doboj. The terrain is stable in this part. The plan is to construct a site with service and catering facilities, three interchanges, five larger bridges and two tunnels on this stretch. The total length of the bridges is 2750 m, and of the tunnels about 1960 m. The design of these interchanges shall ensure the connection with the existing and the planned road network.

7.3. Spatial planning documentation of impact area

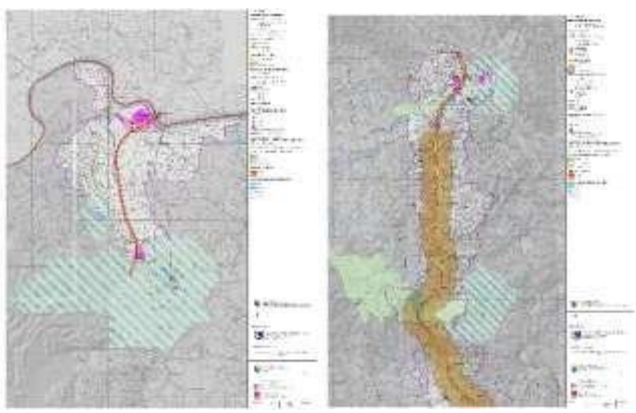
The route of the motorway on Corridor Vc, on the stretch of LOT 1, passes through the municipalities of Odžak, Vukosavlje, Modriča, Doboj, Usora and Doboj South. The spatial coverage of the wider impact area includes the region of Doboj, which comprises eight municipalities. The more limited impact area includes six municipalities, three in the territory of Republika Srpska (Vukosavlje, Modriča and Doboj), and the other three in the territory of the Federation of Bosnia and Herzegovina (Odžak, Usora and Doboj South). Until 1992, this area was part of the municipalities of Odžak, Modriča and Doboj. In the past ten years or so, significant changes occurred in this area, as well as in BiH and the entire region; war events, formation of new territorial–political borders, changes in the geopolitical environment, etc. The newly formed municipalities are Vukosavlje (formed from parts of the municipalities of Odžak and Modriča), Doboj South (by separation of settlements from the municipality of Doboj), and Usora (by separation from the municipalities of Doboj and Tešanj).

The Federation of Bosnia and Herzegovina is also organized at the cantonal level, unlike Republika Srpska, so that the municipalities of Doboj South and Usora are located within the Zenica-Doboj Canton, while the municipality of Odžak is in the Posavina Canton.

7.3.1. Data and spatial planning documentation of the specific area through which the Motorway on Corridor Vc will pass

Excerpt from the Spatial Plan of BIH for the period 1981–2000, consolidated text (1988)

The Spatial Plan of BiH identifies the routes of European roads (E 73, E 661, E 761 and E 762) with special emphasis that on the course of the "North-South" trans-European motorway, overlapping with the road E 73 and passing along the valleys of the Bosna and Neretva rivers, the protection of municipality and town areas where the route of European road E 73 is



planned should be included in the preparation of their spatial and urban plans. Given that Corridor Vc has had the adopted Spatial Plan for areas with special features of importance to the Federation of Bosnia and Herzegovina since 2017, "Motorway on Corridor Vc", thus the municipalities through which the Corridor passes have adapted to that.

Combined overview of the land-use in the planning period

7.4. Socioeconomic significance of the Project

The aspect of the project socioeconomic significance was recognized as a global phenomenon related to the area along the project of the motorway on Corridor Vc, i.e. both the parts (LOTs) that are in the planning (design) process and the parts that are under construction or already constructed from Svilaj to the southern border. Such approach has a completely grounded principle since it is not possible to view the 'capital investments – socioeconomic effects' processes otherwise than as the projects of national significance.

Preparation of the planning-study documentation for the motorway on Corridor Vc through Bosnia and Herzegovina is implemented in an environment where it is very difficult to reach a general national, political, regional, economic, and any other consensus on any issue, which is a consequence of war-disrupted relations. A rare positive exception is the general consensus regarding the construction of this motorway that is of particular importance in the present conditions. The motorway construction project was declared a priority development project of national interest, and is treated as the "development project of the century". Such treatment stems from its general socioeconomic and political significance for Bosnia and Herzegovina. The following facts, inter alia, point to the wider socioeconomic significance:

a) At the Third Pan-European Transport Conference (Helsinki, 1997), the Budapest-Osijek-Sarajevo-Ploče transport corridor was included in the Pan-European Transport Network as Corridor Vc, which confirmed its wider international significance. The Corridor Vc passes through the central area of BiH in the north-south direction, along the valleys of the Bosna and Neretva rivers, i.e. the area with the highest concentration of population, natural and anthropogenic resources;
b) In the Corridor belt of around 40km (on less than 20% of the territory) resides over 50% of the population, which accounts for over 60% of the total GDP of Bosnia and Herzegovina. This area includes the administrative, cultural, sports and economic center and the capital of BiH - Sarajevo, the cultural, sports, economic and tourism center and the largest city of Herzegovina - Mostar, the mining and metallurgical center of BiH - Zenica, the largest road traffic and railway junction - Doboj, as well as a number of other important industrial-energy, tourism-hospitality, sport-recreation, cultural-historical and religious centers, such as the Nature Park - Hutovo Blato, the religious tourism center - Međugorje, the winter tourism centers around Sarajevo on the Olympic mountains of Jahorina, Bjelašnica and Igman, and Vlašić mountain near Travnik, the hydropower plant system on the Neretva River with artificial reservoirs, the health-spa facilities of Ilidža, Fojnica and Teslić, the thermal power plant and mine Kakanj, lumber industry Zavidovići, cellulose Maglaj, oil refinery Modriča, etc.
c) The main existing two-lane road with the width of 7.00 m, which runs along the Corridor (road M17), has long failed to meet the traffic requirements in terms of service levels and traffic safety. The M17 road passes through larger cities, so some of its sections turn into urban and suburban roads on which the transit (long-distance) source-destination traffic and the local urban-suburban traffic are mixed, with all negative consequences for both the environment and the traffic itself (creation of other columns, traffic jams with longer delays, numerous accidents, air pollution, excessive noise, etc.). Such situation results in very high costs for transport users, big time losses, productivity decline, a decrease in competitiveness, a shrinking market, deterrence of potential foreign investors, etc. The elimination of traffic restrictions that result from the

existing unsatisfactory state of traffic infrastructure, which will be achieved by the construction of the high-order road, i.e. the motorway, will create conditions for the reduction of transport cost share in production costs, reduction of non-productive in favor of productive time and thus also an increase in the overall productivity; it will facilitate the accessibility to production and consumption centers leading to the more balanced market conditions, as well as the processes of cooperation, spatial and productive-technological restructuring in production; it will increase the labor force mobility, and all this will affect the faster and more comprehensive development of Bosnia and Herzegovina and strengthen the competitiveness of its economy.

d) Radical improvement of accessibility to tourist centers, religious-recreation and catering facilities, hunting grounds, health and other facilities for vacation and recreation will create special advantages for this sector of the economy. The construction of the facility, the estimated value of which BAM 6.20 billion, will certainly lead to the creation of a large number of jobs, intensification and increase of production in existing plants, as well as especially in the construction sector, the production of construction material and equipment, agri-food industry and services. After the commissioning of the facility, there will be direct additional employment in the motorway management and maintenance, as well as in numerous services.

e) The impact of motorway construction on employment and increase in production shall cause a chain reaction of a wide range of indirect manufacturers and suppliers of consumer goods, materials and equipment, thus multiplying the effects. Engagement of the domestic construction operative in such large and complex works will provide the staff, technical and technological strengthening and training to enter the world-wide markets and restore its pre-war reputation and position. Engagement of the domestic highly qualified staff in the provision of consulting services in the phases of preparation, execution of works and operation project management will create the staff structure, capable of creating its own development strategy and policy and managing other development projects.

f) It is common that in such projects the attention of ecologists and environmental experts is focused on the negative impacts of the project on the environment. This, in any event, is good because it shall result in measures that will eliminate these negative impacts, which undoubtedly exist, or reduce them to an acceptable level. With such approach, we usually lose sight of the positive impacts and effects. In this particular case, the construction of the planned motorway with bypasses around larger cities will greatly relieve the network of urban roads, mitigate the congestion problems, and thus put off the need for investment interventions; it will alleviate the noise, reduce the emission of harmful substances, and thus improve the general living conditions in cities. Bearing in mind that the mentioned negative impacts from densely populated and built urban areas, where protection from these impacts is practically impossible or very difficult, spread to uninhabited areas even with the application of protection measures, it is easy to conclude that the overall impact of motorway construction on environment will be very positive.

g) Re-routing the transit traffic outside the narrow urban zones will enable a more purposeful use of space, more favorable distribution of various urban facilities, i.e. will help a more rational and functional development thereof. Although it can be expected that the value of real property (land and buildings) will decrease in certain limited areas along the motorway due to the proximity of the motorway and the "obstacles" effect, it is certain that, on a larger scale and in a wider area, real property values will be on the rise. Increased investment activity, increased production, increased trade, and GDP growth, will also lead to the increase in fiscal revenue of socio-political communities. As a positive ripple effect, it can influence the reduction in tax rates and other fiscal burdens, which is an additional incentive to economic progress.

These positive effects of the motorway on the overall economic development cannot be quantified and expressed in monetary terms. Some of them are contained in the effects of transport users in the cost-benefit analysis (vehicle operating costs, travel time of goods and passengers, accidents), but there will certainly be significant indirect effects. Some attempts have been made to assess the indirect impact of motorway construction on the overall economic development of Bosnia and Herzegovina.

7.5. Technical description of the adopted route

The project starts at the inter-entity border within the Putnikovo Brdo 2 tunnel (total length of 700 m, while the length in the FBiH is around120 m). Upon exiting the Putnikovo brdo 2 tunnel, the route descends down the slope where it intersects the existing local road and comes to the Usora interchange on the left bank of the river, and it then crosses the Usora riverbed.

The motorway has been designed with two carriageways, divided by central reservation, each with two traffic lanes and one breakdown lane. All technical elements of the motorway have been defined according to the Terms of Reference and Rulebooks for the category and importance of the subject motorway, for the design speed Vp=120km/h.

Route of the northern part of the section (Inter-entity border – Karuše)

Main Design and the changes thereof: the Northern part of the Section (Inter-entity border – Karuše) was the subject of extensive consultations with local communities, held during 2009 and 2010. Representatives of the municipalities of Usora and Doboj-South made requests for the route changes relating to the local access roads and conflicts with existing facilities. All proposals and complaints were adopted and the route was changed within the Main Design. As a result, the adopted version of the route is technically more demanding and somewhat less environmentally friendly compared to the option from the Preliminary Design. The adopted option crosses the Usora River in three places (instead of one), requires relocation of the M-4 regional road closer to the river, which brings it into the impact zone of the planned Usora River regulation, and finally intersects two protected groundwater sources (Karuše and Makljenovac). After the final decision was adopted in 2010, no changes have been made.

Limiting elements of the plan and profile

Limiting elements imply the estimate of the minimum and maximum values for the Layout plan, vertical alignment, cross-section and sight distance in the function of design speed of the section.

Layout:

- Maximum length of the direction max L 20·Vp ....240.00 m
- Minimum radius of horizontal curve min R .... 750.00 m
- Minimum radius of horizontal curve with i_{pk} min R' ....4000.00 m
- Maximum radius of horizontal curve max R ....5000.00 m
- Minimum parameter of transition curve min A..350.00

Vertical alignment:

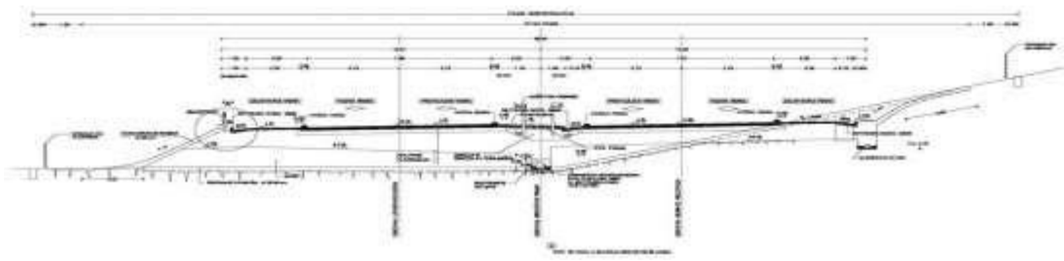
- Maximum vertical alignment grade max i_N ....4.00 %
- Minimum vertical grade min i_N ....0.30 %
- Maximum carriageway rotation grade max i_{rv}..0.50 %
- Minimum carriageway rotation grade min i_{rv}... 0.20 %
- Minimum radius of convex curvature min Rv $_{konv}$..12000m
- Minimum radius of concave curvature min Rv' $_{konk}$... 12000m

Cross-section:

- Width of the lane for continuous flow t_v..3.75m
- Breakdown lane width t_z..2.25m
- Marginal strip width t_i 0.25m
- Flank width b... 2.00m
- Minimum carriageway crossfall min i_p ....2.50 (%)
- Maximum carriageway crossfall in curve max i_{pk} .... 7.00(%)

Sight distance:

- Minimum length of stopping sight distance ascending grade min Pz 250m
- Minimum length of stopping sight distance descending grade min Pz 310m



Normal cross-section of the motorway

Waste materials and emissions

During the operation of the motorway, wastewater starts coming off the road, and is collected and treated by a specific internal drainage system with ancillary facilities. The emission limit values in this wastewater should be satisfactory and harmless to the overall environment. As regards the limit values, it is necessary to respect the ones that have been defined.

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

8.1. Demographic and economic characteristics

In Bosnia and Herzegovina, there is a true problem in perception of demographic trends, given that there are no reliable data on the number of inhabitants, and that the last census was conducted fifteen years ago. The Entity Statistics Offices and the Brčko District Bureau of Statistics make annual population estimates that are subject to criticism. However, in the absence of more reliable ones, the available estimates of the number of inhabitants are used, which, in addition to natural ones, also respect the basic migration trends.

8.1.1. Municipality of Odžak

8.1.1.1. Settlements and settlement systems

Table: Municipality area, number of inhabitants and population density

Area (km^2)	Number of inhabitants (2004)	Population density inh/km^2
171.4	17.074	99.6

Before the war, the municipality of Odžak had 14 settlements with a total of 30.056 inhabitants. The following table shows the overview of the settlement structures and population status from the year 1991.

Table: Settlement structures and population status from the year 1991

Ord. No.	Size structure	Number of settlements	Total population	Structure
1.	Up to 199 inhabitants	–	–	–
2.	200-499	1	252	0.84%
3.	500-999	3	2436	8.11%
4.	1.000-1.999	6	9809	32.64%
5.	2.000-4.999	3	8173	27.19%
6.	5.000-10.000	1	9386	31.22%
7.	More than 10.000	–	–	–
TOTAL		**14**	**30.056**	**100%**

The Dayton Agreement changed the pre-war territory of the municipality of Odžak, its area and the settlement system. The area of the municipality was 205 km^2 in 1991.

The settlements from the municipalities of Bosanski Šamac and Bosanski Brod were annexed to the municipality of Odžak, while the municipality of Vukosavlje was formed from one part of the municipal territory. In the municipality of Odžak area, the most numerous group comprises the settlements having 1000-2000 inhabitants with the highest number of inhabitants in the overall structure, which is favorable in terms of further development. The municipal center is a settlement of 5000-10.000 inhabitants.

8.1.1.2. Demographic characteristics

The municipality of Odžak occupies 52.8% of the Posavina Canton area, where 38.2% of the population resides. The population density is below the average population density of the canton. The number of inhabitants was significantly lower in 2004 as a result of changes in the size of the territory and migratory movements of the population.

Table: Demographic characteristics

Municipality area (in km^2)		**171.4**
Indicators		**for 2004**
1.	Number of inhabitants	17.074
2.	Population density (inh/km^2)	99.6
3.	Population growth rate (1991 – 2004)	-4.3

8.1.1.3. Macroeconomic characteristics

The state of the economy of the more limited impact area, which consists of six municipalities: Odžak, Modriča, Vukosavlje, Doboj, Doboj-South and Usora, will be looked at through the following indicators: income, employment, capital[4] and the number of business entities.

Table: Economic indicators of municipal development

Employment	
Number of employed persons	1.465
Employment rate	9.2
GDP per capita in BAM	2.110
Unemployment	
Number of unemployed persons	2.207
Labor force	3.672
Labor force unemployment rate	60.1
Municipality development level in relation to FBiH	
GDP/accommodation	62
Population employment rate	61
Labor force unemployment rate	130

According to the basic indicators of development, the municipality of Odžak is considerably below the development level of the Federation of BiH by 38% in GDP per capita and by 39% below the employment rate of the FBiH. The labor force unemployment rate is 30% higher than in the FBiH.

8.1.1.4. Economic structure

Table: Economic structure of the municipality per activity in 2003

Activity	Business entities	
	Number	%
Agriculture and forestry	10	3.8
Industry, mining and power supply	44	16.9
Civil engineering	16	6.2
Trade, hospitality, crafts and tourism	90	34.6
Transport and telecommunications	12	4.6
Other activity	88	33.8
Total	*260*	*100*

Table: Economic structure of the municipality per activity sector

Structure of entities %	
Sector I	4.2
Sector II	22.7
Sector III	43.5
Sector IV	29.6

The sectoral structure of registered business entities shows the dominance of the tertiary and quaternary sectors with 43.5% and 29.6%. Such structure of economy corresponds to the developed areas, whereas it inadequate at this level of development, as the tertiary and quaternary sectors have a small employment potential.

8.1.2. Municipality of Usora

8.1.2.1. Settlements and settlement systems

Table: Municipality area, number of inhabitants and population density

Area (km^2)	Number of inhabitants (2004)	Population density inh/km^2
49.8	7100	143

The municipality of Usora is a newly formed municipality in the Federation of Bosnia and Herzegovina, formed after the signing of the Dayton Peace Agreement, from the municipalities of Tešanj and Doboj. The municipality of Usora is characterized by a smaller number of settlements, and the seat of the municipality is in the settlement of Sivša.

The largest number of settlements was in the category of 1000-2000 inhabitants, in which resided around 60% of the total population. According to data from 1991, there were about 9.100 inhabitants in this area.

8.1.2.2. Demographic characteristics

Table: Demographic characteristics

Municipality area (in km^2) **Indicators**		49.8 for 2004
1.	Number of inhabitants	7100
2.	Population density (inh/km^2)	143
3.	Population growth rate (1991 – 2004)	-1.9

The municipality of Usora occupies 1.5% of the Zenica-Doboj Canton area, with 1.8% of the population. The number of inhabitants was lower in 2013 than in 1991. Population density of the municipality is above the average in the canton.

8.1.2.3. Macroeconomic characteristics

Table: Economic indicators of municipal development

Employment	
Number of employed persons	504
Employment rate	7.1
GDP per capita in BAM	1.146
Unemployment	
Number of unemployed persons	1.143
Labor force	1.647
Labor force unemployment rate	69.4
Municipality development level in relation to FBiH	
GDP/accommodation	34
Population employment rate	47
Labor force unemployment rate	150

According to the basic indicators of development, the municipality of Usora is considerably below the development level of the Federation of BiH by 66% in GDP per capita and by 53% below the employment rate of the FBiH. The labor force unemployment rate is 50% higher than in the FBiH.

8.1.2.4. Economic structure

Table: Economic structure of the municipality per activity in 2013

Activity	**Business entities**	
	Number	**%**
Agriculture and forestry	0	0
Industry, mining and power supply	11	16.2
Civil engineering	4	5.9

Trade, hospitality, crafts and tourism	19	27.9
Transport and telecommunications	5	7.4
Other activity	29	42.6
Total	68	100

Table: Economic structure of the municipality per activity sector

Structure of entities %	
Sector I	0
Sector II	22.1
Sector III	36.8
Sector IV	41.2

The sectoral structure of registered business entities shows the dominance of the tertiary and quaternary sectors with 36.8% and 41.2%.

8.1.3. Municipality of Doboj-South

8.1.3.1. Settlements and settlement systems

Table: Municipality area, number of inhabitants and population density

Area (km^2)	Number of inhabitants (2004)	Population density inh/km^2
10.2	4852	473

The Municipality of Doboj-South is a newly formed municipality on the territory of the Federation of Bosnia and Herzegovina, formed after the signing of the Dayton Agreement from a part of the territory of the Municipality of Doboj. Its territory comprises two settlements, Matuzići and Mravići. The seat of the municipality of Doboj-South is in Matuzići.

Both settlements belong to the group of settlements of 1000-2000 inhabitants (Matuzići - 1783; Mravići - 1476 inhabitants). In 1991, 3259 inhabitants resided on the territory of the municipality.

8.1.3.2. Demographic characteristics

Table: Demographic characteristics

Municipality area (in km^2)		10.2
Indicators		for 2004
1.	Number of inhabitants	4852
2.	Population density (inh/km^2)	473
3.	Population growth rate (1991 – 2004)	3.1

The municipality of Doboj-South occupies 0.3% of the Zenica-Doboj Canton area, where 1.2% of the population resides. The population density is above the average population density of the canton. The number of inhabitants in 2014 was higher than in 1991 as a result of changes in the size of the territory and migratory movements of the population.

4.1.2.3. Macroeconomic characteristics

Table: Economic indicators of municipal development

Employment	
Number of employed persons	576
Employment rate	12.1
GDP per capita in BAM	2.369
Unemployment	
Number of unemployed persons	1.252
Labor force	1.828
Labor force unemployment rate	68.5
Municipality development level in relation to FBiH	
GDP/accommodation	69
Population employment rate	81
Labor force unemployment rate	148

According to the basic indicators of development, the municipality of Doboj-South is considerably below the development level of the Federation of BiH by 31% in GDP per capita and by 19% below the employment rate of the FBiH. The labor force unemployment rate is 48% higher than in the FBiH.

8.1.3.3. Economic structure

Table: Economic structure of the municipality per activity in 2003

Activity	**Business entities**	
	Number	**%**
Agriculture and forestry	2	2.7
Industry, mining and power supply	14	18.7
Civil engineering	8	10.7
Trade, hospitality, crafts and tourism	22	29.3
Transport and telecommunications	4	5.3
Other activity	25	33.3
Total	75	100

Table: Economic structure of the municipality per activity sector

Structure of entities %	
Sector I	4.0
Sector II	28.0
Sector III	38.7
Sector IV	29.3

The sectoral structure of registered business entities shows the dominance of the tertiary and quaternary sectors with 38.7% and 29.3%.

8.2. Climatic and meteorological characteristics

The area around the lower course of the Bosna River has a temperate continental climate with the average annual air temperature of about 11°C and annual precipitation of 745-907 mm.

As part of the valley of the Bosna river opens towards the west, north and northeast, the analyzed area is exposed to frequent northwestern and western penetrations of humid Atlantic air that bring considerable amounts of precipitation, especially during the period May-July. The amount of precipitation for the warmer part of the year is 56%, which confirms the continentality of the precipitation regime in this area.

With a view to examine in more detail the climatic conditions of the wider area of the Svilaj-Doboj motorway section, the available data of meteorological measurements and observations for the period 1951-2004 were analyzed for the following meteorological stations:

Slavonski Brod............	φ = 45° 10' N,	λ = 18° 00' E,	H = 88 m
Derventa.......................	φ = 45° 00' N,	λ = 17° 55' E,	H = 105 m
Modriča.........................	φ = 44° 59' N,	λ = 18° 18' E,	H = 115 m
Brčko.............................	φ = 44° 53' N,	λ = 18° 50' E,	H = 96 m
Gračanica.....................	φ = 44° 43' N,	λ = 18° 16' E,	H = 160 m
Doboj.............................	φ = 44° 44' N,	λ = 18° 06' E,	H = 165 m

8.2.1. Air temperature

Local relief conditions and low altitude of the analyzed area cause the temperate continental climate with very uniform thermal conditions. For the most of the year (April-October), the average monthly air temperatures are higher than 10°C, while the other months are cold with considerably lower temperatures. Winters here are often harsh, and summers are temperate. The average annual air temperature in the lower course of the Bosna River is about 12°C.

Analysis of the average annual air temperatures shows that the lowest temperature is -0.5°C in January, while the warmest month is July with the average air temperatures of 20.6°C. It should be emphasized that due to the global climate change over the last decade of the XX century, the highest increase in air temperature has been recorded both globally and locally. The average annual air temperatures in the analyzed area during the last decade of the 20th century were higher on average by 0.3°C compared to the standard 30-year average in the period 1961-1990, which is confirmed by the results of observations at meteorological stations.

It has been observed that the temperature extremes are more pronounced in the valleys than in the hilly area of higher altitude, due to the occurrence of temperature inversions.

Autumns are only slightly warmer than springs, which indicates that the analyzed area is in the zone of mild maritime influence on the thermal regime.

8.2.1.1. Frost

A high frequency of frosts (days with a minimum air temperature Tn below 0°C)and fog is also a significant climatic characteristic of the wider area of the observed section of the motorway. The annual average is 79 to 92 days with frost, mostly from October to April, with rare occurrences during the months of May and September.

8.2.1.2. Summer and tropical days

During the summer, the bottom of the valley and ravine warms up considerably, so as the altitude decreases, the number of summer days (days with a maximum air temperature Tx above 25°C) and the number of tropical days (days with a maximum air temperature Tx above 30°C) increase. Tropical days occur in the period from April to October, but most of them occur during the summer, with an average of 25 days. The number of summer days is proportionally higher than the number of tropical ones.

8.2.1.3. Wind

As regards the wind regime, the dominant impact of local geographical obstacles on both the wind direction and intensity is observed. The prevailing winds during the year are the ones from the western and northern quadrants. Proportionally high frequency of calm indicates that around 40% of days are windless in this area. The occurrence of days with a stormy wind (strength above 8 Beaufort) is much rarer and averages two days a year.

4.2.5. Humidity

The relative humidity is high and averages from 79% to 82% annually. From September to March, the relative humidity is high and is over 80%. The highest values of relative humidity occur in November, December, January and February and average over 85%, while the lowest value occurs in the period from April to August and averages about 75% in the analyzed area.

4.2.6. Precipitation

The precipitation regime is certainly one of the most important climatic elements from the aspect of road traffic safety. The spatial distribution of annual precipitation indicates that, during the year, there is an average of about 850 mm of rainfall in the municipality of Usora. The higher hilly areas around Doboj see a larger amount of rainfall that averages 1000 mm to 1200 mm.

4.2.7 Appearance of fog

Besides the impact on the wind regime, local topographic conditions also contribute to the appearance of fog. Thus, in the Doboj valley, a relatively large number of days with fog occur, on average 78 days a year. At the site of Usora, the average annual number of days with fog is 40. In addition to the relief, the rivers also affect the formation and retention of fog by increasing humidity in the river valleys and ravines.

8.3. Geological, engineering-geological and geotechnical characteristics

8.3.1. Geological characteristics of soil

The geological structure of the terrain along the Corridor Vc corridor on the stretch from Svilaj to Doboj consists of the Mesozoic Jurassic and Cretaceous sediments, the Cenozoic; that is, the Paleogene, Neogene, and Quaternary periods.

- **Mesozoic (Mz)**

- **<u>Jurassic (J)</u>**

These sediments cover the area from the Rudanka River (in the north) to Alibegovci (at the end of the Corridor Vc section).

The oldest Mesozoic sediments in the subject area belong to the Jurassic period (J), i.e. ophiolite mélange built of sedimentary rocks (sandstones, claystones, and cherts) with olistoliths of silicified limestone and igneous rocks (spilites, diabases, and serpentinites). Spilites usually appear as pillow-lava or brecciated pillow-lava. They are the product of submarine eruptions. Diabases appear as individualized shapes. The relations of these igneous rock masses with the sedimentary formations of the ophiolite zone are usually tectonic, where the serpentinites lie above or next to the sedimentary rocks.

- **<u>Upper Cretaceous (C2)</u>**

These sediments form a smaller part of the terrain in the immediate vicinity of Doboj.

The Upper Cretaceous sediments are composed of laminated marly limestone, brecciated limestone, and laminated dark-red marly limestone.

- **Cenozoic (Cz)**

The Cenozoic is represented by the Tertiary and Quaternary sediments.

Within formations of the Tertiary sedimentary complex, deposits belonging to the Paleogene and Neogene have been isolated. They spread from Svilaj (in the north) to Alibegovići and Karuše (in the south).

Within the Paleogene formations, sediments of Paleocene and Eocene epochs have been isolated.

- **<u>Paleocene – Lower Eocene (Pc,E)</u>**

These rocks cover a small part of the terrain around the confluence of the Usora and Bosnia rivers and around Alibegovići and Karuše.

They are presented in two packages: clastic and carbonate. The clastic package is built of four lithological components: sandstones, siltstones, claystones and, rarely, limestones. The carbonate package is built of massive to banked limestones, siltstones and claystones.

- **<u>Eocene sediments (E)</u>**

These sediments cover the area west of the Corridor Vc route, from Vrbovec (in the north) to Modriča and Jakeš (in the south), and the area along both banks of the Bosna River, all the way to Grapska. The detailed position of the individual Eocene stratigraphic members is shown in the attached maps and profiles. Evolved in limestone-sandstone facies and flysch facies. Lower and Upper Miocene (E1 i E2) evolved in the facies of clastic-flysch development, namely:

- E1 - fine-grained and medium-grained sandstones with graded bedding in alternation with siltstones and, rarely, marlstones;
- E2 - developed in the facies of marly sandstones, limestones, conglomerates and sandy limestones,
- E3 - massive banked sandstones, thin-layered claystones, clayey marlstones and, rarely, conglomerates.

- **Neogene (N)** is represented by the Miocene and Pliocene sediments.

- **Miocene (M)**

Miocene sediments cover the area west of the Corridor Vc route, from Svilaj (in the north) to Modriča and Jakeš (in the south) and the area along both banks of the Bosna River, all the way to Karuše. The detailed position of the individual Miocene stratigraphic members is shown in the attached maps and profiles.

The Older Miocene complex ($M_{1,2}$) is formed of conglomerates, sandstones, claystones and marlstones.

The Middle Miocene (Tortonian stratum - M_2) occurs in the facies of organogenic (lithothamnic) limestones, sandy limestones, marl conglomerates and sandstones.

The Lower Pliocene (Pl_1) and Plio-Quaternary (Pl,Q) cover the same spaces as the Miocene sediments above which they are deposited.

The Lower Pliocene (Pl_1) is composed of quartz sands, gravels, marls, clays, sandstones and coal, while the Plio-Quaternary (Pl,Q), in lithological terms, is represented by ferruginous, mainly quartz gravel mixed with sand and clay.

- **Quaternary formations (Q)**

Most of the motorway is positioned on these sediments. They had developed in a wide area which actually is the lowland part of the Bosnian Posavina. They are represented by the following genotypes:

- terrace, lake-river (t_3) and river sediments ($t_{1,2}$),
- flood-facies sediments (ap);
- abandoned riverbed sediments (am);
- bog sediments (b), and
- riverbed formations (a).

The sediments of the third river terrace are represented by poorly sorted mixed clayey and gravel-sandy materials, which indicates their proluvial origin.

The sediments of the second river terrace are represented by clays, clayey sands, yellowish silty clays, and at depths of 8 m below the clays, gravels and sands lie.

The first river terrace is marked with a scarp formed by subrecent meanders of the Bosna River. Gravels of alluvial deposit prevail and, only sporadically, sediments of the flood facies.

The flood-facies sediments consist of fine-grained, plastic deposits in which sands, silts and clayey sands are predominant. The thickness does not exceed 5 m.

The sediments of abandoned riverbeds consist of silty clays and silt filled with plant remains. The thickness of these deposits is up to 5m.

Organogenic-bog sediments consist of fine-grained, plastic material and plant residues. Dark green and dark gray clays of illite composition predominate, and fine-grained sands and smaller lenses of fine-grained gravel also appear. The thickness of these sediments does not exceed 2 m.

Alluvial deposits are mostly made of pebbles and sand grains of sandstones, carbonate rocks, cherts, quartzites, gabbros, spilites, serpentinites, quartz-porphyries, amphibolites, and other rocks.

8.3.2. Engineering-geological characteristics

Rock masses along the considered routes are of heterogeneous composition and anisotropic structure. They differ in terms of engineering-geological categories, groups and units, and especially in terms of structural-textural and physical-mechanical properties. An overview of the spatial distribution of engineering-geological features of the area is given in the graphical annexes 12.3.3.1- 12.3.3.4 to this Study.

In accordance with the recommended "engineering-geological classification of rocks" (as per International Association of Engineering Geology), within the considered area, rock masses can be classified into lithological complexes and types as follows:

Lithological complexes

In solid rocks with crystalline bond, i.e. sedimentary chemical rocks with alternations of mechanical and chemical deposits, the special units are: sandstones, clays, cherts and silicified limestones of Jurassic period; marly sandstones, limestones, conglomerates and sandy limestones of the Middle Eocene; limestones, siltstones and claystones of the Paleocene-Eocene; marly limestones, brecciated limestones and Upper Cretaceous marls; limestones and dolomites of the Middle Triassic, and sandstones, claystones, clayey marls, conglomerates and siltstones of the Lower and Upper Eocene.

The category of diagenetically weakly bonded rock masses includes marly clays, marly limestones, sands and sandstones, and conglomerates of the Upper Miocene; limestones, marls, conglomerates, sandstones, clays and sands of the Lower and Middle Miocene and Pliocene.

The category of loose rock masses includes the plio-quaternary gravels, sands and clays, as well as gravels, sands, silts, clays, loams and muds of different genetic types of Quaternary, i.e. Pleistocene and Holocene.

Lithological types

The igneous rocks represented by spilites, diabases, and serpentinites belong to this category of rock masses with crystalline bond. The first kilometers lie on very decomposed and loose deposits of soft consistency and low hardness. These are predominantly compressible materials but the terrain seems stable due to the flatness.

The remaining part of the route is located on the sediments of river terraces. These are more moderately decomposed and loose deposits of hard consistency and moderate hardness, stable and non-compressible. They are a favorable milieu for the construction of the road.

Part of the route around Karuše is on the river terrace of good physical and mechanical properties.

The terrain before Doboj South is built of a tectonic mélange containing serpentinite and spilite igneous forms.

On the whole, the stretch within the Upper Cretaceous and Jurassic formations represents the environment of poor engineering-geological characteristics and weak physical-mechanical properties. It would be particularly unfavorable to set up tunnels with a relatively small surcharge of less than 10 m in height, and it is not recommended to perform pre-cuts, cuts, side cuts and foundations of facilities in the relatively high grades.

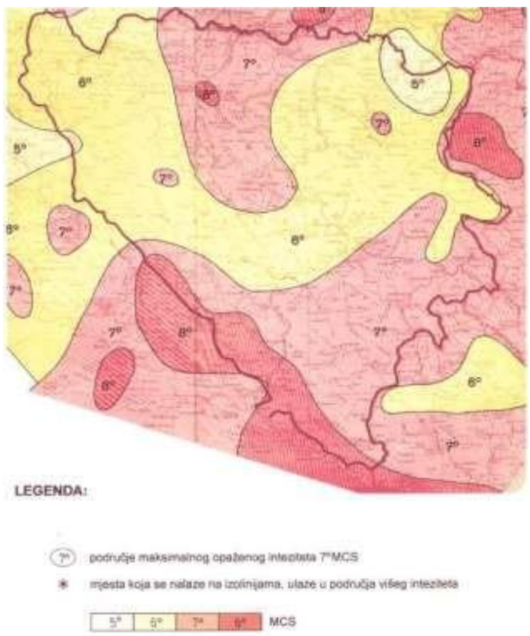
The final part of the route is laid on the sediments of the river terrace, which are a favorable environment for construction.

8.3.3. Seismotectonic characteristics

The most important and most active epicenter areas in the territory of BiH are: Treskavica - Sarajevo; Foča;Zenica - Travnik; Jajce - Bugojno; Banja Luka; Žepče; Livno; Drinovci; Ljubuški; Mostar; Dokanovići; Stolac; Ljubinje; Dabarsko polje; Nevesinje and Drežnica. Within the Basic Neotectonic Map of the SFR Yugoslavia M 1:500.000, the territory of BiH from southwest toward northeast is divided into three tectonic areas:

- fault zone;
- fold-fault zone, and
- fold zone.

Within this Study, only those seismic zones that include a wider area of the considered corridor are presented, and the attached map shows the spatial distribution of the epicenters in relation to the Corridor Vc



LEGEND:

area of the maximum observed intensity of VII MCS

places located on the isolines, they belong to the area of higher intensity

Seismic map of Bosnia and Herzegovina for the return period of 100 years

Fault zone

Deep fractures in the Earth's crust, manifested as fault zones, are the sources of tectonic impulses along which individual blocks do not stay still. This is caused by thermodynamic processes in the sub-crust parts, due to which the blocks oscillate with different amplitudes and frequencies, i.e. intensity. The zones of deep faults are also the areas of current tectonic movements. And deep faults are exactly the most common cause of earthquakes in the territory of BiH.

Along the Corridor Vc in northern Bosnia, the following dominant lineaments can be distinguished within the fault zones: faults of the Sava and Bosna river valleys and Tuzla fault.

Faults of the Sava and Bosna river valleys

This area includes the surroundings of Bosanski Brod and Odžak, Derventa, Bosanski Šamac and Modriča. In tectonic terms, this zone mostly covers the "southern Sava fault" and the deep fault along the Bosna River valley. The maximum earthquake intensity on the said stretch is VI and VII on the MCS scale, while along the Bosna River, from Svilaj to Maglaj, the earthquake intensity is VII on the MCS scale.

It is realistic to assume that the tension equalization in the zone of the "Sava fault" is done gradually, over a long period, when no earthquakes occur. However, this does not mean that at some point there will be no sudden release of energy and the occurrence of an earthquake. Hence deep faults along the Sava and Bosna rivers should be considered as the potential earthquake foci.

It is necessary to emphasize that in terms of structural-tectonic, engineering-geological and geomechanical soil characteristics, the earthquake impact on the future facilities of the motorway can be significant. Hence this area should be seismically tested in more detail, especially in terms of seismic hazard adjustment, that is, a detailed seismic zoning should be done for certain facilities in the next phase of the project.

Tuzla fault

This fault is marked by gravimetric measurements and registered epicenters on the Zvornik-Tuzla-Doboj stretch. Indirect indicators of the existence of deep fault(s) are also the thermal and mineral waters along this stretch, as well as the current movements of the Tuzla block, based on rising, and the Spreča valley, based on lowering According to the mentioned phenomena, this fault is active even in current times. However, the abrupt movements of blocks along this fault are relatively rare, and thus no earthquakes of higher frequency have been registered. In the wider area of Doboj, seismic zoning should also be done.

8.4. Hydrogeological and hydrographic characteristics and there hydrological features

8.4.1. Hydrogeological characteristics

Following the adopted route of the motorway on Corridor Vc in the area of LOT 1, it can be stated that the surveyed area is mostly characterized by hilly and lowland relief, in which the most dominant watercourse is the Bosna River with a large number of tributaries (Usora, Spreča, Lukavica, Lovnica, Glogovica, Bosnica, Plavuša, Ljubioča, Botajička, Babešnica, Gnionica, etc.), which gravitate to this catchment basin. The Sava River, into which the Bosna empties at Bosanski Šamac, is a typical lowland watercourse of a wide alluvial area and makes an almost complete northern border of BiH with the Republic of Croatia.

Given the size of the subject linear facility, the surveyed area cannot be observed as a unique aquifer but as associations of rocks with different hydrogeological characteristics, which alternate in the geological plan and profile. In line with certain lithological types of variable and inconsistent physical and chemical properties, there are more or less pronounced characteristics of permeability in the subject rock material, that is, the lithological complex of fracture, fracture-cavernous or intergranular porosity.

According to the data from previously conducted hydrogeological surveys and exploitation pumping of intake structures, it has been concluded that Quaternary (Q) alluvial aquifers (rocks of intergranular porosity) exist as the primary aquifer environment. Other rock complexes in the area have the characteristic of a secondary aquifer, from which water is usually supplied to a small number of individual residential buildings.

At several sites within the alluvial sediments of the Bosna and Usora rivers, groundwater is used to supply the populated areas. More important sources of drinking water are located in the immediate vicinity of the municipalities of Doboj-South (Havdine), Tešanj (Kraševo), and Usora (Alibegovci, Matuzići, Ularice).

Section Svilaj – Odžak

On this section, the route passes through two characteristic sensitive stretches. The first position is the crossing of the Sava River, which is the characteristic contact point of the motorway with an open watercourse at the entrance to BiH. Part of the route up to chainage of km 2+925 is located in the flood facies.

The second sensitive stretch is on the first and second river terraces of the Sava and the Bosna Rivers (t_1 and t_2), which represent the main aquifer environment of the groundwater intake for the purpose of water supply of Odžak as well as other surrounding settlements that, administration-wise, belong to it. This stretch goes from the chainage of km 2+925 to 10+890.787, that is, to the end of Section 1. From chainage of km 6+000 in a short part it touches on the third river terrace (t_3).

The Svilaj – Odžak Section of the motorway, over 10 km long, represents the northernmost part of the Corridor Vc in Bosnia and Herzegovina.

The Section starts directly after the future interstate "Svilaj" bridge that will bridge the Sava river, and ends at the "Odžak" interchange, located to the north of the town of Odžak. The bridge over the Sava River is also a junction of the motorway that passes through Bosnia and Herzegovina and Croatia.

The beginning of the route is at the elevation of 86.74 masl, and the end at the elevation of 108.21 masl. As the motorway passes through the lowland terrain, the requirement for it was to have slight elements of vertical and horizontal curves so as to better adapt to the terrain. The design speed of the route is 120 km/h.

Important facilities on this Section include the border crossing, two interchanges, rest area, frontal toll station, 2 bridges, 3 wildlife crossings, 4 overpasses, 3 underpasses, and 2 culverts for irrigation canals.

Since the route lies on terrain that has the pronounced long-term subsidence, technical solutions of subsidence acceleration were applied using vertical drains that were previously built into the ground.

As part of the motorway construction, an access road of approximately 4 km in length will be built, which will connect the motorway with the primary road M14.1. The access road shall include the future southern arm of the Odžak bypass.

8.4.2. Description of the route with the main facilities

8.4.2.1. Route

The start point of the Section Svilaj-Odžak also represents the end point of the future interstate bridge "Svilaj" over the Sava river. The bridge is located at the inflection point of two vertical curves and designed in alignment that extends up to km 1+582.61. Since the construction of the bridge ends at chainage km 0+328.05 as measured from the middle of the bridge, the motorway section begins at that very chainage.

At this point, the construction of the Border Crossing of 550x200 m has been planned, as well as the "Svilaj" interchange, km 1+406.00. From the said alignment, the route goes into the right curve T1, R=2200 m. A frontal toll station "CP" has been designed for this point. The route then continues in a long alignment, L=2402.07, up to km 7+ 073.36, and goes into curve T2 with R=3500 m.

At km 7+000.00, a Type C rest area has been designed, on both sides. The Section end is at km 10+762.5, which is also the Entity border. At the Section end, construction of the Odžak interchange has been planned, and access road to connect the motorway with the primary road M14.1. The length of the access road that has elements of the primary road is approx. 4 km.

The following are the applied Technical elements of the route (both Sections):

- Length of the route: 10.434.45 m
- Minimum length of transition curve, L=350 m, applied once
- Minimum radius of horizontal curve: 1750 mm
- Maximum gradient of level line: 0.5% / 944. 00 m, excluding the bridge over the Sava River where it is 2%
- Minimum gradient of level line: 0.3 % / 7.609.00 m
- Minimum radius of vertical curve, concave: 14.000 m
- Minimum radius of vertical curve, convex: 40.000 m

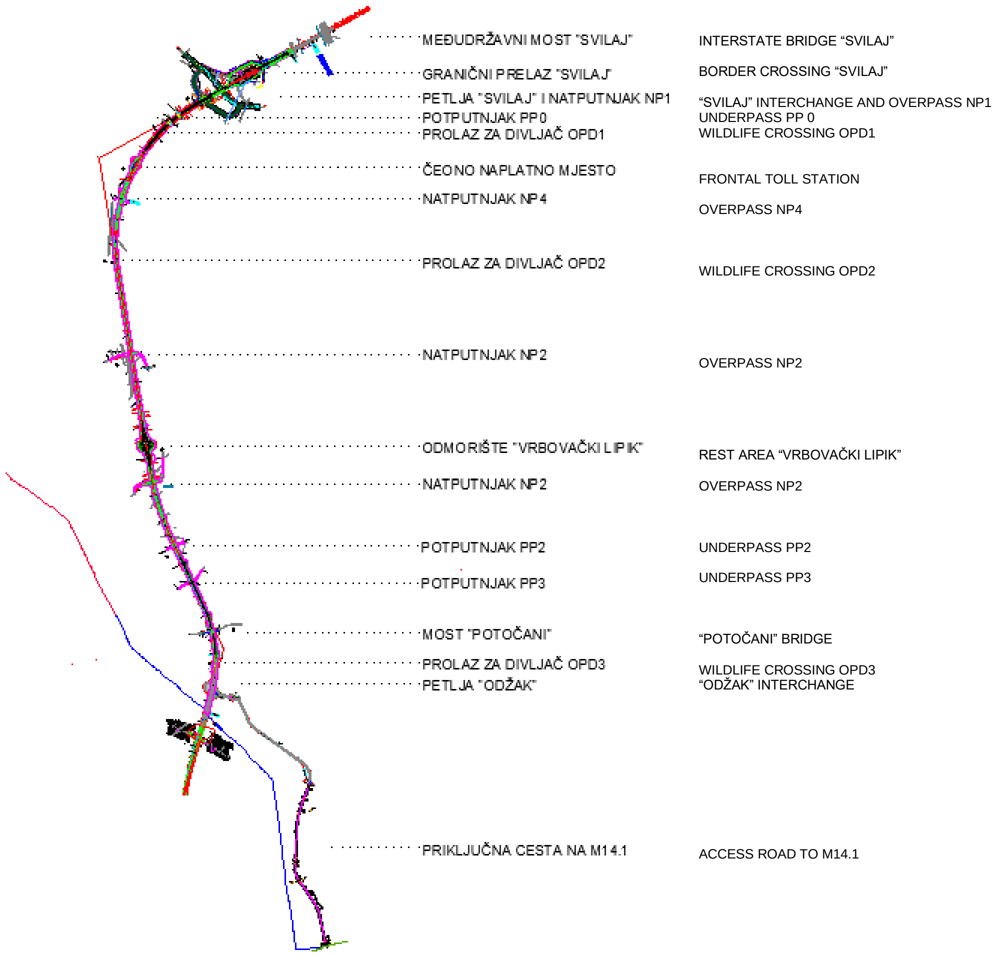


Diagram of the route with positions of the most important facilities

8.4.2.2. Facilities

8.4.2.2.1. Animal crossings

Three wildlife crossings and several minor culverts for smaller animals have been designed along the motorway, thus complying with the requirements of the Environmental Permit. The following is a layout solution with a graphical representation of the characteristic wildlife crossing.

The crossings are planned as an integral reinforced-concrete structure of a total length of 20.00 m. The normal cross-section consists of beams that vary in height from 1.0 m in the middle to 1.6 m at the abutment junction. Abutments consist of a 1.60 m thick body, with the average height of 6.5 m, and are firmly connected to eleven piles arranged in a single row, of 1200 mm in diameter. Wing walls, 8.00 m long, are placed on abutments and are connected to one pile of 1200 m in diameter.

Transition slabs are placed behind the abutments; they consist of a single 3.7 m part and rest on the intended projection.

8.4.2.2.2. Overpasses

A total of 4 overpasses are designed on the Section. The overpass NP1 is designed as part of the primary road M14.1, while the remaining overpasses enable transverse communication on local roads.

Although overpasses differ in the number of spans that bridge the obstacle, which is caused by the geometric elements the overpasses must fit into, they are all designed with a similar static system and geometric elements to streamline the construction thereof.

The overpasses are designed as a semi-integral structure of prestressed concrete, except for the overpass NP4 which is of reinforced concrete. There is no median pier in the central reservation, the right and left carriageways are bridged with only one span. The normal cross-section consists of plates, with cantilever arms on both sides.

The overpass prestressing requires 11 strands of 19Ø15.7mm (150mm²) made of ST 1570/1770 steel.

The abutments are done as massive capping beams, dimensions __. The capping beams rest on piles of Ø1200mm in diameter which are arranged in a single row. Short hanging wings of ___ in length are placed on the abutments. The span structure is firmly connected to the median piers. Median piers over the foundation pad rest on the 1200mm diameter piles. Pile lengths are adjusted to geotechnical characteristics of the formation soil.

At the ends, the span structure has overhangs for anchorage and protection of the prestressing strands.

The front of the inclined embankments is lined with stones in cement mortar.

8.4.2.2.3. Border crossing "Svilaj"

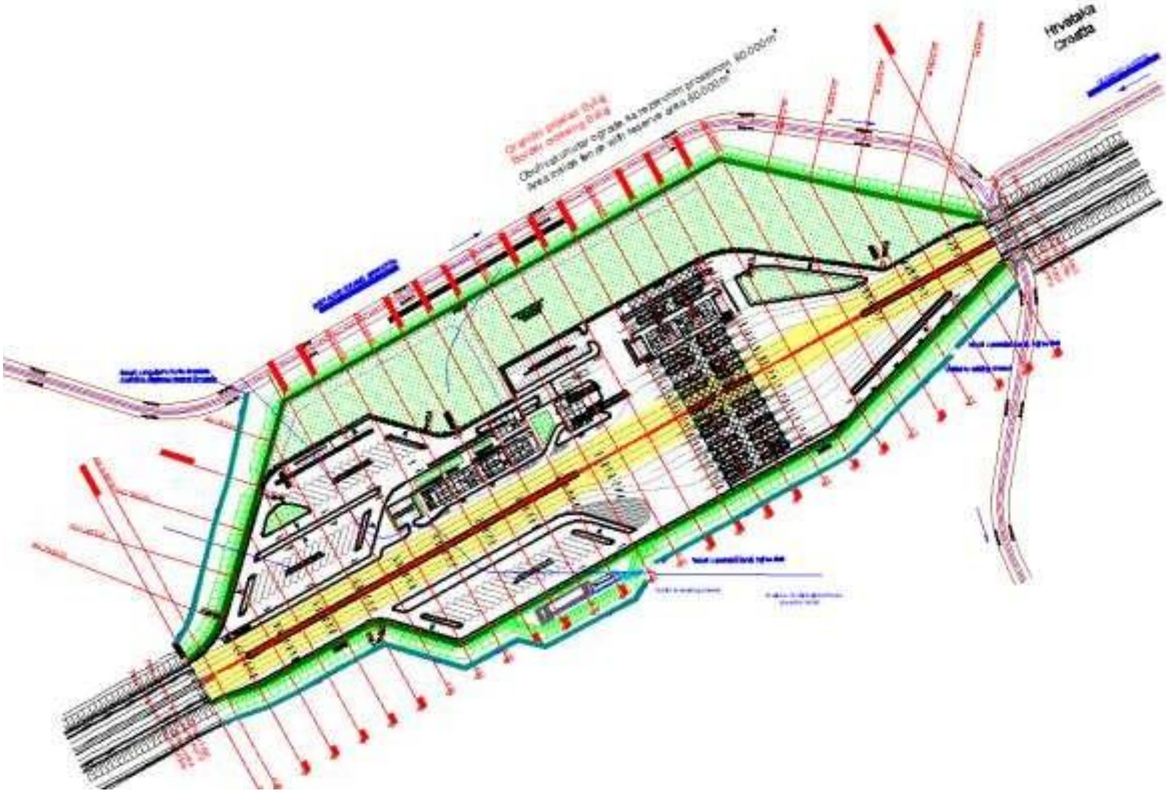
The "Svilaj" border crossing is located in the northernmost part of Bosnia and Herzegovina where the Sava River forms the natural border between BiH and the Republic of Croatia. The total length of the border crossing is 550.0 m from km 0+760.00 to km 1+310.00. With its size and amenities, it shall accommodate the future passenger and freight traffic.

The entire plateau of the border crossing is situated on the lowland terrain and surrounded by a 5-6 m high embankment. It partly crosses the existing primary road M14.1 Bosanski Brod – Odžak and the Srnotača river, which is why the existing design documentation provides for their relocation and regulation.

The total surface area of the border crossing within the confines of protective guarding is 80.000 m^2, with the reserved area of 20.300 m^2 for possible extensions.

In terms of layout, the entire plateau of the border crossing is in the alignment. Its width varies from the basic width of the motorway route at its beginning to the width of approx. 180 m at the canopy position. In vertical sense, one concave curve R=35.000 m has been planned for the plateau, with a slight downward or upward slope of 0.3%. Such elements are taken from the Main Design of the route of this part of the motorway.

The border crossing plateau contains all necessary facilities and infrastructure. In addition to lanes as the main traffic part of the crossing, the parking areas for trucks, buses, emergency vehicles, and staff vehicles are also planned on the plateau.



Layout plan of the Border crossing

8.4.2.2.4. Rest area "Vrbovački Lipik"

The ancillary service facility PUO "VRBOVAČKI LIPIK" is located at km 6+920.00 of the motorway, on both sides.

Both PUOs (Eng. ASFs) are located on the alignment in both the horizontal and the vertical sense. Due to the construction needs and other requirements, road widening was carried out on both sides. The level of construction of the rest area is next to the level of the facilities, including drainage.

8.4.2.2.5. "Odžak" interchange

The position of the interchange is defined by the Spatial Plan for areas with special features of importance to the Federation of BiH - "Motorway on Corridor Vc", 2008-2028, at km 10+471.63 on the main route of the motorway. The location of the interchange is partly in the circular curve (R=L750m) and partly in the transition curve.

The connection is achieved by the "trumpet" type interchange as the most suitable type of three-leg connections in terms of taking up space and investment costs. The trumpet-type interchange belongs to the Category 1 junctions where only merging and diverging traffic flows are present on the main carriageways. It consists of two direct ramps, one semi-direct ramp, and one indirect ramp. Based on that, the right-hand trumpet interchange has been planned. The interchange itself consists of four ramps, two for each – merging and diverging as well as of acceleration and deceleration lanes (speed-change lanes).

Section Putnikovo brdo – Doboj South

Upon exiting the Putnikovo brdo 2 tunnel, located in the Municipality of Usora, the route descends down the slope where it intersects the existing local road and comes to the Usora interchange on the left bank of the river, and it then crosses the Usora riverbed. The first bridge over the Usora River (Usora 1) is planned in this part. On the other side of the Usora River (right bank), the route enters the territory of the Municipality of Doboj South, and afterwards the territory of the Municipality of Tešanj, thus approaching the existing primary road M4, and running in parallel with the primary road, and then crosses the Usora riverbed for the second time (Tešanjka 1 bridge), thus getting back to the left bank, and enters the territory of the Municipality of Usora, then again intersects the Usora riverbed for the third time (Tešanjka 2 Bridge). Lot 1 ends at the intersection with the road M4 Doboj-Teslić.

The following facilities are planned for this Section:

- 4 bridges on the motorway,
- 1 smaller bridge on the Usora river regulation,
- 1 underpass,
- Usora interchange,
- Frontal toll station Doboj South.

A part of the Project is also the regulation of the Usora river in the length required for the construction of this Section on the motorway on Corridor Vc, as well as the relocation of the existing primary road M4.
The total length of the motorway route on this Section is approximately 5 km.

Section: Putnikovo brdo - Doboj South (Karuše)

8.4.3. Description of the route with the main facilities

In terms of layout, the route of the motorway is harmonized with the Spatial Plan and, for the most part, with the previously prepared documentation at the level of the Main Design Putnikovo Brdo – Karuše and the Preliminary Design Karuše – Medakovo.

The beginning of the route has been agreed upon with the designer of the previous Section (Section: Johovac – Putnikovo Brdo) at chainage km 10+920 of the previously done Main Design Johovac – Doboj South from 2010, with the same horizontal and vertical elements taken from the mentioned project and, at the request of Investor, the said chainage was marked as zero chainage, so that it corresponds to km 0+000.00 (LOT1 2020) = km 4+750.00 (LOT2 2010).

8.4.3.1. Route

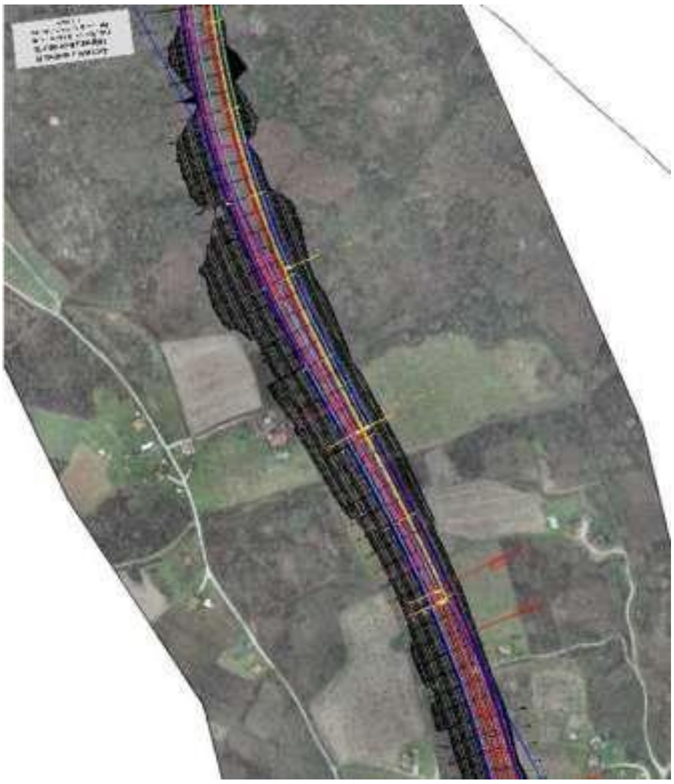
The beginning of the LOT 1 Section Putnikovo Brdo – Doboj South (Karuše) is located in a curve with the radius R=1200m, after which the route, in a wide "S" curve with R=1450m, descends towards the settlements of Ularice and Makljenovac passing between them.

At the initial part of the route (km 0+000.00 - 1+120.00), the level line is in the larger cutting (consisting mainly of claystone, marlstone and sandstone).

After that stretches a part of the route which is positionally conditioned by the Usora interchange, since there are water wells near the route from which the mentioned settlements are supplied with the drinking water (highest level of water protection) and there is limited space where interchange legs can be connected to the motorway route.

8.4.2.1.2. Technical elements of the route

- Type of road: motorway
- Terrain category: Lowland, hill and mountain categories alternate
- Design speed: 120km/h
- Maximum gradient: 4%
- Minimum radius of horizontal curve: 700m
- Minimum transition curve: 90m
- Traffic lane: 3.75m
- Breakdown lane: 2.50m
- Marginal strip along the central reservation: 0.50m (included in central reservation) Marginal strip along the breakdown lane: 0.25m (on the outer side of the breakdown lane and included in its width)
- Central reservation: 4.0m, including the gutter, curb and marginal strip
- Flank: min. 1.50 m + gutter or segmental ditch needed
- Berm: min. 2.50 m (conditioned by the drainage regime and geomechanical properties of the material)
- Full road cross-section: 4.70m



Beginning of the motorway LOT1 Section Putnikovo Brdo – Doboj South (Karuše)
(after exiting the "Putnikovo Brdo 2" tunnel)

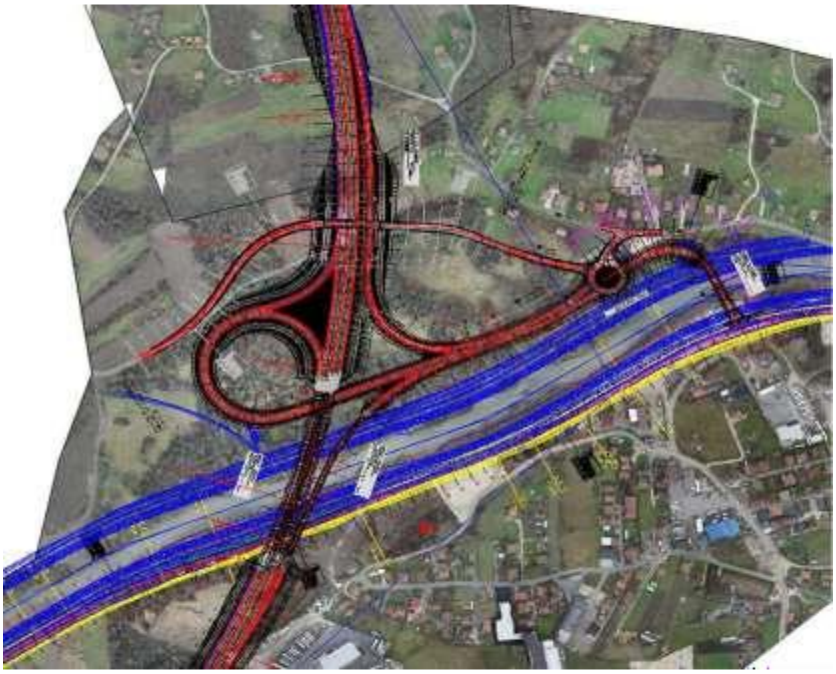
8.4.3.2. Facilities

In a relatively small area, several projects have been planned, namely:

- Usora interchange with the connection (roundabout) to the relocated primary road M4 and local road through the Municipality of Usora
- Regulation of the Usora River
- Usora 1, Usora 2 and Usora 3 bridges
- As well as the relocation of the local road that connects Ularice and Makljenovac.

8.4.3.2.1. Usora interchange

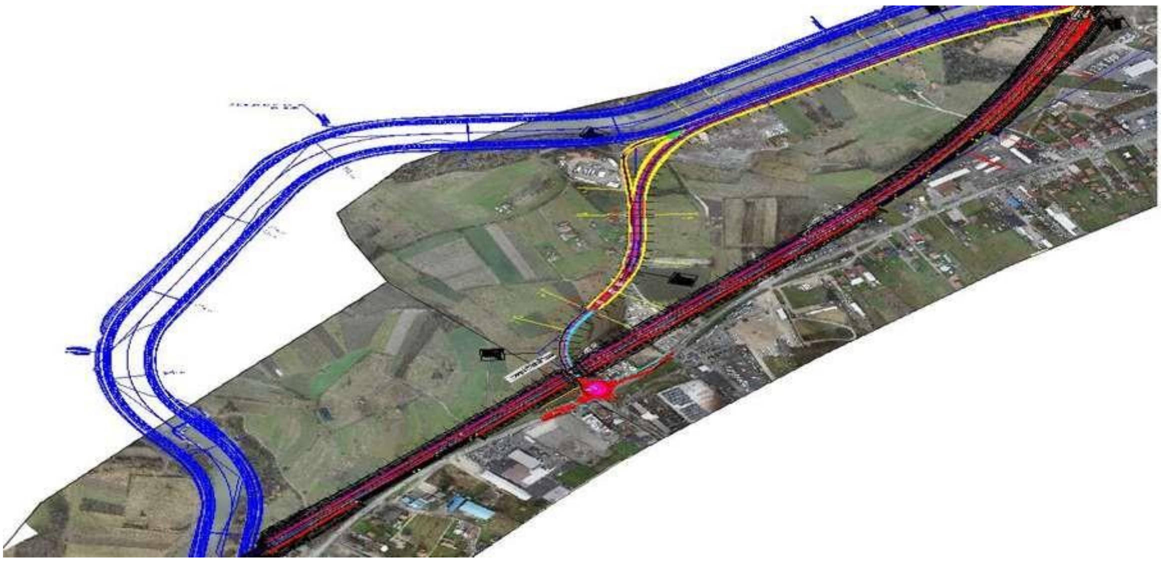
The crossing over the regulated riverbed of the Usora River and the relocated primary road M4 is achieved by the "Usora 1" bridge of L=276.00 m in length, and the "Usora 2" bridge on the interchange leg which spans these obstacles is also planned.



Usora interchange area, regulation of the Usora River and relocation of the primary road M4

8.4.3.2.2. Regulation of the Usora River and relocation of the primary road M4

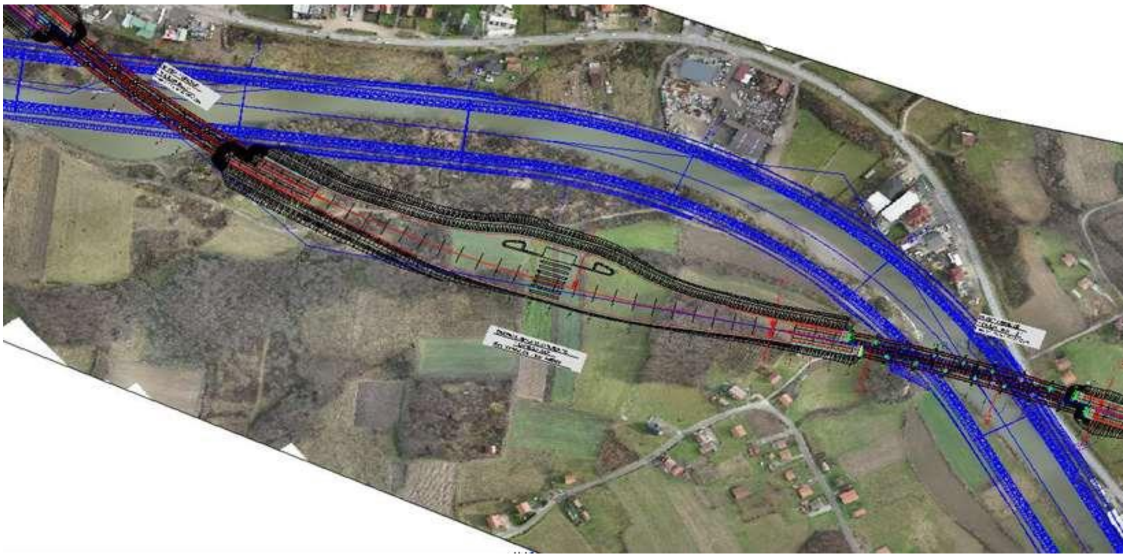
From km 2+000.00 to km 3+650.00 the route passes along the settlement at the beginning, and along the industrial zone parallel to the existing primary road M4. The existing primary road and commercial facility are protected by support structures of reinforced soil. The route is in the embankment of an average height of 7-9 m. At km 3+020.00, the route of the motorway crosses the relocated primary road over the 28m long "Kraševo" bridge.



Parallel stretch of the motorway route to the existing primary road, regulation of the Usora River and relocation of the primary road M4

From km 3+650.00 to km 4+750.00, the route crosses the regulated riverbed of the Usora River twice over the bridges "Tešanjka 1" of L=228m and "Tešanjka 2" of L=228m between which lies the frontal toll station "Doboj South" of l=500m (km 3+980.00 - km 4+480.00) in length).

8.4.3.2.3. Toll station



Frontal toll station "Doboj South"

8.4.3.3. Groundwater sources for water supply

In the surveyed area, there are a number of local sources that are not included in the public water supply system of the municipalities in the territories of which they are located. These local sources are used for the water supply of the population in the settlements, through the area of which the motorway either passes or is located in the immediate vicinity thereof.

Water sources in the municipality of Odžak

At the motorway chainage of km 2+000, on the right side of the route at a distance of about 2000 m to the west in the village of Donji Svilaj - the hamlet of Poljari, there is a local well. This well supplies 250 households Water quality testing is conducted twice a year by the Public Health Institute of Tuzla Canton and Sodaso Holding Tuzla.

At the same chainage but on the left side of the route at a distance of about 2300 m to the east in the town of Novi Grad, there is a local well. This artesian aquifer is used for water supply, but there is no distribution network.

At the motorway chainage of km 4+000, on the left side of the route at a distance of about 2100 m to the east, there is an artesian aquifer owned by the Ratar company. This artesian aquifer serves for the needs of this company. Water quality data from these wells were not available.

At the motorway chainage of km 4+500, on the right side of the route at a distance of about 1400 m to the west in the place of Vrbovac, there is a local well. The yield of this well is about 20 l/s. This well has no distribution network. Water quality was tested by the Public Health Institute of Sarajevo Canton in 2005.

At the motorway chainage of km 9+000, on the left side of the route at a distance of about 1800 m to the northwest in the town of Prnjavor, there is a local well. The yield of this well is about 9.5 l/s. Some 250 households in the settlements of Prnjavor, Lipik and Posavska Mahala get their water supply from this well. Water quality was tested by the Sodaso Holding Tuzla d.d. Institute of chemical engineering in 2005.

At the motorway chainage of km 10+500, on the left side of the route at a distance of about 2300 m to the west, there is a source in the public supply system in Odžak. The source of the water supply system in Odžak is located next to very urban area of Odžak, about 1.0 km to the northwest of the downtown. From this source, drinking water is supplied to the population and economic and public consumers who are located in the inner urban area of Odžak, and in part of the nearby suburbs. The source was formed in 1965, when the first well was built on this site. In the period that followed, three more wells were built in the same area and all these water intake structures are still in use today. Until June 2003, the water from these wells was sent directly to the reservoir placed in the water tower located in the water source area, and from there it was gravitationally distributed to the consumption area in Odžak. However, due to the presence of iron and manganese in groundwater, a drinking water treatment plant, also located in the source area, was put into operation in June 2003. Thus groundwater taken in is now treated before distribution to consumers. This source is the only water supply source for the urban area of Odžak with the yield from 15 to 50 l/s of water, depending the immediate needs. The source formed in the alluvial sediments of the Bosna and Sava rivers, in the area where intensive agricultural production prevails and where no significant industrial activities are present.

The protection of water supply sources in Odžak is currently determined by the Decision on sanitary protection zones and protective measures for the water supply source in Odžak, adopted in May 2004 ("Official Gazette of the Municipality of Odžak", no. 2/04). However, this decision is not fully in accordance with the Federal Law on Waters ("Official Gazette of the FBiH", no. 18/98), because the sanitary protection zones, that is the protection regime of this source, have not been determined on the basis of the conducted survey works. For that reason, the established protection regime was evaluated as insufficient since the valid decision protects a much smaller area than the one that needs to be protected in accordance with the valid legal regulations. A protection project was prepared for the Odžak source in December 2005, according to the terms of reference and conditions for determining the sanitary protection zones prescribed by the "Rulebook on conditions for determining sanitary protection zones and protective measures for sources of water used or planned to be used for drinking" ("Off. Gazette of the FBiH, no. 51/02). The proposed groundwater protection zones, sanitary protection measures as well as the preliminary draft of the Decision on the protection of water supply sources in Odžak have been determined within this project. It is expected that in the near future, the Decision on the protection of drinking water sources in Odžak will also be adopted by the Federal Ministry of Agriculture, Water Management and Forestry.

Municipality of Usora

The Municipality of Usora three registered sources are a part of the water supply system under construction, and expected to be under the authority of PCE Usora Sivša in the future.

At the chainage of km 59+000, in the Makljenovac local community of the Municipality of Usora, on the left side of the route at a distance of about 250 meters to the east, there is a local well of the 5 l/s yield, built in the period 2002-2004.

At the chainage of km 59+300, in the Ularice local community of the Municipality of Usora, on the left side of the route at a distance of only ten meters or so to the east, there is a local well of the 5 l/s yield, built in 2002.

At the chainage of about km 61+500, in the Alibegovci local community of the Municipality of Usora, on the left side of the route at a distance of about 25-50 meters to the east, there are two local wells of the 10 l/s yield, built in 1986.

These sources are used for the public water supply of the settlements of Ularice, Bejići, Makljenovac and Alibegovci in the Municipality of Usora. The quality of water at these springs is inspected periodically at the Medical Center Tešanj. Quality data are available, but only the network ones.

In the area of the Municipality of Usora, there are a few unregistered local sources from which a few houses are supplied. It should be noted that in January 2000, the Municipal Council of Usora passed a Decision on determining the urban areas, land use and terms of construction in the Municipality of Usora which also treats the area of the Usora watercourse and sources that are in... (the rest of the sentence is missing)

8.4.3.4. Surface water quality

Watercourse pollution is a very complex and dynamic process that depends on various factors, primarily on the amount and type of pollutants, and the reception capacity of the watercourse itself. For these reasons, it is difficult to give a true quality assessment without systematic water monitoring, that it, long-term continuous sampling and testing.

The quality of surface waters in the area covered by the motorway route will be presented through two periods:

- the period until 1992 - historical data, and
- the period from 1992 to 2005

Such approach is conditioned by the fact that in the period until 1992, the quality of surface watercourses in BiH was systematically monitored. In the period from 1992 to 2000, there was no continuous monitoring of water quality. Since 2000, the monitoring of surface water quality has been conducted in Republika Srpska.

Until 1992, the quality control of surface watercourses was carried out systematically on the Bosna River and its tributaries. In the section of Corridor Vc (LOT 1), the quality of surface watercourses was monitored on the Bosna River, and on the Usora and Spreča rivers. On the Bosna River, along the surveyed section, the quality was monitored on the profile of Maglaj downstream, Doboj downstream from the confluence of the Usora, downstream from Doboj and downstream from Modriča. In addition, the quality of the tributaries Usora-confluence and Spreča-confluence was also monitored.

According to the data of quality testing from 2000, a general estimate can be made that it is certainly significantly better than the prewar one, and that the surface water quality, at the worst, is within the limits of the prescribed class for the considered section. The results of bacteriological analysis of samples from the Bosna River and selected tributaries suggest that the analyzed water meets the limit values prescribed for the Class II water.

8.5. Soil and land capability

8.5.1. Applied methodology of research

The geological substrate on which the key soils had formed along the planned route on Corridor Vc was examined on the basis of: Katzer's Geological maps of 1:200 000 scale (Katzer, F., 1906), Geological maps of Yugoslavia of 1:500 000 scale, and Geology (Katzer, F., 1926). The Pedological Map of BiH of 1:50 000 scale, Section Explanation Brod 3 and 4 (1974), Derventa 1 (1972), Derventa 2 (1974) and Derventa 3 (1977) served as the basis for insight into the condition of the soils on the LOT 1 route of the motorway. Besides, a detailed reconnaissance of the terrain and drawing of maps 1:25 000 was performed, the existing data and the situation on the ground were compared using the Orthophoto background of 1:5 000 scale. A map of 1:25 000 scale was used to present the data.

The assessment of impact on all segments of the environment, including the soil segment, was carried out in two basic steps:

- Preliminary Environmental Impact Assessment for the preparation phase of the Technical Study and Conceptual Design, and
- Environmental Impact Assessment for the preparation phase of the Preliminary Design.

To achieve the set goal on the basis of available data, the most important general natural characteristics of the motorway route area that affect the state of soil formation and agro-hydrological conditions were analyzed. The most important characteristics are:

- Climate of the area
- Lithological (petrographic) conditions
- Relief of the area, and
- Soil characteristics.

8.5.2. General characteristics of the route area

Lithological (petrographic) overview

Based on the Katzer's Geological map of 1:200 000 scale (Katzer, F., 1906), the Geological map of Yugoslavia of 1:500 000 scale, and Geology (Katzer, F., 1926), in the wider area of the route on Corridor Vc prevail the following lithological substrates on which the current soils had formed: alluvial-diluvial deposits, tertiary clays, claystones and loams, sands, shales, sandstones, gravels, marls and solid limestones.

No eruptive rocks are present on the entire route. Most bedrocks on which the existing soils have developed are sedimentary, and mainly weathered, originating from younger geological formations. Even the limestones, seemingly solid sediments are easily crushed and weathered. Such structure of the parent substrate on which these soils had formed indicates its erodibility and potential mobility through erosion. Fluvial meadow carbonate and non-carbonate soils with and without gleyed horizon had developed here. There are also mineral gley (hypogley) and bog gley (epiglaye) soils formed under the impact of the moderately moving groundwater, as well as surface and occasionally flood waters. Pseudogley dystric valley soils developed on the slightly elevated terraces on the valley diluvium or Pleistocene, while pseudogley terrace and sloping soils developed on the terraces of the sloping Pleistocene. Tertiary clays on which the fluvial meadow gley and pseudogley soils had developed also occur here. Vertisols, the heavy clay soils, had developed on marls, marly clays, and carbonate and non-carbonate clays.

Cretaceous and partly Jurassic formations appear when it comes to Mesozoic. The most represented Cretaceous sediments are marls, shale clays and limestones. The Eocene limestone was identified on the right bank of the Bosna River, in the direction of its course where quarries were built.

From the above, it can be concluded that the parent substrate, being an important pedo-genetic factor, had played a significant role in the formation of various soils, while relief, climate, vegetation and humans had directed the pedogenetic processes depending on the constellation of these factors.

8.5.3. Soil type abundance in the wider area of the Corridor Vc route

In the wider area of the corridor route, 24 pedosystemic units were identified, of which 7 belong to the Order of Automorphic soils and 17 to the Order of Hydromorphic soils. In the Order of Automorphic soils, the predominant types belong to the class of Cambic and Humus-accumulative soils, while in the Order of Hydromorphic, to the class of Fluvial and Fluvial gley soils, and the class of Hypogley soils.

A. Order of Automorphic soils

The basic characteristics of soil types within particular classes of this order are as follows:<u>Class of cambic soils A - (B) – C profile type</u>

Association of brown soils is a characteristic and regular phenomenon in our classification. The class of cambic soils is also commonly called the class of brown soils. The typical profile is Amo-(B)-C-R.

Dystric cambisols, (acid brown soils) in this area occur in a number of varieties depending on the parent substrate on which they developed, namely:

- Dystric cambisol – Brown acid medium deep soils on shales
- Dystric cambisol – Brown shallow and medium deep soils on shales
- Dystric cambisol – Brown soils on claystones
- Dystric cambisol – Brown podzolic soils on clays
- Dystric cambisol – Brown degraded soils on clays
- Dystric cambisol – Brown degraded, gleyed soils on clays

The characteristic profile type is Aoh (or Aum)-(B)v-C (or R) structure. This soil type had formed on acidic substrates such as non-carbonate gravels, shales, non-carbonate clays, claystones and sands that can be less compact or loose, base-poor, with presence of intensive weathering of primary minerals and argillogenesis; however, due to lack of bases there is no significant formation of clay. Unfavorable climatic conditions and a large amount of precipitation cause a higher accumulation of humus, leaching and acidification. The degree of base saturation of the adsorption complex is lower than 50%, and the reaction in water is below 5.5. Base-richer substrates evolve into lessivage soil. These are poor soils of favorable physical and unfavorable chemical properties. They are often skeletal and of low water holding capacity, except for those formed on phyllites and alumina. The content and character of humus depend on altitude, exposure, and vegetation character. In agriculture, they are mainly used as meadows and pastures, less as arable fields (potato, rye, barley, and oat). In general, these are forest soils. Reclamation measures are: protection from erosion, calcification, humification, and fertilization with NPK. In these soils, similar to luvisols, the free phytotoxic Al+++ ion can also appear at low pH values. Generally, they are suitable for development of a successful animal husbandry and crop production of standard quality, provided that good agromelioration and agrotechnical measures have properly been applied. In this area, these are the soils of the elevated part of the relief. These are soils on which mostly pastures, natural meadows and forest vegetation have developed.

If kept under permanent vegetation, these soils can be quite resistant to the process of erosion The limitations of these soils mainly pertain to their distinctive water permeability, and poor retention properties for both water and potential pollutants that would form on the motorway route. From the agricultural aspect, these are the soils relatively poor in nutrients, but, through agromeliorative interventions they could be easily transformed into relatively fertile soils suitable for agriculture. Otherwise, these are generally very good forest soils.

Eutric cambisol – Brown carbonate soils on marls, (Eutric brown soils) in the area of the motorway route occur on marls and they are carbonate soils by their nature. Brown carbonate soils on marls – do not occupy sizeable areas. Morphologically, they are similar to brown soils on weathered limestones. They are usually shallow soils of eroded humus layer and weathered marl on the surface. hey are carbonate across entire depth, structural and water permeable. Their fertility largely depends on the depth of the humus layer on which continental fruits can be successfully grown. They are very sensitive to the water erosion processes even on the slightest slopes if the soil is not covered with vegetation.

B. Order of Hydromorphic soils

The basic characteristics of soil types within particular classes of this order are as follows: Class of alluvial or fluvio-gley soils (A)-I-II...

Alluvial soils, or recent river deposits – fluvisols, have (A)-I - II…C profile type. These are our best soils and occur in the flood zones of all rivers, including the Bosna River, where the major part of the motorway will be located, and partly on the alluvial terrace of the Usora. Alluvium means a river deposit, of recent (young) character and layered structure. Sedimentation is the dominant process so that pedogenesis cannot come "to the fore". They have good natural fertility, even at depositing.

The basic properties depend on the type of material, however, in terms of mechanical composition, they are very heterogeneous soils, from skeletal to clayey ones, but generally of favorable physical properties. They can be carbonate and non-carbonate, they are weakly humic, and the content of biogenic elements depends on their material of origin. As regards production, they are used for growing various crops, unless the areas are endangered by floods or, in sandy forms, if there is no irrigation during the summer period. They can be used in all types of agricultural production.

At the same time, these are the most endangered soils from both physical destruction and pollution by communal and industrial waste. All major cities in our country had developed in the river valleys, thus permanently excluding thousands of hectares of such soil from agriculture.

Irrigation of alluvial soil is desirable, particularly those skeletal ones which appear along the riverbeds and in upper parts of the river course. Proper management of this soil is a key to achieving high yields and high quality.

Within the scope of this survey, these are the most represented soils, grouped into varieties based on the parent substrate on which they developed:

- Alluvial carbonate clayey soils
- Alluvial carbonate loamy soils
- Alluvial carbonate sandy soils
- Alluvial carbonate soils on sands
- Alluvial carbonate sandy soils on sands
- Alluvial carbonate soils on gravels

The presence of the parent substrate largely indicates their properties and can also determine the protection measures. These are pedosystemic units located at lower relief positions, generally in dry and wet air-deposition accumulation zones. As these soils are occasionally exceedingly wetted or in direct contact with surface and groundwater they can be a potential source of pollution for groundwater and watercourses. On the other hand, these soils are used in extensive agricultural production. That is why they require the most intensive protection, i.e. the closed water drainage systems and windbreak belts.

8.5.4. Overview of the land use value categories

All stated pedosystemic units are divided into four categories of use value. The highest use value category is II (two), and the lowest is V (five). This indicates that the motorway route mainly goes across the agricultural land which is, given the terrain conditions, more or less extensively used.

Based on the permanent soil properties, such as: inclination, depth, mechanical composition, soil drainage, and other physical and chemical properties, the following soil use-value categories were identified in the surveyed area:

The use-value Category II includes soils from the alluvial class, which are mainly carbonate, of a divergent mechanical composition from clayey to loamy and sandy. They had developed mainly on sands, gravels or both sands and gravels, depending on conditions during the sedimentation process of the material on which the alluvial soil was formed. These are very good agricultural soils, with moderate limitations, suitable for growing a wide range of agricultural crops, especially at lower altitudes, and the reclamation measures of these soils are relatively simple. Relative to the first, i.e. the best use-value category, these soils differ in their hydrological regime, which can vary depending on the regulation of watercourse regime.

The use-value Category III includes soils from the alluvial–diluvial class and the class of semi-gley soils. These are moderately good agricultural soils with certain limitations in terms of the soil properties, topography or drainage. In the isolated pedosystemic units, the most important limitations pertain to the hydrological regime, i.e. drainage, regardless of whether they belong to semigley or alluvial-diluvial soil classes. Due to this phenomenon, the crop options have been reduced, especially winter crops, thus certain actions in the area of hydro- and agro-melioration are required. Ecological aspect of the soils in this category, found on the motorway route, should be viewed through the fact that they have a high level of groundwater and thus the appearance of harmful traffic-caused pollutants in watercourses.

The use-value Category IV includes soils from the class of cambic soils, where dystric cambisol or acid brown soil is predominant. These soils are considered to be quite good in agriculture, with certain strong limitations. The soils in this category can be divided into two subcategories. The first subclass contains those that do not require hydromelioration but have poor natural fertility (acid brown soils), degraded and inclined; while the second subclass includes the lowland soils (valley) that require hydromelioration. As for clay-mineral hydromorphic and pseudogley soils, they are usually used as natural meadows as is the case here or for growing crops with very uncertain end result. Ecologically, these are sensitive areas due to the heightened hydromorphism, be it groundwater or surface waters. The communication with surface waters or aquifer is present over a long period of the year; therefore, they represent a sensitive environment, particularly in view of potential water pollution. On the other hand, pollutants can bind to the clay fractions that these soils are abundant in, but their buffer capacity is reduced due to the acidic pH reaction.

The use-value Category V includes mainly the forest soils from the class of cambic, dystric or eutric type, with natural meadows and pastures appearing within the forest. These soils had generally developed on shale rocks on the slopes. They can be very good forest soils, but they don't have to be prone to erosion, as they are covered in vegetation. They have a number of limitations that mainly concern cultivation and production of the majority of crops and are thus rarely used as arable fields. These soils are mostly on slopes of up to 20°, and at favorable exposures they are often used for orchards. These are the terrains of natural associations of forests and accompanying vegetation where a slightly lower level of protective measures is needed.

8.6. Flora

Natural conditions, relief and climate, directly affected the appearance and condition of the vegetation of the project area. Anthropogenic factors have considerably altered the original appearance of its vegetation, but the area still abounds in diverse ecosystems and habitats.

As per their origin, the ecosystems are grouped into primary and secondary. Of the primary ecosystems in the project area, there are forests, and of the secondary (anthropogenic) ecosystems, there are agricultural (grasslands, arable fields), urban (settlements, cities), artificial aquatic ecosystems (reservoirs, fishponds), afforested areas and other. Thus, the project area is characterized by the following ecosystems:

- Forests
- Grasslands
- Arable fields.

8.6.1. Forests

The lowland parts of the section are characterized by larger or smaller areas of residual pedunculate oak and common hornbeam forests, the micro-depressions by black alder forests, and the fluvisols by willow and cottonwood forests. In spatial terms, this belt is the continuation of the forest belt in Slavonia known as the "Slavonian oak forest". In the hilly and elevated areas there is a forest community of sessile oak and common hornbeam, and in some places beech forests of the subalpine belt have developed.

Hence, the LOT 1 section is characterized by the following forest phytocoenoses that had formed depending on the relief, climatic conditions and other factors:

- Pedunculate oak and common hornbeam forests of the Illyrian area (Carpino betuli-Quercetum roboris)
- Sessile oak and common hornbeam forests (Querco-Carpinetum illyricum)
- Hill beech forest of the Illyrian area (Fagetum montanum illyricum)
- Pedunculate oak and hornbeam forests of the Illyrian area (Querco-Carpinetum illyricum)

Sessile oak and common hornbeam forests of the Illyrian area (Querco-Carpinetum illyricum)

The sessile oak and common hornbeam forests of the Illyrian area belong to the community of mesophilic hornbeam forests, which are characterized by the average rainfall of 900 mm and the average annual temperatures of 8.5 - 11.5°C; the altitude interval for Croatia and Bosnia and Herzegovina is up to 700 m.

RUSCO-CARPINETUM ILLYRICUM Horv. et al. 1974. Distributed on deeper luvisols of weak acid to neutral reaction, transitioning toward climatogenic forest of the Hungarian oak and Turkey oak. This forest is characterized by the presence of butcher's broom (Ruscus aculeatus) and silver linden (Tilia tomentosa), and is a depleted type of forest with very mixed and rich vegetation of the younger Tertiary and Quaternary (Jovanović, 1951).

On limestone and other basic substrates, transitional stages of shrubland (especially hazel, hawthorn or juniper) are widespread, and they pass into communities of meadows of xero-mesothermal character (from the order of Brometalia erecti).

On acid silicate substrates, by clearing sessile oak and hornbeam forests, communities of meadows with more mesothermic conditions (from the order of Arrhenatheratalia) are formed).

QUERCETUM MONTANUM ILLYRICUM Stef. (1964) 1966. It is a widespread community in Bosnia on Paleozoic, Tertiary and Werfen substrates of the northern and inland areas.

Hill beech forest of the Illyrian area (Fagetum montanum illyricum)

Unlike the beech forests of Central Europe, this Illyrian Forest is characterized by a greater species richness and, besides the neutrophil Central European elements, is composed of very characteristic Illyrian elements, which distinguish this community as a special florigenetic entity. Some of these elements (e.g. Omphalodes verna, Hacquetia epipactis, Scopolia carniolica, Lamium orvala, etc.) are more characteristic for the central part of the Illyrian area and disappear in the southeastern direction as soon as on the Velebit-Plješevica-Grmeč-Klekovača-Osječenica stretch. However, a number of neutrophil-mesophilic elements remain.

Beech is an edificator and builds formations of dense composition with the mixture of: Acer platanoides, A. pseudoplatanus, Ulmus montana, Sorbus torminalis, Tilia platyphyllos (in some formations, Taxus baccata and Ilex aquifolium); in the bush layer are Daphne mezereum, D. laureola, E. europaeus, Ruscus hypoglossum, and other; in the layer of ground flora are: Cardamine bulbifera, C. trifolia, C. savensis, C. polyphylla, Asperula odorata, Paris quadrifolia, Pulmonaria officinalis, Sanicula europaea, Asarum europaeum, Anemone nemorosa, A. ranunculoides, Mercurialis perrenis, Aspidium filix mas, Athyrium filix femina, Lilium martagon, Mycelis muralis, Allium ursinum, Geranium robertianum, etc.

Depending on the intensity and the effects of anthropogenic factors, all types of degradation stages occur – from low coppice forests, over shrubbery to thicket, and are composed of different elements (Corylus avellana, Crataegus monogyna, Prunus spinosa, Juniperus communis, etc. Depending on the manner and intensity of anthropogenic factor effects).

Beech forest is divided into several subassociations, among which the most common are: lathyretosum Horv. 1938; corydalitosum Horv, 1938; festucetosum silvaticae Stef. 1963, cardaminetosum Fab. 1966; tilietosum, Fab. 1966; carpinetosum betuli Stef. 1966.

8.6.2. Grasslands and arable fields

Grasslands and arable fields are ecosystems created by direct or indirect human impact in areas that naturally used to be covered in forest.

8.6.2.1. Grasslands

Grasslands, despite the fact that they are not of natural origin, represent habitats that greatly enrich the biological and landscape diversity of the project area. They are inhabited by plant species that originate from forests, and partly from other, especially steppe areas of Eastern Europe and Asia, while some members of polymorphic species have developed precisely due to anthropogenic influences on the grasslands.

In the project area, grasslands had traditionally been used in an extensive manner, which left them mostly endangered because they have been turned into arable fields. They are today very extensively and only occasionally used for grazing and haying. Grasslands are characterized by various species from the families of grasses (Poaceae), daisy family (Asteracae), then rushes (Juncus), mints (Mentha), which extremely like wet habitats.

Grassland areas that have resisted anthropogenic influences are areas of diverse representatives. Characteristic continental meadows that are typical for the project area are:

- Meadow of tall oat-grass (as. Arrhenatheratum eltioris)
- Meadow of bromes and dogstail (as. Bromo-Cynosuretum cristati)
- Meadow of bromes and hoary plantain (as. Bromo-Plantaginetum mediae)

8.6.2.2. Arable fields

Arable fields as artificially made ecosystems are intended exclusively for agricultural production, and are cultivated in the way that respects the protection of biological diversity.

These are nitrophilous ecosystems, which include the orchards, vineyards, gardens, field-edge areas, channels and houses, trampled areas of roads and yards, and landfills. Their common feature is the increased amount of nitrogen, which leads to floristic affinity reflected in the multitude of common nitrophilous plants (the so-called Ruderal communities). The work carried out here is a strict selection of plants by various agricultural measures (plowing, digging, fertilizing, using pesticides.

The vegetation of trampled areas and ruderal habitats is as follows:

- Sward of ryegrass and broadleaf plantain (as. Lolio-Plantaginetum majoris)
- Community of thorny knotweed and beggarticks (as. Polygono-Bidentetum)
- Community of tansy and common mugwort (a. Tanaceto-Artemisetum)
- Sward of silverweed (as. Potentilletum anserinae)

8.7. Fauna

Today's prevalence of animals is the current state of the historical product of all depending factors, and it is not fixed and permanent, because they are all together with animals subject to constant change.

The composition of the fauna in the area of Corridor Vc has probably changed in relation to the latest data available to us with regard to the war events at the end of the last century in Croatia and Bosnia and Herzegovina. The anthropogenic impact in the area after the war should also be taken into account, especially in areas with the increased settlement.

It should be emphasized that pre-war data were taken for the overview of the current situation, whereas to obtain the actual situation a series of long-term scientific surveys are needed which will require significant material resources.

The beginning of Corridor Vc, the lowland part of Posavina, zoogeographically belongs to the so-called European Sub-Area Pannonian Subprovince, or the Subalpine Slavonian-Syrmian Region, while the remaining part belongs to the Central European Alpine Region.

These lowland areas are inhabited by common and well-known European animals.

Mammals

Among the mammals living here are foxes and smaller wild animals - martens, polecats, stoats, weasels, badgers; by the waters – otters; then there are hares, shrews, moles, hedgehogs, small rodents such as mice, voles, hamsters, squirrels, dormice, etc. The American muskrat has been settled along the waters since 1932. Various bats also live here, and the forests are home to wild boars and roe deer, while larger forests are home to deer, and some hunting grounds to fallow deer.

Birds

This area is rich in the following birds: swallows, warblers, flycatchers, thrush nightingales, pipits, wagtails, finches, goldfinches, buntings, tits, larks, starlings, orioles, magpies, jays, jackdaws, crows, common cuckoos, quails, hoopoes, rollers, kingfishers, falcons, kestrels, harriers, hawks, sparrowhawks, buzzards, etc. Pigeons, turtle doves, woodpeckers, picus woodpeckers and lesser spotted eagles live in the forest areas, and black storks close to the waters. Woodcocks stay in humid forests over the summer, and even have fledglings. In the lowland villages nest the white storks, and by the ponds and bogs are herons, ducks, grebes, cormorants, coots, crakes, reed warblers, plovers, knots, dunlins, common gulls, terns, white-tailed eagles, ospreys, etc. The ringed turtle doves have become widespread in recent years.

Reptiles

Among the venomous snakes, common European vipers are most prevalent, and horned vipers are rare. Among the water snakes, prevails the two-striped variety. Then there are colubrid snakes, smooth snakes, and the most common lizards are the sand and common wall ones, and blindworms are also common. By the waters live the European pond turtles.

Amphibians

As regards the frogs/toads, there are the fire-bellied toad, tree frog, green frog, gray and green true toad, while the common spadefoot is rare. Big green newts live everywhere.

Insects

Large areas of cultivated soil are suitable for insects, especially grasshoppers, but there are also true bugs, beetles, butterflies, true flies, hymenoptera, etc. Steppe forms also appear among them. Numerous insects are big agricultural and forest pests, e.g. gypsy moths, potato beetles, and other.

Many dragonflies, mayflies, caddisflies, stoneflies, etc. fly along the water, and the mosquito swarms include also the malaria-bearing ones. Various freshwater beetles are present, such as predaceous diving beetles, water beetles, whirligigs, as are true bugs – backswimmers, giant water bugs, while water measurers stay on placid waters. The larvae of mosquitoes and similar flies, mayflies, caddisflies, stoneflies and dragonflies develop in the water.

Mollusks

Various snails can be found everywhere–pulmonates: Roman, garden and grove snails, and keelback slugs; of rare land gilled variety there is round-mouthed snail. Bivalvia live in all waters – swan mussels, painter's mussels, and at the end of the 19th century, zebra mussels spread from the Black Sea over the Danube. The most often found snails are the pond snails, horned snails, river snails, and some smaller such as Neritina, Amphimelania, etc.

Spiders

Various kinds of millipedes and centipedes, as well as many spiders, stay on the ground. In water, the water mites are very common, and among real spiders – the diving bell spider.

Fish

In the rivers and other waters, most common fish are the ray-finned ones, such as carps, crucian carps, tenches, barbels, nases, breams, various sunbleaks, perches, pikes, zanders, sterlets, and sometimes sturgeons and belugas show up when spawning. The biggest one is catfish that can weigh even over 100 kg, and then huchen that can weigh over 30 kg. The North American brown bullhead and pumpkinseed found their way from fishponds into some rivers.

Crustaceans

Larger crustaceans present are noble and swamp crayfish; the smaller mountain streams also have stone crayfish, while the most common small ones are scuds and cress bugs; and in small transient puddles are the fairy shrimps - Branchipus, Chirocephalus, Apus i Limadia.

Other animals

Of the other animals, we should mention leeches, small earthworms like sludge worm, then the roundworms, horsehair worms and planarians, and moss animals such as creeping bryozoan, and also Fredericella sultana. There are freshwater sponges everywhere.

Groundwater

Besides the surface waters, there are also groundwater flowing slowly in the porous sandy and gravel soils, with their own special wildlife, specifically adapted to the living conditions thereof. Thanks to the protection, some ancient animals have been preserved in these groundwater, especially simpler crabs such as Bathynella and some other, which have become extinct on the surface, so today can only be found in Australia and Tasmania.

Hot springs

There are also hot springs in these areas where smaller and simpler plants and animals live, specifically adapted to the conditions of elevated water temperature. The ones standing out are protozoa, especially the ciliates, planarians, roundworms, earthworms, rotifers, shrimps, some insects and their larvae, as well as water mites and tiny snails.

Standing waters

In puddles, fishponds and lakes, the living community of plankton has developed, in which there are a large number of microscopic protozoa, especially the ciliates, flagella and bigger plankton animals – particularly numerous copepods, water fleas and rotifers. Of the insect larvae, only the larvae of the Chaoborus crystallinis mosquito hover in such puddles.

Most of Bosnia and Herzegovina belongs to the Central European Alpine Region, including the mountainous part of Corridor Vc. The characteristic species of that area are presented below.

Mammals

Of the large mammals, there are the bears, which are disappearing, and wolfs are becoming rarer. Wildcats are rare, and in addition to foxes, badgers and polecats, there are beech martens and pine martens. Only black-brown squirrels are found in Bosnia, and there are Bosnian hares and Herzegovinian hares, the latter being smaller and light grey. Chamois live in the high mountains, and roe deer are rarer due to deforestation and other disasters. Bosnia also has wild boars, and otters too. Numerous types of bats are present. There are hedgehogs, shrews, moles, stoats, weasels, and many types of dormice: common dormouse, forest dormouse (Dryomys nitedula), garden dormouse (Eliomys quercinus), and hazel dormouse (Muscardinus avellanarius). In addition to house rats and brown rats, there are wood mice and field mice and, in all waters, water voles (Arvicola scherman), and subterranean mole rats (blind mole rat, Spalax monticola).

Birds

Only the most important birds are mentioned here. Alpine choughs (Pyrrhocorax alpinus), rare guests are rosy starlings (Pastor roseus), oreoles are common, and the guests from the north are common redpolls (Acanthis flammea); crossbills live in the mountain forests, and the highest mountains are home to white-winged snowfinch (Montifringilla nivalis). Worth mentioning are rock buntings (Emberiza cia), Lapland longspurs (Calcarias laponicus) are rare, but snow buntings (Passerina nivalis) are more common, and the highest peaks are taken by horn larks (Otocorys penicillata). Dalmatian wagtails (Budytes melanocephalus) nest in the western BiH. Nuthatches (Sitta caesia i neumayeri) are interesting, wallcreepers (Tichodroma muraria) in high hills, and in the hollow trees the sombre tits (Parus lugubris) nest. In the high mountains, red-throated pipits (A. cervina) live. Among shrikes, woodchat shrikes (Lanius senator) are rare, and the Bohemian waxwing (Bombycilla garrula) rarely comes to Bosnia from the north. Flycatchers pass through Bosnia in their migrations, so it is worth mentioning collared flycatchers (Muscicapa albicollis) and other cognates. As for warblers, the most common ones are Savi's warblers (Locustella luscinioides), and then aquatic warblers (Acrocephalus aquaticus) in wetlands, during migration. Nightingales are represented by small nightingales (Erithacus luscinia) and bluethroats (E. cyaneculus). Alpine accentors (Accentor collaris) are important for the high mountains. European rollers (Coracias garrula), bee-eaters (Merops apiaster), and common kingfishers (Alcedo ispida) can be seen too. At higher altitudes, Alpine ring ouzels (Turdus torquatus alpestris) and common rock thrushes (Monticola saxatilis) can be heard. Croatian woodpeckers (Dendrocopus leuconotus lilfordi) are interesting, and in the mountain coniferous forests the three-toed woodpeckers (Picoides tridactylus alpinus). In Bosnia, wild pigeons are resident birds, less common are hazel grouses (Tetrastes bonasia rupestris), wood grouses (Tetrao urogallus) in the mountain coniferous forests. One can rarely see great bustards (Otis tarda) for winter migrations in Bosnia. Rare guests are marsh sandpipers (Tringa stagnatilis) and godwits (Limosa). Reiser states that Eurasian woodcocks (Scolopax rusticola) nest in Bosnia, so they are present even in autumn. Among the useful scavangers, the largest are griffon vultures (Gyps fulvus). Worth mentioning of the 8 species of eagle in this fauna are golden eagles (Aquilla chrysaetos); the rare ones are eastern imperial eagles (A. heliacea) and ospreys (Pandion haliaetus). Booted eagles (Hieraetus pennatus) and snake eagles (Circaetus gallicus) are also mentioned. In winter, rough-legged buzzuards (Buteo lagopus) are rare, long-legged buzzards (B. rufinus) are more common. Black-footed falcons (Cerchneis verspertinus) are interesting, which "pass through Bosnia in large numbers in late April and early May, hunting insects and going from the south to the lowlands, and in autumn use a completely different path with their young, not coming to Bosnia." The most magnificent birds of BiH are bearded vultures (Gypaetus barbatus aureus), which feed on bones and carrion. Along with sparrowhawks and goshawks, there are also Levant sparrowhalks (Astur brevipes). Western marsh harriers (C. aeruginosus) and Montagu's harrier (C. pygargus) nest here. About 10 species of owl live in Bosnia, so in the high mountain conifer forests there are boreal owls (Aegolius tengmalmi) and pygmy owls (Glaucidium passerinum), eagle-owls (Bubo) are residents, and the smallest ones are scops owls (Pisorhina scops) that come to Bosnia in late April.

The Bosnian fauna includes tufted ducks (Fuligula fuligula) and ferruginous ducks (F. nyroca), which stay over the winter in places that do not freeze and nest. Pochards (Nyroca ferina) can be seen during migration, and greater scoups (N. marila) are less common. Golden-eye ducks (Clangula glaucion) stay on fast currents in winter.

Reptiles

The most widespread venomous snake is the horned viper (Vipera ammodytes), which feeds on wood mice (Apodemus sylvaticus dichrurus) and lizards; higher mountains host the meadow viper (V. macrops) and the Bosnian variety of the common adder - Bosnian adder (V. Mesocoronis bosniensis) known as "the most venomous snake of Europe with the venom equal to the one of the infamous cobra from India" (Bolkay, 1929), and V. pseudaspis is also present. BiH is home to a dozen non-venomous snakes with several varieties. Of the 10 BiH lizard species, it is important to mention the Bosnian sand lizard (Lacerta agilis bosnica), and the viviparous lizard (L. vivipara) on humid mountain meadows, which seems to be disappearing in Bosnia and is considered "the rarest lizard on the entire Balkan Peninsula".

Amphibians

There were 12 species identified, of which the predominant ones in Bosnia are Greek stream frogs (Rana graeca) and agile frog (R. dalmatina), showing a climatic transition from terrestrial to Mediterranean form, important for southern Bosnia. A distinct inhabitant of the water is the marsh frog (R. ridibunda). The most common amphibian is the yellow-bellied toad (Bombina variegata, Kolombatovići), then the Alpine salamander (Salamandra atra, Prenj), and from Bosnia, and especially Herzegovina, the olm or 'human fish' (Proteus anguinus); the current geographical distribution of human fish, Bolkay determined, goes from Slovenia and Istria over Western Croatia and Western Bosnia to Dalmatia and Herzegovina.

Fish

The most significant ones are trout: soft-muzzled trout (Trutta obtusirostris), brown trout (T. fario), huchen (Salmo hucho), brook trout (S. fontinalis), lake char (S. salvelinus), grayling (Thymalus vulgaris); others include Romanian barbel (Barbus petenyi), spirlin (Alburnus bipunctatus), and (A. mento), etc.

Mollusks

Among snails (Clausilia), many endemic forms are known in the karst area, where Campylaea also belong - Dinarica, Liburnica, Helix and Zonites forms. The Balkan form coming to Bosnia is Xerocampylaea zelebori, the Mediterranean are Fruticicola cinctella, Helix aspersa, Iberus vermiculatus, and the endemic Unio Bosniensis in the Bosna River.

Anthropods

Among them, the centipede fauna of Bosnia and Herzegovina is rich in endemic forms, and even in genera such as Microchordeuma, Microbrachysoma, Heterolathelia, Typhiogiomeris, and the endemic forms from genera Julus, Brachyiulus, Lysiopefalum, Brachydesmus, etc.

Arachnida

Along with various forms of Euscorpisus europaeus, we find Neobisium spelaeum in the caves of Bosnia and Herzegovina. Typical spiders are karst forms of Argipe lobata, A. brunichi, Lycosa apuliae, and in southern Bosnia the cave form of Taranucnus patellatus. Atypical spiders significant for BiH are Ischiropsalis-forms, big form of Trogulus in the caves, Nelima troglodytes, and long-legged tick (Eschatocephalus Haemalastorgracillipes).

Insects

As for the Balkan Peninsula insects, V. Apfelbeck said that their fauna consists of Central European, Siberian, and Mediterranean forms, Eastern (Pontic) comers from Western Asia, adapted alpine species and endemic forms, some remnants from the Ice Age (boreoalpine species), and the main part consists of the Central European (Siberian) and Eastern species. According to Apfelbeck, endemic Balkan insects belong mostly to the alpine region, and there is a large number of karst endemics. The mountains of Dalmatia and Herzegovina are an obstacle to the penetration of Mediterranean species into Bosnia, he says.

There are 13 endemic butterflies known in Bosnia and Herzegovina, of which Hiptelia apfelbecki is worth mentioning, and Erebia gorge hercegovinensis and coenonympha tiphon occupata in the high mountains.

As for other insects, there are many native species of caddisflies in Bosnia. Net-winged insects have 11 genera and 17 species (Apfelbeck). Of the flat-winged insects, the 2 cm long Labidura riparia is mentioned, and there are several native species of Hymenoptera, then mantis, Trixalis nasuta, in central and southern Bosnia the Balkan form of Psorodonotus fieberi (with stunted wings). The most important European wasp in southeastern Bosnia and Herzegovina is the Mediterranean form Scolia flavifrons (5 cm); the biggest sawfly is Cimbex (femorata). In forests, on snow or under leaves, lives a wingless fly (Chionea araneoides), which resembles a spider, and the big Tachinid fly (Echinomyia fera).

Per Apfelbeck, many breeds of the genus Carabus are important for Bosnia and Herzegovina, such as C. caelatus sarajevoensis, C. croaticus bosnicus, C. cancellatus apfelbecki, then Nebria bosnica, apfelbeckii speiseri, endemic subgenus Stenochoromus (Molops), Pterostichus meisteri, Tapinopterus setipennis, Omphreus apfelbecki, O. beckianus, and many endemic forms of cave horned beetles. As for true bugs, the big cicada of central and souther Bosnia and Herzegovina, red-veined cicada (Tibicina haematodes) stands out.

The cave fauna of Bosnia and Herzegovina in large underground spaces and waters under uniform living conditions of the light, heat, humidity, etc. is a completely unique biotope, where many special forms have developed. In this geographical area, according to Apfelbeck, "there are favorable conditions for the development of large fauna, especially rich in endemic forms. Further east, this fauna is declining due to the development of crystalline mountains, and is the richest in the area of BiH and the western neighboring areas, as it has 21 genera with 70 species already known in beetles, while endemic genera and species are also known in other arthropods". As early as 1887, V. Apfelbeck found the first cave insects in Bosnia and Herzegovina and described them.

Cave fauna

Research has shown that most Balkan endemic animals of the caves are composed of arthropods. The real inhabitants of the caves have no pigment, no eyes, and have highly developed senses of smell and touch, and the long legs. Insect fauna in the caves of BiH contains many native forms, e.g. Anthoherpon has 18 known species. These forms are phylogenetically completely isolated in today's fauna and represent "the oldest recent forms among beetles". Apart from beetles, few other insects live in caves, such as some grasshoppers, wingless insects – the endemic one being Verhoeffiella cavatica, etc.

8.8. Landscape

Wider area of the project is characterized by a valley type landscape bordering on a hilly one. This area is also characterized by the zone of contact of these two types of landscape with the lines of sight containing elements of both.

The landscape of a wider spatial unit is characterized by four basic categories of landscape:

- Natural landscape
- Cultivated landscape
- Built landscape
- Cultural–historical landscape.

For the purpose of drafting the documentation related to the motorway on Corricod Vc, the Landscape Planning Project was prepared, which treats this issue in detail.

8.8.1. Natural landscape

The characteristics of this type of landscape belong to spaces dominated by natural elements over which there were no civilizational interventions, and if there were any, they happened permanently and without radical moves. For the most part, these are water and riparian areas, and forests.

Forests

Forests cover approximately one third of the total surface of the project area. As the most exposed element of the landscape in this area, forests are the vehicle of its identity, but the level of the forest autochthony preservation is low since they are mostly carved up by agricultural areas.

Water surfaces

Water surfaces as a landscape element are also of great significance for the entire area. With its natural attractions, both in ecological and aesthetic sense, the Bosna River represents a category that gives a special quality to this area.

The natural landscape is prevalent in the hilly part of the area where mostly smaller settlements and scattered individual structures are, agricultural activity is underdeveloped, and forests and fragmented vineyards predominate. Due to the poor economic development of this area, there were no significant interventions, so the landscape remained largely original, and the greatest danger for it is depopulation, which leaves behind the neglected residential buildings and agricultural land.

8.8.2. Cultivated landscape

Preserved natural areas and a relatively low level of urbanization and industrialization have protected most of the area from major damage, i.e. the recognizable identity of the rural structure is blended with the natural background. It is these smaller towns, villages and hamlets intertwining and merging with and fitting the natural background that make up the image of a typical rural landscape. This landscape type features the predominant agricultural areas and places with low population density, that is, the construction that does not inherently disturb the natural landscape but merges with it. The lowland part of the area almost entirely has the cultivated-landscape properties. Dispersed larger rural settlements are typical.

8.8.3. Built landscape

Such landscape has an urban structure, and the natural landscape is altered to such an extent that it becomes unrecognizable. This landscape type is related to three towns (Odžak, Modriča, and Doboj), industrial zones and plants outside them, and some larger municipal centers that have a semi-urban character. In the lowland landscape, higher residential and industrial buildings are Carrico big accents in the lines of sight. With the expansion of settlements along the roads, their original morphology is lost, the points of the beginning, middle and end of the settlement disappear and, in urban sense, unnatural units are created.

In the system of settlements and population, the settlements - complexes stand out, because they are fragmented and occupy a large territory. The settlement system is extremely dispersed. Most settlements are rural structures which elements of urbanization have just started to pervade, but are very well consolidated in the landscape.

8.8.4. Cultural-historical landscape

A landscape that has been created over a long period of time, and consists of units and structures that have monumental value together with their immediate surroundings. As this type of landscape is a whole with recognizable spatial, historical, cultural and other values, an integral approach to the protection of cultural monuments and the natural heritage that surrounds them comes to the fore.

8.9. Protected areas of nature

Upon review of the Spatial Plans, that is, upon review of the bases for the planning documentation of the motorway on Corridor Vc - LOT1, it has been concluded that there are no specially protected areas of nature in the impact area. The recorded plant species proposed for protection in this area are the following ones:

- Cerastium dinaricum G. Beck – Dinaric mouse-ear
- Dianthus knappii Ascherson – Knapp's carnation
- Dianthus liburnicus Bartl. – Liburnian carnation
- Dianthus sanguineus Vis. – Blood-red carnation
- Minuartia bosniaca K. Maly – Bosnian sandwort
- Silene sendtneri Boiss. – Sendtner's campion
- Silene reichenbachii Vis. – Reichenbach's campion
- Silene tommasinii Vis. – Tommasini's campion
- Aquilegia dinarica G. Beck – Dinaric columbine
- Aquilegia grata F. Maly – Pleasant columbine
- Aquilegia kitaibelii Schott. – Kitaibel's columbine
- Ranunculus scutatus Waldst. – Tora buttercup
- Corydalis ochroleuca Koch – Yellow corydalis
- Barbarea bosniaca Murb. – Bosnian winter cress/yellow rocket
- Hesperis dinarica G. Beck – Dinaric mother-of-the-evening
- Saxifraga prenja G. Beck – Prenj rockfoil
- Potentilla carniolica A. Kerner – Kranj cinquefoil
- Potentilla montegrina Pant. – Montenegrin cinquefoil
- Potentilla visianii Pančić – Visiani's cinquefoil
- Astragalus illyricus Bernh. – Illyrian milkvetch
- Chamaecytisus tommasinii Rothm. – Tommasini's broom
- Genista sericea Wulfen. in Jacq. – Silky broom
- Lathyrus binatus Pančić – Binate vetchling
- Oxytropis campestris DC. – Dinaric locoweed
- Vicia montenegrina Rohl. – Montenegrin vetch
- Vicia ochroluca ten. subsp. Dinara K. Maly – Dinaric vetch
- Euphorbia gregersenii K. Maly – Gregersen's spurge
- Haplophyllum boissieranum Vis. and Pančić – Boissier's rue
- Rhamnus intermedius Steudel – Coast buckthorn
- Rhamnus orbiculatus Bomm. – Round-leaved buckthorn
- Kitaibela vitifolia Willd. – Vine-leaved kitaibelia (B. Luka, Teslić, Zvornik)
- Daphne malyana – Maly's daphne (Volujak, Maglić)
- Viola beckiana Fiala – Beck's violet
- Viola elegantula Schott. – Graceful violet
- Viola zoysii Wulf. subsp. – Zois' violet
- Fumana bonepartei Maire – Bonaparte's needle sunrose
- Athamanta hainaldii Borbas – Haynald's candy carrot
- Bupleurum karglii Vis. – (Hare's ear)

- Caerophillum coloratum L. – Colored cohosh
- Eryngium alpinum – Queen-of-the-alps
- Grafia golaka Reich. – Kranj grafia
- Pancicia serbica Vis. – Serbian burnet
- Peucedanum neumayerii Reich. – Neumayer's pimpernel
- Seseli globiferum Vis. – Stone parsley
- Seseli malyi A. Kern. – Maly's stone parsley
- Gentiana dinarica G. Beck. – Dinaric gentian
- Vincetoxicum huteri Vis. – Huter's swallow-wort
- Asperula scutellaris Vis. – Woodruff
- Halacsya sendtneri Dörfl.
- Onosma stellulata Wald.
- Acinos majoranifolius Šilić – (Thyme)
- Micromeria croatica Schott
- Micromeria parviflora Seich.
- Micromeria thymifolia Fritsch.
- Salvia brachyodon Vandas – Short-toothed sage
- Saturea horvatii Šilić – (Savory)
- Saturea subspicata Bartl. ex Vis. – (Savory)
- Stachys anisochila Vis. – Bee's heal-all
- Teucrium arduini L. – (Germander)
- Thymus braceosus Vis. – (Thyme)
- Euphrasia dinarica Murb. – Dinaric eyebright
- Pedicularis hoermannianum K. Maly – Hörmann's lousewort
- Scrophularia bosniaca G. Beck – Bosnian figwort
- Scrophularia tristis K. Maly – Sad figwort
- Verbascum bosnense K. Maly – Bosnian mullein
- Veronica satureioides Vis. – (Speedwell)
- Plantago reniformis G.B. – (Plantain)
- Lonicera glutinosa Vis. – Honeysuckle
- Viburnum maculatum Pant. – (Guelder rose)
- Valeriana bertiscea Panić. – (Valerian)
- Cephalaria pastricensis Dörf.
- Knautia sarajevensis Szabo. – Sarajevan widow flower
- Scabiosa fumarioides Vis. – (Pincushion flower)
- Scabiosa silenfolia Wald. – (Pincushion flower)
- Succisella petteri G. Beck.
- Campanula hercegovina degen – Herzegovinian bellflower
- Campanula portenschagiana Schultes – Dalmatian bellflower
- Campanula waldsteiniana Schultes – Waldstein's bellflower
- Edraianthus serpyllifolius A. Dc. – Creeping rock bell
- Edraianthus tenuifolius A. Dc. – Narrow-leaved rock bell
- Symphyadra hofmanii Pant. – Bosnian bellflower
- Achillea abrotanoides Vis. – Yarrow

- Centaurea glaberima Tausch. – Bare knapweed
- Centaurea derventana Vis. – Derventa knapweed
- Cicerbita pancicii Beauverd. – Pančić's blue sow thistle
- Crepis dinarica G. Beck – Dinaric hawksbeard
- Omalotheca pichler J. Holub – Pichler's cudweed
- Leucanthemum chloroticum A. Karn. – Green ox-eye daisy
- Leucanthemum ilyricum Papeš – Illyrian ox-eye daisy
- Reichardia macrophylla Vis. – Large-leaved swothistle
- Tanacetum cinerariifolium Shultz. – Pellitory
- Fritillaria gracilis Ascherson
- Lilium cataniae Vis. – Catani's lily
- Scilla litardierei – Amethyst meadow squill
- Crocus dalmaticus Vis. – Dalmatian saffron
- Iris reichenbachii var. bosniaca. G. Beck – Bosnian iris
- Iris peudopallida Vrin – Adriatic iris
- Arum petteri Schott – (Adder's root)
- Nigritella nigra Rchb.
- Homogyne discolor Cass. – Two-colored coltsfoot
- Amphoricarpus autariatus Bleč.
- Achillea clavenae L. – Silvery yarrow
- Achillea liugulata Wald. et Kt. – (Yarrow)
- Leontopodium alpinum Cass. – Edelweiss
- Aster alpinus – Alpine aster
- Aster bellidiastrum Scopo. – False aster
- Arnica montana L. – Wolf's bane
- BellflowerEdrainthus sutjeskae Lakuš – Sutjeska's rockbell
- Campanula thirsoidea L. – Yellow bellflower
- Campanula alpina Jacq. – Bellflower
- Knautia travnicensis Szabo
- Gentiana kochiana Pert. et Song.
- Gentiana lutea L. – Great yellow gentian
- Gentiana punctata L. – Spotted gentian
- Plantago gentianoides Sibth. – (Plantain)
- Lamium gargamicum L. – (Dead-nettle)
- Scutellaria alpina L. – Alpine skullcap
- Pinquicula leptoceras Rohö. – (Butterwort)
- Pedicularis brashydonta Schlos. – (Lousewort)
- Veronica aphylla L. – Leafless stemmed speedwell
- Veronica alpina L. – Alpine speedwell
- Ligusticum mutellina Srautz. – Mountain lovage
- Linaria alpina Mill. – Alpine toadflax
- Primula uricula L. – Bear's ear
- Androsaceae lactea L. – Milkwhite rock jasmine
- Androsaecae villosa L. – Woolly rock jasmine

- Soldanella pusilla baumg. – Sea bindweed
- Soldanella alpina L. – Alpine snowbell
- Armeria canescens Host. – (Thrift)
- Linum capitatum Kit. – (Flax)
- Daphne cneorum L. – Garland flower
- Geum bulgaricum Panč. – Bulgarian avens
- Geum montanum L. – Alpine avens
- Dryas octopetala L. – Mountain avens
- Saxifraga caesia L. – Blue-green saxifrage
- Saxifraga oppositifolia – Purple saxifrage
- Sedum alpestre bill – Alpine stonecrop
- Sempervivum schlechanii Schott – Red houseleek
- Alyssum scardicum var. bosniacum Hayek – Bosnian madwort
- Papaver kerneri Hayek – Kerner's poppy
- Trollius europaeus L. – Globeflower
- Ranunculus crenatus nj. k. – Crenate buttercup
- Anemone anrcissiflora L. – Narcissus anemone
- Pulsatilla alpina Schrank – Alpine pasqueflower
- Saponaria bellidifolia Sm. – Alpine soapwort
- Silene acaulis L. – Moss campion
- Drypis spinosa L.
- Dianthus superbus L. – Fringed pink
- Polygonum bistorta L. – Meadow bistort
- Rumex sotuatus
- Asplenium fissum Kit. – (Fern)
- Taxus baccata L. – English yew
- Alnus viridis – Green alder
- Salix retusa – Notchleaf willow
- Leontopodium nivale hent. – Edelweiss
- Dactylorhiza sambucina Soö – Elder-flowered orchid
- Dactylorhiza cordigera Soö – Heart-flowered marsh orchid
- Adaianthum capillus veneris L. – Venus hair fern

8.10. Cultural-historical heritage

In the observed survey area, for the purposes of environmental analysis of the planned route of the motorway on Corridor Vc, according to the available spatial-planning documentation and data related to the work of the Commission to Preserve National Monuments of Bosnia and Herzegovina, archaeological and architectural heritage has been recorded.

The following overview contains no detailed specification regarding the precise position, exact name and type of cultural-historical goods. It is considered that data at this level can meet the needs of the Environmental Impact Study with reference to the relation to the route.

8.10.1. Municipality of Odžak

According to the available data, the following cultural and historical monuments are located in the Municipality of Odžak:

Archaeological sites - Prehistory:

- BRŠČANICA, Svilaj. Prehistoric settlement.
- DONJI SVILAJ, Donji Svilaj. Incidental finding from the Eneolithic.
- KADAR, Gornji Svilaj. Paleolithic site.
- PRODANOVIĆA KUĆE, Gornji Svilaj. Prehistoric settlement.

Rome:

- GAJEVI, Donji Svilaj. Roman building.
- NEVOLjICA, Donji Svilaj. Roman settlement.

National monuments

Decision of the Commission to Preserve National Monuments on the Proclamation of national monuments of BiH

- Municipal Building (Beledija or Small town hall), historical building
  Provisional List of National Monuments of BiH
- Donja Dubica – Church of the Holy Mother of God

Petitions to designate the property as a national monument addressed to the Commission to Preserve National Monuments of BiH

- Municipal Building Odžak
- Odžak Mosque

8.10.2. Municipality of Doboj

The Municipality of Doboj is rich in archaeological and cultural heritage, and has cultural monuments on the Provisional List of National Monuments of Bosnia and Herzegovina. The list of archaeological sites in the municipality:

- Archaeological sites
- <u>Prehistory:</u>
  - BARE, Grabovica. Prehistoric necropolis with tumuli.
  - HENDEK, Makljenovac. Paleolithic station and Iron Age settlement.
    KAMEN and LONHA, Makljenovac. Paleolithic stations.
  - DANILOVIĆA BRDO, Podnovlje. Paleolithic station and traces of a Neolithic settlement.
    GRABOVCA BRDO, Podnovlje. Paleolithic stations.
  - GREDA, Podnovlje. Prehistoric necropolis.
    DOBOJ-CENTAR, Doboj. Prehistoric settlement.
  - ĐUKIĆA VIS, Božinci. Paleolithic station and prehistoric necropolis with burn marks.

KUŠUM, Karuše. Paleolithic station.

- Rome:
  - GRADINA, Doboj. Roman castrum and lectus.
- Middle Ages:
  - BAŠČA, Alibegovci. Medieval necropolis.
    KOSICA, Alibegovci. Medieval necropolis.
  - CRKVINA, Podnovlje. Medieval church on the right bank of the Glogovina rivulet.
    GREBLjE NA LIPI, Podnovlje. Medieval necropolis.
  - HAMIJA NA ČARŠIJI, Doboj. Necropolis and medieval church.
  - GRAD, Doboj. Medieval fortress. (On the Provisional List of National Monuments of Bosnia and Herzegovina).
  - DOBOJ, Old Town. (on the Provisional List of National Monuments of Bosnia and Herzegovina).
    GRČKO GREBLjE, Brestovo. Medieval necropolis next to a current village cemetery.
    GRADINA, Mravići. Medieval fortress and necropolis.
  - ULER, (Razvale), Bukovica Velika. Medieval necropolis.
- Prehistory, Rome, Middle Ages:
  - GRAČAC, Alibegovci. Prehistoric and Roman settlement.
  - CIGANIŠTE, Brestovo. Prehistoric settlement above the Ukrina river, and upwards from the medieval fortress called Gradina.
  - CRKVINA, Makljenovac. Paleolithic station, late Neolithic, late Bronze and younger Iron Age settlement, late antique refugium, medieval church and necropolis.
  - KUŽNO GREBLjE, Mali Prnjavor. Roman settlement and medieval necropolis.
    GRADINA, Kožuhe. Prehistoric hillfort, fortress and settlement from the Middle Ages.

National monuments

Decision of the Commission to Preserve National Monuments on the Proclamation of national monuments of BiH

- Old Town Doboj, architectural ensemble; Provisional List of National Monuments of BiH
- Fortress
- Old town
- Boljanić – Church of the Descent of the Holy Spirit
- Dragalovci – Cemetery chapel and cemetery
- Srpska Grapska – Church of the Ascension of Christ

8.11. Hunting

The motorway route mostly passes through the area with the habitats of small (low) game, and partly of large (high) game. Species that inhabit the area included in the adopted option, and which are important for the hunting economy are primarily the European hare (Lepus europaeus Pallas), grey partridge (Perdix perdix L.), pheasant (Phasianus colchicus L.), quail (Coturnix coturnix L.), and various waterfowl (wild ducks and geese, Eurasian coots, etc.), mainly along watercourses, and the large game ones are the roe deer (Capreolus capreolus L.) and wild boar (Sus scrofa L).

8.12. Status of noise pollution

No data exist on the current noise levels for the area of the planned project. The area through which the motorway will be passing will be in various zones for which different maximum permissible noise levels have been defined.

The survey of environmental noise was carried out in accordance with the international standards ISO 1996and ISO 9613, as well as the regulations that accompany these standards. The survey equipment used belongs to the Class 1 instruments and fully complies with the IEC 62672 standard (which replaced the IEC 60651 and IEC 60804 standards). Standards and regulations for noise rating are different, and permissible environmental noise levels are not same in all countries. The values that appear in the rating are the most common or only the equivalent noise level Leq (dBA), or the relevant rating level Lr, which includes certain additions depending on the noise type.

Noise survey instrument

The noise level survey was carried out with the following instrument:

- Integrating Sound Level Meters (Class 1) 2238 MediatorTM - Brüel & Kjaer - Denmark, serial number 2368859 with the following built-in variants:
- Basics Sound Level Meter Software BZ 7126
- Enhanced Sound Level Meter Software BZ 7125
- Logging Sound Level Meter Software BZ 7124
- Frequency Analysis Software BZ 7123
- Sound Level Calibrator – Type 4231 Brüel & Kjaer as well as with a computer data processing software
- Noise explorer 7815.

The following software version was used: Enhanced Sound Level Meter, Software BZ 7125, because it best characterizes the traffic noise which, in this case, is dominant.

Noise survey was conducted by fixing the instrument to tripod, 1.5 m off the ground. In the vicinity of buildings, the instrument was always at a distance of more than 5 m. Since the noise was measured in the outside environment, the microphone was directed towards the noise source in the "Frontal" position. To establish the noise intensity, the survey was carried out during several time intervals during the day.

8.12.1. Description of the survey locations

At the observed place, noise level survey was done at several survey locations. Selection of these locations was made based on the impact zone of the future motorway with a view to seeing the current state of the usual noise level near the future motorway. Two specific points on both sides of the Bosna River were determined (survey locations MM-1 and MM-2).

Survey location MM-1 was in the area of the construction materials yard, about 40 m away from the bridge of the primary road Bijeljina – Doboj. The instrument was placed in the direction of the bridge. There were no obstacles or barriers on that stretch. On the left and right side of the survey location, looking towards the bridge, were pallets with construction material up to 2 m high, and about 20 m on the left side - a prefabricated open-warehouse building.

Survey location MM-2 is about 80 m downstream from the future road route, 150 m downstream from of the existing transmission line, 30 m from the river bank and 50 m upstream from the cottage on the lot with cadastral registered number 879/16. The surrounding terrain, save the river bank, is not overgrown in vegetation and is mostly made of meadows and fields.

8.12.2. Sources of noise

The main source of noise at the survey location MM-1 is the traffic taking place on the primary road Bijeljina - Doboj. An additional, but not crucial, source of noise are the works taking place in the yard area. The effect of this noise is limited in nature and present at the time of loading the pallets with a forklift into the truck. The noise of traffic, which is very frequent on this part of the primary road, can be characterized as intermittent, of variable intensity and with periodic impulses that occur when a truck with a trailer passess.

Noise sources at the survey location MM-2 can be observed at a greater distance. The constant noise recorded here has the character of background noise and originates from the traffic that takes place on the existing bridge in Modriča. The second registered noise source is located 200 m downstream and comes from the excavator loading the gravel exploited from the riverbed. There is no significant source of noise at the very survey location.

8.12.3. Survey conditions

Noise was measured in the external environment, with the parameters given in the survey reports, and using the methodology described. There are constructed facilities at the survey location MM-1. Of importance is the prefabricated building in the form of a semi-open warehouse, about 5 m high, close to which the sound level meter was placed. Pallets with construction material up to 2 m high can be considered as possible reflecting surfaces. There are no obstacles in the survey direction. Vegetation overgrowth is present in the riparian zone and just slightly affects the survey results.

Mean values of weather conditions are shown in the table, as well as the equivalent noise levels at the survey locations.

Table: Mean values of weather conditions

SURVEY LOCATION	AIR TEMPERATURE (ºC)	AIR PRESSURE (mbar)	Air current velocity (m/s)	Weather conditions
MM-1	18.2	1008	0.7-3.0	sunny
MM-2	19.8	1008	< 0.3	sunny
MM-2	6.8 (a.m.)	1009	0.6-2.3	sunny

Table: Equivalent noise levels at the survey locations

SURVEY LOCATION	SURVEY DATE	START AND END OF SURVEY	SURVEY DURATION	EQUIVALENT NOISE LEVEL [dB(A)]
MM-1	19/11/2003	12:32:01-12:53:26	0:21:25	58.3
MM-1	19/11/2003	12:56:19-13:17:49	0:21:30	55.9
MM-1	19/11/2003	18:11:50-18:31:18	0:19:28	56.1
MM-2	19/11/2003	14:12:59-14:37:04	0:24:05	46.6

MM-2	20/11/2003	08:28:57-09:06:57	0:38:00	53.2
MM-2	20/11/2003	10:03:34-10:25:02	0:21:28	46.7
MM-2	20/11/2003	10:49:56-11:08:59	0:19:03	52.1
MM-2	20/11/2003	11:17:19-11:35:38	0:18:19	47.5

8.13. Infrastructure

8.13.1. Municipality of Odžak

8.13.1.1. Road network

The area of Odžak municipality is located at the northern border of Bosnia and Herzegovina and borders on the right bank of the Sava River. The primary road M14.1 passes through the area of Odžak municipality, with its section Vukosavlje – Odžak – Svilaj, as well as the regional roads R464 Odžak – Šamac and R464a Odžak – Svilaj. These three listed roads intersect in the central area of Odžak, creating a junction (intersection) with a very high degree of capacity utilization and poor level of service.

These three routes form the primary traffic network in the area of Odžak municipality. The length of the primary road M14.1 through the municipality of Odžak is 24 km. The surfacing of this section is in a relatively good condition. Regional roads R464 and through the area of Odžak municipality are 16 km and 14 km, successively.

In addition to the mentioned primary road network, the rest of the network consists of a large number of local and unclassified roads in the area of Odžak municipality. Considering that the area of Odžak municipality is located in the lowland part of Bosnia and Herzegovina, the relief as the influence factor had no major influence on the geometric elements of road network. The table below gives the outline of local roads delivered by the administrative bodies of the Municipality of Odžak.

Table: Road network

	Section	Asphalt	Macadam	Total
1.	Odžak-Čokori	1.50 km		1.50 km
2.	Ožak-Cvekovi	1.40 km		1.40 km
3.	Cvek-Gornjani	1.60 km		1.60 km
4.	Bijele Bare-Novo Selo	5.40 km		5.40 km
5.	Donjani-Lužnjani	1.70 km		1.70 km
6.	Donjani-Neteka	4.40 km		4.40 km
7.	Neteka-Posavska Mahala	6.20 km		6.20 km
8.	Doljani-Posavska Mahala	1.60 km		1.60 km
9.	Posavska Mahala-Vrbovači Lipik	5.30 km		5.30 km
10.	Lještrak-Brezik	4.40 km		4.40 km
11.	Točak-Vrbovac	1.40 km		1.40 km
12.	Panjik-Pantića Kosa	4.20 km		4.20 km
13.	Brezik-Kočijaš	1.70 km		1.70 km
14.	Donji Svilaj-Kadar	3.00 km		3.00 km
15.	Gornji Svilaj-Pavlovci	2.30 km		2.30 km

16.	M14.1-Trnjani-M14.1	1.80 km		1.80 km
17.	Trnjani-M14.1	0.70 km		0.70 km
18.	Donji Brezik-M14.1	2.30 km		2.30 km
19.	Gornji Brezik-Panjićka	1.30 km		1.30 km
20.	Gornja Dubica-Novi Grad	6.80 km		6.80 km
21.	Oštice-Papučija	3.30 km		3.30 km
22.	Donja Dubica-Papučija	2.30 km		2.30 km
23.	Vojskova-Donja Dubica	1.20 km		1.20 km
24.	Zorice-Donja Dubica	4.00 km		4.00 km
25.	Donja Dubica-Prud	4.80 km		4.80 km
26.	Zorice-Trnjak	2.50 km		2.50 km
27.	Gornja Dubice-Papučija	1.50 km		1.50 km
28.	Gornja Dubica-Kućište-Burum	2.20 km		2.20 km
29.	Novo Selo-Donjani-Neteka	4.50 km		4.50 km
30.	Novo Selo-Arambašići-Bijele Bare	5.30 km		5.30 km
31.	Prnjavor-Arambašići	1.00 km		1.00 km
32.	Lještrak-Vrbovački Lipik	4.3 km		4.3 km
33.	Bijele bare-Novo Selo	15.00 km		15.00 km
34.	Čivčije Bukovačke-Grabovica	7.50 km		7.50 km
	TOTAL LOCAL ROADS	118.40 km		118.40 m

8.13.1.2. Electric power system

In the area of Odžak municipality, the future route of the Vc motorway will be crossing 04/10 and 0.4 kV lines at several places, while the 35 kV transmission line Odžak – Novi Grad is located in the wider zone of Corridor Vc.

8.13.1.3. Telecommunications

The network of telecommunication system in the area of Odžak municipality includes the regional automatic telephone exchange (ATE) located in the town center and local ATEs (outpost RSSes) in the settlements of Svilaj, Pavlovac, Vrbovec, Novi Grad, Posavska Mahala, Gornja Dubica, Novo Selo, Ada, Malo Polje, and Kacevi. An optical cable was laid from Odžak to all the above-mentioned outposts.

There are telecommunication cables on the part of the route of the future Vc motorway passing through the municipal areas of Odžak. Also, laying an optical cable along the regional road Svilaj - Novi Grad is planned. As far as postal traffic is concerned, it has been reduced to a post office in Odžak, and in smaller populated places there are post counters and letter boxes.

8.13.2.1. Water supply and wastewater disposal

The main source for water supply of the urban area of the municipality of Odžak is groundwater pumped from 4 wells located in the immediate vicinity of the town, with a total capacity of about 25 l/sec. The water intake covers an area of about 2.5 ha of land owned by PE "Komunalac" d.o.o Odžak. The reservoir capacity is a metal tank of 200 m3, placed on the water tower 40 m above the ground.

In addition to the main source in Odžak, the municipality area has water intake sources (wells) in the settlements of Odžak, Ada, Novo Selo, Gornja Dubica – Papučja, Vojskova, and Zorice.

8.13.2. Municipality of Doboj

8.13.2.1. Road network

The municipality of Doboj is located on the banks of the Bosna River, at the intersection of the primary roads M4 and M17, which are among the most important roads in Bosnia and Herzegovina. The primary road M17 in the area of the municipality of Doboj is presented through the sections shown in the table.

Table: Primary road M17

	Section	Length	AADT (2003)	AADT (2004)	AADT (2005)
1.	Podnovlje - Šešlije	11	5282	5176	5042
2.	Šešlije - Johovac	5	7553	7402	6690
3.	Johovac - Rudanka	7	6931	6994	7126
4.	Rudanka - Doboj	/	9821	10583	10328
5.	Doboj – Karuše	4	12309	12556	13155

In the area of Doboj municipality, in addition to the mentioned primary roads, a network of regional roads has been developed, which roads together form the primary road network of the municipality of Doboj. Regional road R465 Doboj – Modriča plays an important role in flow collection from the right bank of the Bosna River and their connection with Modriča and the rest of the road network. Regional roads R474, R482 and R472 connected the primary road M17 with the section M169.1 Klašnica – Derventa, the section M 17.2 Derventa – Šešlije as well as the section M 14.1 Derventa – Brod.

Table: Road network – local and unclassified roads

	Section	Asphalt	Macadam	Total
1.	M17-Podnovlje-Podnovlje Gornje- Dobra Voda	8.00 km		8.00 km
2.	Partizansko groblje-Ritešići-Majevac	6.00 km		6.00 km
3.	P482-Komarica-M17b	4.20 km		4.20 km
4.	M17-Bukovac-P482			
5.	M17-Kotorsko-Johovac	10.00 km		10.00 km
6.	Johovac-Foča-Prnjavor Veliki	14.00 km		14.00 km
7.	Johovac-Zarječa	4.50 km		4.50 km
8.	M17-Čivčije Bukovačke-Opsine-Uler-Grabovica-P474a	6.50 km		6.50 km
9.	M17—L5-Bukovica Velika-Bukovica Mala-P474a	7.50 km		7.50 km
10.	P474a-Ljeskove Vode-Tisovac	6.00 km		6.00 km

11.	P474a-Ljeskove Vode-Jelanjska (connection with Osinja)-Cvrtkovci-Mitrovići- Brestovo-Most na Ukrini	14.00 km		14.00 km
12.	P474-stanari- P474a-Ostružnja Gornja	8.00 km		
13.	Raškovci-Cvrtkovci	2.50 km		2.50 km
14.	Dragalovci-Brestovo	2.00 km		2.00 km
15.	Dragalovci-Osredak	4.20 km		4.20 km
16.	P474-Cerovica- P474a	1.50 km		1.50 km
17.	P474a-Ostružnja Donja-Cerovica- Miljanovci	6.50 km		6.50 km
18.	P474a-Grabovica-Brezik-Stanovi- Puračić-	8.50 km		8.50 km
19.	Doboj-Miljkovac-Prisade-Čaire	1.50 km		1.50 km
20.	Vila-Makljenovac-Ularice-Omanjska	6.50 km		6.50 km
21.	Ularice-Šivša	7.50 km		7.50 km
22.	M4-Alibegovci-Sivša	9.00 km		9.00 km
23.	P465-Potočani			
24.	P465-Pridjel-Preslica-Suho Polje- Boljanjić	12.50 km		12.50 km
25.	Suho Polje-Tekućica	1.50 km		1.50 km
26.	M4-Brijesnica Mala			
27.	M4-Klokotnica-Lukavica Rijeka	5.00 km		5.00 km
28.	Sjenina-Sjenina Rijeka-Lukavica Rijeka-kraj Opštine	20.00 km		40.00 km
29.	P465-Štale-Sjenina	3.50 km		3.50 km
30.	P465-Osječani Donji-Čivčije Osječanske-Duge Njive	7.00 km		7.00 km
31.	Novo Selo-Sivša	6.00 km		6.00 km
32.	Podnovlje-Bukovica	7.50 km		7.50 km
33.	Novi Grad-Trnjani	3.50 km		3.50 km
	TOTAL LOCAL ROADS	205.00 km		205.00 km

Table: Number of registered vehicles in the area of Doboj municipality in 2004 and 2005

Vehicle type	2004	2005
Bus	40	39
Motorcycle	13	10
Towed vehicle	84	63
Passenger vehicle	9078	8545
Work vehicle	25	24
Special vehicle	35	25
Heavy goods vehicle	526	457
Tractor	36	6

Table: Number of registered traffic accidents in the area of Doboj municipality

TA*/road category	2004			2005		
	Primary	Regional	Local and city streets	Primary	Regional	Local and city streets
TA* with persons killed	2	3	2	4	1	0
TA* with persons injured	53	37	38	48	23	35
TA* with material damage only	171	76	140	144	61	161

8.13.2.2. Electric power system

In the area of Doboj municipality, the future route of the Vc motorway will be crossing 0.4 and 10 kV lines at several and the 110 kV transmission lines at three places. It will be crossing 110 kV transmission line Doboj–Derventa, Osječani–Gradačac and Doboj–Teslić. In Osječani, the future motorway Vc route will be passing right by the power substation 110/H kV Osječani (Doboj 3), while the power substations 110/H kV Doboj 1 and Doboj 2 are in the wider scope.

In the wider scope of the motorway on Vc are the 35 kV transmission lines Miljkovac–Kotorsko and Miljkovac–Jelah, and 35 kV power substations Miljkovac, Kotorsko and Jelah. The route of the future Vc motorway will be crossing the 400 kV transmission line Tuzla – Banjaluka in the southern part of the city of Doboj.

8.13.2.3. Telecommunications

The network of telecommunication system in the area of Doboj municipality includes the regional automatic telephone exchange (ATE) located in the town center and local ATEs (outpost RSSes) in the settlements of Rudanka, Kotorsko, and Lipljak. In those settlements there are post offices, i.e. postal counters through which postal traffic takes place.

8.13.2.4. Water supply and wastewater disposal

The main source for water supply of Doboj is at the locality Luke next to the Bosna River, from which the groundwater recharge for the water intake of the well zone is carried out. The source is located near the city center and the industrial zone. It consists of the following wells: 5 dug wells of Ø2500 mm, 8.00 to 9.00 m deep; 3 dug wells of Ø1000 mm, 11.00 to 13.00 m deep; 3 drilled wells of Ø350 mm, 10.00 to 15.00 m deep; 2 technological wells of Ø350 mm, 8.00 to 10.00 m deep; one absorption dug well of Ø1000 mm, 9.0 m deep. The estimated total yield of all wells is about 135 l/sec (about 140 l/sec in favorable hydrogeological conditions). However, in unfavorable conditions during the summer months, when the recharge of water-bearing layers is reduced, the yield of sources is up to 30%. Previous analyses have determined that the maximum safety capacity during the dry season is 80-90 l/sec. The Luke source is in the middle of the populated area that is only partially connected to the sewer system.

Another important source for water supply of Doboj is the Rudanka source. It consists of seven drilled wells with a total yield of about 65 l/sec, while the safe maximum yield during the dry season is 45 – 50 l/sec.

As for other major existing water supply systems, a significant one is the source of water supply Osječani (locality "Bare" with one dug well in the first phase, about 10 m deep, with the yield of about 20 l/sec) for supplying the settlements of Osječani, Brđani, Čivčije, Smići (a total of 4000 inhabitants). Among the larger local waterworks are the following: Kostajnica, Grapska, Kotorsko and Šeplije waterworks, and other local rural waterworks.

The large amount of losses in the existing water supply systems further complicates the issue of providing the required amount of water for the population and other needs.

As per previous study analyses, besides the neighboring municipalities, for the analyzed area of Doboj as well, the orientation was on the use of water resources of a regional character. For this reason, the construction had been planned earlier - of the reservoir "Marica" on the Usora river, the territory of Teslić Municipality, and the reservoir Krajinići on the Krivaja river near Zavidovići as well as a number of smaller reservoirs.

This regional water supply system would be connected to the source systems (surface water reservoirs): Marica, Krajinići, Šibošnica, Drenova, Brestovo, Stoglav, Poljana, Sladna, Mrdići, Malivojevići, Maoča, Donji Islamovac, Vidara, pumping stations (Krajinići, Žepče, Mrkotić), conditioning devices (Krajinići, Marica, Brestovo, Drenova, Sladna, Šibošnica), main system reservoirs (Krajinići, Mrkotić, Doboj), distribution reservoirs in consumption centers, and main and distribution pipelines.

The existing sewer system of Doboj was built as a combined (mixed), common for both wastewater and stormwater. All water in the city is collected by two main collectors, which are discharged into the Bosna River at one location, without prior treatment. At the junction of the main sewage collectors there is an over-pumping station that, at high water levels in the Bosna River, over-pumps the collected wastewater and surface waters.

The city has no wastewater treatment plant, although its construction has been planned downstream from the settlement of Kotorsko, and it should have a regional character for the largest part of the municipality of Doboj.

Other settlements in most cases do not have any sewer network, but dispose of their wastewater in the individual septic tanks or directly into the nearest watercourses.

8.13.3. Municipality of Usora

8.13.3.1. Water supply and wastewater disposal

The area of Usora uses water intakes in the alluvion of the Usora River. In the area of the Alibegovac settlement, there are two wells with a yield of 10 l/sec, in the area of Ularice the yield of the existing well is 5 l/sec. The settlement of Makljenovac has the water supply from the well of 5 l/sec, while in the area of the settlement in the local community of Žabljak there is a source with 4 wells with a total yield of 15 l/sec.

This area has no stronger sources to permanently solve the problem of water supply. For the existing sources, in addition to limited yield, a major problem is the implementation of prescribed measures for sanitary protection of sources (both groundwater and surface flows from which the alluvion is recharged).

As per previous study analyses, besides the neighboring municipalities, for the analyzed area of Usora as well, the orientation was on the use of water resources of a regional character. For this reason, the construction of the reservoir "Marica" on the Usora river, the territory of Teslić

Municipality, had been planned earlier. The municipalities of Northern Bosnia would be included in this system. An alternative solution are the water resources of the Krivaja river with the planned construction of the Krajinići or Buk reservoir.

The problem of wastewater disposal in this area has not been solved comprehensively and systematically. Only municipal centers have partially constructed sewer systems. These are usually the mixed type sewer systems with discharges into the nearest recipients without prior treatment.

8.13.3. Municipality of Doboj South

8.13.3.1. Water supply and wastewater disposal

The area of Doboj-South municipality uses water intakes in the alluvion of the Usora and Bosna rivers. The existing water supply systems consist of two separate (unconnected) systems Matuzići and Kraševo. In the area of Matuzići settlement, the existing well yield is 10 l/sec, and the reservoir capacity is 300 m^3. The well yield of the Kraševo source is about 18 l/sec, the total reservoir capacity is 350 m^3.

This area has no stronger sources to permanently solve the problem of water supply. so that in addition to neighboring municipalities, as per previous stydy analyses, the orientation was on the use of water resources of a regional character. For this reason, the construction of the reservoir "Marica" on the Usora river, the territory of Teslić Municipality, had been planned earlier. This system would include the municipalities of the Northern Bosnia. An alternative solution are the water resources of the Krivaja river with the planned construction of the Krajinići or Buk reservoir.

The problem of wastewater disposal in this area has not been solved comprehensively and systematically. Only municipal centers have partially constructed sewer systems. These are usually the mixed type sewer systems with discharges into the nearest recipients without prior treatment.

Table: Overview of all motorway – infrastructure collision points

TRANSPORT		
1	1+496.364 km	PRIMARY ROAD M14 ODŽAK-BOS.BROD
2	5+957.92 km	LOCAL ROAD VRBOVAČKI LIPIK-BREZIK
3	9+819.92 km	REGIONAL ROAD R464
4	11+300.00 km	LOCAL ROAD ODŽAK-SRNAVA
5	13+275.64 km	LOCAL ROAD POTOČANI-GNIONICA
6	13+538.95 km	LOCAL ROAD GNIONICA-ODŽAK
7	16+206.47 km	LOCAL ROAD PEĆNIK-MODRIČKI LUG
8	16+070.00 km	PRIMARY ROAD M17 BOS.ŠAMAC-DOBOJ
9	16+798.40 km	PRIMARY ROAD M14.1 MODRIČA-GRADAČAC
10	20+452.00 km	REGIONAL ROAD R465 MODRIČA-DOBOJ
11	22+793.30 km	REGIONAL ROAD R465 MODRIČA-DOBOJ

12	25+872.30 km	LOCAL ROAD DUGO POLJE-VRANJAK
13	39+710.00 km	UNCLASSIFIED ROAD PRNJAVOR-BOŠNJACI
14	45+150.00 km	MOTORWAY BANJALUKA-DOBOJ
15	52+465.052 km	PRIMARY ROAD M17 BOS.ŠAMAC-DOBOJ
16	55+108.46 km	LOCAL ROAD DOBOJ-PRISADE-MILJKOVAC-ČAIRE
17	55+871.10 km	LOCAL ROAD DOBOJ-PRISADE-MILJKOVAC-ČAIRE
18	56+901.30 km	LOCAL ROAD OMARSKA-ULARICE
19	58+783.55 km	LOCAL ROAD OMARSKA-ULARICE
20	59+891.59 km	LOCAL ROAD ULARICE-ALIBEGOVIĆI
21	60+706.540 km	LOCAL ROAD ULARICE-ALIBEGOVIĆI

ELECTRIC POWER SYSTEM		
1	23+100.00	Transmission line (TL) 110kV
2	40+000.00	TL 110kV
3	43+000.00	Next to TS Osječani
4	54+900.00	TL 35kV above the tunnel
5	62+800.00	TL 400kV and PTL 35kV

HYDROPOWER SYSTEM		
1	15+800.00	PLANNED SEWERAGE AND PLANNED WATER
2	16+000.00	PLANNED WATER
3	16+200.00	PLANNED WATER
4	16+400.00	SEWERAGE AND PLANNED WATER
5	16+600.00	WATER STATUS
6	16+800.00	PLANNED WATER
7	17+000.00	PLANNED WATER
8	52+400.00 TO 52+600.00	WATER STATUS, PLANNED WATER, AND SEWERAGE
9	54+000.00 TO 54+200.00	STREAM

10	55+000.00 TO 55+200.00	WATER AND SEWERAGE STATUS
11	62+400.00 TO 62+600.00	PLANNED WATER

8.14. Danger of landmines

Data on the position and approximate size of minefields were taken from the documentation systemized in the Spatial Plan of the motorway on Corridor Vc, in the Annex on the conditions of use and protection of area. The fields of potential mine pollution were defined according to PTLA the map of minefields registered by the Mine Action Center – MAC on 1:100000 and 1:25000 scale base maps. A special study is required for more detailed data on landmines in the subject area. It is quite understandable that it is necessary to clear the area of mines, that is, to demine all the minefields. It should be emphasized in particular that attention must be paid to this issue in the construction phase, as well as to the possibility of finding mines even in places that are not marked as such in the plans and maps.

As per data from the Basis for planning documentation, the presence of landmines was noticed on the part of the section Doboj South - Karuše. It is important to emphasize that due to external impacts, primarily precipitation, precise data on landmines are not known, and for this issue, i.e. for disclosure of information in the territory of BiH, the Mine Action Center - MAC is exclusively responsible, whose cooperation is necessary in further project implementation process.

8.15. Emissions and air quality

Air pollution is the result of the emission of harmful substances from various sources. All gases and particles that are not normal constituents of air are considered pollution. It is a variable in space and time, and depends on the location of the source of pollution, type, quantity, speed and temperature of substances emanating from the source (emission), the terrain configuration, vegetation, season and meteorological situation.

Deposited matters are all those substances in solid, liquid or gaseous state that are not the constituents of the atmosphere, and are deposited by gravity or washed out of atmosphere to the ground by precipitation. Large particles prevail in deposited matters, usually larger than 20 to 40 µm. They are a measure of visible environmental pollution (dust accumulating on the windows, the drying laundry, cars and other surfaces, and on the plants – it can clog them and affect their breathing, and humidity may cause particles to dissolve and penetrate the plants tissue). Thus deposited matters impair the quality of the environment and can indirectly adversely affect humans, but are too large to be able to enter the human body by inhalation.

Due to the complicated political situation that followed the war, there was very little cooperation between the Entities on environmental issues. As regards the air quality in Bosnia and Herzegovina, data are generally not available. Most air pollutants come from industrial activities, but a significant part also comes from transport. Before the war, industry was the key air polluter: the steel mill in Zenica, thermal power plants in Kakanj, Tuzla, Ugljevik and Gacko, detergent and fertilizer factory in Tuzla, and many others. Most of industry ceased operations during the war, and has not yet been reconstructed to pre-war level. As a result, air pollution is much lower than before the war, although no accurate data are available on the current air quality in Bosnia and Herzegovina.

At Doboj – Usora, emissions measurement was conducted at two survey locations. The selection of these survey locations was made based on the impact zone of the future motorway with a view to seeing the current state of the air quality near the Bosna River. Survey locations were marked as MM-1 and MM-2.

Survey location MM-1 was in the area about 40 m downstream from the bridge of the primary road M-17. On the left and right side of the survey location, looking towards the bridge, were pallets with construction material up to 2 m high, and about 20 m on the left side - a prefabricated open-warehouse building.

Survey location MM-2 was in the cottage yard about 30 m away from the left bank of the Bosna River and about 100 m downstream from the alignment of the future bridge. In the vicinity of survey location in the direction of the alignment, a livestock-fair facility was situated. The surrounding terrain, except for the river bank, is not overgrown with vegetation; these are mostly meadows and arable fields.

The results of air measurement are given in the table. The results of the deposited matter analysis at survey locations MM-1 and MM-2 are also shown in the table.

Table: Results of the deposited matter analysis

SURVEY LOCATION	DEPOSITED MATTER (mg/m^2/day)				
	DISSOLVED	UNDISSOLVED	TOTAL	LIMIT VALUES	pH
MM-1	118.2	35.5	153.7	450	6.76
MM-2	31.5	27.5	59.0	450	6.2

Table: Air quality testing results

PARAMETER	UNIT OF MEASUREMENT	SAMPLING PERIOD	MM-1	MM-2	EMISSION LIMIT VALUE (ELV)	SOURCE
sulfur dioxide	μg/m^3	24 hours	12.2	< 5.0	125 150 365 100-150 80-120 90	TA Luft, 2000 OG of the Republic of Serbia 54/92 EPA (NAAQS)EC, 1980 Decree on recommended and limit values of air quality in the Republic of Croatia, OG 101/96 and 2/97 Rulebook on air quality limit values for the FBiH

nitrogen oxide	µg/m³	24 hours	18.6	21.2	40 85 100 60 60	TA Luft, 2000 OG of the Republic of Serbia 54/92 EPA (NAAQS) Decree on recommended and limit values of air quality in the Republic of Croatia, OG 101/96 and 2/97 Rulebook on air quality limit values for the FBiH
carbon monoxide	mg/m³	24 hours	max. 0.8	max. 0.4	10 (30) 10 10 (40) 2 10	TA Luft, 2000 OG of the Republic of Serbia 54/92 EPA (NAAQS) Decree on recommended and limit values of air quality in the Republic of Croatia, OG 101/96 and 2/97 Rulebook on air quality limit values for the FBiH
soot	µg/m³	24 hours	145.3	34.6	50 40-80	OG of the Republic of Serbia 54/92 Decree on recommended and limit values of air quality in the Republic of Croatia, OG 101/96 and 2/97
suspended particles	µg/m³	24 hours	55.0	32.3	120 150	OG of the Republic of Serbia 54/92 Decree on recommended and limit values of air quality in the Republic of Croatia, OG
					150	101/96 and 2/97 Rulebook on air quality limit values for the FBiH
lead	ng/m³	24 hours	283.4	293.4	500 1000 1500 2000	TA Luft, 2000 OG of the Republic of Serbia 54/92 EPA (NAAQS) Decree on recommended and limit values of air quality in the Republic of Croatia, OG
mercury	ng/m³	24 hours	3.3	3.6	1000 1000	OG of the Republic of Serbia 54/92 Decree on recommended and limit values of air quality in the Republic of Croatia, OG 101/96 and 2/97
cadmium	ng/m³	24 hours	13.4	18.0	10 40	OG of the Republic of Serbia 54/92 Decree on recommended and limit values of air quality in the Republic of Croatia, OG 101/96 and 2/97
manganese	ng/m³	24 hours	210.0	137.8	1000 2000	OG of the Republic of Serbia 54/92 Decree on recommended and limit values of air quality in the Republic of Croatia, OG 101/96 and 2/97

These methods were used to determine the concentrations during the measurements:

- Analysis of sulpfur dioxide (spectrophotometric method with tetrachloromercurate and pararosaniline JUS ISO 6767:1998)
- Analysis of nitrogen oxide (spectrophotometric method as per Griess-Salzmann JUS ISO 6768:1990)

- Analysis of soot (reflectometric, recommended methods: Guideline SDČVJ 202, Association of the Clean Air Societies of Yugoslavia)
- Analysis of suspended particles (gravimetric VDI 2463)

Analysis of heavy metals in suspended particles:

- lead (atomic absorption spectrophotometry, 12128-02-73T, Methods of air sampling and analysis, APHA intercos. comm. 1977)
- mercury (atomic absorption spectrophotometry, 42242-01-74T, Methods of air sampling andanalysis, APHA intercos. comm. 1977)
- cadmium (atomic absorption spectrophotometry, 12110-02-73T, APHA intercos. comm 1977)
- manganese (atomic absorption spectrophotometry, 121312-02-73T, Methods of air samplingand analysis, APHA intercos. comm. 1977)
- Deposited matter from air (gravimetric BS 1747, VDI 2119)
- Heavy metals in deposited matter: lead, cadmium, zinc (atomic absorption spectrometry method)
- Carbon monoxide (repeated short-term sampling with a Dräger gas analyzer)

9. DESCRIPTION OF POTENTIAL SIGNIFICANT IMPACTS OF THE PROJECT ON ENVIRONMENT

9.1. Bases for environmental impact assessment

All types of transport systems, with their current characteristics, represent sources of significant environmental pollution. In this sense, the planning, design, construction and operation of motorways is a very important issue in preserving and protecting the environment.

In view of the stated, it can be argued with certainty that the planning and, consequently, the construction of high-capacity communications, which by its nature the Svilaj – Doboj motorway certainly is, always brings about a series of conflicts between the motorway and the environment.

The global analysis of the motorway impact on the environment shows that all effects manifest themselves within three basic types of impact. The first type is represented by impacts resulting from the construction of the facility and being mostly temporary by nature. They are a consequence of human and machine presence, as well as the technology and organization of construction works. As a rule, negative consequences occur as a result of excavation/dumping, transport and building in large quantities of construction materials, as well as permanent or temporary occupation of the area and all related activities.

Environmental impacts that occur as a result of the existence of the motorway in space and its exploitation over time are mainly permanent in character and, as such, surely represent the effects that are particularly interesting from the aspect of the motorway - environment relationship. These impacts in most cases possess the character of spatial and temporal growth, which warns us of the need to pay attention to their nature in a timely manner.

All processes within the complex motorway - environment relationship take place on the basis of the interdependence of a multitude of relations, and as a result thereof, many changes happen. These changes range from quite insignificant ones to ones so radical that certain elements completely lose their basic characteristics. A systematic approach to these relations through the analysis of individual criteria produces satisfactory results in the majority of cases, only with their objective quantification and consistent adherence to the hierarchy of methodological steps.

Each of the criteria may become dominant in certain conditions, but the practice to date has outlined the basic relation matrices, which does not mean that in the future, with the development of certain knowledge and sharpening of environmental awareness such matrices will not undergo changes, on the basis of which we define the majority of potential impacts.

Within this research, respecting all the specifics that characterize the route of the planned motorway, and local spatial relations, consideration was given to the basic criteria that turned into indicators through quantification procedures with the basic intention to quantify future relations in detail and define the true nature thereof. Based on the prescribed limit values of certain impacts and their projected values in the context of future relations, adequate environmental protection measures have been proposed.

The analysis and assessment of the current state of the environment as well as the assessment of possible impacts resulting from the construction of the planned motorway show that unambiguous quantified data may be obtained only on the basis of a comprehensive analysis.

All previous experiences in this issue show that today we can speak with sufficient reliability about the known impact matrix, always bearing in mind that such matrix is a spatially and temporally variable category and that both the relative importance of individual impacts and their absolute boundaries must always be observed in real spatial relations. These facts primarily mean that each impact must be quantified through verified procedures and that its true significance must be determined depending on the specific local relations.

In order to adequately quantify the significance of each impact, it is necessary for specific conditions to associate each impact with a series of indicators which, by the nature of things, should be exact values, then simply used in the process of defining the necessary measures of protection. Part of the problem in the relationship between the motorway and the environment lies in the fact that for certain impacts, which we know to exist, the exact indicators cannot be determined and that part or all of the impact takes place in the sphere of a subjective relationship.

Defining individual impacts (criteria) and their indicators in detail is essentially related to the phase of the project for which the analyses are performed. As each phase of the project or planning documentation is related to the characteristics of the information base, which entails all important facts regarding the scope and accuracy of available information, the possibility of quantification and the accuracy of exact indicators are limited by these facts.

The basic impacts (criteria) have been defined in this research based on the previously defined facts and concrete location conditions.

The matrix of analyzed criteria is the result of previous knowledge about issues in the relationship between the motorway and the environment. What is clear at first glance is the fact that not all criteria are equally important, especially if we take into account the specific spatial relations within the analyzed area.

The primary impact of the project relates to traffic noise, air pollutant emissions, water leakage off the road without prior treatment and its entry into waterways and underground, land use changes, permanent land loss and negative impact on the property including housing, flooding of the fields, carrying out soil drainage, loss of habitat function, disturbance of biodiversity, disturbance of landscapes, etc.

The issue of air pollution is a factor that requires quantification given the potential impacts along the planned section of the motorway, primarily in relation to the flora, and also to a limited extend the human population and facilities.

The issue of noise in the analyzed area is present primarily as a parameter of current and future relations along the planned motorway in relation to the population inhabiting the analyzed area.

The issue of water pollution is a criterion of significance primarily in the context of pollution of the Bosna River and its tributaries.

Soil pollution, land expropriation and accessibility issues are important criteria in these circumstances, given the fact that the analyzed corridors intersect the land in the valley of the Bosna River, which land is the characteristically reproductive soil.

The specifics of spatial relations in the zone of the analyzed corridors determine the importance of the impact on the flora and fauna, since the existence of certain potentials in this domain has been confirmed within the analysis of the current state.

The existing relations within the analyzed area condition the lesser importance of other criteria. Lesser importance is reflected primarily in two basic phenomena that can be defined as: local spatial distribution of impact or low intensity along the analyzed corridors. Microclimatic impacts and impacts related to resources and energy are local in character.

Impacts in social sphere shall have certain significance, primarily in the context of the current situation along the valley of the Bosna River. The construction of the new motorway in this area will bring significant economic changes.

All these facts show that the clarification of relations in the field of environmental issues can be expected only if each of the mentioned criteria is analyzed within specific spatial relations and through quantification procedures turned into a representative indicator.

Taking into account specific location conditions, characteristics of traffic flows, the intended use of areas inside the corridor, as well as the fundamental laws of relevant relations within most criteria that define the motorway – environment relationship, based on quantified indicators, the requirements for necessary protective measures shall be specified.

9.2. Social impacts – impact on population and density

9.2.1. Impacts during construction

Given the fact that the construction of the road in question requires the expropriation and demolition of existing buildings, mostly residential, in the populated zones, there will surely be certain problems related to this issue, especially if take into account that the motorway construction will also claim some arable land. The effects that may appear as a consequence of construction, and which may have a certain impact in the social sphere, are related to possible induced, uncontrolled development along the planned road, which would significantly disturb the existing relations, and the phenomenon of uncontrolled construction would become even more pronounced. This phenomenon can be expected in the zone of all settlements, where the space is not already taken.

There may also be impacts arising from exposure to social contacts of a significantly higher level (practically of international importance), which may result in significant problems for communities that have so far lived in a traditional environment. Some of these problems must be solved in the period before the construction of the road, primarily at the level of contact with these communities and clarification of the basic problems that will arise during and after the construction of the planned motorway.

A special impact characteristic of this motorway is the taking of agricultural land and its permanent expropriation from its current owners. Such problem is extremely important in terms of social impact, and a more detailed analysis of this phenomenon, from the spatial aspect, is given in Chapter 5.6 "Impact on soil and agricultural land". The expropriation of agricultural land, or the division of current lots into smaller ones, as well as the severance of direct connections between lots, and the negative effects on the current way of living can be prevented by the implementation of adequate measures.

Potential negative impacts in the social sphere:

- Lost house and all land
- Lost house and some land (the remaining land is not good for use)
- Lost house and some land (the remaining land can be used)
- Lost house, land remained
- Lost house, the owner has no land
- Lost house, the owner is a lessee
- Lost house, illegal construction
- Lost land but not the house
- Lost some land (the remaining land cannot be used, house was not lost)
- Lost income from work done at home (temporarily), but not the house
- Lost a job done at home or a job
- Lost the business location, tenant or illegal user

A significant impact is the intersection of traditional local roads by site roads, as well as the commitment of land for temporary landfills, borrow pits, construction equipment and machinery, accommodation of workers and other supporting infrastructure. In the work zone of the existing roads, there will be temporary traffic interruptions during the works, which will affect the overall mobility of the population of these areas. To reduce these impacts, it is necessary in the next phase to prepare the Construction Site Environmental Management Plan, as well as the Project of Organization Structure, which will define the norms and activities during the execution of works. Also, special study examination should be conducted for each element of the site infrastructure, asphalt and batch plants, borrow pits, landfills, etc., according to the applicable laws of Bosnia and Herzegovina within which the necessary measures of protection against the impact of these facilities will be considered.

9.2.1.1. Land expropriation

The issue of expropriation of land needed for the construction of the motorway and additional facilities that are important for the complete construction program implementation is one of the important parameters relevant for defining the relationship between the road and the environment. The study of this issue became topical at the moment of realization that the areas occupied by roads shall represent a permanently lost resource, practically without the possibility to use them for any other purpose ever again.

The stated fact as well as the fact that especially arable land is limited in terms of available quantities, has led to the need to consider this indicator. In the process of defining potential impacts, the need to occupy these areas must be considered from the ecological standpoint and appropriate measures must be taken for the best possible minimization of impacts.

Methodological bases for determining the extent of land possession

Defining the need to take possession of land during the construction of the motorway is a simple procedure, provided all elements of the cross section have been defined in advance, the level of comfort of the accompanying facilities adopted, the positions and concepts of all intersections defined, and the topographic characteristics of the areas through which the motorway will pass are known. For the subject route, these data have been defined in the design documentation. Based on everything that has been defined, the basic methodological steps for quantification of this indicator have been determined.

Possession of the land for the construction of the motorway can be divided into two basic categories. The first category is the land irrevocably committed for the road and the second is that which is most often committed temporarily during construction. Areas that are irrevocably committed include:

Roadbed areas:

- traffic lanes
- breakdown lanes
- central reservation
- speed-change lanes
- flanks

Road base areas:

- cut and fill slopes
- drainage system (canals)
- areas designed to ensure visibility
- areas containing various protective and supporting structures

Accompanying facilities:

- intersections with all their elements
- parking lots and rest areas
- gas stations
- road maintenance depots
- various ancillary roads and paths

Other areas

- road land within the expropriation belt

The data presented in the previous table show that taking possession of areas for the construction of the motorway is an impact that weighs significantly under the circumstances, especially if we take into account the area of the highest quality lowland in the valley of the Bosna River. There are no measures to remove this impact and this additionally aggravates the problem.

Committed land

The planned use includes the motorway belt approximately 100 m wide. The actual width of the motorway belt will be determined following the preparation of the Preliminary Design and the examination of layout relationships. The belt width will be reduced to approx. 30 meters at those parts of the motorway where viaducts and bridges will be built, while this evaluation excludes the strips where tunnels will be constructed.

Table: Total committed land in the motorway belt of 110 m in width

Ord. No.	Municipality	Expropriation belt [ha]	Municipality area
1.	Doboj	289.4	36.01%

2.	Doboj-South	15.8	1.97%
3.	Usora	40.97	5.10%
	Total	346.17	43.08%

Based on the observed data, it can be concluded that a total of approx. 350 ha of land will be expropriated. This is a very important fact, especially since it is mostly agricultural land in the valley of the Bosna River.

9.2.2. Impacts during operation

The impact of the planned road on the social environment may be assessed only if certain social groups are clearly determined as users of space and facilities on it, in relation to which this phenomenon can be examined. In this sense, two basic interest groups can be clearly distinguished in the actual context of the planned motorway. One group consists of the road users, and the other group consists of inhabitants along the motorway, as well as the property owners to be affected by the construction.

The first social group, which consists of road users, shall benefit from the fact that the construction of the motorway will significantly improve traffic safety, reduce fuel consumption (which will have a positive effect on a number of related global problems), shorten travel time, improve traffic connections in the wider area with all the positive characteristics as the result of this, and create more favorable conditions for the development in the wider area.

The construction of the motorway is expected to increase the mobility of the population, which will bring opportunities for the development of certain activities that improve the social structure.

Part of the population in the immediate vicinity of the existing roads will get more unfavorable housing conditions following the construction of the motorway, since there will be an increase in certain impacts in relation to the current situation. The favorable effect in these zones, in terms of improving business conditions, will appear as a consequence of the increase in the demand for services along the new road. Also, a change in the value of the surrounding land is inevitable, primarily due to the new purpose thereof.

An estimate of the temporary financial loss or relocation costs will be required for those facilities that will be relocated in the immediate vicinity. Contrary to that, for those facilities that will have to be relocated from that area or that will suffer large losses, it will be necessary to estimate the costs of relocation or reopening. For farmers, economic losses can include the value of the field harvest and the loss of earnings due to ignorance of the new economic conditions. Land expropriation and displacement shall have an impact on both residents and buildings that remain in old locations. These persons may face the problem of leaving their properties, as well as the reduced price of these properties.

Due to the construction of the motorway, there will be changes in the rest of the road network, in the sense that the volume on alternative routes will increase, as well as the number of roads with the formation of new access roads. These new facilities can have two effects on the local population: they will enable better communication at the local level, which will reduce the consequences of having the area crossed with the new motorway; however, these new roads will take on certain traffic, which will cause traffic impacts on the areas where the traffic had not been of significance before. Therefore, after the final definition of the access road network, it is necessary to assess the impact of these roads on the environment.

A comparison of all the effects leads to the realization that the benefits for the social environment in case of the construction of the planned road are many times greater than the damages that also occur as a result of construction and operation thereof.

9.3. Microclimate

9.3.1. Impacts in the construction phase

Impacts during construction on the microclimatic characteristics of the area are not of major importance, except for the possible and inevitable increase in temperature at microlocations currently covered in greenery, which will be stripped of greenery during construction or will be under some anthropogenic impact (warehouses, material depots, asphalt and batch plants, etc.)

9.3.2. Impacts in the operation phase

Changes in microclimatic characteristics in the area covered by the route of the planned motorway resulting from its construction can be observed only in the terms of strictly local features. These are the microclimatic characteristics that are a result of the presence of facilities in the area and occur primarily due to artificial creations which, volume-wise, cause consequences that bring changes to the relatively stable microclimatic regimes.

Based on the known characteristics of certain microclimatic phenomena that can be caused by the elements of the planned motorway, it is possible to concretize them in specific spatial conditions. The basic microclimatic indicators that can be registered above the motorway and on its both sides (temperature, humidity, evaporation, radiation), and without the influence of major manmade facilities, indicate the stable patterns that apply in specific spatial relations.

In terms of microclimate, the space immediately above the motorway surface will be characterized by increased temperature on the surface itself, which are already at steady values at distances of a few meters away from the motorway curbs. The same nature of change is characteristic of evaporation and radiation of light, while humidity has the opposite principles, having the lowest values above the motorway. All these microclimatic changes shall be spatially limited to the narrow belt on both sides of the motorway (approx. up to 10 meters) and, in the main, shall not have any negative effects on the broader surroundings.

Other potential microclimatic changes are inherent in the possible impacts that artificial structures (fills, cuts, tunnels and other ancillary structures) bring to the local area. Considering the specific morphological characteristics along the designed route, the spatial characteristics of the route and the features of the local climate, of which the currents of air masses are of special importance, it is possible to conclude that certain impacts can be expected only in the zone of high fills and cuts as well as in the zone of tunnel portals, which is particularly characteristic of the last section in the zone of Doboj.

Given the previously stated facts, local impacts that will not have a particularly pronounced negative effect can be expected. As there are mostly green areas on both sides of the planned sections of the motorway, the presence of negative impacts should be considered primarily in terms of the impact on vegetation. Considering the adopted elements of the cross section as well as the width of the road land, all the mentioned impacts will primarily be concentrated within these areas, thus the special negative impacts of microclimatic changes on vegetation should not be expected.

9.4. Impact on waters

Motorways cause changes in the environment along the route to a greater or lesser extent depending on the method of construction and operation. Certain impacts on waters can be avoided in the design phase by appropriate design solutions: external and internal drainage, bridge structure crossings over watercourses provided that spans ensure high waters flows, as well as respect for cambers between the high water table elevation and the bridge superstructure, watercourse regulation, horticultural treatment of road reserve, and the design of vertical barriers (safety fences) along the motorway at sites designated as vulnerable and sensitive in terms of water resources. Adequate organization of the construction site and application of prevention measures during construction and in the operation phase, by maintaining the constructed facilities for internal drainage and wastewater treatment off the road, can help in avoiding negative impacts on the quality of groundwater and surface waters.

Particular danger comes from pollution in the event of accidents, especially those involving heavy-duty vehicles transporting dangerous goods (traffic accidents, breakdowns) due to temporal and spatial unpredictability.

The analysis of hydrogeological characteristics of the corridor identified 11 sensitive areas along the LOT 1 route. Furthermore, in terms of construction and operation, sensitive areas are considered to be the banks of watercourses along which the motorway runs and which it intersects, and sources inside and outside the public water supply systems.

For the graphic presentation of sensitive areas, a hydrogeological map of 1:25.000 scale was used for the LOT 1 Technical Study and Conceptual Design. Having in mind the importance of these sensitive areas and potential negative impacts thereon, in the next phases of the Preliminary Design it is necessary to conduct a detailed hydrogeological survey of the terrain where the motorway route will be passing, to enable a more reliable assessment of the potential negative impact on waters.

The planned motorway route shall be located within the proposed Zone III of the sanitary protection of water supply sources in Odžak. It touches on the water-protection zones of the Kraševo drinking water source, which are determined by the Decision on implementation of the spatial plan of the Municipality of Tešanj, and in certain areas runs over aquifers that are currently use or may be used for water supply in the future.

In the light of the specific location conditions described within the existing situation (hydro-geological, hydrological and hydrographic characteristics, etc.), it can be concluded that the area has considerable water resources, so it is essential to consider all potential impacts and determine adequate measures their prevention/minimization. Having in mind all the above, the impact of the motorway on the waters will be observed through two aspects:

- Impacts on waters during construction,
- Impacts on waters during operation.

Impacts in the construction phase

During construction works on the route, there are a number of activities that can cause negative impacts on the flow regime and water quality. In this respect, the greatest danger is posed by:

- Construction works (blasting, deep excavations, destruction and removal of the capping, etc.). This may result in disturbing the process of the natural recharge, as by removing the capping and creating new catchment areas, turbid or otherwise polluted water quickly drains into the ground.
- Construction machinery – potential danger of effusion or accidental spillage of oil and oil derivatives, disposal of motor oil and similar waste.
- Uncontrolled disposal of excavated material, and placement of machinery parks or asphalt plants in the vicinity of surface waters and groundwater.
- Use of unsuitable building materials.
- Uncontrolled sewage disposal at the workers’ accommodation sites, where minor pollution is possible from food preparation process, as well as lavatory facilities.

Given the spatial disposition of the planned motorway route, considerable impacts on surface and ground water resources are possible as a result of the motorway construction.

The water sources included in the public water supply systems of Doboj and Doboj-South are quite far from the motorway route, thus no negative impacts on them are expected.

Having in mind the hydrogeological conditions and relations along the examined section of LOT 1, as well as the position of the motorway route in relation to the sources within the water supply system of Osječani and the Municipality of Usora, it can be said that works on the construction of this section could cause significant impact, especially in the form of turbidity of these sources, but also disturbances of the hydraulic flow regime in case of application of mass construction excavations, and pollution with various harmful substances used in construction technology and for construction machinery. In designing and constructing the motorway, it is necessary to work in line with the restrictions specified for Protection Zone III for sources belonging to aquifers of intergranular porosity, and plan facilities that will meet the requirements prescribed by the current “Rulebook on conditions for determining sanitary protection zones and protective measures for sources of water used or planned to be used for drinking – October 2002”.

In the motorway route area, on the right bank of the Usora River, there is also the Kraševo source (Municipality of Tešanj), for which no considerable impact is expected in the phases of construction and operation. This is explained by the fact that the motorway route in the zone of the Kraševo source shall be laid along the entire length on the left-bank side of the Usora River, while the source in question is located on the right side of the same watercourse.

Analyzing the hydrogeological environment, and the hypsometric position of the source in relation to the position of the motorway route, the listed negative impacts during construction can be most serious on the following sources:

- Source Bare-Osječani (Municipality of Doboj)
- Source Ularice (Municipality of Usora)
- Sources Makljenovac (Municipality of Usora)
- Sources Alibegovci (Municipality of Usora)

In cases of turbidity of the source, which is the impact most likely to occur, it should be emphasized that such occurrence is not permanent and after the cessation of works along with the necessary measures to rehabilitate the excavation and by proper drainage, these phenomena would be reduced or disappear completely over time.

In order to prevent and minimize harmful effects on these sources during construction, it is necessary to take all proposed measures to prevent as much as possible the occurrence of erosion in the excavation zone as well as the leakage of oil and grease from construction machinery.

At all intersections of the motorway and watercourses, as well as in areas where the route is located along the banks of watercourses, significant negative impacts are possible in the construction phase. This is particularly true of the junctions in the vicinity of watercourses, where extensive works are expected. Construction works on such sites along the motorway may lead to the serious turbidity of surface waters, but also their backfilling, even their contamination with various hazardous substances. Adherence to a range of proposed prevention measures during construction will minimize the impact on these sensitive areas.

The motorway route shall intersect or be located in the immediate vicinity of several sensitive areas, where significant negative impacts on groundwater can occur during the construction phase. Additional problem here is the lack of research data on their depth and yield, which means that the assessment of possible impact of the motorway construction on them, but also the impact of groundwater on the motorway itself, must be taken with hesitation. During the impact assessment, their importance was considered from the aspect of water supply now and in the future, especially having in mind the increasingly acute lack of good-quality potable water, i.e. the need to assure safety standards. Given the current situation, this is a very sensible approach, as the possible consequences might be permanent. Adherence to the proposed prevention measures during construction will minimize the impact on these sensitive areas. However, there is still a need for their detailed research in the higher phases (in the Main Design) in the light of the identified potential negative impacts. Therefore, it is necessary to inspect our predicted impacts on waters based on the data that will be obtained after the completion of exploration works, i.e. hydrogeological maps and vertical profiles of the narrow belt of the motorway in a more detailed (1:5.000) scale.

All characteristic crossings of the motorway over the watercourse along LOT 1 per section are given below.

Motorway chainage	**Locality/ watercourse**	**Length and method of watercourse regulation / Bridge on a watercourse**	**Expected impact on waters**
Section 6. Doboj South – Karuše Km 0+000 - 4+750			
Km 0+650	Suva voda Grgića potok	Concrete bridge	

Km 1+250	Greda – Brezićka Potok Ograđeno vac	Concrete bridge	
Km 3+950	Ularice	Concrete bridge	
	Alibegova čka rijeka		
Km 4+750	Usora	Concrete bridge	

Since the Study writer had no access to solutions regarding all facilities on the motorway route that had been given in the Preliminary Design, the assessment of their impact in the construction phase can be only general and based on related experiences from the literature. It is certainly necessary to comply with the water management requirements where watercourses are to be bridge-spanned (min. superelevation of 120 cm between 1/100 high water flow and bridge superstructure above the water table elevation). An overview of the necessary measures for prevention or minimization of the impact is given in Chapter 6.3.2.

5.4.2. Impact in the operation phase

The use and maintenance of the motorway are always accompanied by pollution of the road itself and the immediate area along its sides, which negatively affects water quality and relates to:

Pollution of rainwater that falls on the road due to:

- engine leakage and greasing (gas, oil, motor oil, coolants and brake fluids),
- tyre particle residue and layer wear and tear (asphalt and bitumen dregs),
- fuel combustion emission (lead and lead compounds, unburnt hydrocarbons, nitrogen oxides, soot and tar).

Precipitation-triggered, these pollutants can enter surface and groundwater and thus contaminate them.

Sudden pollution caused by traffic accidents. Accident situations lead to leakage and spillage of harmful and dangerous material; the most common ones are those involving the spillage of oil derivatives that easily penetrate and diffuse in the ground. Due to the complexity of the flow process and retention of water in the ground, oil pollution has the character of long-term effects. Pollution can be activated in various hydrological conditions.

It is necessary to say that the hazard of pollution of water of water coming off the road is directly linked to the number of vehicles using that road. Given the anticipated annual average daily traffic of 20.000 vehicles, significant impacts on surface and groundwater can be expected.

Bearing in mind that the sources included in the public water supply systems of Doboj and Doboj-South are quite far from the motorway route, no negative impacts are expected on them.

Similar to the motorway construction phase, the water sources that are in the water supply systems of Osječani and the municipality of Usora will be most exposed to harmful effects during the motorway operation phase. This negative impact is assessed as significant and, in accordance with that, prevention or minimization measures have been proposed.

The Kraševo source, located on the right bank of the Usora River, is not expected to have significant negative impacts at this phase. The same applies to local sources registered in the area of Doboj-South municipality.

Negative impacts during use, as well as during construction, are most pronounced at the following local sources:

- Source Bare-Osječani (Municipality of Doboj)
- Source Ularice (Municipality of Usora)
- Sources Makljenovac (Municipality of Usora)
- Sources Alibegovci (Municipality of Usora)

Significant negative impacts on the quality of water from the use of the facility are possible at all sites where the motorway will run across or along the banks of watercourses. Sensitive areas, such as aquifers, may considerably be affected during the use phase. All anticipated negative impacts on these waters during the use phase can be avoided or reduced by the measures proposed in Chapter 6.3.2. of this Study.

5.4.2.1. Basic characteristics of pollution sources

The process of pollution, according to its time characteristics, can be sustained, seasonal and incidental (accidental pollution).

Sustained (systematic) pollution is related primarily to the volume, structure and characteristics of the traffic flow, road characteristics and climatic conditions. The consequence of the traffic is the permanent deposition of harmful substances on the road surface and the accompanying elements of the cross section, which substances get washed out by precipitation. It is primarily the deposition of exhaust gases, fuel, oil and grease, tire and road wear and tear, car body wear, etc.

Seasonal pollution is related to a certain time of the year. A typical example of this type of pollution is the use of salt for road maintenance in the winter months or pesticides for the cultivation of green belts along the motorway during the growing season. This type of pollution is specific for the huge quantity of harmful substances occurring in a very short period of time.

Incidental (accidental) pollution is most often caused by traffic accidents. Accidents lead to spillage and diffusion of harmful and dangerous material. This is mainly oil and its derivatives, although these accidents frequently involve vehicles transporting highly hazardous chemical products. This is a serious problem as it leads to the practically instantaneous release of high concentrations, which cannot be anticipated in terms of time or space. The consequence is that, from an environmental point of view, very wide belts often have to be protected.

5.4.2.2. Types, form of presence and amount of pollutants

In the waters that run off the traffic surfaces, many harmful substances are present in concentrations that often exceed the maximum permitted for discharge into watercourses. These are primarily components of fuel, such as hydrocarbons, organic and inorganic carbon, nitrogen compounds (nitrates, nitrites, and ammonia), sulfates, chlorides, etc. A special group of elements are heavy metals such as lead (fuel additive), cadmium, copper, zinc, mercury, iron and nickel.

Equally important are solid substances of various structures and characteristics present in the form of deposited, suspended or dissolved particles. It is also possible to register substances that result from the use of specific materials for the protection against corrosion. A special group of highly carcinogenic materials is made of polycyclic aromatic hydrocarbons (benzo[a]pyrene), which are the product of incomplete combustion of fuel and used motor oil.

The method of determining indicators that would be used to assess the impact of the motorway involves primarily the calculation of relevant concentrations in the off-road waters, and then the relevant flows in the motorway drainage system, based on which it is possible to obtain the total quantity of pollutants which may reach recipients.

In accordance with the views expressed, and based on a number of foreign experiences, using the interpolation procedure for different traffic volumes, an estimate was made of the amount of pollutants in the waters being washed off the road surface of the planned motorway. At this level of analysis, it is possible to establish some basic rules only with global parameters (traffic volume, traffic structure, etc.). Table 5.4.1. gives the anticipated amounts of pollutants contained in the section's off-road waters.

Table: Expected concentration values of pollutants in off-road waters

Substance	Unit	Section
Suspended particles	mg/l	100-150
Chlorides	mg/l	50-80
Sulfates	mg/l	0.04-0.07
Total phosphorous	mg/l	0.4-0.8
Motor fuel	mg/l	0.005-0.008
Mineral oils	mg/l	0.004-0.007
Cadmium	mg/l	0.002-0.005
Chromium	mg/l	0.004-0.008
Copper	mg/l	0.03-0.07
Iron	mg/l	0.1-0.3
Lead	mg/l	0.07-0.1
Zinc	mg/l	0.1-0.2

It is particularly important to determine the total concentrations of pollutants present in precipitation washed off the road surface. The basic views that are of particular importance for the calculation of the pollutant concentration can be summarized in the form of the following conclusions:

The highest concentrations of pollutants were registered in the waters washed off the roads in the winter months when the use of salt is most common. The concentrations of most pollutants directly depend on the duration of the dry period before rain and on the traffic volume. The highest concentrations occur in the first 5 to 10 minutes of precipitation, after which they abruptly drop. The concentrations of suspended particles are proportional to the intensity of the rain and the highest concentrations are measured during the strongest flow. Water loss due to splatter caused by the passage of vehicles does not exceed 10% of the total quantities. The dissipation of material off the road during the dry period due to air currents caused by the passage of vehicles does not significantly affect the reduction of concentration. The pollution of surface waters caused by the drainage from the motorway surface can be significant, which is why it is necessary to conduct a detailed analysis and determine the need for possible protection measures. Pollution caused by traffic accidents is a special problem and is not covered by the previously stated views. This issue is analyzed separately in the chapter dealing with possible accidents.

5.4.3. Impacts on waters in case of accidental situations

In the event of accidents, especially those involving vehicles transporting hazardous loads, one possible danger is the spillage and diffusion of harmful and dangerous material along the road, and possibly even closer surroundings if there are no safety fences or concrete blocks (new jersey) to physically prevent the vehicle rollover. The most frequent accidents are those involving the spillage of oil and its derivatives that have a great capacity to diffuse into the ground. The probability of these impacts is small; however, if an accident situation occurs, the consequences can be very severe and long-lasting. This impact is especially strong in areas where the route runs over aquifers, zones of influence of local sources, and along the boundaries of water protection areas, as well as at the locations where the route runs across open watercourses.

Having in mind the severe consequences in case of accidents, in addition to adhering to prevention measures, it is necessary to have an Emergency Intervention Plan in Case of Accidents, both in the construction phase and in the operation phase.

9.5. Impact on air

Air pollution caused by traffic, as one of the criteria that defines the relationship between the motorway and the environment, can be quantified only if all the parameters that essentially determine this phenomenon are taken into account (meteorological, topographic, traffic-related, construction-related, etc.).

Taking into account the above facts, the scope of this study, in the field of air pollution, reaches limits that allow certain levels of quantification in accordance with the level of data that can be collected from existing project and study documentation. Following these findings, along with appropriate numerical procedures and functional rules, a methodological basis for quantification of relevant air pollution parameters was created with the principal goal of obtaining relevant data to assess potential negative impacts on humans, plants and facilities along the analyzed corridors.

9.5.1. Basic principles of quantification

Previous experiences in the field of research on the issue of air pollution have crystallized some views considered to be a generally valid model of quantification of relevant indicators. In that sense, as a rule, the quantification of air pollutant emissions is possible for each period sharing uniform characteristics.

If all characteristics of the relevant parameters that affect the concentrations of pollutants are taken into account, it can be concluded that such uniform characteristics can be obtained only with quite significant simplification. Due to the previous facts, most of the analyses so far have shown that the best bases for quantification are obtained for the average annual values of the relevant indicators understood as long-term concentrations. This statement greatly facilitates the important planning settings, which are related, in general and as far as traffic is concerned, to the parameter

AADT (annual average daily traffic). The scope of this study is based on indicators defined as annual average values (long-term concentration) and the 95th percentile values (maximum short-term concentration).

9.5.2. Relevant air pollution components

To date, the analyses of waste gases released as the byproduct of vehicle engines show the presence of as many as several hundred harmful organic and inorganic components. It is quite understandable that such a large number of indicators cannot be analyzed, and it would not make any sense to do so anyway. This statement is based on the fact that for most of them there are still not enough sufficiently acceptable rules to describe their origin, and not all of them are equally harmful to the environment. In that sense, today all analyses related to the issue of air pollution are based on several indicators for which, with acceptable accuracy, numerical data can be obtained.

The long-standing practice of measuring carbon monoxide (CO) as the only relevant air pollutant in air pollution analyses is considered obsolete. In addition to carbon monoxide, it is considered very important to include nitrogen oxides, sulfur oxides, hydrocarbons, lead, and soot particles in these analyses. The increase in the number of vehicles with diesel engines has led to greater importance of nitrogen oxides, which has been emphasized by the transition to unleaded fuel. Research has also shown that nitrogen oxides, given the permissible values, are often closer to the limit or above it than is the case with carbon monoxide.

All the presented facts conditioned the adoption of carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO2), sulfur dioxide (SO2), hydrocarbons (CxHy), lead (Pb) and soot (CC) particles as relevant components of air pollution for the analyses within the framework of this study.

9.5.3. Impacts of relevant air pollutants

Basically, any analysis of the negative impact of air pollutants needs to take into consideration a wide range of findings related to this issue. The reason for this is simple – there is no agreement on the character of negative impacts – and this is the only possible way to obtain reliable findings about the unresolved issues in this area. In that sense, it is possible to systemize the findings that describe the character of these impacts, primarily with regard to humans, animals, plants and materials.

Having in mind the nature of the road which is the subject of this research as well as the character of the spatial units in its zone of impact, it was deemed necessary to define the impacts of individual air pollutants in more detail.

In the context of these facts, it is necessary to emphasize the fact that there is very little research conducted today that integrally considers the negative interactions of certain air pollutants. Existing experiences show that, in principle, these impacts are added up, but that increased impacts (synergy) are equally possible and that the neutralization of individual impacts is present.

9.5.3.1. Carbon monoxide

The main manifestation of the carbon monoxide impact on humans is primarily reflected through its binding to hemoglobin, thus eliminating oxygen and hindering its transport through the body.

The negative effects of carbon monoxide, which are manifested even at relatively low concentrations, are primarily the result of 240 times greater affinity for hemoglobin than that of oxygen. This usually results in disturbed balance, problems with vision, impaired concentration, difficulty breathing or headaches.

The general conclusion regarding this phenomenon is the already accepted fact that a CO concentration in hemoglobin of 2% can be considered insignificant while concentrations higher than 2.5% represent a critical value.

The effect of carbon monoxide on plants can be considered insignificant. This fact is deemed relevant in terms of the effect on construction materials.

The presented facts show that the issue of carbon monoxide is primarily expressed in the field of its effects on humans, and from that point of view, it makes sense to have it considered within the overall negative impacts.

9.5.3.2. Nitrogen oxides

The effect of nitrogen monoxide on humans is similar to that of carbon monoxide. It drives oxygen out of blood, which jeopardizes the nutrition of tissues. High concentrations of nitrogen monoxide in the blood cause death. The fact is that the concentrations of nitrogen monoxide in the atmosphere are hardly ever harmful, but as an air pollutant, it is important for the formation of nitrogen dioxide (NO2), which is more toxic and very harmful to the respiratory organs. The limit values that are legally prescribed are derived from the stated statements.

The impact of nitrogen oxides on vegetation is most dangerous in the event of nitrogen dioxide. Its presence makes leaves look waxen, causes their necrosis and premature defoliation. Given these impacts, the general view is that all plant species are protected from the negative effects of nitrogen oxides at long-term concentrations of 0.03 mg/m^3.

9.5.3.3. Hydrocarbons

The combustion process in a car engine results in the occurrence of numerous hydrocarbons. Specific analyses of their effects are primarily related to five groups (paraffins, naphthene, olefins and alkenes, aromatics, oxidized hydrocarbons). What characterizes their negative impact is certainly the fact that polycyclic aromatic hydrocarbons are attributed the carcinogenic effects. Today, the connection between the presence of hydrocarbons in the air and the occurrence of cancerous lung diseases has already been proven.

The effect of hydrocarbons on plants is quite complex and is reflected in a large number of disturbances. High concentrations cause necrosis of flowers and leaves, and the lower ones defoliation and difficulty in flowering.

Very sensitive plants react even at very low concentrations of hydrocarbons. The effect of hydrocarbons on building materials has not been reliably proven.

9.5.3.4. Sulfur dioxide

As regards the issue of sulfur dioxide as an air pollutant, it is necessary to emphasize that traffic appears only to a lesser extent as the cause of this phenomenon. Considering the effects of sulfur dioxide on humans, it is necessary to point out that, combined with fine dust, it has an extremely harmful effect on the mucous membrane (eyes) and the respiratory tract.

The impact of sulfur dioxide on the flora is significant and is reflected primarily in the decomposition of chlorophyll and death of certain tissues. Some species of evergreen forests proved very sensitive to sulfur dioxide suffering damage even at concentrations of 0.05 mg/m^3. Sulfur dioxide has the greatest negative impact on buildings out of all air pollutants.

In combination with moisture, sulfur dioxide reacts as sulfuric acid and thus has a destructive effect on organic matter. As these reactions can take place even at the lowest concentrations, it is certainly important to consider these phenomena in relation to the historical and artistic value of individual objects. All damages caused in this way deteriorate with the rise of temperature, humidity and intensity of light.

The functional dependencies that would connect these phenomena still do not exist, which is why it is difficult to evaluate the negative consequences.

9.5.3.5. Lead and its compounds

As regards the issue of lead and its compounds, it is clear today that humans take in much higher quantities of lead and its compounds through food than by inhaling them from the atmosphere. Permanent exposure to lead pollution leads to chronic poisoning, which primarily manifests itself in the form of loss of appetite, stomach/digestive problems, fatigue, dizziness, kidney damage and unconsciousness. However, the dilemma still lingers regarding the acceptable limits of lead concentration in the atmosphere. The result of these facts is the "temporary" character of the maximum permitted concentrations of lead in some countries. The toxicity of lead in vegetation is low. Lead concentrations in plants are highly correlated with the lead content in soil. The presence of lead in plants reduces their growth capacity and enzyme activity.

9.5.4. Standardized values

According to what was noted about the negative impacts of individual air pollutants, as well as the views on their possible combined impact on humans, plants, animals and materials, the adoption of legal norms that regulate this issue is of special importance.

Most of the global norms in this domain define the limit values of air pollutants in relation to plants and materials. From the aspect of cultivated plants, where the issue of air pollution in relation to plants is predominantly, foreign experiences from literary sources are presented. It is believed that all plant species are safe from nitrogen oxide concentrations of 0.02 mg/m^3 (long-term value) and 0.10 mg/m (short-term value).

As for sulfur dioxide, negative impact may be expected from the concentration of 0.6 mg/m^3, whereas especially sensitive plants require the limit value of 0.25 mg/m^3. The stated values refer to short-term concentrations.

9.5.5. Impacts in the construction phase

Execution of construction works by its nature is a significant source of air pollution due to the use of construction machinery that uses mainly fossil fuels. The movement of large earth masses during the construction of the road base (cut, fill) causes the lifting of large amounts of dust into the atmosphere, which can cause negative consequences for the population and vegetation. Operating the asphalt plant as well as laying the asphalt mass on the road lead to emissions of the easily volatile organic compounds (VOC), which in their composition have a significant percentage of polycyclic aromatic hydrocarbons (PAHs) the impact of which on the occurrence of carcinogenic diseases in the population has been confirmed.

In this particular case, the area where construction works are carried out is in part next to the populated places, i.e. villages, thus the negative effects of gases from exhaust systems of construction machinery, dust during earthworks and evaporation during the placement of asphalt mass can be expected. The plant for the production of asphalt mixtures is located outside the impact zone of the project.

9.5.6. Impacts in the operation phase

Regardless of all the views expressed on the difficulties related to the quantification of air pollution parameters as well as the lack of standardized procedures, at the current level of knowledge on this issue, data can be obtained that can usefully and with sufficient accuracy serve to draw conclusions about negative impacts.

It should be emphasized, however, that for the quantification of air pollution parameters as a consequence of road traffic, procedures of different levels of detail are available today, primarily as a function of the number of factors included in the analyses.

The decision on minor or major simplifications is primarily conditioned by the design phase. In all situations when air pollution analyses should serve as a basis for assessing adverse impacts, which is certainly the domain of this study, then their presentation must be such that it unequivocally indicates the essence of the problem. In this sense, relativization and unification of emissions, usually above the annual average value in mg/m^3, has shown as useful.

Having in mind all the presented facts related to air pollution indicators, influencing factors, possibilities of their quantification, specific conditions from the field of study research as well as the level of analysis defined by the planning and desi documentation phase, the calculation of air pollutant emissions was performed at average annual values as relevant and the values of the 95th percentile as an indicator of expected short-term concentrations.

9.5.6.1. Calculation methodology

The concentration of pollutants in the atmosphere can be determined by calculation, measurement and combination. The measurement is performed by sampling and air analysis a certain number of times a year (minimum 52 samples, but not on the same day during the week), and statistical processing (calculation of the average value and the 98th percentile). The calculation is done by applying a forecasting model.

There are a number of forecasting models, which can be classified into the following groups: (1) models based on differential diffusion equations with turbulent diffusion coefficients derived from atmospheric stability (determined on the basis of meteorological synoptic or climatological parameters), (2) models based on integral solutions of differential equations for certain configuration conditions and meteorological situations (atmospheric stability classes), (3) statistical models, etc. It is best to use some of the models calibrated by the measurement results.

The calculation of the concentration of pollutants in the atmosphere, for the purposes of this Study, was done using the program for the calculation of emission and concentration of pollutants near the roads "MLuS 02", which was calibrated in Germany. The program uses databases on a specific emission, depending on the type of vehicle (for the reference year), type of engine and fuel, as well as data on traffic flows and road characteristics.

As reliable and/or representative indicators of the state of air quality in the observed area were not available, the recommended values of the program were used as input values of the background concentration. For the sections on which the modeling was performed, the values of the highly polluted populated area (small town) were assumed. Given the assumed values of the specific emission of motor vehicles for 2008, this is considered a pessimistic scenario.

The following is an overview of other input parameters, which are taken from the relevant planning and study documentation prepared for the purpose of the project "Motorway on Corridor Vc":

- Road category: Motorway with a design speed of 120 km/h
- AADT: 12289 vehicles
- Percentage share of heavy-duty (cargo) vehicles: 9.6%
- Level line gradient: 0%
- Climatological data: Average wind speed 2 m/s and average relative humidity 80%.

9.5.6.2. Calculation and analysis results

In general, the obtained result shows that the impact of the future motorway on air quality is certainly not a limiting factor, but this issue should be given appropriate attention in accordance with the prescribed procedures. However, the following should also be noted:

Given that this is the section with the highest AADT, the above scenario can be considered a pessimistic picture of air quality in 2013 (the year of commissioning the motorway on Corridor Vc) on open sections of the motorway, further calculations have been deemed unnecessary.

It can be assumed that, in the short term, human protection standards could be exceeded for PM10 and NO2, but only in areas with high background pollution and in the immediate vicinity of the future motorway, especially close to tunnel portals. In such situations, individual residential buildings should certainly be protected by sound barriers that reduce the diffusion of emitted pollutants, and there should be vertical ventilation pipes in the tunnels.

It is possible that air quality limit values in order to protect ecosystems for NOx will be exceeded. However, this standard cannot be applied to areas in the immediate vicinity of the motorway.

9.6. Impact on soil and agricultural land

The road construction project on the LOT 1 section will significantly disrupt the existing environment that has been established, mostly thanks to the activity of humans over a long period of time.

9.6.1. Sources of damage and pollution

a) Damage to land

The areas of agricultural and other land that will be affected by the construction of the motorway can be divided into three levels:

The narrowest belt is considered to be up to 60 m wide (30 m on the left and right side of the road axis to the embankment or slope) will be fully "attacked" either by the very route of the motorway or by the facilities and machinery during its construction

A slightly wider belt is considered to be 200 m in diameter (100 m of the road axis on each side). Along with the previous one, this is considered to be the belt of direct impact of the motorway traffic, and is mostly owned by the state. During expropriation or purchase, a belt of this width is purchased. Basically, all protection measures apply to this belt.

The wide belt is considered to be 500 m in diameter (250 m of the road axis on each side, or 150 m in continuation of the previous one). This belt includes the land areas suffering direct damage of land and loss of soil; areas along the motorway under direct traffic impact on land, and land areas on which the traffic has an indirect impact (0 + 30 + 70 + 150 m of the road axis on each side).

b) Soil pollution

Since the major part of the LOT 1 motorway route passes through agricultural areas and land of high use-value, it will be necessary to take special soil protection measures and establish full control over the key traffic-generated pollutants.

The shorter the route and the larger the route section with viaducts and tunnels, the lesser the loss of soil through the change of use. From the agricultural standpoint, it is logical to request that deep fertile soils of this area be avoided as much as possible.

When selecting the route for the motorway, it is inevitable, of course, to first consider the basic purpose – the efficient traffic flow. This requirement is often in conflict with the requirement to reduce fragmentation of production lots. This is hard, yet not impossible to achieve. For example, in the part of the sector at the foot of the slope, the route should be directed, if possible, so go along the margin, thus avoiding the intersection of major production lots. In this way, at least three significant effects shall be achieved:

- more valuable soils are preserved from change of use
- fragmentation of land lots is prevented
- the route is elevated relative to the soils in the valleys and fields where air currents are more frequent
- less haze and number of foggy days on the motorway itself

The agro-ecosystem represents very complex relations between the agro – biotope – agricultural habitat (defined by soil and climate characteristics) and agricultural living community – agro – biocoenosis, the key members of which are agricultural plants and domestic animals. The fundamental regulatory role in these complex relations belongs to humans. Only a stable agro-ecosystem provides stable and high production of quality food. Any emission of harmful substances into agricultural soil calls into question its function. Traffic is a very important source of harmful emissions. As regards the basic significance of harmful emissions from traffic, they can be divided into four groups:

- emission of solid particles - dust
- emission of liquid matters
- emission of gases
- emission of snow-melting salt.

Solid particles are emitted from the motorway in the form of fine dust that is generally widely dispersed by the wind. The most important harmful substances emitted in the form of dust off the roads are lead and soot, and Oelischlager (1972) listed as many as 26 elements, including zinc, phosphorus, chromium, nickel, copper, molybdenum, arsenic, cadmium, and mercury. Lead is derived from exhaust gases, and cadmium from car tires. It is a significant component of dust and soot, to which various gaseous pollutants are adsorbed.

Distinction is made between coarse and fine dust. Coarse dust is usually deposited on plant leaves near the road, and fine dust dispersed by wind to more distant areas as suspended dust or aerosol. Deposition of dust on plants reduces the penetration of light and the intensity of photosynthesis. In addition, the deposition of dust on the back of the leaf prevents normal transpiration and causes physiological disorders. This results in reduced growth of the plant. According to research so far, soot emitted from car engines shows no harmful impact on plants.

Emission of liquid matters are all liquids dripping out of car engines: fuel (gas or diesel), motor oils, transmission and brake oil, windshield washing liquids and antifreeze coolant for the radiator. Some of these liquids contain heavy metals: lead, cadmium, copper, nickel, vanadium, and molybdenum. The total quantity of these substances depends primarily on the intensity of traffic, i.e. number of vehicles and the driving regime. Cold engines emit significantly larger quantities than warmed-up engines in the optimal operating regime.

The gaseous component of emission is a mixture of engine gas exhaust matters. These emissions contain some known, but also a significant number of hitherto unknown organic compounds, and fewer inorganic ones. The former include: carbon monoxide, carbon dioxide, ethylene, sulfur dioxide, and the latter include polycyclic aromatic hydrocarbons – PAHs and benzopyrenes.

Industrial salt is used to melt the snow on the road. As snow is a regular phenomenon on this road section, there is also a direct danger from salt for the agricultural soils. If contamination occurred, it would reflect in the form of destruction – peptization and formation of crust. In addition, chlorine would damage sensitive crops. Protective measures, which should be foreseen anyway, can protect the agro-ecosystem from the effects of salt with great certainty.

The problem of soil contamination with heavy metals, which are then washed into water or through the cultivated plants included in the animal and human food chain, is a current problem of modern ecology, and especially agroecology.

The biggest contamination does not have to occur and be in the immediate vicinity of the road (except of course the closest – marginal part), but lies a bit farther. This depends on the way the pollutants are dispersed and on the given local conditions.

9.6.2. Estimation of heavy metal concentration

Heavy metals and polycyclic aromatic hydrocarbons (PAHs) are the most dangerous pollutants from traffic that accumulate along the road. However, PAHs such as benzopyrene can be transformed into less hazardous components in a relatively short time, while heavy metals remain in the environment for a long time. In addition, upon their dispersion into environment, they can be carried by water and wind over long distances, accumulate in sediments and enter the human and animal food chain through plants. Water is especially at risk in sediment zones where heavy metals accumulate.

In the 1980s, a lot was done on research into soil pollution in narrow embankments along motorways, where leaded gasolines were a complicated environmental problem (Mander, 1983, 1985a, 1985b). Lately, more than 80% of vehicles have engines that burn unleaded fuel. In comparison with the eighties, the traffic intensity has increased by 50%, and even up to several times in urban areas and city outskirts. The level of traffic pollutants in soil around the motorway routes continues to be a major problem. Sources of water pollutants most often originate in the area of flanks and embankments along the road. The situation is similar in marginal agricultural areas. This should be kept in mind when taking measures to protect, maintain or rehabilitate sites where the level of pollution is high. Although a number of heavy metals can be found in nature, lead (Pb), cadmium (Cd) and zinc (Zn) are the most common ones that accumulate along the roads.

Thanks to the widespread use of unleaded gasoline, the lead pollution is considerably reduced. Unlike lead, cadmium (Cd) comes mainly from diesel fuel, and the level of its pollution is at the same level as in the past or shows a declining trend. Zinc (Zn) is ten times less dangerous to living organisms than lead and cadmium; it originates in car tires and gets spread with the dust along roads. Surely, zinc can accumulate over time and its concentration in soil can reach a critical level. Metals differ from each other based on their solubility and mobility in soil. Compared to lead and zinc, cadmium has the highest level of mobility in the soil. The acidic reaction increases the ability to move in heavy metals. At pH reaction below 4, the leaching of heavy metals is twice as high as at neutral reaction (pH 6.0-7.5; Dierkes and Geiger, 1999). Unlike other metals, cadmium can be leached even at the alkaline soil reaction, up to pH 8.5. Given the acidic sulfate deposition that is mostly emitted by diesel cars, as well as nitrogen gas emissions, the roads and marginal areas along the roads (grassy flanks and embankments) always have the acidic environment.

Many studies have also shown that the addition of salts to prevent the formation of ice on the roads (especially NaCl and KCl) can significantly accelerate the leaching of heavy metals (Norrstrom and Jacks, 1998). Consequently, there is an increased possibility of leaching the heavy metals from the flanks and embankments along the road. The use of reinforced concrete to build bridges, viaducts and tunnels can, during construction, result in increased leaching of cadmium. Although no research on leaching of heavy metals off roads and their transport into the watercourses, groundwater or accumulations have been conducted in BiH, some research suggests that this factor may play a significant role in the accumulation of heavy metals in river sediments (Sults, 1997).

The indicators of environmental traffic impact assessment are given through the example of the presence of average content of heavy metals in the soil (mg kg-1) of the flank and embankment along the road, in a 3 m wide zone, as per research of Mander 1983, 1985b, (Table T.5.6-01).

Table: Estimated average concentration of heavy metals (mg kg-1 yr1) in soil (of the flank or embankments) of the road at the width of up to 3 m from asphalt

Traffic intensity vehicles/day	Pb	Cd	Zn
<1000	<40	<4	<50
1000 – 2000	40-80	4-6	50-80
2001 – 3000	80-120	6-9	80-110
3001 – 4000	120-150	9-12	110-130
4001 – 5000	150-170	12-15	130-150
>5000	>170	>15	>150

The estimated quantities of heavy metals for LOT 1 by sections are shown in Table 6, based on the following calculation:

MHM=2*w*L*d*BD*(CHM (0-20)+CHM (20-50)*HM/1000

where:

MHM = estimated quantity of heavy metals in the upper layer (50 cm of flank or embankment in kg),

w = width of the belt (flank or embankment from asphalt, 3 m),

L = length of the belt along the motorway in m,

d = depth of embankment, 0.5 m

BD = bulk density 1.6 g cm-3,

CHM (0-20) = average concentration of each heavy metal in the surface layer (0-20 cm) of the flank or embankment interpolated from the previous table (Table 5) (if, for example, the average traffic intensity on the section is 4700 vehicles per day, the interpolated values of Pb, Cd and Zn are 165.14 and 145 mg/ kg-1),

CHM (20-50) = average concentration of each heavy metal in deeper layers (20-50) of the flank or embankment, estimated as 20% of the quantity in the surface layer,

HM = leaching factor (0.33, 0.2, 0.33) for Pb, Cd and Zn,

2 = both sides of the road (2x3m),

1000 = factor of transformation from g into kg, or from kg into tons.

As an example, the calculation of the average concentration of heavy metals (Pb, Cd and Zn) in the 3-meter belt off the road margin (flank or embankment belt) was performed, and the traffic intensity was taken from the Study "Final Report Prefeasibility Study-Lot 5" for 2015.

Table 6 shows the estimated accumulation of the three major heavy metals in the 3 m wide belt off the asphalt on each side of the road, by sections and for the total length of the route, and where it is necessary to plan measures for protection and remediation of surfaces.

Total quantities of Pb, Cd and Zn in the treated zone along the entire length of the route are 9.44, 5.69, and 9.44 tons. This surely is a rough estimate, but it indicates the potential danger of contamination of the motorway margin areas. A conflict is very likely to ensue unless comprehensive protection measures are taken for margin areas used for agricultural production.

However, it should be emphasized that the availability of heavy metals for the plant depends on the condition of the soil, and especially the pH reactions, and the intervention of changing the pH reaction of the soil can prevent heavy metals from entering the food chain. Table T.5.6-04. gives an example of the maximum permissible content of heavy metals and other potential harmful substances, harmonized with the countries of the Alpes - Adria Regional Association, which our country should join, as the first step in other integrations.

Table: Maximum permissible content of heavy metals in agricultural soil (in mg/kg of soil) extracted in aqua regia*

Element	Texturally light soils , skeletal soils or soils poor in humus	Texturally heavier soils and soils rich in humus
Cadmium (Cd)	1	2
Mercury (Hg)	1	2
Lead (Pb)	100	150
Molybdenum (Mo)	10	15
Arsenic (As)	20	30
Cobalt (Co)	50	50
Nickel (Ni)**	50	60
Copper (Cu)**	60	100
Chromium (Cr)**	60	100
Zinc (Zn)	200	300
(PAHs)***	2	2

* In carbonate soils with over 2% of CaCO3, content can be higher by 25%
** Values pertain only to the soil of arable fields, gardens, meadows and pastures
*** PAHs – Polycyclic aromatic hydrocarbons

9.6.3. Impact in the construction phase

Soil as an important component of the environment and a medium for many biological and human activities, including agriculture will be under significant pressure from various external factors during the construction of the Corridor.

Particularly sensitive areas will be in marshy parts of the terrain, along watercourses and across slopes. In addition to direct soil damage through the construction of the Corridor route itself, indirect damage during construction may be significant unless the necessary preventive protection measures are taken. Damages can be not only for the environment, but also for the farmers as well as the Investor, since the Investor will have to compensate the farmers for incidental damages. The loss of fertile agricultural land affected by the Corridor route can also have an economic and social impact on the local population. Haphazard and unnecessary movement of machinery on agricultural land can lead to compaction of the soil and reduction in its productivity.

The problem that will be most pronounced during construction is the occurrence of erosion and landslides. The removal of vegetation (forest, thicket, grass) on a slope will provoke erosion and potential landslides, which should be anticipated within the preventive measures. Furthermore, erosions have a cumulative impact, not only on the construction of the road route but also on the physical damage to the slopes by rills and gullies, pooling of surface waters, and downstream accumulations.

By cutting the slope without first addressing the drainage runoff, water flows can cause landslides. This is especially present on soils that have developed on impermeable substrates such as shales, marly substrates, clays and the like. The moving material destroys vegetation and triggers instability of the slope. Large amounts of material have to be taken to another location and disposed of, which in turn causes further consequences for the environment. This can also have major financial implications for the investment.

These potential impacts on the soil can be expected especially in the hilly part of the relief which is characteristic for the section Doboj South - Karuše.

Other impacts on the soil are characteristic for the construction of infrastructure facilities and the motorway route itself, whereby a permanent loss of quality agricultural land occurs. Access to agricultural lots, buildings and houses on certain parts of the route, especially in the valley of the Bosna River from one side of the Corridor to the other, will be significantly difficult during construction. In addition to erosion, the construction also involves waterlogging, construction material debris, construction of temporary warehouses, chainage sites, machinery parks, asphalt plants, etc.

Some localities will be affected in a wide zone, especially at the sites of construction of intersections, toll booths, flanks and side slopes, structures for drainage of rainwater off the road, water purifiers and leachate drainage networks, rest areas, parking lots, gas stations, road maintenance facilities, etc.

The impact will also be significant on the construction sites of bridges, viaducts, and crossings for the local population. Watercourses will have to be diverted and new land surfaces occupied, which should be restored to their original state upon the completion of works.

During construction, unsuitable construction material accumulates and gets deposited on the land surfaces, or wastewater from kitchens and lavatory facilities becomes a construction site runoff.

Accidents in terms of oil and grease spills from construction machinery and improper handling of equipment can be expected, and adequate measures should be planned for the protection and rehabilitation of these localities.

Since during the preparation of this Study the solutions of the Preliminary Design of the facilities in the area of the motorway route were not available, the assessment of their impact on the soil during the construction phase is given in general. Therefore, during the design and construction of the route, acceptable principles and practices of soil protection should be used and legislation on soil protection should be applied. An overview of protection measures is given in point 6.3.4.1.

9.6.4. Impact in the operation phase

During the use of the motorway, emissions of harmful substances will constantly occur on the road, which will be transported to the ground via rainwater in the motorway belt, and beyond depending on the hydrological regime. Rainwater will mix with waste materials of gasoline, oil, motor oil, coolants, cleaning liquid, tire residues (asphalt, bitumen) as well as with fuel combustion by-products (lead, lead compounds, incombustible carbons, nitrogen oxides, soot, tar, etc.). All these pollutants, via water, can get into the soil and cause its contamination.

Incidents, primarily caused by traffic accidents, may further aggravate the situation, particularly in case of environmentally hazardous substance spillages. It is not only the soil in this chain that will suffer damage since, via soil, the groundwater and surface water will get polluted as well, which will further affect the entire chain of plant and animal world. The degree of damage greatly depends on the hydrological regime and seasonal variation. The growing season and patterns of dry spells with lower water levels can undeniably cause greater damage. Given the projected annual average daily traffic of about 20 000 vehicles, the load and pressure on the ground along the motorway will be high. Soil protection also means the most direct protection of water sources for public water supply in the cities of Modriča, Vukosavlje, Doboj and Doboj-South. south. The sources that will be most exposed to the motorway operation impact are in the water supply system of Odžak, Osječani and the municipality of Usora. A wider range of impact and adverse impact can be anticipated at motorway intersections, entry and exit points, and at the sites of infrastructure and service facilities along the motorway route.

9.7. Impact on flora

9.7.1. Impacts in the construction phase

In addition to areas that will permanently be used for the needs of road, additional zones will be occupied for the needs of the construction site. During the works, harmful substances will be emitted into the air, which will settle on the vegetation cover, and there will also be the discharge of certain wastewater that can indirectly affect the flora of the area. These impacts should be observed and minimized through the Construction Site Environmental Management Plan once the project dynamics and realization are fully known and defined.

At this level of analysis, the procedure of quantification of impacts on flora is possible only through the definition of areas with a total loss of vegetation, areas with altered vegetation and areas with autochthonous vegetation under certain impacts.

Areas within the road base that, after the construction, are to be under the process of landscaping the road belt (embankment slopes, channels), as well as the areas that were expropriated for the needs of road construction shall be areas with altered vegetation, and they are under the biggest negative impact of the road.

On the section Doboj South - Karuše, about 50 ha of beech forest (Fagetum montanum) will be felled, while the impact of the planned tunnel on the flora shall not occur except in the portal zone. A detailed analysis of the amount of felled trees as well as permanently damaged zones will be addressed in the Environmental Protection Design documentation. All data on deforestation needs are defined on the basis of data from the literature and orthophoto, and in the next phase of implementation a more detailed analysis must be conducted to obtain more accurate data.

9.7.2. Impacts in the operation phase

Based on the analyzed impacts in the field of air pollution, water and soil pollution and land expropriation, it is possible to draw conclusions with regard to potential impacts on the flora of the area through which the route of the planned motorway passes.

The facts presented within the current state show that, given the local conditions and the floristic diversity of the area, limited impacts are to be expected. This is based on the findings that the area interesting for the analysis is not characterized by high ecosystem potentials, and no specific habitats of rare and protected species have been identified in the analyzed area.

The impact of air pollution on the most sensitive species is spatially limited to a narrow strip along the motorway itself, since these are concentrations that reach the limit values, given the possible negative impacts, at distances of up to 50 meters from the road margin for a majority of components. This is a consequence, as concluded in the chapter on air pollution, of traffic volume and conditions for the transmission of pollutants on motorways without marginal construction.

The impacts of soil pollution on the flora of the motorway area are also spatially limited along the motorway margin and in drainage channels. What has already been stated under impacts on soil should should be mentioned again, that is, that due to the emission of certain substances, a change in the pH value of the surrounding soil can occur and thus significantly disrupt the existing vegetation. Certain impacts, in the immediate area along the motorway, can be expected through the effects of soil salinization as a consequence of the winter road maintenance.

The largest impacts on the flora within the considered area are certainly expressed in the already analyzed effect of land expropriation. This impact is expressed along the entire route because these are mostly arable areas.

As regards the identified areas under vegetation that has certain quality, which are defined in the chapter on the characteristics of the existing state, it is necessary to emphasize that the analyzed route minimally interferes with these ecosystems.

9.8. Impact on fauna

The need to research all negative impacts that are a consequence of construction of the planned motorway section also requires research into potential negative impacts on fauna. These impacts are a consequence of some already quantified criteria (noise, air pollution, water and soil pollution, land expropriation, accessibility etc.) that reflect their impact on existing habitats, but they are also a consequence of some specific criteria inherent to fauna of a particular area. These impacts are primarily expressed through the phenomena of intersection of traditional (established) roads that represent the formed network characteristic of each area as well as possible animal accidents that are inevitable in such cases.

9.8.1. Impacts during the execution of works

The works on the construction of the project in question, will cause disturbance of animals as well as sudden changes in the established course of their movement. Habitats located in the forest area will especially be endangered by construction works, primarily by vibrations and noise. In addition, air pollution will also have an impact on fauna, but not a significant one. A special problem will be sudden disruptions of migration routes since construction sites will represent an obstacle that shows up "without alert", but they will also be temporary in character. It should be noted here that, per existing literature, there are no protected or particularly endangered species.

If the works are carried out while the birds are brooding, then due to deforestation, the existing number of birds can be extremely affected as well as the permanent loss of their habitats. Therefore, it is necessary to design the works in such a way that deforestation is carried out in the winter when these impacts will be minimized.

Also in the construction phase, a significant impact on the Bosna River fauna is anticipated, since there will be watercourse regulations in certain zones, as well as the presence of construction sites at the locations of bridge structures construction. In addition to the above, the accidental situations should be mentioned, which can often have permanent and irreparable consequences.

9.8.2. Impacts during operation

Field research, which included the area of the planned motorway and which was conducted in terms of defining potential negative impacts on the fauna, showed that no prominent negative impacts are to be expected in most parts of this area during operation.

A particularly important factor that needs to be pointed out is that the spatial and operational elements of the planned road contribute to potential negative impacts because this is the road with a relatively big traffic volume and a large width of the road base with a guardrail that significantly affects the spatial division.

There are a number of structures with a directional alignment in the form of bridges, pipe and box culverts. The fact is that majority of species use the riparian belt along watercourses when migrating. For the subject area, there is no data on the established paths of movement of animals that could be the basis for the formation of special structures for their movement. It is the Investors' obligation, upon the registered data on migratory movements of animals in the subject area, to build special structures for the movement of animals in the form of passages, i.e. crossings, which should be developed through Designs of special structures for the crossing of animals.

An impact of the planned road on the aquatic fauna during operation should be considered an impact without especially prominent negative effects given the quality characteristics of the Bosna River watercourse.

An analysis of the existing situation established that no rare and protected species have their habitats in the wider area, thus no negative impacts should be expected during operation. Taking into account the spatial position of existing habitats and the spatial position of the subject route, it can be concluded that no special negative impacts should be expected.

9.9. Impact on landscape

The issue of visual pollution as a criterion of the relationship between the motorway and the environment has been relevant since the moment it became clear that the landscape visual characteristics are a qualitative factor that significantly contributes to the quality of design solution or they appear as an element of degradation of usual and established relation.

All research in this field is significantly related to the phase of design documentation creation, because the possibility of quantification of certain indicators that characterize the issue of visual pollution depends greatly on the level of information. In order to make a transition from descriptive assessment of impact in this field to quantitative methods that include a complex valorization of the area, it is necessary to conduct a series of specific analytical procedures, which require graphic and visual information at a high-tech level.

9.9.1. Impacts during the execution of works

The construction of the motorway, due to its temporary character, will have no significant consequences for the area.

9.9.2. Impacts during operation

As for the specific research, all information is consistent with the basic scale, R = 1:25000, since the bases in this scale served to valorize the basic relations, which significantly predetermined all possible quantification procedures, and thus the level of accuracy of the obtained indicators. Given the previous remarks, the issue of visual pollution is examined at two basic levels. The first level implies the issue of spatial relations of the route itself and elements of homogeneity of its projections included through the concept of the so-called geometric design, and the second level implies the relation of the route, as a structure, and the space viewed in terms of defining the impact on the landscape.

9.9.2.1. Geometric design of the route

The concept of geometric design implies the process of harmonious composition of design elements with the basic goal of achieving a spatial image of the road that in a visual sense leaves positive impressions and gives drivers a sense of security. Since the driver's line of sight includes several geometric shapes at the same time, which together define the spatial flow of the route, it is necessary to take consideration the optical properties of each design element. Harmonious relations are achieved only with harmonized elements of the road route in the layout plan, longitudinal and cross-section profiles.

Quantification of relations in the field of geometric design at this level has been done using the information from the Preliminary Design. The analysis of the applied layout and leveling plan elements, as well as their interrelationship, has led to the conclusion that the homogeneity criteria were mostly satisfied. Deficiencies in the field of spatial design are present only in places of the forced spatial planning of the motorway route in the zone of Doboj, which resulted from the need to comply with the local spatial plans.

9.9.2.2. Landscape characteristics

For the quantification of relations between the road structure and the landscape, the methodology of disaggregation into individual components (morphology, vegetation, surface waters, facilities and general appearance) was applied. These components do not have the same characteristics as the characteristics of the area through which the construction of the motorway is planned, but a certain potentials are present, which require the adequate analysis. In fact, new architecture will be created. Many surfaces will be exposed to erosion. Facilities constructed for the protection of soil, agriculture, and collection and treatment of wastewater should not be left unattended.

The zone of altered landscape characteristics can be defined on the basis of the medical threshold of visibility, by adopting the relevant viewing angle of 10 degrees as a measure for perceiving the maximum height difference in the alignment profile to the terrain line. This relationship implies that the width of the zone of potentially endangered landscape is 600 H (X is the maximum height difference in the cross-section profile).

Based on the spatial relations of the planned motorway route (maximum height of fills and cuts), it is possible to say that the maximum width of this zone is about 2000 through 10000 meters. Therefore, the largest deleveling in the cross-section profile would be visible even from a distance of 10 kilometers. Based on the above, it can be concluded that in specific conditions, high embankments in the zone of the Bosna River Bosna have dominant features, as well as some facilities.

As the change in morphological characteristics is considered as a dominant change in landscape, the quantification of this indicator was performed by calculating the coefficient of "disturbance" of the landscape, defined as:

O – coefficient of "disturbance" of the landscape

P – "landscape profile" of the road

dp – distance of the profile

K – landscape endangerment in function from the class and terrain category

Based on the obtained data, it is possible to get quantified indicators on the impacts of the planned motorway on the landscape. The coefficient of "disturbance" of the landscape for individual sections is between 3480 and 4850, which can be considered a significant impact. This result is a direct consequence of the high embankments along the valley of the Bosna River. The presented data show that in the morphological sense the route of the planned motorway will burden the landscape and that certain protection measures must be taken in that regard.

The impact of the planned motorway on landscape characteristics in terms of vegetation can be assessed on the basis of the elements presented in the chapter related to forest characteristics. All the elements that could have been collected so far do not provide a sufficient basis for quantification according to this parameter.

The impact of surface water on landscape elements is also significant, primarily due to the fact that the route for the most part is in an almost direct contact with the riverbed of the Bosna River. Construction of the planned motorway could cause the visual characteristics that encompass this landscape element to become considerably degraded. This is especially related to the possibility of interrupting the visual contact of the surrounding settlements with the watercourse of the Bosna River. The construction of the planned motorway shall also create conditions for positive effects, which are contained in the fact that it shall give to the traffic participants some new views on the interesting landscape characteristics in the Bosna River zone.

As regards the facilities planned for construction along the analyzed road, there are no significant ones that would visually enrich the existing landscape characteristics, apart from the positive visual characteristics to be expected in relation to bridge constructions over the Bosna River.

As a special parameter of landscape quantification, it is necessary to define its general appearance. For the procedures of such quantification, given the great importance of subjective assessments, the primary definition of interesting landscape units was done, followed by their quantification. The assessment of the landscape characteristics within the scope of current state did not point out the presence of significant potentials, since they are mainly cultural ecosystems.

The final views regarding the impact of the planned road on the landscape characteristics of the spatial unit that includes the subject route can be systematized within the fact that negative impacts can be expected due to the need to build high embankments in the valley of the Bosna River. Reduction of these negative impacts can be done if adequate vegetation is used for landscaping purposes.

9.10. Impact on protected areas of nature and cultural-historical heritage

9.10.1. Impacts during the execution of works

Determining the impact of the planned motorway in the field of natural and cultural heritage implies, in fact, the potential impacts related to protected natural and cultural goods or facilities of natural and cultural heritage that are not categorized as such but deserve special protection measures. Within the analysis of the current state, it was determined that there are no specially protected parts of nature that can be exposed to negative impacts.

In terms of impact on historical heritage, considering that 12 buildings from the category of cultural heritage are within the research area, as well as the spatial position of these buildings, no particularly negative direct impacts are expected if the construction site is properly organized. Given the potential zone of indirect impacts, due to changes in the groundwater regime, air pollution and vibrations, the occurrence of negative impacts on monuments that are located in the wider area is possible.

There are also five archaeological protected zones in the subject area, with the route passing through two: from km3 8.5 to km 43 in the area of Kožuh, and from km 61 to km 62 in the area of Alibegovci. Considering the above, it is necessary to define special measures for the protection of archaeological sites.

Regardless of the already mentioned zones and potential places of impact on the cultural and historical heritage in the analyzed area, it is possible to find archaeological remains that had not yet been registered during the earthworks in the road construction phase. Should archaeological remains be discovered, it is necessary to inform the competent Institute for the Protection of Cultural Monuments, and take all measures to preserve the discovered archaeological remains, which are specified in the chapter on protection measures.

9.10.2. Impacts during operation

Owing to the road construction, a linear obstacle will appear, which can visually disturb the existing environment and negatively affect the cultural and historical sites. However, despite that, if traffic signs with information about the local cultural and historical heritage are placed along the road, the level of awareness will be raised, which will certainly have positive effects on these potentials.

9.11. Impact on forests and hunting

The adopted route will inevitably cause physical separation of the populations of the mentioned species, i.e. it will restrict the free migration of game. In addition to this, the future route will certainly cause damage due to traffic, pollution and disturbance, and will make it more difficult and in some parts limit the possibility of performing any work in breeding, protection and use of game, i.e. the hunting economy. This is especially apparent in the area of the initial part that is characterized by lowland and hilly areas, which are the best habitats for living and breeding of small game, and the slopes of hilly and mountainous areas, which are inhabited by large game.

9.11.1. Impacts during construction

After crossing the Bosna River in Rudanka, the route encroaches upon forest area, first the beech forest, and then under the sessile oak and common hornbeam forest. In this part, the route intersects forest habitats and affects the way these forests are grown and exploited. Two tunnels with a total length of about 2 km are present on this section.

During the works, occasional impacts on the surrounding hunting area will occur on the subject route, however, these impacts are of temporary and local character and will not significantly affect this aspect of the environment.

9.11.2. Impacts during operation

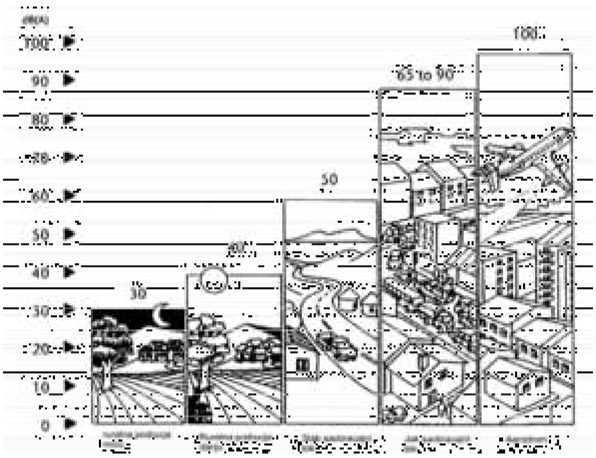
On this section, the route passes along the Bosna River and directly occupies the belt important for living and reproduction of shorebirds, as well as for hunting (difficult organization of and almost disabling any shooting on this stretch as it could jeopardize traffic).

9.12. Impact of noise

One of the most important impacts caused by traffic is exposing the humans who live in the settlements close to the route to traffic noise. Research carried out in the European Community reveals that a large part of the population feels uncomfortable due to the noise caused by road traffic.

The unit for measuring the noise level is decibel (dB), and is based on the logarithm. In practical terms this means that a doubling of source intensity (e.g. doubled traffic volume) will increase noise by +3 dB. Conversely, from the receptor's point of view, a subjective impression of the doubling of the traffic volume will mean the noise increase by about +10 dB. In general, changes lower than 1 dB are not considered as significant.

The issue of the impact of noise caused by traffic, taking place on the road, is generally solved by the measures incorporated in the phases of road design, construction and operation. These measures apply not only to the road but also to the urban planning of the road areas.



Since human beings are sensitive to sounds, which depends on the frequency thereof, a convention is in place to use the frequency tuning curve (curve A) to obtain the measure of noise level that is independent of frequency (expressed as dB(A)).

Examples of noise levels of common environmental sounds are:

- ambulance siren at a distance of three meters 140 dB(A)
- plane take-off at a distance of 100 meters 110 - 120 dB(A)
- air hammer 90 - 110 dB(A)
- crowded restaurant (inside) 65 - 75 dB(A)
- office with many employees (inside) 60 - 65 dB(A)
- normal conversation 40 - 60 dB(A)
- quiet living room 30 - 40 dB(A)
- quiet bedroom at night 20 - 30 dB(A)
- quiet garden 30 dB(A)

9.12.1. Sources of noise on the motorway

Road noise has four main sources: (a) motor vehicles; (b) friction between vehicles and the road surface; (c) drivers' behavior; and (d) construction and maintenance activity. Vehicle noise comes from the engine, transmission, exhaust, and suspension system, and is greatest during acceleration, on upgrades, during engine braking, on poorly maintained roads, and in "stop and go" traffic conditions. Poor vehicle maintenance contributes to increased emissions of road noise. Road noise is caused by friction at the contact point of road and tires of the motor vehicle and contributes to the overall level of traffic noise. The level depends on the type and condition of tires and road surface. Frictional noise is generally greatest at high speeds and during quick braking. Drivers' behavior contributes to the increased noise when using their vehicles' horns, by playing loud music, and as a result of sudden starting or braking. Construction and maintenance generally require the use of heavy machinery during operation work, which contributes to increasing noise levels on the construction site.

The most important noise propagation factors are:

- Type of source (point or line)
- Distance from source
- Atmospheric absorption
- Wind
- Temperature and temperature gradient
- Obstacles, such as barriers or buildings
- Soil absorption
- Reflection
- Humidity
- Precipitation

To obtain representative measurement results, these factors must be taken into consideration. The provisions often specify the conditions for each of these factors.

9.12.2. Noise impacts

Noise generated on roads affects the environment through which the road passes and contributes to degradation of the quality of life and to disruption of wildlife. The quality of life decreases by exposure to noise both psychologically and physiologically. Chronic exposure to noise can cause nausea, create communication problems and lead to increased stress as well as related health effects. Noise can lead to temporary and permanent lessening of hearing ability, sleep disorders, and can even contribute to learning problems in children. Vibrations induced by the resonance of traffic noise can have a detrimental effect on structures near the road. This is very important in the case of cultural-historical facilities that had not been designed to withstand such impacts. Wildlife disturbance is caused occurs due to the fear of animals to cross the road on which the traffic takes place. As a result, roads become barriers to regular migrations of wildlife from one area to the other.

9.12.3. Current and future noise impact at the existing road network

If the daily traffic volume ranges from 4.000 to 20.000 vehicles in 2013, the impact of traffic noise in settlements along the existing road networks (sections of roads M5 and M17) can be seen as quite uneven, and on certain sections as high. Endangered residential facilities are located along the roads M5 and M17 on almost 60% of the length of the road section, especially in settlements located directly along the motorway. The existing road touches on or passes through settlements. The construction of the motorway on Lot 1 will lead to redistribution of traffic elements from the existing network to the new network and cause reduction of noise levels in populated areas along the network route without investments.

Construction of the motorway will be beneficial when it comes to noise situation on most of existing sections. With projected traffic volume increase of 62% by 2013, the current noise levels will increase by about +2.0 dB(A) without the motorway construction.

The impact of future traffic growth will result in a dual effect. On the one hand, the local roads will be relieved, hence the reduction in traffic noise levels, and on the other hand, an increase in noise levels due to the operation of the motorway.

With the projected increase in traffic volume, it will be necessary to improve mitigation measures. This will also depend on the actual traffic growth rate. Assuming no progress is made in reducing road or vehicle noise, the calculated noise level for 2013 will increase between 1.3 dB(A) and 6dB(A) in 2042. The need for additional noise protection measures, besides the planned ones, will be defined on the basis of noise level monitoring data during the operation of the motorway.

Upon completion of the motorway, predictions are that the traffic volume on the existing roads will be reduced by about 400% compared to the current ones on some sections, which means a reduction in noise levels by -6.0 dB(A).

9.12.4. Environmental standards for noise impact levels

To date, standards for noise levels have not been specified by the Government of Bosnia and Herzegovina. Therefore, the standards to be applied for the motorway Lot 1 have been set by the Sarajevo Canton. The relevant legislation being applied is the Law on Noie and Air Quality, Official

Gazette of Sarajevo Canton, no. 95/99, 28 May 1999, as in Table T.5.12-02.

Table: Permitted levels of external noise according to BiH regulations

Zone	Zone function	External noise standard in dB(A)		
		Daytime	Night-time	Peak time
I	Hospitals	45	40	60
II	Tourist and recreational area	50	40	65
III	Residential and educational areas only	55	45	70
IV	Mixed residential and commercial areas near the road	60	50	75
V	Mainly economic, administrative, business and trade centers, public facilities	65	60	80
VI	Industrial zone, warehouses, road network with no population	70	70	85

Since rural settlements along the route are of a mixed character, both residential and commercial use, hereinafter the zone IV category shall be used for settlements along the motorway. Thus in this Study, the noise standards being used for evaluation of noise impact are 60 dB(A) during the day, and 50 dB(A) during the night. In cases where the facility or facilities belong to groups I, II or III, the permissible noise level has been determined for the corresponding zone category.

The applied standards of 60/50 dB(A) can be compared to those applied according to the WHO (World Health Organization) regulations and the regulations of the EC Countries.

9.12.5. Noise impact without noise protection measures

Motorway traffic will cause noise emissions at a very high level, given the anticipated AADT. The noise level at night will exceed the standard value of 50 dB(A) in the vicinity of motorway. Hence the noise will have a negative impact on settlements located along the planned route.

The "SoundPLAN" Noise Modelling Software (Version 6.1), a standard software program used in Germany and other countries of EC, was used to model noise emissions in the affected areas. The basic conditions used are as follows:

- Projection of the traffic volume for the bypass in 2013 according to the data specified in the Traffic Study-Final Report, given in Chapter 4 of this study.
- Specifications of the motorway are taken from the Conceptual Design (for example, motorway cross-section profile, design speed, etc.).
- As for the pavement, asphalt concrete will be used.
- Calculation method is taken from the "Guidelines for Traffic Noise Abatement" – RLS 90 issued by the German Ministry of Transport (1990).
- Settlement drawings were collected from several sources: e.g. topographic maps and satellite imagery from 2005.

For the assessment of anticipated noise impact, noise levels at night-time were used as criteria since the noise standard at night is more restrictive than the daytime noise level standard. Contour lines of noise at night-time are shown on noise maps. Results show the impact of noise on facilities located close to the motorway. Noise maps show two scenarios. The first one shows a noise map for a situation without protection measures, and the other a situation with protection measures.

The noise map without protection measures determined the possible length of the protective acoustic panel in populated areas that are affected by noise because the noise level is higher than the noise standard during the night. The noise map without protection measures was obtained on the basis of calculation that analyzes the situation with the motorway construction in 2D.

Motorway characteristics include defining diurnal and nocturnal periods and the standard used to calculate noise levels. AADT was taken from the Traffic Study and so were the ratio of daytime and night-time traffic and the participation percentage of heavy vehicles in the traffic flow. The motorway profile has been defined in the Preliminary Design. A detailed calculation of the noise level and protection measures for LOT 1 will be made on the basis of the Preliminary Design of Lot 1 in the Preliminary Design of Noise Protection.

9.13. Impact of vibrations

Vibrations are also one of the criteria that characterizes the relationship between the motorway and the environment, and they are the result of oscillatory movements of vehicles participating in traffic flow. Given the limitations in terms of its spatial impact, the significance of this criterion is lesser in comparison with noise and air pollution, but in certain situations it may be a relevant fact in terms of negative impacts. Taking into consideration those facts, the issue of vibration has been paid due attention in terms of quantification of relevant indicators and assessments of potential negative consequences.

Vehicle oscillations that result from movement across uneven road surfaces cause the phenomenon of vertical dynamic reactions on the contact area between tires and road surface, thus generating vibrations in the ground that move upwards in the form of surface waves and trigger negative consequences for humans and facilities. The generated vibrations are basically a result of the vibration of three main systems that can be described as:

- The vehicle system as a whole, with a frequency range from 1 to 10 Hz, depending on the type of vehicle,
- The system of elastically suspended masses (wheels, axles, etc.) with their own frequencies ranging from 10 to 20 Hz,
- The system of individual structural frames oscillating at much higher frequencies.

The basic nature of vibrations generated by road traffic is in vibrations caused by the oscillatory movement of the vehicle as a whole.

The negative effects of vibrations on buildings are reflected primarily in the fatigue of materials, which leads to their shorter life-span. The effects of vibrations on humans are reflected in the direct mechanical impacts of variable acceleration on the moving parts of the human body, as well as in the secondary biological and psychological effects due to irritation of and damage to the nerve receptors.

Normalized values

Each analysis of the issue of traffic-induced vibrations must find its final interpretation within the existing legislation which defines the maximum permissible levels of particular indicators. The issue of traffic-induced vibrations is at present regulated by general legislation in the field of vibrations and their impact on humans and buildings.

As there is no verified national legislation in this field, the use of the international standards ISO 2631 and DIN 4150 is common for the purpose of analysis. Standard 2631 is probably the most acceptable document currently in effect that deals with the general issue of vibrations.

The standard that in terms of objective evaluation provides the possibility of valorization of the impacts of traffic-induced vibrations on buildings and humans is DIN 4150. This standard defines the curves of the permissible levels of vibrations (acceleration, velocity, and movement). The specificity of this standard is that it covers a wide range of vibration sources, including traffic-induced vibrations. Given the nature of this research and the requirements to assess the impact on humans and buildings, the limit values defined by DIN 4150 standard, and given in Table, were taken as the basis for valorization.

Table: VC values – parameters according to DIN 4150

Area function	Period	VC - values	
		Steady vibrations	Infrequent vibrations
Strictly residential, general residential, holiday homes, low-rise buildings	day	0.2 (0.15)	4
	night	0.15 (0.1)	0.15
rural area, mixed area, central zones	day	0.30 (0.2)	8
	night	0.20	0.20
Commercial zones (including offices)	day	0.40	12
	night	0.3	0.3
Industrial zones	day	0.6	12
	night	0.4	0.4
Other special-purpose areas	day	0.1 to 0.6	4 - 12
	night	0.1 to 0.4	0.15 - 0.4

The conclusion on the impact of traffic-induced vibrations on humans and building will be made taking into consideration the previously defined limit values and indicators that will be calculated for the characteristic cross-sections and in line with specific location conditions that characterize the nature of emission and transmission.

9.13.1. Impacts during construction

Given the characteristics of the construction environment, vibrations at the time of blasting shall be potential adverse effects during construction. This can be avoided by applying the required blasting techniques, as well as by applying the prescribed amount of explosives when executing the works, either in the open or in the tunnels.

9.13.2. Impacts during operation

Taking into consideration all the given facts as well as the importance of the bypass road, and even the potential negative consequences that may occur during the operation phase, the issue of emission, transmission and emission has been given its due attention in proportion to the knowledge about this phenomenon and its significance in specific conditions. To assess the negative impacts of vibrations on humans and buildings, the calculation of relevant indicators has been done for the characteristic profiles where such impacts are anticipated.

9.13.2.1. Basic methodological procedures of calculation

In order for assessment on negative impact of traffic-induced vibrations to be objective, it is necessary to determine the indicators that will enable one such assessment as a function of specific location characteristics. As a relevant indicator for all analyses in this study, the vibration velocity (mm/sec) was adopted, which by its nature is a derivation of movement over time. The magnitude of vibrations depends on the characteristics of traffic flow, the characteristics of road surface, the characteristics of soil expressed by damping coefficient and other characteristic spatial relations that occur on the transmission path from the source to the receiver. The general model used for the calculation of indicators implies the rule for the velocity of vibrations at the edge of the outer traffic lane in the form:

$$V = a\,W^{b}\ \text{(mm/sec)}$$

Where:

V = vibration velocity in mm/sec

W = characteristic of the relevant traffic flow

a, b = constants that depend on roughness of road surface

Vibration attenuation with distance is defined as:

$V = (Vo / \sqrt{d}) \cdot e^{-\alpha d}$ where:

Vo = vibration velocity at the edge of the road

d = distance

α = damping coefficient

For the purpose of this specific calculation, coefficients 'a' and 'b' were adopted as values that characterize the road surface with roughness defined using the standard for flexible pavement structures in the category of primary roads. Specific values for the damping coefficient are adopted as a function of soil characteristics.

9.13.2.2. Calculation within the impact zone

Calculation of vibration velocity at different distances from the road edge was made for the characteristic cross-section of the planned motorway, using the appropriate software package. The corresponding coefficient VC (DIN 4150) has been calculated within the obtained data, providing basis for direct insight into the consequences.

9.13.2.3. Results of calculations and analyses

Based on the data obtained from the analysis of vibration issues, conclusions can be made about the potential negative consequences within the area that is in the impact zone of the planned motorway. Given the nature of the impact, negative consequences are observed in relation to humans and buildings. The assessment of the negative impact was carried out in relation to the values of the VC coefficient (DIN 4150), in which sense the following conclusions are possible:

The permissible values of the VC coefficient have been exceeded only at the edge of the road; the values obtained for greater distances are lower than the maximum permissible ones.

The impact of vibrations on buildings and the environment is insignificant, and no damages caused by vibrations are expected in the planning period.

9.14. Impact on infrastructure

9.14.1. Impacts during construction

9.14.1.1. The relation of the route to populated places and road network

The Motorway on Corridor Vc shall constitute the central transport corridor through Bosnia and Herzegovina from its northern to its souther border with the Republic of Croatia, and shall form the backbone of the road traffic system in our country. In its longest part, the Corridor stretches along river valleys of Bosnia and Herzegovina, thus colliding with the existing network of primary, regional and local roads as well as the main two-gauge Modriča-Doboj and Doboj-Sarajevo. The road network in the Corridor area will not significantly change, but with the construction of the motorway basic route, these roads will be relieved of the source-destination and transit traffic, which will be taken over by the motorway.

Table: Overview of the primary and regional road network for the area of direct impact in the municipalities

Municipality	Length of primary roads (km)	Length of primary roads (km) in direct impact zone (km)	Length of regional roads (km)	Length of regional roads in direct impact zone (km)	Total network (km)	Total network in direct impact zone (km)
Doboj	44.5	36.7	113.9	23.3	158.4	60.0
Usora	2.6	2.59	2.6	0.0	5.2	2.6

Municipality of Usora

The route of the motorway is laid in the part of the municipality that borders the municipality of Tešanj, along the left bank of the Tešanjka river. In relation to the populated places of Brkovići and Tokme, the motorway is located to the east of these settlements on the border with the municipality of Tešanj and does not jeopardize their spatial development.

Municipality Doboj-South

From the Entity border, a smaller part of the motorway route passes through this municipality and is laid in an uninhabited area.

9.14.1.2. The relation of route to water management

The area on which the motorway construction will have a direct impact generally falls within the Sava River Basin, or the Bosna River sub-basin. Smaller parts in the areas of Municipality of Usora and Municipality of Doboj-South belong to the Usora River basin (which is a sub-basin of the Bosna River).

From the water management aspect, the lower course of the Bosna River, from Doboj to the mouth where it flows into the Sava River, is currently used as a groundwater source (alluvion is charged from the Bosna River) for water supply of the settlements located along the river.

From the hydropower potential aspect, the Bosna River basin has been relatively poorly studied, primarily due to the fact that the river valley is fully urbanized. That was the reason why thermal power plants (TPP Kakanj) have been built in that valley so far, as opposed to hydropower plants. In the lower course, downstream from Doboj, the construction of smaller stepped weirs without significant water accumulation was analyzed. The process of urbanization and the construction of transport infrastructure (roads and railways) has limited the construction of larger facilities for the use of water and energy potential of this watercourse.

9.14.1.3. The relation of route to water supply and water infrastructure

The motorway route has met the set criteria, avoiding the areas of the existing and planned zones of drinking water sources, planned reservoirs, as well as the zone of positions of larger melioration channels.

In addition, attention has been paid to the impact of the motorway on the facilities of the main urban water supply and sewage systems (existing and planned main pipelines, collectors, reservoirs, and wastewater treatment plants).

The crossing of the motorway route through supply pipelines of smaller capacities is evident, which indicates the need to apply certain technical solutions for relocating these pipelines through deleveling passages intended for relocation of local roads.

9.14.1.4. The relation of route to electric power system

Production capacities

No electric power production capacities exist on this section of the route of the future motorway Vc.

9.14.2. Impacts during operation

Since all points of collision with the existing infrastructure will be resolved during the execution of works, there will be no negative consequences for them in the operation period. However, given that the development of infrastructure will continue after the motorway construction, new assessments should be conducted in respect of potential collisions of new installations and the motorway on Corridor Vc.

9.15. Impact of motorway in terms of traffic accidents

The issue of traffic accidents is one of the important criteria that describe the relation of the planned motorway to the environment. Detailed research on the issue of traffic accidents must be carried out within a scope of traffic-related research. Based on previous knowledge in the field of this issue for the motorway profile that is characteristic of the section Doboj South - Karuše, we should expect for the planning period about 0.1 accidents per year per kilometer of the planned motorway. If the presumption is applied to the entire motorway section from Doboj to Karuše, it is possible to expect about 5 traffic accidents a year.

According to the above assessment, it is concluded that a sufficient level of traffic safety can be achieved on the planned motorway and that, from that point of view, the impacts in the field of the environment are within the limits of acceptability for this kind of facility.

10. DESCRIPTION OF MEASURES TO MITIGATE IMPACTS ON ENVIRONMENT

In view of the previous conclusions, certain protection measures will have to be taken for particular impacts in order to reduce the possible negative consequences to acceptable limits.

Taking account of the previous remarks, the data obtained withing the impact analysis as well as the local spatial conditions that significantly determine the possible actions, environmental protection measures are systematized in a few basic groups.

- General environmental protection measures
- Special measures
- Technical protection measures

10.1. General environmental protection measures

The complex of general environmental protection measures includes global knowledge in this domain that is in line with the global strategy and the local spatial conditions and characteristics of the road planned.

- All activities that were proclaimed within the general development policy at the state level and that are were concretized through the highest planning documents should be taken account of in terms of rational environmental management for the specific section of the road.
- As part of the general development policy, ensure strict compliance with the regulations of wider importance in terms of limit values of certain impacts as well as the regulations on the characteristics of the vehicles in terms of level of noise and quality of exhaust gases.
- Provide preconditions for constant monitoring of the state of the environment in the zone of the planned motorway by providing data obtained through field measurements.
- Provide preconditions for continuous maintenance of the motorway.
- Provide timely road maintenance plans for the winter months, with special consideration being given to minimizing the use of sodium chloride.

10.2. Special measures to mitigate negative impacts on environment

Given all the conclusions obtained in the impact analysis phase, and primarily in terms of implementing adequate protection measures, it is necessary to define certain procedures that must be implemented in the facility operation phase. These measures imply the following:

- The road needs to be equipped with adequate horizontal and vertical signalization, which includes all forms of necessary prohibitions and notifications.
- For the procedures of winter maintenance it is necessary to design special operational plans, primarily taking care of the protection of waters and soil, and then of global problems of environmental protection.
- 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 surface only by mechanical means (putting it back into new adequate packaging, cleaning, vacuuming, etc.), without water-rinsing.

- In case of accidents with vehicles transporting hazardous liquids, traffic shall be immediately stopped, the competent service alarmed and specialized teams for rehabilitation of damage engaged. The spillage should be removed off road surface with special sorbents. If the liquid got outside the profile and contaminated the soil, rehabilitation is done by removing soil. All materials collected in this way are treated using special regeneration methods or are disposed to sites intended for such materials.
- During the construction phase, the road needs to be equipped with adequate horizontal and vertical signalization.
- During the operation of the motorway, constant supervision must be provided in order to prevent the consequences caused by weather and other disasters (landslides, falling rocks, snowdrift, etc.)

The measures provided for in the pre-defined procedures are an obligation that must be met in order for the impacts of the road to be reduced to acceptable limits.

10.3. Technical measures to mitigate negative impacts on environment

The set of technical measures for environmental protection includes all those measures that are necessary to bring the quantified negative impacts within the permitted limits, as well as to take certain measures in order to minimize the impacts in the construction process. As this Study discusses in detail the individual impacts that may occur during operation, protection measures are systematized separately for each impact.

10.3.1. Population

10.3.1.1. Protection measures in the construction phase

10.3.1.1.1. Land expropriation

To reduce the negative effects in the earliest design phases, an approximate number of properties, houses, shops and roadside activities/businesses that could be affected by expropriation should be determined. This procedure provides the first indications on the extent of possible problems related to land expropriation and displacement. Wherever minor impacts are evident, further analysis should determine the category of humans, land and activities and the possibility of simple measures to avoid or mitigate these effects.

In some unregistered activities, it is not easy to determine who will be affected or the nature of potential long-term impacts. Many roadside markets or small catering establishments are not officially organized and often do not have documentation of ownership, lease, income, or lease period. A special problem lies in the fact that it is often the case that the anticipated compensation measures do not reach the damaged parties, especially if the alternative means are of better quality than the lost ones and are then more attractive to other more influential groups. Overview of possible measures to reduce the negative impact in the social sphere.

Consequences	Actions
Lost house and all land	Relocating the owner, building a house and giving land in a new place
Lost house and some land (the remaining land is not good for use)	Relocating the owner, building a house and giving land in a new place
Lost house and some land (the remaining land can be used)	Renovate the house on the remaining land, compensate for the loss of land
Lost house, land remained	Rebuild the house on the remaining land
Lost house, the owner has no land	Rebuild the house on a new plot in that same or new area as the owner wants
Lost house, the owner is a lessee	Assist in finding a new home in the old or new area, depending on the wishes of the lessee
Lost house, illegal construction	Assistance in finding a new home in the old or new area, depending on his/her wish
Lost land but not the house	Provide land within a reasonable distance from the house, otherwise relocate the owner, provide the house and land in the new area
Lost some land (the remaining land cannot be used), house was not lost	Provide land within a reasonable distance from the house if possible
Lost some land (the remaining land can be used), house was not lost	Compensate for the lost land
Lost income from work done at home (temporarily), but not the house	Rebuild the house in that or some new area as per wishes of the owner, make up for the lost income during the relocation process
Lost a job done at home or a job	No action
Lost the business location, tenant or illegal user	Provide an alternative location with equal or better access, services and job potentials

Before the commencement of the works, a realistic plan for the development of alternative roads for the local population should be drafted, especially in places where existing roads or traditional roads have been interrupted. Having in mind the need for use of the existing roads, it is the contractor's responsibility to maintain these roads.

10.3.1.1.2. Measures to reduce social impacts

In these specific conditions, two basic social groups that are under the impact of the planned motorway can be clearly distinguished. One group consists of road users and the other group consists of population along the road as well as owners of the properties that are under the impact due to the planned construction.

The construction of the planned road should be expected to increase the mobility of the population of the wider area, which opens opportunities for the development of certain activities that improve the social structure.

To minimize the impacts in this sphere, the current property owners should be given the opportunity under favorable conditions to start their businesses in certain areas near the new motorway. Possibilities of this kind are shown in more detail in the chapter dealing with the land possession.

If possible, the local labor force should be employed for the needs of the construction site in order to create conditions for the motorway to be accepted as soon as possible as an important facility of interest to the local population. Efforts should be made to locate stationary buildings on site in a way so as to avoid conflicts between the workers engaged in the road construction and the local population.

The owners of the land on which the planned road is being built are the interest group with the most to lose in the current situation, regardless of the compensation that belongs to them after the expropriation. Impact models and compensation in such cases are given in detail within the chapter on land possession.

Financial compensation for expropriation and demolished facilities should be awarded on the basis of an investment agreement in order to avoid cases of the money received being spent inadvertently and thus creating the social welfare cases left to the care of the community in the future.

10.3.1.1.3. Other measures

It is important to take special care that all necessary information measures and restrictions on movement are applied during the blasting, so as to ensure the local population would be protected from possible consequences.

Regular control of the machinery and equipment is needed to reduce the pollutant emissions and noise to a minimum. During the works, it is necessary to collect and treat the generated waste at all times.

Where possible, the construction site should be fenced, to be isolated from the surroundings.

10.3.1.2. Protection measures in the construction phase

Comparing the positive and negative effects of construction, it becomes obvious that the benefits for the community in the case of the construction of the planned motorway are several times larger than the damages arising as a result of that construction.

Some effects that can result from the construction and that could have a certain impact on the social sphere are also related to the possibly induced, uncontrolled development along the planned road, which would significantly disrupt the current relations.

The construction of the planned section should also have certain positive effects related to the possible increase in the property values, as well as positive effects in terms of creating employment opportunities for the local labor force. An increase in the value of buildings and land after the construction of the motorway is also expected.

10.3.2. Waters

10.3.2.1. Measures to prevent and mitigate negative effects on waters during the preparation and construction of the motorway

10.3.2.1.1. During the advanced design stages

In the advanced stages of design solution, it is necessary to prepare the Main Design of drainage of water off the motorway road base and related external waters, with detailed hydrological and hydraulic calculations, as well as drawings of the facilities for collection, transport and disposal thereof.

Drainage design must contain at least the following:

- Facilities for the treatment of wastewater off the motorway may, as a rule, be placed within the area defined as sensitive in this Study, but a detailed hydrogeological substrate of the narrow belt around the motorway at a 1:5.000 scale should be consulted before final selection of the location of these facilities. It is necessary to pay attention to the fact that the facilities are not positioned in aquifer areas where high groundwater levels have been identified so as to avoid disrupting the hydraulic regime of groundwater flow, aquifer recharge disturbance, etc.
- Drainage design should at the least foresee the closed system of drainage, with an oil and grease separator and, if necessary, further water treatment that will achieve the water quality in accordance with regulations.
- The construction of the planned facilities for the treatment of wastewater off the motorway must guarantee impermeability, that is, seepage of wastewater into the ground must not be allowed.
- Access to the internal drainage facilities, i.e. separators and lagoons should be designed in an efficient way with the option of vehicle access (e.g. cistern for wastewater transport).
- At places where the route passes through sanitary protection zones, namely the zone IIIa (mild protection regime), according to the Rulebook on conditions for determining sanitary protection zones and protective measures for sources of water used or planned to be used for drinking ("Official Gazette of the FBiH", no. 51/02, Articles 17 and 18), direct or indirect discharge of treated wastewater into the ground is prohibited.
- At places where the route passes through sanitary protection zones, namely the zone IIIb (mild protection regime), according to the Rulebook on conditions for determining sanitary protection zones and protective measures for sources of water used or planned to be used for drinking ("Official Gazette of the FBiH", no. 51/02, Article 18), direct or indirect discharge of wastewater into the aquifer, as well as untreated wastewater into the ground, including emptying the vehicles for cleaning and removal of faeces, is prohibited.
- At places where the route passes through protection zone III, facilities for the treatment of wastewater off the motorway may be placed, provided they guarantee impermeability, and the treated wastewater should be transported by watertight system, and discharged outside these zones so as not to jeopardize them.
- At places where the route passes through particularly sensitive areas (source sanitary protection zones), ditches (external drainage) should be designed and be watertight, so that any contaminants are transported without sinking to the wastewater treatment facility.
- At places where the route passes through particularly sensitive areas (source sanitary protection zones), embankment slopes should be protected by waterproof systems.

- At places where the route passes through sensitive areas, the pipelines of the closed drainage system must be watertight, in order to rule out any possibility of water pollution. Regular control of the quality of the built-in pipelines should be done.
- At places where the route passes through particularly sensitive areas (source sanitary protection zones), a green barrier (windbreak) should be constructed along with watertight ditches.

According to JUS and TEM standards, the internal and external drainage system of the motorway is dimensioned for the relevant rain of a 10-year return period, and the values of rain intensity and rain duration are determined using ITP-curve hydrometeorological stations to which the motorway sections gravitate. These standards were used for the development of the Preliminary Design of the motorway on Corridor Vc.

In the advanced stages of design solution, it is necessary to prepare the Main Design of drainage of municipal and rainwater for all ancillary facilities.

10.3.2.1.2. During the construction phase

- It is necessary to apply special blasting procedures so as not to disrupt groundwater flow directions (at sections where the route passes close to the sensitive groundwater zones) and surface watercourse recharge processes. Apply good site and traffic management practices to avoid watercourse pollution.
- Disposal should not be done in riverbeds or along the river banks, or sanitary protection, zones, or the zones defined as sensitive. In case these sites are located on a water resource or public water resources, approval from water management authorities is required.
- All material from excavations, which will not be immediately used in construction activities, must be deposited at designated locations in accordance with the Construction site organization plan (excess material disposal sites), which locations are protected from erosion, and outside the defined sensitive zones.
- It is necessary to preserve the vegetation cover as much as possible and ensure buffer zones made of vegetation cover between the road and the watercourse.
- Only clean material should be used for embankments near watercourses, e.g. gravel without earth material or other impurities.
- Riparian areas sensitive to erosion must be protected by the use of stabilizing agents and plants that prevent erosion.
- Any temporary or permanent disposal of waste material on the surrounding soil must be prohibited, except at places designated for such purposes by the Construction site organization plan, and impermeable waste containers must be provided.
- Supervise the deposit formation processes and organize cleaning of the bottom of the river and the riverbed slopes to ensure they remain excess material free.
- Carry out frequent and controlled disposal of municipal and hazardous waste in the prescribed manner.
- Establish continuous supervision during the execution of works in the presence of an environmental protection specialist.
- Apply disciplinary sanctions against violators of the established rules of conduct.
- For the workers' needs, it is obligatory to set up eco-toilets on the construction site.
- Ensure that areas for parking and maintenance of machinery have the impermeable base

(floor), outside the defined sensitive zones.

- Oily rainwater from the construction site must be collected and kept in watertight reservoirs and treated in the prescribed manner.
- Prohibit the repair of construction machinery, and the change of oil in the defined sensitive zones.
- All construction site surfaces and other impact zones during construction need to be rehabilitated in accordance with the Rehabilitation Plan, that is, depending on the future use of the subject areas, restored to their state.
- For the locations of construction sites, services, asphalt plants, borrow pits and other facilities, request special water management conditions in the next design phase.
- During construction works in sensitive zones, warning notices must be placed for the workers on site about the execution of works in these areas.
- In case of accidents, oil or grease spills into the environment, urgent action is needed in accordance with the Emergency Intervention Plan in Case of Accidents.
- In case of harmful effects occurring at the sources used for water supply, it is necessary to provide, as soon as possible, an alternative water supply for the population in the endangered area.

10.3.3. Air

10.3.3.1. Protection measures in the construction phase

Regular, and if need be extraordinary, technical inspections of equipment and machinery should be organized to control proper operation, which will ensure a minimum emission of pollutants. Emission of fugitive dust from construction sites and temporary roads must be reduced by fogging these surfaces. Where possible (asphalt plants, open-casts, batch plants, etc.), water from the manipulative surfaces should be collected into decantation pool.

In addition, the following is also suggested:

- Covering the trucks that transport the construction materials;
- Speed limit on non-asphalt (access) roads;
- Avoidance of "idling" of construction equipment;
- Use of modern and efficient machinery.

10.3.3.2. Protection measures in the operation phase

Air pollution analysis shows that for the analyzed conditions relating to the motorway, special protection measures are not necessary given that the limit values have been exceeded only at close distances from to the motorway edge.

Assuming the further development of motor vehicle engine technology and the growing need for alternative fuels, and also bearing in mind the prescribed gas emission standards for new vehicles powered by internal combustion engines, it is considered that the concentration of pollutants should increase at a much lower rate than the AADT.

In any case, monitoring of the concentration of pollutants has been proposed, as a basic protection measure during the operation of the motorway on Corridor Vc. Monitoring should be carried out in accordance with the Rulebook on monitoring, at locations where the motorway passes through settlements, on sections with a higher slope level and AADT, and near tunnel portals.

10.3.4. Soil

10.3.4.1. Measures to prevent and mitigate negative effects on the environment during the preparation and construction of the motorway

Using data from the Basic pedological map M 1:50000, along with additional research activities and terrain reconnaissance, a map of the route pedosystemic units if 1:25 000 scale and up to 500 m in diameter has been made, as well as a map of protection categories (levels) for the entire motorway route and for each section separately. The heterogeneity of the area aggravates the design and especially the implementation of the protection measures recommended in the final study. However, this is the nature of soil on the ground and this is a reason why this is the most complex eco-system in nature. Still, this study gives a simplified approach to the process of designing soil protection measures that are classified into categories according to the level and the need for application of individual measures.

Soil reflects as a mirror and collects as an accumulator a historic course of natural events, incorporating them into its properties. Soil is the most subtle natural laboratory in which the received substances are naturally transformed thus, to some extent, protecting from contamination waters that percolate the soil. However, experience has shown that, in the era of increasing pollutant pressure, this ability of the soil is limited. It was expected that the soil would manage to process or retain the introduced herbicides, pesticides, nitrate fertilizers and other contaminants, but this did not happen, so groundwater has become contaminated in many areas of the world. This should be taken into account, especially when it comes to soil contamination in ecologically sensitive zones of river valleys and underground aquifers such as the zone through which this motorway passes.

Given the geomorphological conditions, type determination, depth, (skeletality), physical and chemical properties of impact on soil fertility, all soils along the section within 500 m of the road axis, in view of necessary measures and level of protection are grouped in four categories (levels), as per following general criteria:

Category I – full protection, includes fertile, deep, most valuable soils on the route, with favorable physical and chemical properties. Additionally, these are the soils that are usually found on the best relief positions, suitable for use of modern agricultural machinery, while the range of crops that can be grown is very big. They are being used as good agricultural land – arable fields, gardens, greenhouses, orchards. These soils need to be fully, that is, completely protected. In the area where the route intersects these soils, it is necessary to apply a closed system of drainage off the road surface, span surfaces with overpasses, and certainly put windbreaks by careful selection of species, all with the aim of collecting emitted pollutants in a narrow zone along the road.

Category II – high protection, includes soils with favorable physical and chemical properties of high fertility, but soils on limited, smaller areas with minor disadvantages that could be easily removed by some agro-meliorative actions. They usually come as arable fields, abandoned arable fields, or abandoned meadows, mainly on the rolling parts of the terrain. A number of these soils are being used as pastures.

Category III – selective protection, primarily soils with sparser or thicker maquis shrubland where deeper soils appear in sinkholes, dells or cuts that are used for extensive cultivation of mainly fruits and vegetables. This category includes barren land, i.e. shallow skeletal soils on steep inclinations, exposed to water erosion. In areas exposed to erosion, selective protection of the soil from erosion is required, especially by grassing, i.e. protection by suitable vegetation cover. This also includes protected forest lands. Should the route intersect such areas, care must be taken to ensure that soil damage by road construction is carried out with extreme caution, so as to avoid pockets of erosion by water.

Category IV – protected (forest) soils, includes soils under coherent forest cover. Should the route intersect such areas, care must be taken to ensure that soil damage by road construction is carried out with extreme caution, so as to avoid pockets of erosion by wind and water. We would particularly like to emphasize the wind erosion issue, which is prone to a very fast progress on the "inclined" localities exposed to the northern winds, unless a wire net or some other protection means is put up.

10.3.4.2 Special measures to mitigate negative effects on the environment

The physical, chemical and biological properties of soil have a large impact on penetration of pollutants into the soil, the mechanism and strength of their binding, transformation and loss of heavy metals from the soil. It must immediately be stressed that two principal soil decontamination mechanisms are – biological binding to the organic part of a plant, micro and macro soil fauna, and leaching from the soil. Both mechanisms are risky for the environment. By binding to plants, heavy metals penetrate the human food chain, and by leaching they penetrate groundwater and aquatic ecosystems.

All sections have diverse pedosystemic units, and thereby diverse categories of protection. Certainly, the first and the second category of protection are the most important ones, since they include fertile, deep, most valuable soils with favorable physical and chemical properties. In the second and third protection category, an emphasis must be put on protection against erosion and physical reinforcement of road sides to prevent landslides and other impacts on the environment.

a) Protection of soil from dust

Effective protection against dust can be achieved by reducing dispersion of fine dust and aerosols to as narrow a space as possible, and in doing so avoid contamination of more valuable agro-biotopes.

In addition, an intensive circulation of organic matter should be ensured in a fenced-off area around the road, by frequent mowing and removal of plant mass. Interventions that reduce the mobility of heavy metals and assure their binding must be conducted outside of that area - on agricultural soil, and especially those areas where hazardous impacts cannot be reduced to an acceptable level by the application of any of the mentioned procedures.

b) Level of the route in relation to the environment

Selection of the level of the route in relation to the environment is very important for the monitoring of pollutant emissions and their direction. A route at the level of the surrounding area is the least favorable in terms of soil contamination around the route. Should a noise-protection wall be installed on such route, it would also provide protection from emission; however, the concentration of pollution on the road itself would increase. he route elevated above the surrounding terrain causes wide distribution of pollutants. Viaducts and bridges have the same effect.

This procedure protects well from contamination through direct planting and other types of barriers in this part of the route. A route below the level of terrain or the route in deep cut does not have to cause an increase in pollutant concentration on the very road, if the dominant air current follows the route direction, which could be considered while designing the route.

c) Biological measures – protective plantations

Plantations for the protection of agricultural soil, and thus water, are placed along the road on one or both sides of the route on which the soils we protect are located. By targeted planting and maintenance of trees and shrubs, purification – filtration of emitted particles is achieved. In the winter, with no foliage present, dust pollution is 5-7 times higher than in the summer, when the leaf mass is developed.

d) Selection of species for the windbreaks

This is the most significant and most delicate issue, which must entirely be solved in a separate design. Several criteria are used to select favorable species for windbreaks. First of all, the requirements of the plant itself in relation to the soil must be respected, i.e. plants must be chosen according to the properties of soil and agroecological requirements of the environment. The best are autochthonous plants, regardless of whether they are grasses, bushes or forest saplings. It is important to keep the following facts in mind when designing and putting up effective protective plantations:

In general, conifers as a filter are more efficient, but in sections that are mostly loaded with traffic during the summer (see a traffic frequency study), deciduous saplings can also be planted.

Dense forests convey the air masses vertically upwards, with prior purification in the treetop, so that purified air mass is conveyed into the atmosphere.

Thinned – pervious forest plantations or layered hedges divide the "main" air stream into numerous currents of reduced speed, and it is these currents that deposit pollution onto leaves, i.e. thin it out and thus protect the surrounding agricultural are.

Dust from the motorway settles on the grass and adheres well to it. Taller grass is more efficient than shorter grass.

The filtration effect of protective plantations is based on a reduction in wind speed. Too dense plantations are unfavorable because they prevent penetration of emissions and their thinning are unfavorable because they prevent penetration of emissions and their thinning. Pervious plantations are better.

The best solution is the one with thick plantation by the road followed by pervious plantation. Such plantation is also efficient from the aspect of noise protection.

10.3.4.3. Measures during the advanced design stages

The advanced stage of design solution implies the preparation of the detailed design documentation (Main Design) with all detailed solutions and calculations of facilities and infrastructure for the collection and drainage of wastewater from the motorway route. These structures should be located at the most hydrogeologically acceptable places, without the possibility of adverse wider impact on soil and surface waters, sources and aquifers. The base must be watertight.

In the water drainage design, it is necessary to envisage a closed drainage system, with an oil, grease separator and, if need be, other impurities. This is also the subject of water protection, which is regulated by the Rulebook on conditions for discharging wastewater into the public sewer system.

The treatment of wastewater not only from the motorway route but also from other public and service facilities will best protect not only water but also the soil as the most important segment of the environment in the construction of such facilities.

On all sections of the highway, it is necessary to plan and design the construction technology at the construction site, which means:

- Abiding by all criteria of good building and protection of space by avoiding to set up construction sites in zones of the best agricultural land wherever possible, but also in zones that are sensitive from the aspect of erosion incidence, etc.
- Due to a potential risk of waste material (fuel and lubricants) spillage, construction site areas for the accommodation of machinery, workshops, asphalt plant, etc. must not be located in zones of high risk, particularly from the aspect of water permeability, and soil and hydrogeology in general,
- Borrow pits and landfills for the building and earth materials must be set up at locations that shall not pose a problem to the local population or be an erosion base for pollution of the surrounding area and watercourses,
- Precise definition of the methods of and responsibilities for removal and final disposal of municipal and hazardous waste,
- Watercourses that the route intersects through the main or ancillary structures for connection and communication should be protected from backfilling, which frequently occurs, and from the consequences of subsequent land inundation.

The design and planning phase must anticipate measures for the rehabilitation of land areas damaged during construction, landscaping, as well as a plan for emergency interventions in case of accidental situations.

Based on preliminary research/surveys, all sensitive places should have protective fences, concrete retaining walls, interceptor drains and similar structures that will prevent erosion or potential landslides.

Relocation of the natural watercourse bed is not desirable and potential other solutions must be sought. However, if this is the only solution, then strict criteria of environmental protection must be applied, especially for the protection of biodiversity that had already been established in a given watercourse.

The design documentation should take to account the envisaged land protection criteria on the entire section of the LOT1 highway at four levels (point 6.3.4.1.), as follows:

- First (I) category of full protection
- Second (II) category of high protection
- Third (III) category of selective protection
- Fourth (IV) category – protected forest soil

Biological protection measures are a significant component of the detailed design documentation, where attention must be paid to propagating material for windbreaks, bush planting, sowing the grass on slopes and afforesting the area surrounding the motorway route.

10.3.4.4. Technical measures to mitigate negative impacts on environment

Taking into account the anticipated drainage concept for the planned motorway, the pollution generated as a consequence of carriageway (runoff) water and the settlement of exhaust gases represent impacts of the greatest importance. Based on the acquired knowledge so far, it can be argued with certainty that these phenomena will lead to increased soil pollution right next to the road base and at close distances on both sides. The intensity of this pollution is in a direct functional relation to the intensity of traffic.

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Water that flows off roads into watercourses and groundwater, and which is very often drinking water, is one of the grave problems. For that reason, it is necessary, especially in the I and II category of protection, construct an efficient drainage system along the route consisting of drainage channels along the cross-section of the catchment section, properly positioned to collect all wastewaters and carry them to the collection pool located at the lowest possible level, and as far away as possible from the settlements or agricultural land used in crop production. These wastewaters coming off the motorway must not flow directly into the rivers and small watercourses, but into the built collection pools or natural wetlands in which the pollutants present will settle and thus remain in a limited space. These natural wetlands are usually farther from watercourses, lying on watertight clays so there is no risk of their percolation into groundwater, which certainly must be researched beforehand. Generally, wetlands have good buffering properties. According to many researchers, the wetland ecosystem is able to purify polluted water from diverse components. Heavy metals also accumulate in wetlands. In some countries, constructed wetlands are successfully used to treat catchment waters from roads and urban areas. Studies show that 80% of metals (Zn, Cu, Pb) that infiltrate such wetlands get absorbed by sediments and accumulated in aquatic plants (Dumbeck et al., 1998). Thus, for example, the root of aquatic macrophytes, especially common reed (Phragmites australie), is capable of accumulating a large quantity of lead, zinc and copper. Wetland grasses also show a high buffer efficiency of 60-85% of the received Pb, Cd, Zn and Cu.

10.3.4.5. Measures during construction and during operation of the motorway

The measures recommended during construction are actually measures of good civil engineering practice. The locations where the works are executed and where the construction sites are organized should be as small as possible in order to reduce losses and damages to land due to construction.

On surfaces that will be permanently covered with asphalt or some infrastructure facilities, the fertile humus soil from the surface should be selectively removed, deposited and preserved for the purpose of filling and landscaping the surrounding damaged area. This primarily refers to the soils in the use-value Category II, which are both the best and the most fertile soils. The depth of removed soil should range from 25 to 35 cm, depending on the quality of the surface layer. By doing this, the permanent loss of soil due to road construction would be at least partly compensated. Landscaping the flanks, embankments, surrounding damaged sloping area exposed to erosion must be conducted according to the regulations of the profession, both from the technical and biological aspect.

Wherever possible, turfs or a protective mesh must be placed on the surface without delay in order to protect the surface from rain drops and erosion that carries not only soil but sown seeds as well. Maintenance during the entire period after construction is mandatory, because without human presence, the area would not undergo rehabilitation.

Construction sites must be marked so that nearby soils do not unnecessarily get trampled and damaged by machinery. It is not appropriate to set up construction sites outside the road bed, on soils that are prone to compaction, or on soils of a heavy mechanical composition, if no other options are available geotextile must be placed on the soil.

Cuts in slopes through which the route passes pose a potential risk of excessive erosion and landslides; special attention must be paid to this and adequate mitigation measures must be taken.

A conflict will certainly arise from a possibility of accessing and using land on both sides of the route since the properties will be disrupted and owners of the lots shall be cut off on both sides. For that reason, it is necessary to keep the existing access roads, and build temporary roads until the new ones are built; these new roads must facilitate undisturbed access to lots and properties for the purpose of unhindered use thereof. Passages from one side of the motorway to the other must be reasonably spaced and natural-traditional, so that farmers do not have to drive their tractors, trailers and other means of transport on the motorway to reach their lots that are located only several hundred meters away on the other side. Field access roads to the crossing that leads to the other side – which will most often be underpasses – must be designed in line with the regulations for the construction of field roads.

Expropriation and financial compensation must comply with the legislation of BiH/RS/FBiH and be based on the form of property ownership list. Otherwise, given the economic position of the population and the significance of agriculture for the population's survival, the unfair loss of gardens, house grounds, and fertile arable land, can have long-lasting economic and social consequences to the population.

The process of preparation, construction and maintenance of the motorway must be planned and conducted in cooperation with local communities so that everyone can feel the benefits of this investment. Particular attention must be paid to land that belongs to religious communities.

When laying the soil flanks, embankments and slopes, the soil quality must be ensured, and the thickness of the backfilled layer for grass sowing must be 20-30 cm, on embankments 30-40 cm, and for planting shrubs and other larger plants, the layer must be 50-60 cm thick.

10.3.4.5.1. Measures during the motorway operation

The design will significantly change the landscape since it will not be on the same level as the surrounding terrain. Even in the lowland part of terrain, it will be raised to a high embankment as it passes through potentially flooding areas. The road will also be a barrier to the view as it currently exists. Visibility will also be disturbed by noise protection walls, embankments, rows of trees, etc. Bridges, viaducts, motorway entrances and exits will also considerably contribute to the altered landscape. The disturbed appearance of the landscape can be mitigated by the green landscape architecture so that structural elements are integrated with the landscape. Planted vegetation is subject to permanent care. Areas in which plants will be sown or planted shall be properly prepared beforehand; adequate, autochthonous seeds of grasses, shrubs and trees for planting and sowing will be selected, and this primarily means:

1. When sowing grass, attention must be paid first to preparation, depth of filling, intake of organic but also mineral (NPK) fertilizers, tilling depending on the relief, inclination and other factors. In the selection of grass, special attention must be paid to climate, soil properties, relief, botanical compatibility of grasses in the mixture, etc. Grasses should be

relatively resistant to de-icing salts during the winter, presence of weeds, possible application of herbicides, etc. As for slopes, grasses with a root of medium depth, horizontal rather than vertical root growth and a longer vegetation period are best, so that the soil is longer and better covered in leaf mass that protects it from raindrops and thus erosion. Grass covers get damaged over time, so they need to be replanted at regular intervals and regularly maintained, especially in the first years after planting, if we want to achieve their real efficiency in the protection of surrounding area.

2. When planting shrubbery, bushes and other undergrowth, special attention must be paid to whether there is a real need and reason for planting this type of vegetation at any locality, the natural properties of the environment, and other properties and effects achieved by this measure. The goal is to protect the soil from erosion, but also to consolidate its deeper layers. When choosing these cultures, care should be taken that the root system be very large, robust and strong, and branches widespread so as to cover as large area as possible. Shrubs must not grow tall too fast, but moderately and slowly, to avoid creating the "Wall effect", which disturbs drivers and blocks visibility. It should be highly resistant to parasite attack and winter solutions (salts) that fall on them. Plants that tolerate pruning without harmful consequences to their further growth should also be used, and can be planted in trenches, in smaller groups, with grass in-between. A low mesh is sometimes placed in this type of hedge. This type of vegetation is usually planted where grasses can hardly thrive.
3. Afforestation is performed on the most endangered inclinations, steep slopes, potential landslides and cuts, around tunnels, etc. Forest saplings that are able to stabilize the soil surface and to improve the appearance of the area, are planted. It is important to select adequate botanical species and harmonize the external appearance of the plant and root development that complies with the previously given requirement of deep soil stabilization. Soil must be well prepared beforehand.

10.3.5. Flora and fauna

10.3.5.1. Protection measures in the construction phase

To avoid unnecessary biotope loss, the construction site must be limited to the minimum possible needed area, especially at the sections of high importance for plants and animals. Disposal of materials must be done on the construction site only. The areas of great ecological importance must be fenced off during the construction phase. Construction machinery should not move outside the construction site due to danger of soil compaction. Removed biotope structures on the construction site should be restored after the completion of works.

Attention must be paid in the vicinity of streams in order to avoid disruption or disturbance of surface waters or groundwater. This achieves the preservation of the existing wetland and aquatic vegetation and ornithological population.

Removal of trees and thicket must be done in wintertime in order not to interfere with the brooding period, which is from 1 March to 30 September 30. Upon the completion of works, the previously removed biotopes must be restored.

During the construction phase of the road, care must be taken not to disturb the landscape values, especially in the aquatic zones. In other words, degradation of space during excavation and embankment works must be minimized, and it must be easily corrigible.

The contractor must undertake to collect and take to the nearest landfill the excess solid waste of any kind, immediately after the completion of works on that section. Solid waste produced in the worker housing zones, on parking lots and vehicle maintenance grounds must be collected and disposed of.

10.3.5.2. Protection measures in the operation phase

Most impacts caused by the road base are inevitable. (places are quoted in the study, where major conflicts occur due to: bridges designed with detrimental effects to the environment, intersections in river valleys, proximity of road and river, et al). Care must be taken when designing to avoid the felling of wild trees such as poplar, cottonwood and willow.

The mandatory measure is the construction and maintenance of the motorway fence along its entire length in order to prevent animals from entering the road. Analysis during operation to see which species are endangered and which need to be protected. If these species inhabit the zones of road construction, it is necessary to transfer them to "safer zones" with similar conditions.

Constant monitoring of the number and species of birds killed along the road, consultations and adequate protection measures to diminish risks should be undertaken on the motorway sections where wildlife is endangered. In cases of a large number of amphibians killed on certain sections of the road, it is necessary to consult with relevant experts in order to find adequate solutions.

Bridges should have high fences to prevent birds (flocks or individuals) from colliding with vehicles, especially during migration periods.

High-value biotopes should not be planted near the road as it is a congested zone that will have a negative impact on the fauna. Birds will be attracted by hedges and use these biotope structures along the road as new habitats. Thus planting the trees and shrubs should be reduced to a minimum, sufficient for the landscape and prevention of erosion, but not for the creation of new biotopes. Planting at cuts is somewhat less problematic since the trees and shrubs are located above the road and, as a result, vehicles and birds will not collide.

10.3.6. Landscape

10.3.6.1. Protection measures in the construction phase

Since the construction process is a temporary disturbance of landscape characteristics, there are no special protection measures.

10.3.6.2. Protection measures in the operation phase

In the light of defined potentials, appropriate measures for protection, minimization of impact or compensation should be sought, and one should always keep in mind that it is not possible to construct a road without impacts in the field of landscape. As part of the design documentation, the Landscape Planning Project was prepared, which treats this issue in detail, and the general guidelines applied therein are set out below.

Efforts in the design process must be made to minimize the measures present, while taking into account the following:

- Elements of design geometry must meet the principles of homogeneity and must conform with the local morphological characteristics.
- Cut and fill gradients should be variable and in line with the local morphological characteristics.
- Bridges, viaducts and tunnels may be used when the road runs across steep slopes rather than using cuts and fills. This will help preserve the visual and physical continuity of the landscape.
- The view from the road can be especially enhanced by purposefully shaping the elements of the situation and leveling plans.

Particularly significant effects can be achieved if special attention is paid to the soft landscaping of the areas through which the road passes, while taking care that:

- The road fits in the local vegetation (trees, shrubs, lines of trees, hedges),
- Plants should be transplanted to harmoniously fit into the existing landscape,
- The selected species match the road category and its function,
- Planted vegetation does not restrict views and that the plants are not to be planted just to fill the space,
- Planted vegetation borders on and underlines various landscape units alternating along the motorway route,
- Vegetation accentuates various conditions of traffic flows (changes in the Layout Plan),
- Care should be taken to use local materials to construct the facilities on the route.

The constructed road maintenance procedures can greatly affect the landscape and visual features of the road. Visual pollution can be reduced if special attention is paid to the shaping of various protective and supporting structures (various structures for noise protection), special penalties introduced, the advertisement system along the road regulated, etc.

Negative impacts on the landscape can be compensated to some extent by afforestation of the landscape to replace those trees that had to be felled during the road construction and rehabilitation of problematic areas.

10.3.7. Protected areas of nature

Determining the impact the planned road will have on the natural heritage requires the analysis of natural complexes that are usually defined as national parks, strict nature reserves, nature reserves for scientific research, areas with special natural features, characteristic landscapes, special nature reserves and natural monuments.

Spatial complexes indicated as such imply a certain level of public care and are usually introduced into a certain system of protection under legislation. As such spatial complexes, by definition, represent nature rarities, the main principle that should be respected is to keep the road at a sufficient distance from these complexes in order to prevent any negative impact.

There are no protected areas of nature in the zone of the analyzed section, that is, there is no need for additional protection measures so this issue is not under consideration.

10.3.8. Cultural-historical heritage

10.3.8.1. Protection measures in the construction phase

The analysis of the current state and possible impacts established that there are archaeological sites at the analyzed location, as well as that their exact spatial position was not precisely determined, which might give rise to certain conflicts. In terms of these facts, the protection of potential sites would be carried out in three phases, which would follow each other according to the development of the specific situation:

Phase One – represents archaeological research by sounding on recorded sites, which would identify the exact cultural affiliation of the very sites, stratigraphy of archaeological layers, chronological determination, and preservation of cultural layers and architectural remains, if any. Research in this phase would have to be conducted before the commencement of works on the route.

Phase Two – based on the findings of archaeological research conducted in Phase One, protective archaeological excavations would be planned for certain parts of sites that might be endangered by construction. If during the research in Phase One it is determined that the cultural layer has not been preserved on the sites or that the route of the road in question bypasses them, the research planned in Phase Two will not be conducted.

Phase Three - represents the expert service supervision, that is, inspection during earthworks on the route, with the mandatory performance of protective archaeological excavations if during the works the previously unknown archaeological sites are uncovered.

Since the route passes through archaeologically protected zones, it is necessary to prepare a Program of archaeological research of these zones during the preparation of the Main documentation, which program would specify the site protection measures in line with the mentioned steps. Also, given the possibility of finding new sites, it is necessary to have a constant presence of expert supervision on the route during the works.

10.3.8.2. Protection measures in the operation phase

An elevated level of air pollution is possible during operation, as well as vibrations and noise, which may cause negative impacts on material goods, and thus on the very cultural heritage exposed to these impacts. Given the above, it is clear that abiding by other measures will minimize the impacts on cultural goods. The sole indicator of the state of cultural goods in relation to potential impacts, is permanent monitoring. Also, given the possibility of finding new sites, it is necessary to have a constant presence of expert supervision on the route during the works.

10.3.9. Noise

10.3.9.1. Protection measures in the construction phase

Sources of construction noise include the execution of works at construction sites (heavy construction machines, possible blasting at tunnel construction sites) and noise caused by traffic of construction machines related to the execution of works.

No information is currently available on the areas where the works will be performed, or on equipment and dynamics of works, so it is not possible to make predictions about the noise that will be emitted from the construction site as well as its impact on the housing communities.

There are no available detailed plans of the execution of construction works, including transport routes so it is not possible to anticipate levels of traffic movement in detail for these roads. However, as a general requirement for mitigation measures, the contractors shall be required to use modern equipment with sound attenuators, as well as to adhere to usual work hours during the day (exceptions may apply, for example, to some structures such as tunnels). However, it is best to use equipment that meets the requirements of European Directive EC/2000/14 regarding the emission of noise generated by equipment for outdoor use; e.g. equipment identified by the EC declaration of conformity. Working with noisy equipment should especially be limited, as much as possible, in the vicinity of populated areas and/or shields should be used, e.g. by placing equipment behind natural sound barriers, mounds, containers, etc. which can serve as protection and by setting up works away from settlements.

All construction machines and vehicles used for road construction must have sound protection/ insulation of the engine and other parts that generate noise or contribute to noise generation.

When blasting for excavations in a rock massif, explosives selected must be the ones with minimum damaging impacts on the environment; and a technique of millisecond detonation of directional shaped charges applied, in order to reduce an effect of superpositioning of dynamic stress waves (vibration, seismics), noise and dust emission. Alternatively, excavation techniques with hydraulic hammers or mechanical excavation with boring machines ("moles"), etc. are used.

Contractors should be required to comply with the general requirements of noise attenuation measures. The requirements relate to the use of modern equipment with sound attenuators, and also to adhere to usual work hours during the day (exceptions may apply, for example, to some structures such as tunnels). Preference should be given to equipment that meets the requirements of European Directive EC/2000/14 regarding the emission of noise generated by equipment for outdoor use; e.g. equipment identified by the EC declaration of conformity. Especially in the vicinity of populated areas, work with noisy equipment should be limited as much as possible and / or shelters should be used, e.g. placing equipment behind natural sound barriers, mounds, containers, etc.

10.3.9.2. Protection measures in the operation phase

One of the main objectives of noise assessment is to examine the effect of mitigation measures so as to avoid the negative impacts of noise on the facilities surrounding the motorway. Noise reduction can be achieved by various approaches:

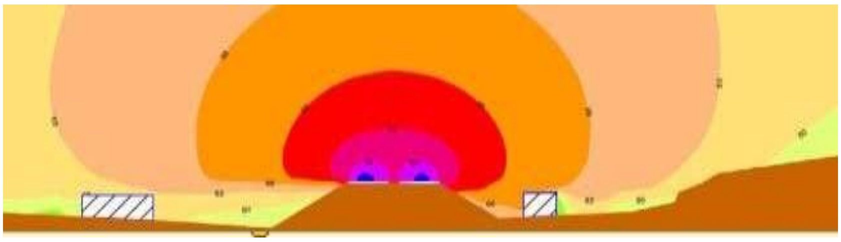
Reduction of noise transmission by installing sound barriers (obstacles).

Reduction of noise emission at its sources (vehicles, motorway surface).

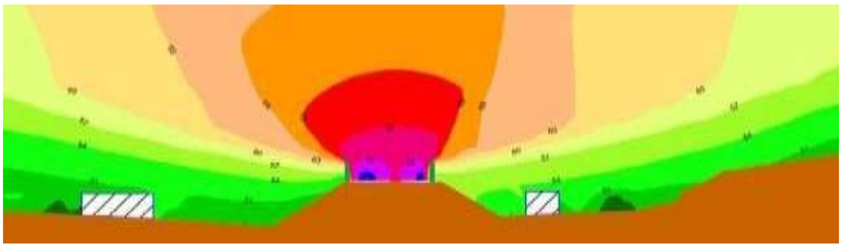
Reduction of noise impact in residential areas by installing noise protection windows in each individual building.

Implementation order of these measures starts with the installation of sound barriers; the second is elimination at source; and the third, elimination at the receiver's end.

One of the most important mitigation measures is the installation of sound barriers.

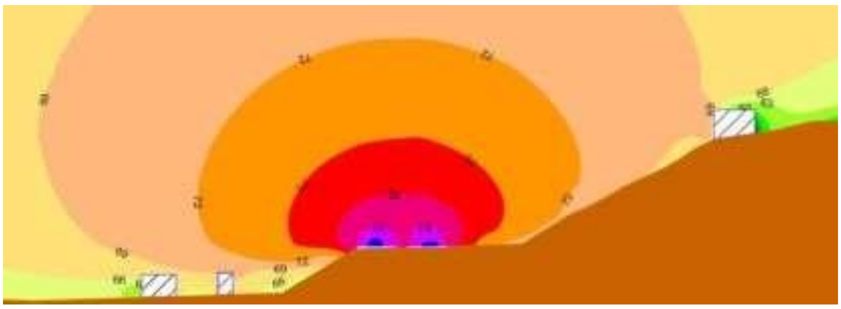


Cross section of embankment with isophones without noise protection measures

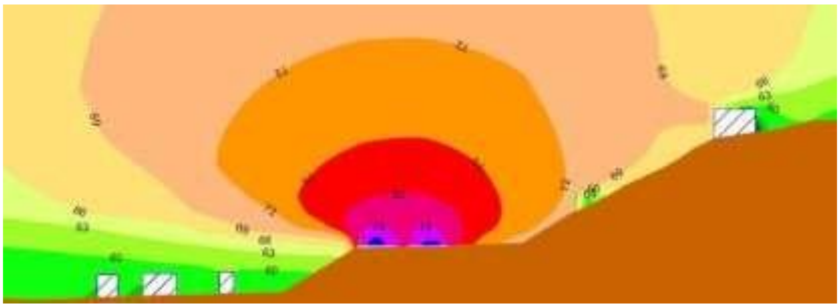


Cross section of embankment with isophones and noise protection panel

Terrain configuration has a crucial influence on the possibility of noise protection by using protection panels. The figure shows an example of a cross-section of a motorway where on the right side the building is on a higher elevation than the motorway. The figure shows that the designed height of the protective acoustic wall of 5m is not sufficient to achieve the anticipated standard, while on the left side of the motorway, where the building is below the level line of the motorway, a height of 2m was sufficient to achieve the anticipated standard of noise level of 60dB(A) in daytime situation. Passive measures are proposed for buildings that cannot be completely protected by protective acoustic walls.



Cross section of the side cut with isophones and without noise protection measures



Cross section of the side cut with isophones and with noise protection measures

Measures of noise reduction at its sources include the use of "silent asphalt" that reduces the noise, local speed limits, and optimized vehicles. The latter is beyond the influence of route planning and depends on the progress of vehicle production relating to noise emission and wheel design. Bearing in mind that a general intention of the motorway is to provide a fast traffic flow, speed limit is not considered something that can be applied unless there are some other more acceptable measures.

Restrictive speed limits can reduce noise emission; e.g. up to 2 dB(A), if the speed for passenger vehicles is limited to 80 km/h instead of 120 km/h, and the speed of large and heavy vehicles to 60 km/h instead of 80 km/h.

Construction of a special type of carriageway, the so-called drained asphalt that provides a smooth surface thus reducing the emission of wheel-generated noise is a significantly more expensive variant than a standard carriageway with asphalt-concrete.

Generally, this is a much more expensive option than the installation of noise barriers. In addition to that, a change of pavement (e.g. in the phase of road maintenance) could become one of the mitigation measures for the future negative impacts that shall be generated by increase in traffic.

In areas with a low density of residential buildings, or in case of individual detached residential facilities outside of rural areas, the installation of noise protection walls is not always economically justified since the number of protected facilities is not proportional to the scope and price of construction. For houses that are so scattered in high risk areas, the installation of soundproof windows (passive noise protection) is recommended. Passive noise protection is also chosen where the buildings are located at higher slopes above a motorway and even high noise protection walls cannot facilitate efficient noise protection due to the fact that noise disseminates upwards. Installation of soundproof windows is also recommended if the compliance with standard is not guaranteed by introducing protection measures on a motorway.

An approach to determine the required height of the noise protection walls

Isophone of the relevant noise was calculated in order to compare protective effects of various heights of noise protection walls on residential areas along the new motorway. These calculations served as a basis for determining the dimensions of noise protection walls depending on location (height and length) with the aim of meeting the standard 50dB(A) noise level at night-time. Certain mitigation measures are presented aggregately in the Table ____. The average wall height of 3 m was adopted for the calculation of noise levels. The analysis used the bases of the corrected route solutions from the Preliminary Design prepared in 2D. The calculated height of the walls is satisfactory in most cases, given that the motorway is largely set upon the embankment. Residential buildings located higher on the slopes relative to the motorway, above the effective height of the noise protection wall, especially those located right next to the route, would require noise protection walls 5 m to 10 m tall, which would not be a reasonable and cost-effective solution, and would block the residents' view. Soundproof windows (passive measures) should be installed in these buildings instead.

With the projected increase in traffic volume, it will be necessary to improve mitigation measures mentioned earlier. This will also depend on the actual traffic growth rate. Assuming no progress is made in reducing road or vehicle noise, 6 dB(A) for 2042. Additional noise protection measures may be required where settlements are located close to the route. In addition to the extension of noise protection walls, other mitigation measures mentioned earlier could be established to prevent exceeding the standards being applied to noise. As one of the justified measures, the road surface structure on certain sections could be improved during the general rehabilitation works by laying the noise-reducing drained asphalt, which decreases the noise emission level by 2-3 dB (A), and this would be a countermeasure for the increased noise from bigger traffic volumes on most sections. However, in order to mitigate the future negative impact of noise, it may be necessary to install windows for noise protection.

10.3.10. Infrastructure

10.3.10.1. Protection measures in the construction phase

Electric power system

All intersections of the future Vc motorway route with the mentioned 110 kV transmission lines must be constructed in line with valid regulations SFRY Official Gazette, Nos. 65/88, 4/74, 13/98 and SRY 61/95, at a point of intersection of existing transmission lines with the future Vc Motorway route. Utility poles must be adapted according to valid regulations and installed at a certain distance from the motorway.

The vertical clearance of power lines from the motorway level must comply with the mentioned legislation, Chapter VIII Articles 100-102, where the safe clearance of the lowest power line above the motorway must be at least 8 m, Articles 124-129, and safety distance of a pole from the motorway edge must be at least 40 m, Article 125 of the mentioned regulations.

Then, the existing poles must be mechanically and electrically reinforced in line with the regulations contained in Chapter V, Articles 41 and 42, Articles 45 and 46, as well as Articles 45-53 of the listed Technical Regulations, Off. Gazette of the SFRY, no. 65/88 and SRY, no. 61/95). In the tension field, where the transmission line and the motorway route shall intersect, suspension must be doubled and the tension force in the conductors must be reduced to that required by the regulations (75% of the normal tension force) Article 126 of the listed regulations.

With regard to static calculation at the location of intersections, utility poles at intersections of the motorway and transmission line must comply with the requirements listed in the mentioned Rulebook, Chapter II, Articles 3 through 11. Transmission-line cables at the point of intersection must meet the requirements of the mentioned regulations in Chapter III, Articles 12 to 23 and JUS N.C1 351/85 and JUS N. 702/85.

The planned Vc motorway route shall intersect a low-voltage grid in the settlements through which it passes. Since the regulations do not permit any installation of low-voltage grid either above or below motorways, the existing low-voltage grid must be relocated from the planned motorway route. Since the construction of the motorway must not cause the population to experience blackouts, new distribution transformer stations, 20 (10) kV transmission line connections and a new low-voltage grid are to be constructed on both sides of the planned motorway route for the facilities that experience blackouts during the Vc motorway construction.

Detailed requirements for intersection of the planned Vc motorway route and 0.4 to 400 kV existing electric grid shall be done in parallel with the motorway requirements, according to the main motorway design and state in the field.

The existing electrical grids shall be recorded on the spot during the elaboration of urban-planning and technical requirements; detailed urban-planning and technical requirements shall be elaborated and detailed intersection requirements shall be prescribed for each case of intersection of the Vc motorway with electric power line.

10.3.10.2. Protection measures in the operation phase

Since all necessary protection measures that will remove all possible conflicts shall be implemented in the construction phase, no special measures will have to be implemented in the operation phase.

11. ALTERNATIVE SOLUTIONS AND DESCRIPTION OF THE REASONS FOR HAVING SELECTED THE GIVEN SOLUTION IN TERMS OF ENVIRONMENTAL PROTECTION

Previous documentation, at the level of the Technical Study and Preliminary Design, considered several variant solutions/alternatives defined through several variants on the sub-section of the subject motorway. Evaluation of variant solutions from the aspect of environmental impacts was conducted as an integral part of the selection of an adequate route within the Preliminary Environmental Impact Study. The evaluation of variant solutions represents a process of documented evaluation of various alternative solutions for the purpose of mutual comparison and selection of the optimal one. For implementation of a valid evaluation process, it is necessary to have documented information, objectives and criteria on the basis of which the evaluation will be conducted.

A fundamental requirement for evaluation is that variant solutions are defined at the same level of detail, where all criteria and their indicators are defined on the basis of the same requirements and verified principles.

The specificities of the process of evaluation of variant solutions for the needs of the study analysis of environmental protection issues are reflected primarily in the simplicity of the main goal, which is expressed in the minimum total impact principle. This goal will be achieved only if all real variant solutions are compared according to defined criteria (impacts) and the optimal one is selected.

Taking into consideration the fact that the evaluation procedure is done at the level of a Technical Study, and that the level of available information acquired from the Impact assessment was relativized by the fact that all analyzed variants are relatively located in the same corridor, the process of evaluating the variant solutions can be expressed in the following way:

First step: implies the systematization of all limitations that have been obtained through the analysis of the existing state, which systematization is presented in the form of corresponding graphic documentation at the level of existing properties for all relevant indicators. The result of this analysis is a synthetic map of limitations that is graded over three basic categories of favorableness for the motorway construction from the aspect of possible environmental impacts. These categories are defined as total limitation, favorable, conditionally favorable and unfavorable. The methodology of generating a synthetic map in this way neglected the relative significance of individual indicators, that is, the principle of synthesis was significantly simplified in the sense that a certain spatial unit was classified favorable only if all indicators are favorable, or unfavorable if only one of the indicators is unfavorable, and conditionally favorable if only one of the indicators is conditionally favorable.

Second step: Given the fact that the synthetic map of limitations can be used to obtain the relatively rough relations for the evaluation of variant solutions, the second step was to assess the alternative solutions at the level of numerical quantification using multi-criteria ranking of the alternative solutions, so the selected variants from the Technical study can be further elaborated at the level of the Preliminary Design. The results obtained by evaluating variant solutions represent the selection of the optimal solution from the aspect of environmental impacts.

Since the aspect of environmental protection is not the only aspect relevant for the selection of one chosen route from all proposed variant solutions, the route selection was initiated by applying multi-criteria optimization for evaluation taking into account several relevant aspects. The first step in evaluation was the elimination of proposed variants that are directly connected with total limitations; and then the evaluation of the remaining variants was done, according to the elements listed in the protocol:

- A Technical – operational characteristics that determine traffic conditions, operational costs, costs of travel time, costs of accidents and maintenance costs,
- B Construction costs that significantly affect the profitability and economic and financial feasibility of the project,
- C Spatial-environmental characteristics, which predetermine the acceptability and feasibility of the project in terms of space usage, environmental and socioeconomic impacts on the environment, and
- D Time and conditions of construction that also have a significant influence on the final decision on acceptability and feasibility of the project.

The mentioned criteria were classified into several subcriteria, the scoring of which gave the assessment of the optimal variant from the aspect of a certain criterion. Since relations are not equal from the same point of view, and since the significance of special criteria is not the same, each point was multiplied with a specific weighting coefficient, which provided a unified evaluation.

Spatial-environmental characteristics predetermine the acceptability and feasibility of a project from the aspect of space usage, and environmental and socio-economic impacts have become increasingly significant in making decisions on investments. A principle of sustainable development increasingly takes to account the mentioned factors that relate to taking care of the human environment and development in line with the minimum disturbance of the environment, or in the worst case scenario, reducing negative impacts to an acceptable level.

The aforementioned was used to evaluate the convenience of alternative variants in some relations; this was done by a multidisciplinary expert team that applied a principle of secret valuation and selected the most optimal motorway route.

12. INDICATIONS OF DIFFICULTY IN THE PREPARATION OF EIA

The greatest difficulty in preparation of EIA for the water resource specialists has been the impossibility of insight in Design for drainage of wastewater from traffic areas of the motorway. Namely, the concept of preparing the EIA in parallel with the Preliminary Design, enabled the EIA developers to have insight only in the working versions of the adopted motorway route, with partially delineated facilities on certain sections. Accordingly, the Study developers had no insight in the solution for drainage, wastewater treatment, and places of discharge of wastewater from traffic areas. Given the unavailability of the above information, this impact assessment in the construction and use phases can only be given in general terms, and based on the literature. In numerous cases, there was the issue with a lack of data, i.e. the need to conduct detailed research of certain water phenomena in the advanced stages of design solution, having in mind their potential negative impact on the motorway as well as potential negative impacts of the motorway on them.

One of the difficulties is also the lack of a detailed hydrogeological map of the narrow belt around the motorway obtained on the basis of research/survey. Facilities for the treatment of wastewater off the motorway may, as a rule, be placed within the areas defined as sensitive in this Study, but a detailed hydrogeological substrate of the narrow belt around the motorway at a 1:5.000 scale should be consulted before final selection of the location of these facilities. It is necessary to pay attention to the fact that the facilities are not positioned in aquifer areas where high groundwater levels have been identified so as to avoid disrupting the hydraulic regime of groundwater flow, aquifer recharge disturbance, etc. Having in mind all of the above, it is necessary to inspect our assumed impacts on waters, on the basis of data that is to be received upon completion of survey works, that it, the hydrogeological maps and longitudinal profiles of narrow belt of the motorway in a more detailed scale (1:5.000).

13. MONITORING SYSTEM AND DETERMINATION OF METHODOLOGY

The Environmental Action Plan is an indispensable part of this documentation and its purpose is to ensure adequate implementation of the proposed protection measures. The EAP also facilitates insight into the effects of protection measures and introduction of the necessary improvements and corrections.

Design phase

A checklist in the design phase is necessary for the adequate consideration and examination of all environmental aspects and issues, i.e. to properly prepare the protection measure design. Special protection zones specified in the design must be respected and special protection measures adopted with regards to them. The same applies to the construction phase and must be emphasized in the tender documentation.

Construction phase

In order to meet all environmental requirements of the project, it is necessary to hire an environmental engineer (expert in ecology) who would oversee the manner of execution of works by conducting frequent inspections, thus protecting the interests of Investor.

The Contractor is also required to have a person or persons responsible for monitoring the implementation of environmental requirements as per tender documentation. This condition should be emphasized to the Contractor during negotiations, and prior to signing the contract.

The parameters monitored during the execution of works include the implementation of the adopted protection measures, and all these parameters will be frequently inspected by environmental engineers, and under the responsibility of the Contractor.

Maintenance phase

The environmental engineer is responsible for the provision of detailed procedures, technical manual/instructions on regular maintenance of drainage system, safety and light signaling systems, accident management (spill/leakage of hazardous substances) and maintenance of green areas (these documents can also be included in the tender documentation).

13.1. Water quality monitoring

The establishment of monitoring is an integral part of the observation and evaluation of changes in the environment during the phases of construction and operation of the facility. Monitoring the zero state of water quality is a precondition for conducting adequate analyses, and taking appropriate measures for both previously mentioned phases.

This study provides a plan for water quality monitoring in the construction and operation phases. Water quality monitoring should be conducted in accordance with applicable laws, as well as the Water Framework Directive.

As the most important element of the plan, it is necessary to project the establishment of a water quality monitoring system in the area of impact of the planned motorway, for: newly planned measuring profiles (4) before performing any construction works (zero monitoring), and for all profiles (4+5=9) for the construction and operation phases.

13.1.1. Baseline (zero state) water quality monitoring

13.1.1.1. Surface waters

After water sampling, the following indicators must be analyzed, which are characteristic for examining the impact of the road on quality of surface watercourses:

- Temperature
- Electrical conductivity
- pH value
- COD
- BOD_5
- Water turbidity
- Total suspended solids
- Annealing loss
- Chlorides
- Sulfates
- Heavy metals (cadmium, copper, chrome, zinc, nickel, lead, iron, manganese, mercury)
- Ammonia
- Nitrites
- Nitrates
- Total fats
- Mineral oils
- Total phenols
- Total organic carbon (TOC)
- PAHs-total (chloroform, carbon tetrachloride, tetrachloroethylene, trichloroethylene, trichloroethane).

13.1.1.2. Groundwater

In the area of our study, along the section, there are several groundwater sources that are in public water supply systems or are of local character (rural waterworks that are not included in the public water supply system, but are used to supply a number of households). Based on the available data collected during the preparation of these studies, the data were estimated to be of zero groundwater quality. These sources are:

- source Rudanka
- source Kraševo

At the Municipality of Usora locality, there are sources Makljenovac, Ularice and Alibegovci, for which the baseline water quality should be observed at the very source sites, and before executing any construction works.

At these sources, after taking water samples in two cycles, during one hydrological minimum and maximum, it is necessary to analyze the following typical indicators of the impact of the road on groundwater:

- Odor
- Color
- Taste
- Water turbidity
- Temperature
- Electrical conductivity
- pH value
- $KMnO_4$ consumption
- Fluorides
- Chlorides
- Sulfates
- Heavy metals (cadmium, lead, iron, manganese)
- Ammonia
- Nitrites
- Nitrates
- Total fats
- Mineral oils
- Total phenols
- PAH-total

The Investor, i.e. Contractor, shall deliver the report on conducted zero-state measuring of surface and groundwater quality to the relevant bodies and institutions in the water and environment sector in the FBiH.

13.1.2. Monitoring in the motorway construction phase

13.1.2.1. Surface waters

During the works on the construction of the motorway, due to the possible impact of the machinery used and the human factor involved, surface water quality monitoring must be conducted. Selection of profiles on which the monitoring will be conducted also depends on whether all subsections or only some of them will be built at the same time. These localities are determined depending on the construction site organization plan and dynamics of the works. These data ought to be specified in the Main Design, i.e. it is necessary to select measurement profiles for monitoring during the construction phase, depending on the section on which the construction site will be active.

With the aim of observing a direct impact on the surface water quality at the established active construction sites and machinery parks that are used for the execution of construction works, it is necessary to conduct more frequent – weekly analyses of water quality that include the following indicators:

- Water turbidity
- COD

- BOD_5
- Total suspended solids
- Total fats
- Mineral oils
- Heavy metals (lead)
- pH value
- Conductivity

The proposed shortened analyses of surface water quality are necessary only for the profiles in the immediate vicinity of the construction sites (where the construction machinery, personnel, etc. will be accommodated). These localities are determined depending on the construction site organization plan and dynamics of the works. These data ought to be specified in the Main Design, i.e. it is necessary to select measurement profiles for shortened analyses. Investor/Contractor will have to hire an environmental expert during this phase, who ought to monitor succession of construction on sections on a daily basis, from the aspect of potential impacts on the surface water quality on locations closest to construction site.

13.1.2.2. Groundwater

During the works on the construction of the motorway, due to the possible impact of the machinery used and the human factor involved, groundwater quality monitoring must be conducted.

Same as for surface waters, the selection of sources which will be monitored also depends on whether all subsections are to be built at the same time or just some of them, i.e. those sources closest to the active construction site should be monitored. As already mentioned for surface waters, it is necessary to specify these data in the Main Design, i.e. select measurement profiles for observation during the construction phase, depending on the section on which the construction site will be active.

13.1.3. Monitoring in the motorway utilization phase

13.1.3.1. Surface waters

As regards the aspect of the impact of wastewater from traffic surfaces on the quality of surface watercourses, which are potentially their future recipients, it should be noted that the design engineer envisaged a controlled closed drainage system in the Conceptual Design, which will be considered in more detail in the Preliminary Design.

During the operation of the motorway, wastewater starts coming off the road, and is collected and treated by a specific internal drainage system with ancillary facilities. The emission limit values in this wastewater should be satisfactory and harmless to the overall environment.

In case of wastewater discharge into watercourses, they must be treated to the point of achieving the same quality as the water-recipient, that is, to correspond in all parameters to the water class of its future recipient.

Measurement profiles for monitoring in the motorway operation phase should be specified in the Main Design, after the conducted hydrogeological research and thereupon precisely determined positions of oil and grease separators and plants for additional wastewater treatment, as well as after having found solutions for the wastewater discharge from them.

13.1.3.2. Groundwater

After commissioning of the motorway, it is necessary to conduct a monthly inspection of water potability at the sources (five identified) of the public and local water supply systems that are close to the motorway, for at least five calendar years. In addition to water potability inspection, local sources should also be inspected for their quantitative status, i.e. the yield of the source.

If during this period it is determined that there is no impact of the motorway in use on these sources, then the number and frequency of these analyses may be reduced.

13.1.3.3. Wastewater from oil and grease separators and treatment plants

It is necessary to control the quality of wastewater coming off road surfaces at the places of discharge from the oil and grease separators and at the places of additional wastewater treatment.

This control should be carried out four times a year, once during heavy rainfall as a must, once after the first rain in the summer, and after a long-lasting dry period, and after the most intensive usage of the road. Monitoring should be conducted on at least two separators' locations, on locations of discharge from the separators and before entering the filtration and after the filtration and prior to discharge of wastewater into the recipient or soil.

Monitoring locations should be specified in the Main Design, after the conducted hydrogeological research and thereupon precisely determined positions of oil and grease separators and plants for additional wastewater treatment. It should be emphasized that these monitoring activities would include separators placed at locations that, after a detailed hydrogeological research, are evaluated as zones and places at the highest risk of groundwater pollution. At the same time, testing has been proposed of the receiving capacity of the filter sediment at least twice a year for certain indicators.

13.2. Soil monitoring

13.2.1. Baseline (zero state) soil monitoring (before the commencement of works)

Determining the zero state and monitoring the state of soils on the Corridor Vc section is one of the major preconditions in creating special precautions and soil protection measures on the jeopardized parts of the route.

The responsibilities of the program proponent should include establishment of a competent survey team, who would execute the field work, sampling, laboratory analyses of the soil and data processing, as well as develop the Study on the current status and monitoring program, namely:

a) Field research

Reconnaissance and sounding of the terrain in the 500 m wide belt on each side of the route, with a view to identifying pedosystemic affiliation of soils and cartographic units.

- Carry out soil sampling, one average sample from the surface layer of the intact - natural soil on the route on average every 2 km.
- For each major soil type, one average soil sample should be taken on a location precisely determined by GPS, which location would be used for a continuous monitoring of the soil status.

- Carry out assessment and detailed observation of the status of crops and natural - forest vegetation on the route, and status evaluation. The method of comparative phenological observations will be used for this purpose.

b) Laboratory analyses

For the purpose of identifying the soils, the laboratory would carry out the standard chemical analyses of all samples that would include: pH, humus, hydrolytic acidity, analysis of adsorptive complex, content of NPK nutrient. In addition, the analysis of heavy metals and PAH - polycyclic aromatic hydrocarbons will be performed in all samples taken.

13.2.2. Monitoring during the construction phase

During the construction phase, an important prerequisite is a good and competent organization of the construction site, which must comply with the aforementioned statements and recommendations, as well as apply the rules of good practice in this field. Supervision over the execution of works should be conducted by an adequate inspectorate that should also include experts in the field of environmental protection, and especially soil protection. The design should precisely define a spatial zone, within which the contractor shall be able to move the plant and equipment during construction; thus avoiding misunderstandings with local population and damages that exceed the necessary scope.

"Excessive" felling of forests and removal of vegetation outside the areas set in the design are very common, and has adverse consequences to the environment.

The erosion of small particles during excavations for channels, where they are emitted into the air, watercourses or onto the soil surface, must be reduced to a minimum because this disturbs terrestrial and aquatic biodiversity; they also transfer heavy metals such as lead and cadmium.

Materials that are installed must also be controlled during construction; these may be contaminated with radionuclides, something which can occur following a flood of diverse materials into the market; some natural materials can also be contaminated. If soil is contaminated in any way (oil, lubricant or some other organic of inorganic pollutant) during construction, soil from the area must be removed and deposited in line with decontamination regulations, at a distance from watercourses and from areas of potential pollution impacts on groundwater and karst.

Treatment of wastewater from the construction site must be controlled during the construction; it must be prevented from entering watercourses directly without previous treatment in basins, ponds, fenced-off pools and similar structures which address both sedimentation and wastewater treatment.

During motorway construction, it is necessary to monitor impacts that occur during the blasting and other dynamic works.

13.2.3. Monitoring during the operation of the motorway

The research that will be done during the preparation of the Zero-State Study will continue in the monitoring period during the construction of the motorway, but also upon its completion. The analysis of samples would be conducted once a year along the motorway route. The selection of locations, as already stated, will be based on the type characteristics of soil, and other pedo-genetic factors deemed important for a particular microlocation.

Exact locations will be established upon the completion of each section, whereby the locations that will cover the immediate area along the highway and at a proportional distance from the edge of the highway will be determined. Monitoring of the status changes would be done on the same location over a long period of time, and the selected indicators would generally center on chemical changes and accumulation of pollutants, with a possibility of expanding the research depending on the changes in the field. Special attention would be given to measuring the level of heavy metals such as Cd, Hg, Pb, Mo, As, Co, Ni, Cu, Cr, Zn, content of PAHs (polycyclic aromatic hydrocarbons) and, if necessary, oils of mineral origin.

Regular monitoring of the drainage system maintenance is crucial in protection and preservation of environment, as it should provide unimpeded transport of all run-off waters coming from the road itself and its surrounding. Inspection and cleaning of the wastewater collection and sedimentation facilities are also extremely important as they are the key barrier to the pollutants getting in the watercourses and potentially the surrounding agricultural land.

Control over the operation and maintenance of at the gas stations as well as other infrastructure along the motorway plays a significant role in soil and water protection and prevention of accidents. Solid waste disposal and liquid waste treatment should be in accordance with the strictest criteria in the field of waste management.

The monitoring should be executed by an institution competent for this type of work, and reports on the status of monitoring of the future motorway should be regularly submitted to the future road administration and the competent ministries of environment. Data must be public and accessible to all parties interested in this issue.

13.3. Ecosystem condition monitoring (biological monitoring)

Zero-state ecosystem monitoring

An integral part of monitoring and mitigating the impact on the water ecosystems of the motorway is also monitoring the quality of surface waters in the construction and operation phases. Adequate evaluation of water quality is also possible according to the qualitative-quantitative composition of phyto and zoobenthos biocenoses and ichthyopopulations. Due to their high sensitivity to the degradation of the aquatic ecosystem, these organisms react very quickly, which can be monitored through their presence or their population numbers.

Monitoring in the construction phase

Monitoring the status of surface watercourses through biomonitoring greatly contributes to the adequate management of natural resources and the revitalization of everything that makes up the construction of motorways. Biological monitoring in the construction phase would be conducted every four months during one year, and would include analysis of the composition of phytobenthos, macroinvertebrates of benthos and the composition of ichthyopopulations.

The approach, profile selection and dynamics for this monitoring should be fully aligned with the proposed surface water monitoring in the construction phase.

During this phase, it is necessary that Investor or Contractor hires an environmental expert who would, on a daily basis, monitor the sequence of construction by sections, from the aspect of potential impacts on the state of ecosystems in the immediate vicinity of the construction site.

Monitoring in the operation phase

Biological monitoring in the motorway operation phase would be conducted every four months over one year, and would include analysis of the composition of phytobenthos, macroinvertebrates of benthos and the composition of ichthyopopulations.

The approach, profile selection and dynamics for this monitoring should be fully aligned with the proposed surface water monitoring in the operation phase.

14. MEASURES RELATED TO WORKING CONDITIONS IN EXTRAORDINARY CIRCUMSTANCES

The environmental impact assessment should also include impacts resulting from accident situations in the motorway construction and operation phases, which pose a risk in terms of potential adverse impacts on the environment.

There are several types of risks that may arise during the construction and operation phases of the planned motorway. It is common for all accident situations to be analyzed within four possible groups:

- The first group of possible risks is present in all situations when the planned environmental protection measures during operation prove to be unsuccessful.
- The second group of possible risks is related to accident situations that may occur in the phase of executing the works, and of the road maintenance works during operation.
- The third group of possible risks is related to accident situations resulting from accidents of that involve vehicles transporting dangerous good.
- The fourth group of possible risks occurs as a consequence of natural disasters in the form of floods, fires, or earthquakes.

The probability of stated risks depends on several factors, it is usually low, but if they occur, serious consequences are possible. The seriousness of the possible consequences is also the main reason for the analysis of the risk of accidents in the process of assessing the subject section impacts on the environment.

14.1. Risk of inadequate protection measures

The failure of prescribed and implemented environmental protection measures may in certain circumstances lead to consequences similar to those analyzed within each of the impacts; however, evident is the presence of a certain risk that can lead to much more significant consequences for the environment.

The risk of these, and similar events, must be analyzed and adequate measures prescribed in order to prevent the problem from getting bigger, which primarily implies the efficient protection against the traffic noise and especially against pollution of water supply sources.

Given the planned environmental protection measures for this specific spatial unit, the risk associated with inadequate solutions may primarily be present in an inadequately implemented system for the collection of atmospheric water, protection of sources, and noise protection. To diminish the probability of these risks, the planned systems must entirely be done in accordance with the technical documentation, and in addition to that:

- Permanently monitor the state of the environment in the zone of the planned motorway (monitoring) and ensure conditions for additional protection measures to be taken in a timely manner;
- Prescribe adequate maintenance measures aimed at protecting the environment in the field of all possible impacts;

- Plan supplementary protection measures in all those places where inefficiency of already taken measures has been proven during operation, or where the possibility of risk due to inefficiently taken measures has been proven.

14.2. Risk of accidents during construction and maintenance

In the period of construction and maintenance of the motorway, circumstances may arise that lead to unwanted and unfortunate cases, most often in the field of risk to the health and life of the immediate participants in the work process, but also the users of the motorway.

Potential accidents can be the trigger of mishaps during the road construction and maintenance works, which mishaps can cause exposure to hazardous chemicals or injury to workers.

Road construction also implies both health and safety risks for the workers who operate machines, handle hazardous materials, power sources or are exposed to adverse spatial conditions during construction (exposure to dust and toxic fumes from chemicals used during the works, exposure to lead-based paint in maintaining the structure of the bridge, scaffolding falls, etc.)

Observance of the basic principles in the field of safety at work will ensure a significant decrease in possible risks during the execution of works. Limiting the time of exposure to dust particles, chemicals, and noise, and wearing protective clothes and goggles for special works can reduce the risk of unwanted consequences. The procedures on handling toxic materials, explosive and other hazardous substances must be fully elaborated.

A particularly significant part of the risk is related to the performance of works under traffic. To diminish these risks, a number of procedures in the field of work performance organization are necessary. In order to lessen the possible risks, it is necessary to develop comprehensive plans for carrying out works under traffic on the existing roads in the area of the planned motorway.

14.3. Risk of accidents involving dangerous goods

Considering all the circumstances that characterize the motorway operation and, above all, having in mind the possibility of a chemical accident as a result of a crash involving vehicles transporting such substances, it is necessary to analyze the possibility of such occurrence so as to be able to develop special procedures relating to this subject.

The planned motorway has been identified as a road on which the extensive transport of hazardous materials will be conducted, given the fact that it connects spatial units of international importance.

Hazardous materials imply all those substances that have very toxic, oxidizing, explosive, ecotoxic, flammable, self-combustible and other properties dangerous to human life and the environment. Each road has a certain role in transport of hazardous materials with regard to its position in the network, and possible consequences are particularly emphasized in biologically valuable areas as well as in places of the concentration of traffic flow, which surely is the characteristic of the planned motorway. Given the characteristics of transport conducted over the planned communication, the following hazardous materials can be expected:

- Flammable liquids - which are transported in tank trucks, and various oils (machine, engine,

reduction, hydraulic, emulsion), which are transported in different packaging,
- Compressed gases - propane, butane, which are packed in special steel containers,
- Oxidizing agents - chlorides, peroxides, which are transported in tank trucks,
- Abrasive or corrosive liquids - sulfuric, hydrochloric and nitric acid, which are transported in tank trucks or in balloons,
- Poisonous and contagious materials – pesticides, herbicides packed in sacks and small carton boxes.

Materials that do not belong to the mentioned groups and that during transport can act as pollutants in case of accidents, are the foodstuffs transported for commercial network, agricultural products, industrial final goods, construction material, textile industry products, technical ware, etc.

The risk of accidents involving hazardous cargo can be defined if the structure of transport and basic data on the traffic accidents on the concerned section are known. Based on these data, it is possible to determine the probability of a potential accident and take special protection measures accordingly. Considering the number of accidents on the planned motorway, it can be concluded that the probability of accidents involving a vehicle with hazardous materials is unlikely but certain, which is why it is necessary to take appropriate environmental protection measures

- 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 surface only by mechanical means.
- In case of accidents with vehicles transporting hazardous liquids, traffic shall be immediately stopped, the competent service alarmed and specialized teams for rehabilitation of damage engaged. The spillage should be removed off road surface with special sorbents. If the liquid got outside the profile and contaminated the soil, rehabilitation is done by removing soil. All materials collected in this way are treated using special regeneration methods or are disposed to sites intended for such materials.

14.4. Risk of natural disasters

Disasters can affect the road and its surroundings, and the road can be a key factor in planning emergency actions. Natural disasters can damage the road and the road can be a factor in spreading or mitigating the impact of these disasters.

- The road was designed in the area that is exposed to the flood wave of the Bosna and Sava Rivers. The leveling relations of the planned motorway guarantee safety with this natural phenomenon.
- All facilities on the road and the road base are designed to provide safety in relation to the occurrence of earthquake.

ENVIRONMENTAL IMPACT STUDY
NON-TECHNICAL SUMMARY

NON-TECHNICAL SUMMARY

Purpose and objective of the Project

Corridor Vc is included in the TEM transport infrastructure network of Southeastern Europe, and runs from Budapest (Hungary), via Osijek (Croatia) and Sarajevo (BiH), to the port of Ploče (Croatia). The route of Corridor Vc in BiH is approx. 330 km long and runs in the north-south direction, through the central part of the country, utilizing the most favorable natural conditions, along the valleys of the Bosna and Neretva Rivers.

The transport Corridor Vc stretch through BiH includes:

- E-road E-73 Šamac - Doboj - Sarajevo - Mostar - Čapljina - Doljani, which reaches the Adriatic Sea via the port of Ploče, while Budapest is its connection point in the north,
- Railway Šamac – Doboj – Sarajevo – Mostar – Čapljina – Metković
- Sarajevo and Mostar airports
- Waterways and ports on the Sava, Bosna and Neretva rivers

In the 1970s, the UNDP Geneva proposed the initiative and the plan to improve the motorway network in Europe. The project also included the Baltic Sea-Adriatic Sea (Baltic-Adriatic) motorway, called the TEM.

At the Third Pan-European Transport Conference, which gathered the European Union member states and international organizations involved in the development of infrastructure in Europe and was held in Helsinki in 1997, the "Helsinki Declaration" was adopted, laying the framework to construct additional 10 Pan-European corridors, including the motorways.

That Declaration also defined the routes of these 10 Trans-European corridors and their branches. The choice of the route direction through BiH was defined under item Vc of the Pan-European Corridor (Budapest-Osijek-Sarajevo-Ploče).

As already mentioned, Corridor Vc belongs to the Pan-European network of corridors connecting the central part of the Adriatic coast, which has great tourism potential, but more importantly the port of Ploče, with Corridor X between Zagreb and Belgrade, ending at the Budapest junction. With the planned increase in the capacity of the port of Ploče, the Corridor has the potential to enhance trade relations for the countries in the region, and for Bosnia and Herzegovina, the Corridor has the potential to improve trade with neighboring countries and Central Europe.

All study and design documents for the motorway aim to provide a comprehensive analysis of the need to improve the quality of transport, capacity and traffic safety in the corridor by constructing a full-profile motorway. Study sponsors and financial institutions will use the study output as a basis for making investment decisions. This should particularly be kept in mind while preparing the Prefeasibility Study and the Environmental Protection Study.

Pursuant to the Pan-European Transport Initiatives and Helsinki Declaration, which have been embraced as a great opportunity for Europe and particularly BiH, increased activity in BiH has recently been observed in preparations for the construction of high-order roads, i.e. motorways and expressways, in order to meet the needs of the population and economy, and to influence the overall development. Along with other roads (Banja Luka-Gradiška, Tuzla-Orašje and Adriatic-Ionian motorway), preparatory activities have also started for the motorway on Corridor Vc. Hence the Ministry of Transport and Communications of BiH:

- issued the Decision on existence of public interest in constructing the motorway on Corridor Vc through Bosnia and Herzegovina on the basis of a concession granted on the section and route to be defined by contract (Off. Gazette of BiH, no. 23 of 7 August 2003),
- signed the agreement and agreed on the border crossing point between the Republic of Croatia and BiH on the Sava River (Svilaj-Odžak) as part of the motorway route along with the route coordinates (3 September 2003),
- deliberated on the proposal of the Republic of Croatia to determine the southern junction point of the motorway on Corridor Vc, and concluded that, due to the insufficiently elaborated design documentation and complexity of connection to the Adriatic-Ionian motorway, determining the position of this point requires a more detailed design documentation,
- continuously exchanged information and views with representatives of the Republic of Croatia and the Republic of Hungary regarding the preparations for the construction of the motorway on Corridor Vc,
- provided the necessary funds for the preparation of planning and study documentation and other preparatory activities for the motorway on Corridor Vc.

Taking into account the country's indebtedness, the status with the World Bank and International Monetary Fund as well as the impossibility of significant borrowing or allocation of funds from the budget, the Council of Ministers of BiH decided that one suitable way to finance the construction of this motorway would be through concessions. Thus the Council of Ministers of BiH made a decision to proceed with the preparation of the study and design documentation as the basis for defining solutions and creating conditions to find the way of financing the construction of the motorway.

Besides BiH, both Hungary and Croatia have also expressed great interest in the construction, intending to construct parts of this corridor, at the motorway level, on their territories by 2010. Thus, the motorway on Corridor Vc Budapest-Osijek-Sarajevo-Ploče through BiH is one of the most important and top-priority projects for BiH.

The objective of the study and design documentation is to determine the economic rationale for the construction of parts of the motorway and the motorway as a whole, as well as the conditions for the project's cost-effectiveness, and that, based on the prefeasibility study, the interest in getting a concession for the entire motorway route through BiH be examined by announcing the International Invitation to Tender. The secondary objective is to attract foreign investments, kick-start the investment cycle by launching the construction works at several points, and enable the development of follow-up activities along the route of the constructed motorway.

Complete planning and design documents in their final form will serve as a basis for submitting the request to obtain the urban planning consent for individual sections of the motorway. There is political willingness to support the development of the country by approving the project, construction and operation of the motorway in a cost-effective manner, and as soon as possible.

Following the political decisions to accelerate the preparations for the construction of the motorway, the study and design documentation for the entire length of the route got underway in line with the contemporary standards of research and design, and in accordance with the standards of the World Bank and other international financial institutions.

Upon its completion, the motorway is expected to be a key driver of economic activity and to enable BiH's inclusion in the main European transport communications network, and the global European economic system. The motorway will achieve a rational connection between Bosnia and Herzegovina and its neighboring countries and regions, and have stabilizing and developmental effects on the country. Improved transport conditions will enhance quality of life, which will be manifested through:

- reduction of travel distance and travel time for goods and passengers,
- cost reduction in transporting goods and passengers,
- increased employment,
- valorization of geo-traffic position of BiH,
- increased economic competitiveness in the corridor catchment area,
- launching new projects and increasing private investments in the regional economy.

The commissioned study and design documentation aims to provide a comprehensive analysis of the need to improve the quality of transport, capacity and traffic safety in the corridor by constructing a full-profile motorway. Study sponsors and financial institutions will use the study output as a basis for making investment decisions.

General description of the Project

Individual sections of the motorway have so far been considered in the form of studies, conceptual designs and preliminary designs. The motorway route may be found in both previous and current spatial plans. Since a prefeasibility study is required for the entire route through BiH, the subjects of two separate Contracts (Lots) are anticipated to be the Traffic Study and Prefeasibility Study for the Sections Svilaj - Sarajevo South and Sarajevo South - Border South. Each of these two sections represents a special, distinctive whole. Thus the study and design documents for the motorway through BiH shall be observed in six functional units through six Contracts (six Lots), while the study and design documents for the entire route length ought to be approached bearing in mind contemporary research and design standards, TEM standards and guidelines, as well as the standards of the World Bank and other international financial institutions.

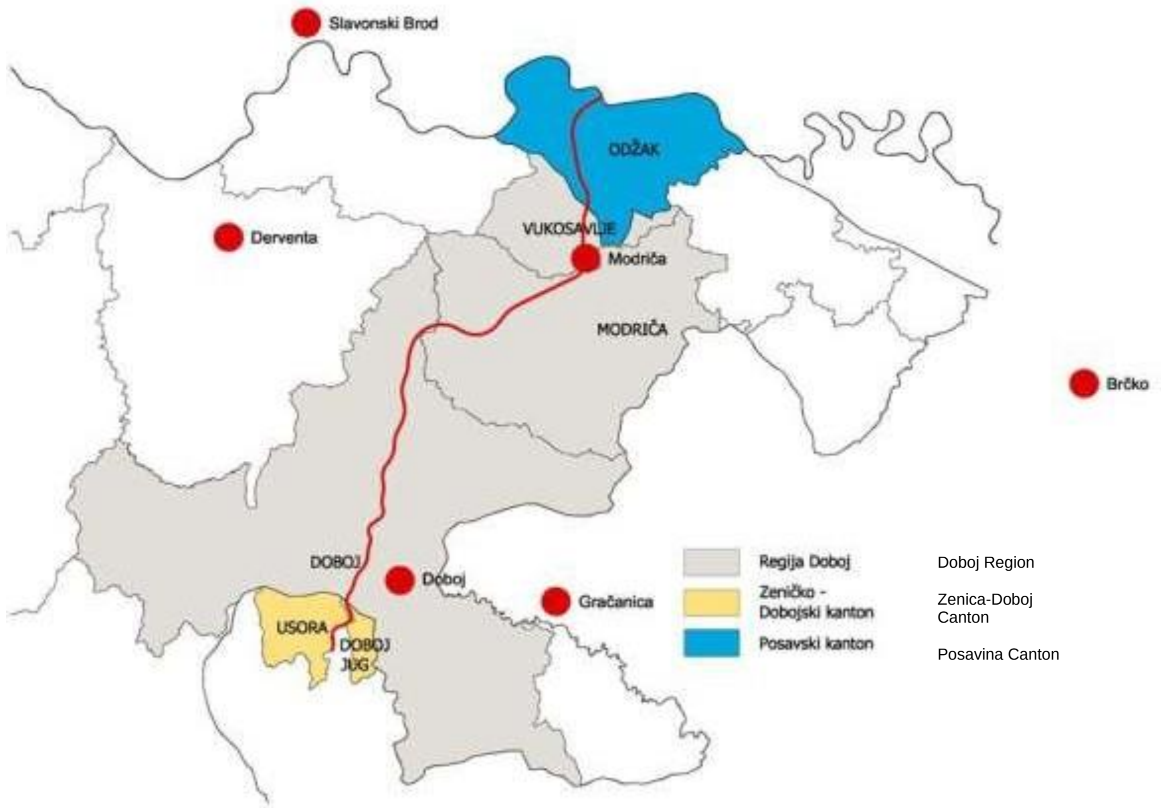
The future motorway route is divided into four design sections, i.e. LOTs, of which LOT 1 includes the Section Svilaj – Doboj South (Karuše) – approx. 63 km long. The Lot Svilaj – Doboj South (Karuše), to be more efficient and operational, is divided into six sections, two of which pass through the Federation of BiH:

Section 1: Svilaj – Odžak,..approx. length of 11 km

Section 2: RS Entity border – Karuše..........................approx. length of 5 km

In addition to the motorway on Corridor Vc, the studies also include the necessary access roads to all cities and settlements close to the route, as well as the Doboj bypass.

LOT1 begins with the bridge over the Sava River (the bridge is a joint investment with the Republic of Croatia) and, in its initial part, runs along the valley of the Bosna River passing by the settlement of Vukosavlje, through the town of Modriča, to the village of Podnovlje. The route is laid along the western rim of Posavina region, and then on the terraces along both banks of the Bosna River. In this part of the route the terrain is flat and suitable; the road lies mainly in the embankment. The soil is made of layers of alluvial sediments found in Posavina and the Bosna River valley, which means it is stable. The highest altitude of the route is 130 masl. There shall be five larger bridges in this part with a total length of approx. 1700 m, two locations with ancillary service facilities. At the approx. chainage km 7+100, the ancillary service facilities "Potočani" (Type C) are built, opposite each other, one for each direction, and at chainage km 30+410 the ancillary service facilities "Podnovlje" as well as three interchanges - – "Odžak" at chainage km 9+410, "Vukosavlje" at chainage km 16+340, and "Podnovlje" at chainage km 32+590. The longest facility is the interstate bridge on the Sava River, about 600 m long, for which the Republic of Croatia has prepared the Conceptual Design that should be reviewed, and the follow-up activities proposed. Besides this facility, bridges are planned at chainage km 16+630 (town of Modriča) – 512m long, at chainage km 23+940 – __ long, at chainage km 27+220 – 245m long, and at chainage km 27+860 – 350m long, each over the Bosna River, since the route intersects the river on several occasions in the zone of Donje Polje. The route also intersects a number of smaller waterways and local roads. The total length of larger bridges in this part is 1650m (excluding the bridge over the Sava).



The motorway has been designed with two carriageways, divided by central reservation, each with two traffic lanes and one breakdown lane. All technical elements of the motorway have been defined according to the Terms of Reference and Rulebooks for the category and importance of the subject motorway for the design speed Vp=120km/h.

Methodology of EIA preparation

Regardless of the already stated fundamental views related to environmental protection issues and certain characteristics of the methods used in the process of impact assessment for the needs of this study, there are a number of facts that require a more detailed analysis of the research methodology applied, where special attention should be paid to the steps taken respecting hierarchy, their objectives and relation to the very planning and design process. This analysis is required in order to make the necessary comparisons with the applied methodology used for the purpose of this study and the methodological bases that are valid within the general legislation regulating this issue (Rulebook on plants and facilities for which the environmental impact assessment is mandatory and plants and facilities which can be constructed and commissioned only if they have the environmental permit (Off. Gazette of the Federation of BiH, no. 19/04)). The main goal consists primarily in trying to adapt the general methodology to the specifics of the subject road and methodological steps in the preparation of the planning and design documentation.

As part of preliminary activities and in line with the legislation requirements of Bosnia and Herzegovina, the analysis of environmental impact in such projects is conducted in two stages: the relevant Ministry prepares the Preliminary Environmental Impact Assessment based on the preliminary assessment documentation, and the relevant Ministry issues the Environmental Permit based on the Terms of Reference of the Ministry and the Environmental Impact Study done on the basis of the Terms of Reference.

General methodology

In order to accomplish the preliminary objectives, the processes of road design and environmental impact assessment will have to be comparable and harmonized on all levels, with a clear hierarchy structure and an established order of mutual data exchange. Based on the presented facts, it is unequivocally clear that there must exist a unique methodological basis with clearly defined steps for the analysis of environmental issues.

The need for unique methodological steps in researching environmental issues stems from the necessity to meet the basic principles of compatibility, harmonization of analysis levels, hierarchical order and successive exchange of information.

The principle of compatibility of the processes of road design and environmental impact assessment is important since it serves to ensure that, first, the results obtained by one process can be used by the other, and secondly, as information, they can be used more broadly and have greater application within both areas.

The need to harmonize levels of analysis is equally important given the scope of approach, the level of detail in the existing and obtained information as well as the elements of any analytical apparatus used. All analyses and conclusions must be at the equal level of detail as only like that will they be relevant for making the right decisions and may be the starting base for further steps.

The hierarchical structure of methodological steps is the prerequisite for the correct methodological approach, enabling primarily the compliance with the established order of actions and the creation of a basis for decision-making. All conclusions drawn from the previous phase are the obligation and the starting base for each subsequent step.

The need for a uniform order of data exchange between these processes is conditioned by the fact that the results of one process represent the input data for the other, and vice versa. It is important to emphasize that this order is not arbitrary but strictly follows the logic of both groups of analyses and their interrelatedness. Another important fact refers to the multidimensional harmonization of these data, both for the needs of the processes and for the needs of creating unique information bases of greater significance.

Having in mind the global character of the environmental protection issue, the basic methodological steps are defined in a broader context. This context implies the process of spatial planning that integrates the specific planning procedures characteristic for the road, given its functional requirements and distinctive consequences. The design process itself must be defined through the common methodological steps compounded with the steps of the preparation of investment documentation.

In terms of these facts, the Environmental Impact Study is a key step in the positive approach to environmental issues. With the selection of optimal design solutions as the essence of the appropriate design phase, it is clear that this level may provide the only real opportunity for environmental protection. The preparation dynamics must be in balance with the preparation dynamics of other design documentation. Part of the most extensive spatial analysis done in the preliminary phase must precede the actual design work. Since this is about the spatial distribution of potential pollutants, it is very important to systematically define all impact criteria and quantify them through appropriate indicators. The informative basis of this study is a 1:25000 scale base map. The purpose of this documentation is to serve as a means of wider communication between all interested parties.

Bases for environmental impact assessment

All types of transport systems, with their current characteristics, represent sources of significant environmental pollution. In this sense, the planning, design, construction and operation of motorways is a very important issue in preserving and protecting the environment.

In view of the stated, it can be argued with certainty that the planning and, consequently, the construction of high-capacity communications, which by its nature the Svilaj – Doboj motorway certainly is, always brings about a series of conflicts between the motorway and the environment.

The global analysis of the motorway impact on the environment shows that all effects manifest themselves within three basic types of impact. The first type is represented by impacts resulting from the construction of the facility and being mostly temporary by nature. They are a consequence of human and machine presence, as well as the technology and organization of construction works. As a rule, negative consequences occur as a result of excavation/dumping, transport and building in large quantities of construction materials, as well as permanent or temporary occupation of the area and all related activities.

Environmental impacts that occur as a result of the existence of the motorway in space and its exploitation over time are mainly permanent in character and, as such, surely represent the effects that are particularly interesting from the aspect of the motorway - environment relationship. These impacts in most cases possess the character of spatial and temporal growth, which warns us of the need to pay attention to their nature in a timely manner.

All processes within the complex motorway - environment relationship take place on the basis of the interdependence of a multitude of relations, and as a result thereof, many changes happen. These changes range from quite insignificant ones to ones so radical that certain elements completely lose their basic characteristics. A systematic approach to these relations through the analysis of individual criteria produces satisfactory results in the majority of cases, only with their objective quantification and consistent adherence to the hierarchy of methodological steps.

Each of the criteria may become dominant in certain conditions, but the practice to date has outlined the basic relation matrices, which does not mean that in the future, with the development of certain knowledge and sharpening of environmental awareness such matrices will not undergo changes, on the basis of which we define the majority of potential impacts.

Within this research, respecting all the specifics that characterize the route of the planned motorway, and local spatial relations, consideration was given to the basic criteria that turned into indicators through quantification procedures with the basic intention to quantify future relations in detail and define the true nature thereof. Based on the prescribed limit values of certain impacts and their projected values in the context of future relations, adequate environmental protection measures have been proposed.

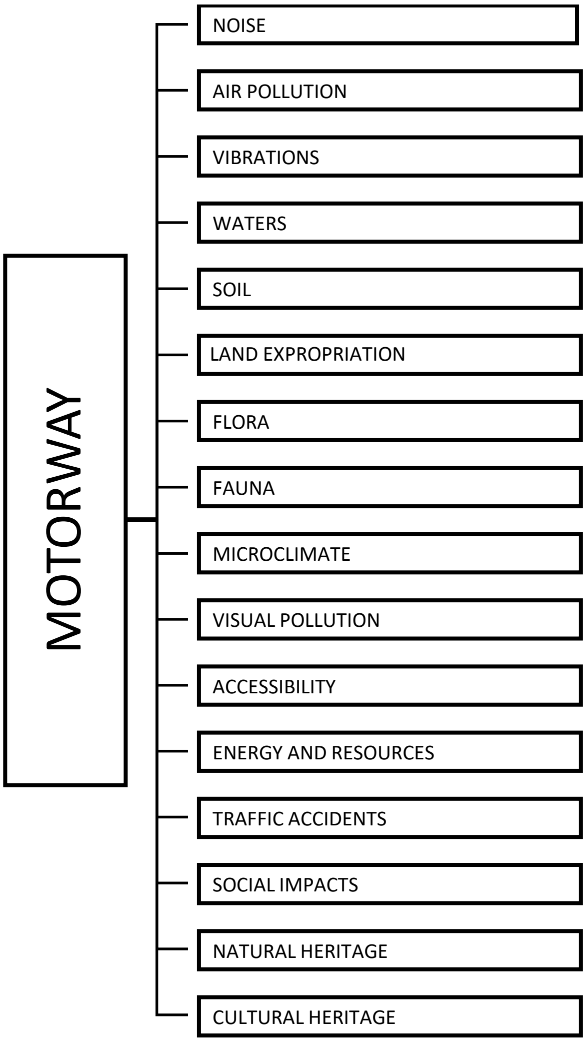
The analysis and assessment of the current state of the environment, as well as the assessment of possible impacts resulting from the construction of the planned motorway show that unambiguous quantified data may be obtained only on the basis of a comprehensive analysis.

All previous experiences in this issue show that today we can speak with sufficient reliability about the known impact matrix, always bearing in mind that such matrix is a spatially and temporally variable category and that both the relative importance of individual impacts and their absolute boundaries must always be observed in real spatial relations. These facts primarily mean that each impact must be quantified through verified procedures and that its true significance must be determined depending on the specific local relations.

In order to adequately quantify the significance of each impact, it is necessary for specific conditions to associate each impact with a series of indicators which, by the nature of things, should be exact values, then simply used in the process of defining the necessary measures of protection. Part of the problem in the relationship between the motorway and the environment lies in the fact that for certain impacts, which we know to exist, the exact indicators cannot be determined and that part or all of the impact takes place in the sphere of a subjective relationship.

Defining individual impacts (criteria) and their indicators in detail is essentially related to the phase of the project for which the analyses are performed. As each phase of the project or planning documentation is related to the characteristics of the information base, which entails all important facts regarding the scope and accuracy of available information, the possibility of quantification and the accuracy of exact indicators are limited by these facts.

The basic impacts (criteria) have been defined in this research based on the previously defined facts and concrete location conditions.



Matrix of analyzed criteria

The matrix of analyzed criteria is the result of previous knowledge about issues in the relationship between the motorway and the environment. What is clear at first glance is the fact that not all criteria are equally important, especially if we take into account the specific spatial relations within the analyzed area.

The issue of air pollution is a factor that requires quantification given the potential impacts along the planned section of the motorway, primarily in relation to the flora, and also to a limited extend the human population and facilities.

The issue of noise in the analyzed area is present primarily as a parameter of current and future relations along the planned motorway in relation to the population inhabiting the analyzed area.

The issue of water pollution is a criterion of significance primarily in the context of pollution of the Bosna River and its tributaries.

Soil pollution, land expropriation and accessibility issues are important criteria in these circumstances, given the fact that the analyzed corridors intersect the land in the valley of the Bosna River, which land is the characteristically reproductive soil.

The specifics of spatial relations in the zone of the analyzed corridors determine the importance of the impact on the flora and fauna, since the existence of certain potentials in this domain has been confirmed within the analysis of the current state.

The existing relations within the analyzed area condition the lesser importance of other criteria. Lesser importance is reflected primarily in two basic phenomena that can be defined as: local spatial distribution of impact or low intensity along the analyzed corridors. Microclimatic impacts and impacts related to resources and energy are local in character.

Impacts in social sphere shall have certain significance, primarily in the context of the current situation along the valley of the Bosna River. The construction of the new motorway in this area will bring significant economic changes.

All these facts show that the clarification of relations in the field of environmental issues can be expected only if each of the mentioned criteria is analyzed within specific spatial relations and through quantification procedures turned into a representative indicator.

Taking into account specific location conditions, characteristics of traffic flows, the intended use of areas inside the corridor, as well as the fundamental laws of relevant relations within most criteria that define the motorway – environment relationship, based on quantified indicators, the requirements for necessary protective measures shall be specified.

Population

The Posavina Canton, with the area of 324.6km^2, makes 1.2% of the territory of the Federation of Bosnia and Herzegovina, and has 1.9% of the total population of the FBiH. The average population density of 137.5/km^2 is above the average density of the Federation of BiH (89.1/km^2). The growth rate in the Posavina Canton is 2.4% and the population density is rather high in comparison with the Doboj Region.

As regards the Zenica-Doboj Canton, there are two municipalities in the scope, Usora and Doboj-South. The area of this Canton is 3343.3 km^2 with a population of 401.667, and the average population density of 120/km^2.

The impact this road will have on the social environment may be observed only if specific social groups are clearly determined, as users of the space and facilities thereon in relation to which this phenomenon may be studied. In terms of the above, in the specific conditions related to the planned motorway, two basic groups of population of interest can be clearly distinguished. One group consists of road users, while the other consists of residents along the road and property owners who will be affected due to the planned construction.

The first social group consisting of road users shall benefit from the fact that the construction of the planned road shall significantly improve traffic safety, reduce fuel consumption (which will have a positive impact on a number of related global issues), shorten the travel time, enhance transport connectivity in the wider area (with all the positive characteristics that result from it), and create more favorable conditions for the development in a wider area.

In situations where the route is located in sparsely populated areas, part of the problem is minimized, but impacts may occur due to exposure to social contacts on a significantly higher level (of practically international importance), which may result in significant problems in communities that have lived in the traditional environment.

Some of these problems will have to be resolved prior to the actual motorway construction, primarily through communication with these communities and clarification of the basic problems that will affect them during and after the construction of the planned motorway.

Part of the problems in the social sphere will be present during the execution of works, whereby efforts should be made to place temporary construction facilities in such a manner as to avoid possible problems between construction workers and local population.

The issue of expropriation of land needed for the construction of the motorway and additional facilities that are important for the complete construction program implementation is one of the important parameters relevant for defining the relationship between the road and the environment. The study of this issue became topical at the moment of realization that the areas occupied by roads shall represent a permanently lost resource, practically without the possibility to use them for any other purpose ever again.

The stated fact as well as the fact that especially arable land is limited in terms of available quantities, has led to the need to consider this indicator. In the process of defining potential impacts, the need to occupy these areas must be considered from the ecological standpoint and appropriate measures must be taken for the best possible minimization of impacts. In order to minimize the undesired effects in the earliest design phases, it is necessary to determine the approximate number of properties, houses, shops and businesses along the route which could be affected by expropriation. Such procedure shall provide the first indications of the extent of potential problems related to land expropriation and population displacement.

Soil and agricultural land

This entire area is characterized by the semi-humid climate with a tendency of the brown soils development. In the wider area of the Corridor Vc – LOT 1 route, predominant are the lithological substrates on which the current soils had formed, namely: alluvial-diluvial deposits, tertiary clays, claystones and loams, sands, shales, sandstones, gravels, marls and solid limestones. Such structure of the parent substrate on which these soils had formed indicates its erodibility and potential mobility through erosion.

In the wider area of the corridor route, 24 pedosystemic units were identified, of which 7 belong to the Order of Automorphic soils and 17 to the Order of Hydromorphic soils. In the Order of Automorphic soils, the predominant types belong to the class of Cambic and Humus-accumulative soils, while in the Order of Hydromorphic, to the class of Fluvial and Fluvial gley soils, and the class of Hypogley soils. All stated pedosystemic units are divided into four categories of use value. The highest use value category is II (two), and the lowest is V (five). This indicates that the motorway route mainly goes across the agricultural land which is, given the terrain conditions, more or less extensively used. The physical, mechanical and chemical properties of these pedosystemic units are also presented. The highest use value category is II (two), and the lowest is V (five). The section has no land of the use value category I (one). This indicates that the motorway route mainly goes across the agricultural land which is, given the terrain conditions, more or less extensively used.

Based on the permanent soil properties, such as: inclination, depth, mechanical composition, soil drainage, and other physical and chemical properties, the following soil use-value categories were identified in the area of research:

Use value Category II

The use-value Category II includes soils from the alluvial class, which are mainly carbonate, of a divergent mechanical composition from clayey to loamy and sandy. They had developed mainly on sands, gravels or both sands and gravels, depending on conditions during the sedimentation process of the material on which the alluvial soil was formed. These are very good agricultural soils, with moderate limitations, suitable for growing a wide range of agricultural crops, especially at lower altitudes, and the reclamation measures of these soils are relatively simple. These include the pedosystemic units marked in the table and map under the ordinal numbers: 8, 9, 10, 11, 12, 13, 14, and 16.

Use value Category III

The use-value Category III includes soils from the alluvial–diluvial class and the class of semi-gley soils. These are moderately good agricultural soils with certain limitations in terms of the soil properties, topography or drainage. In the selected pedosystemic units shown in Table 2, the most significant limitations pertain to the hydrological regime, i.e. drainage. This category contains the pedosystemic units marked in the table and map under the ordinal numbers: 15, 17, 18, 19, 20, and 21.

Use value Category IV

The use-value Category IV includes soils from the class of cambic soils, where dystric cambisol or acid brown soil is predominant. The gray-brown meadow degraded soil from the class of semigley soils also belongs to this category, as well as the mineral-hydromorphic gleyed acid soil and mineral-hydromorphic non-carbonate soil. These soils are considered to be quite good in agriculture, with certain strong limitations. The choice of crops is significantly reduced to just a few compared to the previous use category. This category contains the pedosystemic units marked in the table and map under the ordinal numbers: 3, 4, 5, 6, 22, 23, and 24.

Use value Category V

The use-value Category V includes mainly the forest soils from the class of cambic, dystric or eutric type, with natural meadows and pastures appearing within the forest. These soils had generally developed on shale rocks on the slopes. They can be very good forest soils, but they don't have to be prone to erosion, as they are covered in vegetation. This category contains the pedosystemic units marked in the table and map under the ordinal numbers: 1, 2, and 7.

Agricultural land is mainly located in the area of use-value Categories II and III, which is around 70% of the total area, while the rest are areas under degraded forest, sloping agricultural land, or land where agricultural limitations are conditioned by high groundwater levels.

The shorter the route and the larger the route section with viaducts and tunnels, the lesser the loss of soil through the change of use. From the agricultural standpoint, it is logical to request that deep fertile soils of this area be avoided as much as possible, if at all possible.

Efficient traffic flow is often in conflict with the requirement to reduce fragmentation of production lots. This is feasible in the part of the sector at the foot of the slope, by orienting the route along the margin, thus avoiding the intersection of major production lots. In this way, three effects could be achieved: more valuable soils are preserved from change of use, fragmentation of land lots is prevented, and the route is elevated relative to the soils in the valleys and fields where air currents are more frequent, having less haze and foggy days on the motorway itself.

Any introduction of harmful substances into agricultural soil jeopardizes its function. As regards the basic meaning of harmful emissions from traffic, they can be divided into four groups: emission of particulate matter – dust, emission of liquids, emission of gases, road salt emission. As an example, the average concentration of heavy metals (Pb, Cd and Zn) was calculated for the 3 m belt off the road edge (flank or embankment belt), and the traffic intensity was taken from the "Final Report on Pre-feasibility Study" for 2015. The accumulation of three major heavy metals was assessed in the 3 m wide belt on each side off the road surface, by sections and for the entire length of the route. The total quantity of Pb, Cd and Zn in the targeted zone along the entire route was 9.27, 5.59 and 9.27 tons. This is certainly a rough estimate but it indicates the potential danger of contamination of the belt along the motorway. Access of heavy metals to the plant depends on the soil condition, and especially on pH reaction, so the intervention of changing the pH reaction of the soil may prevent introduction of heavy metals into the food chain.

The predictable impacts of the Svilaja – Karuše section of the motorway on Corridor Vc near Doboj on agricultural soils and agroecosystems were analyzed, especially in view of the land use change, fragmentation of production lots, and emissions of harmful substances into soil.

Measures to mitigate negative effects on the soil – given the geomorphological conditions, type determination, depth, (skeletality), physical and chemical properties of impact on soil fertility, all soils along the section within 500 m of the road axis, in view of necessary measures and level of protection are grouped in four categories (levels), as per following general criteria:

Category I – full protection, includes fertile, deep, most valuable soils on the route, with favorable physical and chemical properties. These soils need to be fully, that is, completely protected. In the area where the route intersects these soils, it is necessary to apply a closed system of drainage off the road surface, span surfaces with overpasses, and certainly put windbreaks by careful selection of species, all with the aim of collecting emitted pollutants in a narrow zone along the road, that is, within the enclosure.

Category II – high protection, includes soils with favorable physical and chemical properties of high fertility, but soils on limited, smaller areas. Agricultural lots are rather dispersed, so it is necessary to plan windbreaks and vegetation belts along the edge of the motorway to prevent the spread of waste materials to wider agricultural areas that will be located along the motorway.

Category III – selective protection, primarily soils with sparser or thicker maquis shrubland, where deeper soils appear in sinkholes, dells or cuts that are used for extensive cultivation of mainly fruits and vegetables. This also includes protected forest lands. Should the route intersect such areas, care must be taken to ensure that soil damage by road construction is carried out with extreme caution, so as to avoid pockets of erosion by water.

Category IV – protected (forest) soils, includes soils under coherent forest cover. Should the route intersect such areas, care must be taken to ensure that soil damage by road construction is carried out with extreme caution, so as to avoid pockets of erosion by wind and water.

For the Section LOT 1 that is the subject of this study, we propose the concept of protection of agricultural production area – soil, or agricultural ecosystem, based on several basic principles:

- Effective protection of all more valuable agricultural soils against coarse dust
- Dispersing the fine dust and aerosols on as narrow a space as possible, and in doing so avoiding contamination of more valuable agro-biotopes

In addition, it is very important to have the optimal design of the level of the route in relation to the terrain through which the motorway passes, the application of biological measures and the cultivation of protective plantations, the choice of species for windbreak belts.

The above listed approaches should be applied in the preparation of detailed design documentation in each specific situation on the ground, with regard to the constellation of factors and the environment through which the route passes. Since the corridor route passes mostly through the areas that require the application of Category I – full protection, it will be necessary to apply a combination of biological protective measures with the construction of facilities for collection (drainage) and wastewater treatment, construction of sedimentation tanks, ponds, etc. It is also imperative to know the dominance of wind movements in order to reduce the space of pollutant dispersion to the narrowest belt possible.

Technical measures for the mitigation of negative effects on the environment, especially in the Categories I and II protection, include the construction of an efficient drainage system consisting of drainage channels along the cross-section of the catchment section, properly positioned to collect all wastewaters and carry them to the collection pool located at the lowest possible level, and as far away as possible from the settlements or agricultural land used in crop production. These wastewaters coming off the motorway must not flow directly into the rivers and small watercourses, but into the built collection pools or natural wetlands in which the pollutants present will settle and thus remain in a limited space.

Measures during construction – on surfaces that will be permanently covered with asphalt or some infrastructure facilities, the fertile humus soil from the surface should be selectively removed, deposited and preserved for the purpose of filling and landscaping the surrounding damaged area. This primarily refers to the soils in the use-value Category II, which are both the best and the most fertile soils. The depth of removed soil should range from 25 to 35 cm, depending on the quality of the surface layer. By doing this, the permanent loss of soil due to road construction would be at least partly compensated. In this way, over m3 of soil could be preserved (stockpiled) for reclamation and spreading over the barren surfaces, damaged and shallow soils. Thus through this program, economic benefits can be achieved by establishing new agricultural areas or improving the landscape appearance.

Measures during operation – taking into account that the Project will significantly change the landscape since it will not be at the level of the surrounding terrain. Areas on which plants will be planted or sown require proper preparation and selection of adequate, indigenous seeds of grasses, shrubs and trees for sowing and planting, and this above all means:

When sowing grass, care should first be taken about the preparation, depth of re-spreading, introduction of organic and mineral (NPK) fertilizers, treatment depending on the relief, inclination and other factors.

When planting shrubs, bushes and other undergrowth, attention should be paid to whether there is the actual need and reason to plant such type of vegetation in a particular location, as well as to natural characteristics of the environment and other characteristics and effects achieved by this measure.

Afforestation is carried out on the most exposed slopes, steep inclinations, potential landslides and cuts, near the tunnels, etc.

Soil monitoring primarily involves determining the zero state and monitoring the soil condition on the observed section of the Corridor Vc. This is one of the major preconditions in creating special precautions and soil protection measures on the endangered parts of the route.

The responsibilities of the program proponent should be to form a competent research team that will execute the field work, sampling, laboratory soil analyses and data processing, as well as develop the study on the current status and the monitoring program of the zero-status soil monitoring before the commencement of works, which would require:

- Field research
- Laboratory analyses
- Processing of results

Only after this, the implementation of the following could continue:

- Monitoring during the construction phase
- Monitoring during the operation of the facility

Water resources

The research area in terms of water resources includes a one-kilometer belt both to the left and the right side of the outermost contour lines of the motorway, including the route itself. In cases where justified from the hydrogeological or from the aspect of groundwater protection, when defining the spatial limitations, the natural boundary between aquifers and aquifuges was adopted as a contour boundary, given that such environment frequently yields sources, springs or wellfields for water supply. Surface watercourses and their banks, which the motorway has been routed along or intersects them, are also treated as sensitive areas.

In the zone of motorway passage on this section, there is a densely developed network of watercourses, among which the most important is the Bosna River with its smaller and bigger tributaries, as well as the Usora River with its tributaries. Besides the dense network of surface watercourses, there are also significant groundwater resources, most of which are still insufficiently explored. Significant information regarding water supply sources, as well as assistance in the planning of water resources monitoring along LOT 1 for the construction and operation phases of the motorway, was obtained from the Public Company for the Sava River Basin in Sarajevo.

Bearing in mind that the motorway causes numerous changes in the water phenomena along the route, which largely depend on the method of construction and operation, and taking into account the best environmental practices, the measures of prevention or minimization of adverse impacts have been proposed. Certain impacts on waters can be avoided in the design phase, and in that sense prevention measures recommend the development of appropriate design solutions for external and internal drainage, watercourse regulation, horticultural landscaping of the protection belt, and design of vertical barriers (fences) along the motorway in the locations marked as vulnerable and sensitive from the aspect of water resources. The negative impacts on the quality of groundwater and surfaces waters can be avoided by the appropriate organization of construction sites, the application of proposed prevention measures during construction and in the operation phase, and by the maintenance of constructed facilities for the off-road wastewater treatment.

Flora and fauna

The project area is characterized by a variety of hydrological, hydrogeological, pedological, and geological units, as well as landscape diversity, while on the other hand it is characterized by homogeneity of climatic conditions (characteristics of moderately warm rainy climate), where minor deviations occur due to relief features.

Natural conditions, relief and climate, directly affected the appearance and condition of the vegetation of the project area. Anthropogenic factors have considerably altered the original appearance of its vegetation, but the area still abounds in diverse ecosystems and habitats.

As per their origin, the ecosystems are grouped into primary and secondary. Of the primary ecosystems in the project area, there are forests, and of the secondary (anthropogenic) ecosystems, there are agricultural (grasslands, arable fields), urban (settlements, cities), artificial aquatic ecosystems (reservoirs, fishponds), afforested areas and other. Thus, the project area is characterized by the following ecosystems: forests, grasslands and arable fields.

According to the phytogeographical analysis, the wider part of the project area belongs to the Euro-Siberian/North American region, and as regards forest communities, it can be divided into the lower and higher parts. Mountain ranges belong to the Illyrian plant-geographical province of Illyrian beech forests, and the lower part to the Central European plant-geographical province of Illyrian hornbeam forests.

Grasslands, despite the fact that they are not of natural origin, represent habitats that greatly enrich the biological and landscape diversity of the project area. They are populated with plant species that originate in forests, and partly in other, especially steppe areas of Eastern Europe and Asia, while some cognates of polymorphic species have developed precisely due to anthropogenic influences on grasslands.

In the project area, an extensive way has traditionally been applied in using grasslands, which are mostly endangered because they have been turned into arable fields. They are now used very extensively and only occasionally for grazing and haying. Grasslands are characterized by various species from the family of grasses (Poaceae), daisies (Asteraceae), then rushes (Juncus) and mints (Mentha), which populate the humid habitats.

Arable fields as the artificial ecosystems are intended exclusively for agricultural production, and are cultivated in a way that that insufficiently respects the protection of biological diversity, because they are used intensively with the application of artificial fertilizers and chemical plant protection products.

These are nitrophilous ecosystems, which include the orchards, vineyards, gardens, and field-edge areas, channels and houses, trampled areas of roads and yards, and landfills. Their common feature is the increased amount of nitrogen, which leads to floristic affinity reflected in the multitude of common nitrophilous plants (the so-called Ruderal communities). The work carried out here is a strict selection of plants by various agricultural measures (plowing, digging, fertilizing, using pesticides).

Today's prevalence of animals is the current state of the historical product of all depending factors, and it is not fixed and permanent, because they are all together with animals subject to constant change. Thus, the composition of the fauna in the area of Corridor Vc has probably changed in relation to the latest data available to us with regard to the war events at the end of the last century in Croatia and Bosnia and Herzegovina. The anthropogenic impact in the area after the war should also be taken into account, especially in areas with the increased settlement.

The beginning of Corridor Vc, the lowland part of Posavina, zoogeographically belongs to the so-called European Sub-Area Pannonian Subprovince, or the Subalpine Slavonian-Syrmian Region, while the remaining part belongs to the Central European Alpine Region.

The motorway route mostly passes through the area with the habitats of small (low) game, and partly of large (high) game. Species that inhabit the area included in the adopted option, and which are important for the hunting economy are primarily the European hare (Lepus europaeus Pallas), grey partridge (Perdix perdix L.), pheasant (Phasianus colchicus L.), quail (Coturnix coturnix L.), and various waterfowl (wild ducks and geese, Eurasian coots, etc.), mainly along watercourses, and the large game ones are the roe deer (Capreolus capreolus L.) and wild boar (Sus scrofa L).

No data exist on the routine paths of animals for the subject area that could be the basis for the formation of special structures for their movement. It is the Investors' obligation, upon the registered data on migratory movements of animals in the subject area, to build special structures for the movement of animals in the form of passages, i.e. crossings, which should be developed through Designs of special structures for the crossing of animals.

The planned road impact on the river fauna during operation should be seen as the impact with no distinctly negative effects given the quality characteristics of the Bosna River watercourse.

Analysis of the current state determined that no habitats of rare and protected species exist in the wider area and that, in this regard, no negative impacts should be expected during operation. Considering the spatial positions of the existing habitats and the route in question, it can be concluded that particularly negative impacts should not be expected.

Minimization during the construction phase

To avoid unnecessary biotope loss, the construction site must be limited to the minimum possible needed area, especially at the sections of high importance for plants and animals. Disposal of materials must be done on the construction site only. The areas of great ecological importance must be fenced off and protected during the construction phase. Construction machinery should not move outside the construction site due to danger of soil compaction. Removed biotope structures on the construction site should be restored after the completion of works.

Attention must be paid in the vicinity of streams in order to avoid disruption or disturbance of surface waters or groundwater. This achieves the preservation of the existing wetland and aquatic vegetation and ornithological population.

Removal of trees and thicket must be done in wintertime in order not to interfere with the brooding period, which is from 1 March to 30 September 30. Upon the completion of works, the previously removed biotopes must be restored.

During the construction phase of the road, care must be taken not to disturb the landscape values, especially in the lake zones. In other words, degradation of space during excavation and embankment works must be minimized, and it must be easily corrigible.

The contractor must undertake to collect and take to the nearest landfill the excess solid waste of any kind, immediately after the completion of works on that section. Solid waste produced in temporary worker housing zones, on parking lots and vehicle maintenance grounds must be collected and disposed of.

Minimization of impacts caused by presence of road base

Most impacts caused by the road base are inevitable. (places are quoted in the study, where major conflicts occur due to: bridges designed with detrimental effects to the environment, intersections in river valleys, proximity of road and river, et al). Care must be taken when designing to avoid the felling of wild (autochthonous) trees such as poplar, cottonwood and willow.

Analysis by sections to identify and preserve endangered species. If these species grow in road construction zones, they should be transplanted into zones with similar conditions.

Measures for the minimization of impact caused by traffic

- Constant monitoring of the number and species of birds killed along the road, consultations and adequate protection measures to diminish risks should be undertaken on the motorway sections where wildlife is endangered.
- In cases of a large number of amphibians killed on certain sections of the road, it is necessary to consult with relevant experts in order to find adequate solutions.
- Bridges should have high fences to prevent birds (flocks or individuals) from colliding with vehicles, especially during migration periods.
- High-value biotopes should not be planted near the road as it is a congested zone that will have a negative impact on the fauna. Birds will be attracted by hedges and use these biotope structures along the road as new habitats. Thus planting the trees and shrubs should be reduced to a minimum, sufficient for the landscape and prevention of erosion, but not for the creation of new biotopes.

Planting at cuts is somewhat less problematic since the trees and shrubs are located above the road and, as a result, vehicles and birds will not collide.

Landscape

Framework analysis of the landscape of this area and its features, associated habitation type, its location and relation to the surroundings, manner of agricultural cultivation of the area surrounding the habitation, spatial organization – habitation matrix, characteristics and manner of utilizing the typical lot, structural, morphological and functional characteristics of residential and economic architecture, leads to the following conclusions:

The wider area of the project belongs to the Northern Peri-Pannonian region characterized by hilly terrain that gradually descends to the lowland.

Wider area of the project is characterized by a valley type landscape bordering on a hilly one. This area is also characterized by the zone of contact of these two types of landscape with the lines of sight containing elements of both. The landscape of lowland areas is determined mainly by forested and agricultural areas that alternate in the landscape image. The valley landscape is longitudinally cut by the Bosna River course, almost through the middle. The elevations of the hilly landscape are covered in forests and pastures. This hilly area is filled with suburban-type family housing, with the developed garden agriculture.

The landscape of a wider spatial unit is characterized by four basic categories of landscape:

- Natural landscape
- Cultivated landscape
- Built landscape
- Cultural-historical landscape.

The zone of altered landscape characteristics can be defined on the basis of the medical threshold of visibility, applying the standard measuring viewing angle of 10° as a measure for perceiving the maximum height difference in the alignment profile to the terrain line.

In the light of defined potentials, appropriate measures for protection, minimization of impact or compensation should be sought, and one should always keep in mind that it is not possible to construct a road without impacts in the field of landscape.

Efforts in the design process must be made to minimize the measures present, while taking into account the following:

Elements of design geometry must meet the principles of homogeneity and must conform with the local morphological characteristics.

Cut and fill gradients should be variable and in line with the local morphological characteristics.

Bridges, viaducts and tunnels may be used when the road runs across steep slopes rather than using cuts and fills. This will help preserve the visual and physical continuity of the landscape.

The view from the road can be especially enhanced by purposefully shaping the elements of the situation and leveling plans.

Particularly significant effects can be achieved if special attention is paid to the soft landscaping of the areas through which the road passes, while taking care that:

- The road fits in the local vegetation (trees, shrubs, lines of trees, hedges),
- Plants should be transplanted to harmoniously fit into the existing landscape,
- The selected species match the road category and its function,
- Planted vegetation does not restrict views and that the plants are not to be planted just to fill the space,
- Planted vegetation borders on and underlines various landscape units alternating along the motorway route,
- Vegetation accentuates various conditions of traffic flows (changes in the Layout Plan),
- Care should be taken to use local materials to construct the facilities on the route.

The constructed road maintenance procedures can greatly affect the landscape and visual features of the road. Visual pollution can be reduced if special attention is paid to the shaping of various protective and supporting structures (various structures for noise protection), special penalties introduced, the advertisement system along the road regulated, etc.

Negative impacts on the landscape can be compensated to some extent by afforestation of the landscape to replace those trees that had to be felled during the road construction and rehabilitation of problematic areas. Hence, as part of the documentation, the Landscape Planning Project was prepared, which treats this issue in detail and defines the necessary measures to minimize the impacts.

Protected areas of nature

Determining the impact the planned road will have on the natural heritage requires the analysis of natural complexes that are usually defined as national parks, strict nature reserves, nature reserves for scientific research, areas with special natural features, characteristic landscapes, special nature reserves and natural monuments.

Spatial complexes indicated as such imply a certain level of public care and are usually introduced into a certain system of protection under legislation. As such spatial complexes, by definition, represent nature rarities, the main principle that should be respected is to keep the road at a sufficient distance from these complexes in order to prevent any negative impact.

As per data from the Basis for planning documentation which examined the wider area of the motorway, there are no protected areas of nature in the zone of the analyzed section, that is, there is no need for additional protection measures so this issue is not under consideration.

Cultural-historical heritage

The analysis of the current state and possible impacts established that there are archaeological sites at the analyzed location, as well as that their exact spatial position was not precisely determined, which might give rise to certain conflicts.

Given the potential zone of indirect impacts, due to changes in the groundwater regime, air pollution and vibrations, the occurrence of negative impacts is possible on monuments that are located in the wider environment.

As these sites require special treatment, during the creation of the Main Design it is necessary to carry out sounding and protective research according to special programs of archaeological excavations. In terms of these facts, the protection of potential sites would be carried out in three phases, which would follow each other according to the development of the specific situation.

Phase One – represents archaeological research by sounding on recorded sites, so as to identify the exact cultural affiliation of the very sites, stratigraphy of archaeological layers, chronological determination, and preservation of cultural layers and architectural remains, if any. Research in this phase would have to be conducted before the commencement of works on the route.

Phase Two – based on the findings of archaeological research conducted in Phase One, protective archaeological excavations would be planned for certain parts of sites that might be endangered by construction. If during the research in Phase One it is determined that the cultural layer has not been preserved on the sites or that the route of the road in question bypasses them, the research planned in Phase Two will not be conducted.

Phase Three - represents the expert service supervision, that is, inspection during earthworks on the route, with the mandatory performance of protective archaeological excavations if during the works the previously unknown archaeological sites are uncovered. Given the possibility of new sites in the rest of the area, it is necessary to have archaeological and conservation supervision during the execution of works along the entire section of the subject motorway.

Noise

One of the main objectives of noise assessment is to examine the effect of mitigation measures so as to avoid the negative impacts of noise on the facilities surrounding the motorway. Noise reduction can be achieved by various approaches:

- Reduction of noise transmission by installing sound barriers (obstacles).
- Reduction of noise emission at its sources (vehicles, motorway surface).
- Reduction of noise impact in residential areas by installing noise protection windows in each individual building.

Implementation order of these measures starts with the installation of sound barriers; the second is elimination at source; and the third, elimination at the receiver's end. One of the most important mitigation measures is the installation of sound barriers. Since the motorway on Lot 1 is mostly laid on the embankment, using thin walls for noise prevention (e.g. panels) is considered more reasonable than using broad structures in the form of steep fills, known for the quality of preventing sound diffusion.
To compare the protection effects of the noise protection walls of various heights to be used in residential areas along the new motorway, the isophone of the relevant noise was calculated. Based on this, the dimensions of the noise protection walls were determined depending on the location (height and length) in order to meet the standard of 50 dB(A) at night. A summary of certain mitigation measures is given in the table... The average wall height of 3 m was adopted for the calculation of the noise levels. The study used the bases of revised route solutions from the Conceptual Design completed in 2D. The calculated wall height is satisfactory in most cases, given that the motorway is mainly laid on the embankment. For residential buildings located higher on the slopes of the hill above the effective height of the noise protection wall, especially those located directly next to the route, higher noise protection walls (5 to 10 m) would be required, which would be cost-ineffective and unacceptable, and would hinder the residents' view. Efficient noise protection windows (passive measures) should be installed in such building. All these measures were elaborated in the Noise Protection Preliminary Design, which is a part of the Preliminary Design documentation.

Air pollution

At the level of Bosnia and Herzegovina, data on air quality are very scarce. A survey conducted in the observed area shows that the pollution problem does exist, since the answer to the question on the problem related to environmental pollution that particularly affects the population was – air pollution.

In terms of the impact that various air pollutants have on plants, this phenomenon is significant due to the characteristics of the surfaces in the immediate vicinity of the motorway. Negative consequences should be expected only in the immediate vicinity of the motorway, and the obtained values can be reduced by planting the adequate vegetation. The general conclusion that can be made on the basis of all analyses is that the problem of air pollution is not particularly pronounced in the area of the planned motorway and that, given the modernization of vehicles in the future and significant restrictions with regard to the exhaust gas quality, the reduction in pollutant concentrations should be expected, regardless of the volume increase.

Danger of landmines

As per data from the Basis for planning documentation, the presence of landmines was noticed on the part of the section Svilaj - Odžak and on the section Putnikovo brdo - Karuše. It is important to emphasize that due to external impacts, primarily precipitation, precise data on landmines are not known, and for this issue, i.e. for disclosure of information in the territory of BiH, the Mine Action Center - MAC is exclusively responsible, whose cooperation is necessary in further project implementation process. A special study is required for more detailed data on landmines in the subject area. It is quite understandable that it is necessary to clear the area of mines, that is, to demine all the minefields. It should be emphasized in particular that attention must be paid to this issue in the construction phase, as well as to the possibility of finding mines even in places that are not marked as such in the plans and maps.

Infrastructure

As part of the analysis of impacts that will reflect on the existing and planned infrastructure, all relevant data were collected on the settlements and road network, water management systems, electric power and telecommunications system, planned gas transportation system, and other. Pursuant to these data, measures for the protection of individual facilities during construction have been proposed, thus avoiding collision points and negative impacts that may occur.

Monitoring system

The Environmental Action Plan is an indispensable part of this documentation and its purpose is to ensure adequate implementation of the proposed protection measures. The EAP also facilitates insight into the effects of protection measures and introduction of the necessary improvements and corrections.

Design phase

A checklist in the design phase is necessary for the adequate consideration and examination of all environmental aspects and issues, i.e. to properly prepare the protection measure design. Special protection zones specified in the design must be respected and special protection measures adopted with regards to them.

The same applies to the construction phase and must be emphasized in the tender documentation.

Construction phase

In order to meet all environmental requirements of the project, it is necessary to hire an environmental engineer (expert in ecology) who would oversee the manner of execution of works by conducting frequent inspections, thus protecting the interests of Investor.

The Contractor is also required to have a person or persons responsible for monitoring the implementation of environmental requirements as per tender documentation. This condition should be emphasized to the Contractor during negotiations, and prior to signing the contract.

The parameters monitored during the execution of works include the implementation of the adopted protection measures, and all these parameters will be frequently inspected by environmental engineers, and under the responsibility of the Contractor.

Maintenance phase

The environmental engineer is responsible for the provision of detailed procedures, technical manual/instructions on regular maintenance of drainage system, safety and light signaling systems, accident management (spill/leakage of hazardous substances) and maintenance of green areas (these documents can also be included in the tender documentation).

Conclusion

The overall issue was analyzed within several special chapters which contain the bases for research, characteristics of the planned motorway, characteristics and evaluation of the current state, complex analysis of environmental impacts, necessary protection measures, monitoring and the Environmental Protection Action Plan.

The bases for research define all relevant factors that influenced the subject study, and which primarily covered the initial program bases, legal provisions and research methodology. The chapter dealing with the characteristics of the motorway defines the characteristics defined in the Preliminary Design.

The research and evaluation of the current state have served as a detailed analysis of the existing resources (soil, water, biotopes, climate, landscape, etc.) and an assessment of their state. This analysis has shown that the subject spatial unit possesses substantial resources, and it was absolutely necessary to run all analyses of potential environmental impacts.

The Environmental Impact Study examines the issues of noise, vibrations, air, water and soil pollution, land expropriation, flora and fauna, visual pollution, natural and cultural heritage, and other relevant impacts. Each impact has been defined through indicators that characterize local conditions, taking into account all the spatial specifics and the specifics of the origin and spatial distribution of impacts.

Taking into account the permissible value of individual impacts as well as characteristic spatial relations, the analysis led to the possibility of taking certain protection measures. Based on all analyses of relevant impacts, it is possible to draw a general conclusion that the impact in the immediate riparian zone of the Bosna River and the water protection zone is particularly important.